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Classification and Interpretation of Selected Soil Data from a Tropical Region of Bolivia

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CLASSIFICATION AND INTERPRETATION OF SELECTED SOIL DATA FROM A TROPICAL REGION OF BOLIVIA

by

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I would like to dedicate this report to my families: Enamorado-Alcantara, Sabillon Coto, especially to my husband, German, and my children: Taira, Nohemy, German Jose, and Haskel Noe, who have given support and encouragement at the time when I have needed them most.

Naoemi E. de Sabillon

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INTRODUCTION

"Half of the uncultivated land of the world, or some 80 million hectars (ha), lies in the humid tropics, where the climatic environment offers a high potential for crop production. ... If only 2 percent of this area were put into cultivation with good management practices, enough food could be produced to feed the present population of Latin America" (Committee on Tropical Soils, National Academy of Sciences, 1972).

The main use of the soils is the capability to support land plants; plants that supply most of the animal and human needs, therefore we must be interested in getting the best we can out of the soils we have.

To achieve such important goals, it is necessary to have a good understanding of the soil characteristics, their relationships, and how we could fit them into a classification system that will allow us to extrapolate information and give the adequate use and management practices useful for a praticular need. The purpose of this report is to provide some experience in the soil classification and interpretation procedures. This project was undertaken because there was available a reasonable data set for soils of a portion of Bolivia (Cochrane, 1968). No additional field or laboratory experiments were carried out for this project.

OBJECTIVES

The objectives of this report, using the available pedon descriptions and analytical data are:

1. To classify the 17 selected soils, based on the kind of diagnostic horizon(s) present in each of them.
2. To evaluate each soil, giving its actual use and its capability for other uses according to its own limitations and suitability of response to special management practices.
3. To estimate engineering soil properties and soil limitation ratings that affect their engineering and recreational use.

DESCRIPTION OF THE AREA

Bolivia has been physiographically divided into three regions: (Fig. 1).

1. The highland or altiplano (in western Bolivia, the Andes with cordilleras bordering a massive platea--more than 3,600 m altitude).
2. The valleys (in central Bolivia, a deeply dissected mountainous region--from 600 m to 3,600 m altitude).
3. The lowlands or oriente (eastern Bolivia, vast lowlands and peneplains, the largest region, 3/5 of the country, about 669,000 km^2--less than 600 m altitude). (World Atlas of Agriculture, 1970; Leonard, 1952) (Fig. 1).

The lowland region consists of dense tropical forest of the Amazon Basin, vast natural pasture lands, open forest, and savanna in the south. In the central part, around Santa Cruz, the conditions are very good for the cultivation of sugar cane, rice, oil plants, and citrus fruits.

"The whole region is very flat, within a radius of 400 miles there is no hill, no stones, and no gravel to be seen. Eighty-five percent of the land has been formed in mixing alluvial sandstone sediments. This land is still in the process of formation by the action of the rivers that are building up new layers of sedimentary deposits that they keep carrying from the mountains." (Murillo, 1975).

These sediments are deep, moderately well- to well-drained soils and nearly level to gently undulating slopes, most of them are

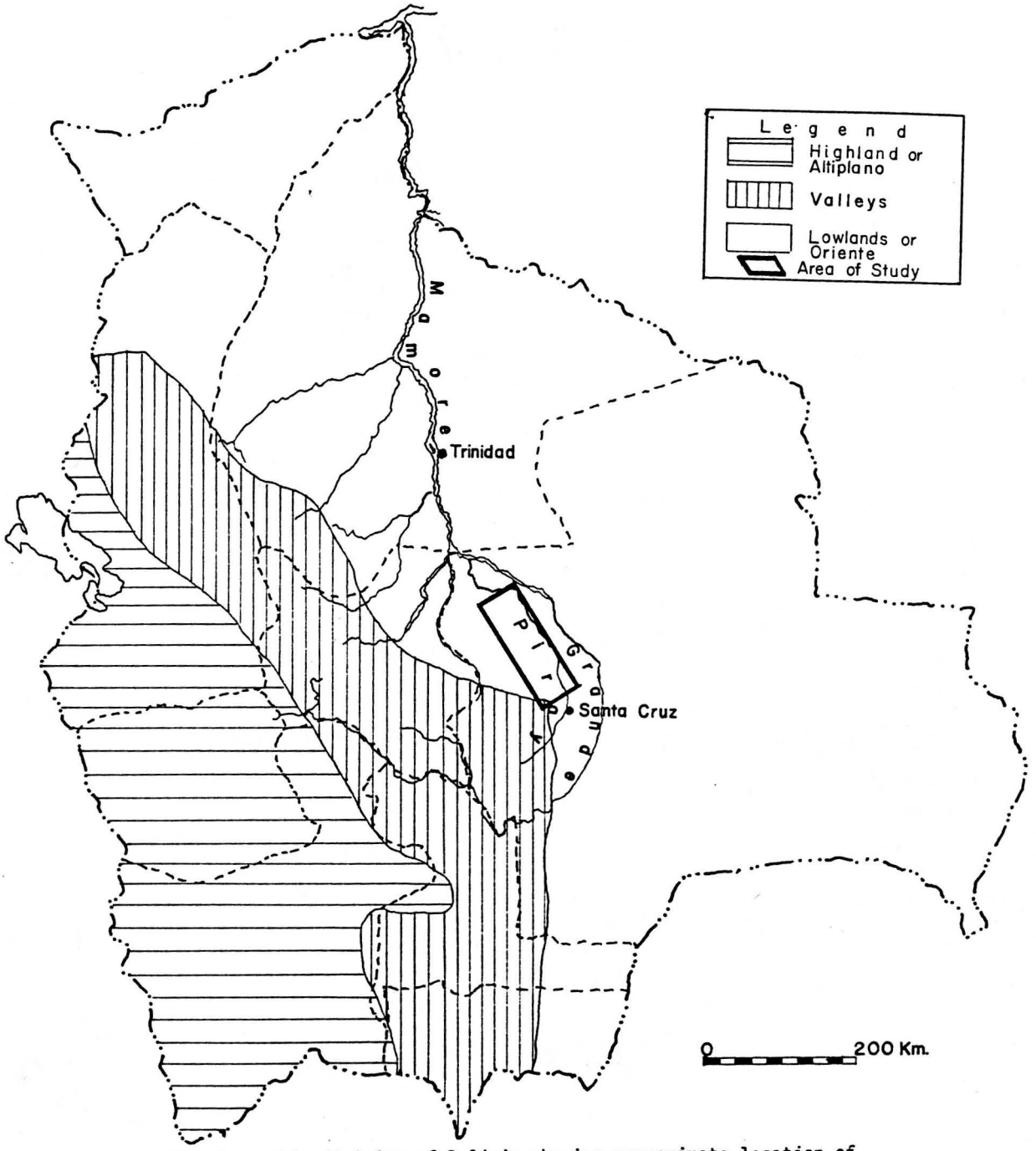

Fig. 1. Physiographic division of Bolivia showing approximate location of area of study on the lowland region.

brownish colored, structureless, very friable, sandy loam to loamy sand textures, and are classified as Entisols.

Location

Bolivia is situated between 57°29'40" and 69°33'36" longitude west and between 09°34'50" and 25°13'00" latitude south in the east and 10°56'40" and 25°00'05" latitude south in the west. It is bounded on the north and east by Brazil, to the south by Argentina and Paraguay, to the southwest by Chile, and to the northwest by Peru (Osborne, 1964).

The region of study, Piray River System, lies within the lowland region northwest of the department of Santa Cruz. The Piray River is a contributor of the Rio Grande, named Mamore in the department of Beni and is one of the largest rivers of Bolivia.

Physiography and Geology

In Bolivia we find diversity in the kinds of rocks that have been formed in different periods of the geologic time, since the Precambiam time to the recent epoch (Holocene) (Fig. 2).

In the altiplano region (east and central mountains) most of the land is from the Paleozoic era, Ordovician period. In the north, northeast of the country, departments of Pando, Beni, and Santa Cruz, the predominant rocks (granite, a coarse-grained igneous rock, and gneiss, a foliated metamorphic rock) are formed since the precambrian time, the most stable and massive section of the earth's crust, that advances forward to the west under the tertiaries and quaternaries alluvium that cover the west lowlands of Beni (Munoz, 1977).

The area of study, Piray River system, is part of the great

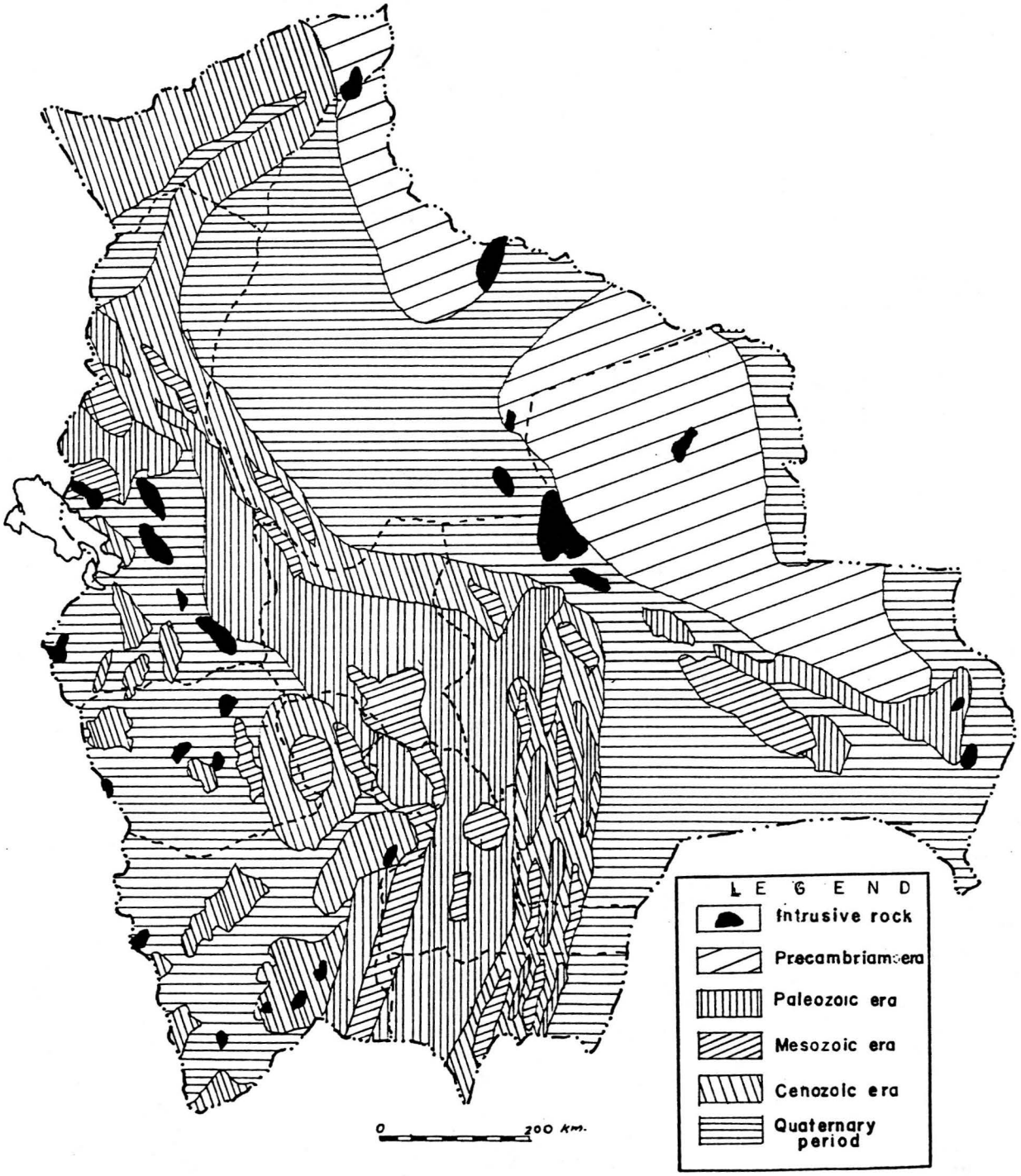

Fig. 2. Geologic Map of Bolivia According to Jorge Munos R. (pg. 11).

alluvial plain named "Planicie of Chaco - Beni." This area, during the last period called "The Wisconsin", was flooded leaving different kinds of sedimentary deposits (Murillo, 1975).

Climate

The climate is determined by the altitude rather than by the latitude or distance south from the equator. Temperature, rainfall, and productivity are altered by this important factor.

Rainfall. Precipitation is greatest in the northern parts, decreasing gradually toward the south. The average rainfall is from 1,200 to 1,300 mm. The rainy season is from October to April; more than 75 percent of the rainfall occurs during this time. December to March there is an adequate and well distributed amount of rainfall for most cultivated crops (Osborne, 1964).

Temperature Warm to hot through the year. Annual mean temperature is 23.7°C. Winter (May to July) is 19° to 20°C and summer (September to March) temperatures are from 24°C to 28°C. November and December are the warmest months (up to 40°C.).

Wind. The winds are strong during May to August, some cold winds, usually accompanied by rainfall come from the north. Most of the winds come from the south, especially during summer and they are accompanied with clouds of sand, dust, and rainfall causing a drop of temperature of 15°C up to 20°C in a short period of time (hours). They are called "Surazos" and last from 3 days up to a week.

Vegetation. The native vegetation is seasonal forest and deciduous seasonal forest. Cleared areas are used for sugar cane, corn, and pastures.

Soils. Soils have formed in mixed alluvial sandstone sediments deposited by the Piray River. They are deep soils, moderate well to well drained, brown sandy loams with moderate subangular blocky structure to structureless soils.

USE AND MANAGEMENT OF SOILS

The soils of the Piray River area have a wet stream bottom dominant range site. Its present land use is mostly pastures and grasslands with tufted grasses. The crop suggestion has been improved pastures and grasslands due to the risk of wind erosion and flood hazards.

These soils are moderately too weakly leached and the levels of the major plant nutrients appear to be low. The water table is usually found within 1 m, showing mottles and "Mn" concretions. Most of the soils are well drained with moderate to high permeability.

Capability Groups of Soils

There are three levels of soil management: Land Capability Class, Capability Subclass (Soil Conservation Service, 1961), and Capability Unit (Donahue et al., 1977).

Land Capability Class. There are eight classes (I to VIII), classified depending on crop production limitation factors, such as the slope gradient, soil and water depth. Classes I to IV can be used for cultivation, classes V to VIII can be cultivated without special management practices.

Land Capability Subclass. The subclasses are designated by lower case letters that follow the Roman numeral of the soil class. These lower case letters are used to explain the reason for the limitations of intensive crop production.

The soil capability subclasses are expressed as follows:

e - Erosion hazard

w - Wetness

s - Shallow, droughty, or stony

c - Climate, too cold or too dry.

Land Capability Unit. The land capability units are subdivisions of the subclasses. There are nine divisions, and this means that the soils belonging to a determined soil unit are similar in vegetation suitability and can be treated with similar crop management practices to obtain a desired productivity. For example, IIIw-4 means Soil class III, subclass w (wetness limitation) and capability unit 4 (coarse texture or excessive gravel).

The nine capability units are defined as follows:

0 - Sand and gravel in the substratum

1 - Erosion hazard

2 - Wetness caused by poor drainage or flooding

3 - Slow or very slow permeability of the subsoil or substratum

4 - Coarse textured or excessive gravel

5 - Fine or very fine texture

6 - Salts or alkali

7 - Cobblestones, stones, or rocks

8 - Nearly impervious bedrock or a hardpan

9 - Low fertility or toxicity

METHODS AND PROCEDURES

Field Methods

Eighty-eight soil profiles were examined by T. T. Cochrane, AICTA Ag SC (British Advisors in Tropical Agriculture to the Ministry of Agriculture of Bolivia). The descriptions were recorded in accordance with the criteria specified in the "Soil Survey Manual" of the United States Department of Agriculture. The soil color was determined by the comparison of the wet soil color to Munsel color charts. These data provided the basis for this paper.

Field Morphology

The studied soils are moderate to well drained and derived from sandy, quartz rich, wind-blown alluvium from the Piray River system parent materials. These soils occur in the lowland tropical region of Bolivia and on a flat to very gently undulating topography.

Pedon Descriptions

Pedon 400.

Location:	Latitude 8056700, Longitude 487000
Soil Suite:	Rio Piray
Vegetation:	"Pampa", including native tufted grasses such as Sporobolis spp.
Present Land Use:	Extensive grazing

Horizon	Depth (cm)	Description
A11	0- 3	Dark brown (10YR 3/3) sandy loams, very friable; structureless, single grained; abundant roots; distinct smooth boundary.
A12	3-15	Dark brown (10YR 4/3) loamy sands; very friable; structureless, single grained; many roots; indistinct smooth boundary.
A2	15-45	Strong brown (7.5YR 5/6) sands; very friable; structureless, single grained, many roots; indistinct smooth boundary.
A3	45-70	Strong brown (7.5YR 5/6) coarse sandy loams, with profuse, medium sized, faint, light brownish gray (10YR 6/2) mottles; very friable; structureless, single grained; many roots; indistinct smooth boundary.
B1	70-95	Grayish brown (10YR 5/2) weakly gleyed, coarse sandy loam with profuse, medium sized, distinct to prominent, dark reddish brown (5YR 3/4) mottles; very friable; structureless, single grained; inhibition to roots due to water table at about 75 cm; indistinct smooth boundary.
B2	95-?	Reddish gray (5YR 4/2) weakly gleyed, coarse sandy clay loam with profuse, coarse sized, prominent, yellowish red (5YR 4/6) mottles; friable; structureless,

single grained; inhibition to roots due to water table.

Pedon 401.

Location: Latitude 8066000, Longitude 467500

Soil Suite: Rio Piray

Vegetation "Pampa" with native tufted grasses such as Sporobolis spp.

Present Land Use: Extensive grazing.

Horizon	Depth (cm)	Description
A11	0- 3	Dark brown (10YR 3/3) sandy loam; very friable; weakly developed, medium granular structure breaking to single grains; abundant roots; distinct smooth boundary.
A12	5-30	Dark brown to brown (10YR 4/3) sandy loam, very friable; structureless, single grained; many roots; indistinct smooth boundary.
A2	30-55	Brown (10YR 5/3) sandy loam with abundant, medium sized, distinct, strong brown (7.5YR 5/6) mottles; a few small "Mn" concretions; very friable; structureless, single grained, many roots; indistinct smooth boundary.
B2	55-90	Brown (10YR 5/3) sandy loam, weakly gleyed with abundant dark brown to brown (10YR 4/4) medium sized, faint mottles, a few "Mn" concretions lup to 2.5 cm in

		diameter; very friable; structureless, single grained; few roots; indistinct smooth boundary.
C	90-?	Brown (10YR 5/3) sandy loam, weakly gleyed with a few "Mn" concretions; very friable; structureless, single grained; inhibition to roots due to excessive moisture-water table at at about 90 cm.

Pedon 402

Location: Latitude 8115200, Longitude 481400

Soil Suite: Rio Piray

Vegetation: An ex-maize field. Land cleared from original semi-evergreen seasonal forest about 7 years previously.

Present Land Use: Maize cultivation.

Horizon	Depth (cm)	Description
A11p	0-8	Very dark grayish brown (10YR 3/2) loamy sand; loose; very weakly developed, medium sized, crumb structure, breaking to single grains; many roots, distinct smooth boundary.
A12	8-30	Dark brown (10YR 3/3) loamy sand, very friable; structureless, single grained; many roots; indistinct smooth boundary.
A2	30-60	Dark yellowish brown (10YR 3/4) loamy sand; very friable; structureless, single

		grained; many roots; indistinct smooth boundary.
B2	60-140	Reddish brown (5YR 4/3) loamy sand, very friable; structureless, single grained; many roots; diffuse smooth boundary.
C	140-?	Brown (7.5YR 5/4) loamy sand with a few reddish brown spots; very friable; structureless; single grained; few roots.

Pedon 403.

Location: Latitude 8115200, Longitude 477000

Soil Suite: Rio Piray

Vegetation: Grasslands. Land has probably been cleared from original forest vegetation for over 10 years.

Present Land Use: Some sugar cane and food crops.

Horizon	Depth (cm)	Description
A1p	0- 8	Very dark grayish brown (10YR 3/2) loamy sand, loose; structureless, single grained; many roots; distinct smooth boundary.
A12	8-25	Dark brown (10YR 3/3) sandy loam, very friable; structureless, single grained, many roots; diffuse smooth boundary.
A2	25-60	Dark brown to brown (7.5YR 4/4) loamy sand, very friable; structureless, single grained; many roots; diffuse smooth boundary.

B2	60-110	Brown (7.5YR 5/4) sandy loam with many medium faint, dark reddish brown (5YR 3/4) mottles occasionally showing signs of "Mn" precipitation in their centers; very friable; structureless, single grained; many roots; indistinct smooth boundary.
C	110-?	Yellowish red (5YR 5/6) sandy loam with abundant, medium, distinct, dark reddish brown mottles and some "Mn" concretions; very friable; structureless, single grained; few roots. The horizon may indicate the upper limit of the water table.

Pedon 404.

Location: Latitude 8106000, Longitude 477200

Soil Suite: Rio Piray

Vegetation: Grassland

Present Land Use: Pastures

Horizon	Depth (cm)	Description
A11	0- 5	Very dark grayish brown (10YR 3/2) loamy sand, loose; structureless, single grained; many roots; distinct smooth boundary.
A12	5-30	Dark brown to brown (7.5YR 4/4) sandy loam; very friable; structureless, single grained; many roots; indistinct smooth boundary.

A3	30-60	Strong brown (7.5YR 5/8) loamy sand with some fine sized, faint mottles (7.5YR 5/6); very friable; structureless, single grained; many roots; indistinct smooth boundary.
B2	60-120	Strong brown (7.5YR 5/6 loamy sand with profuse fine sized; faint mottles (7.5YR 5/8), and some redder stains along ald roots traces; friable; structureless, single grained; many roots; diffuse smooth boundary.
C	120-?	Reddish yellow (7.5YR 6/6) loamy sands abundant, medium sized, distinct, dark reddish brown (5YR 3/3) mottles; friable; structureless, single grained; some inhibition to root development due to the water table that was found at 120 cm.

Pedon 405.

Location: Latitude 8097800, Longitude 477800

Soil Suite: Rio Piray

Vegetation: Grassland

Present Land Use: Grazing.

Horizon	Depth (cm)	Description
A11	0- 3	Very dark grayish brown (10YR 3/2) sandy loam; very friable; very weakly developed medium crumb structure breaking down to

		single grains; many roots; indistinct smooth boundary.
A12	3-30	Dark brown (10YR 3/3) sandy loam; friable; structureless, single grained; many roots; diffuse smooth boundary.
B1	30-60	Dark brown to brown (7.5YR 4/2) sandy loam with some traces of "rusty" coloration along some root traces; friable; structureless, single grained; many roots; indistinct smooth boundary.
B2	60-100	Pale brown (10YR 6/3) loamy sand, with abundant medium sized, faint to distinct strong brown (7.5YR 5/8) mottles; sand; very friable; structureless, single grained; few roots; diffuse smooth boundary.
B3	100-160	Pink (7.5YR 7/4) sands with abundant, coarse sized, distinct strong brown (7.5YR 5/8) mottles; very friable; structureless, single grained; few roots; indistinct smooth boundary.
C	160-?	Reddish brown (5YR 5/4) sandy loam with many coarse, distinct pink (7.5 YR 7/4) mottles; friable; structureless, single grained; few roots.

Pedon 406.

Loction: Latitude 8087700, Longitude 475400

Soil Suite: Rio Piray

Vegetation: Grasslands

Present Land Use: Extensive Grazing

Horizon	Depth (cm)	Description
A11	0- 5	Very dark grayish brown (10YR 3/2) loamy sand; loose; very weakly developed, medium, crumb structure breaking down to single grains; many roots; distinct smooth boundary.
A12	5-35	Dark brown (7.5YR 3/2); sand; very friable; structureless, single grained; many roots; indistinct smooth boundary.
A3	35-60	Yellowish brown (7.5YR 5/6) loamy sand with profuse, fine sized, faint to distinct, yellowish brown (7.5YR 5/4) mottles; very friable; structureless, single grained; many roots; indistinct smooth boundary.
B2	60-80	Light brown (7.5YR 6/4) loamy sand with many medium, distinct, yellowish red (7.5YR 5/6) mottles; very friable; structureless, single grained; few roots; indistinct smooth boundary.
C	80-?	Light brown (7.5YR 6/4) loamy sand with abundant, yellowish red (5YR 5/6) mottles;

very friable; structureless, single grained; some root inhibition due to water table which was noted at approximately 90 cm.

Pedon 407.

Location: Latitude 8076500, Longitude 456300

Soil Suite: Rio Piray

Vegetation: Grasslands - some "Grama negra"

Present Land Use: Pastures.

Horizon	Depth (cm)	Description
A1	0-10	Dark brown (7.5YR 3/2) sandy loam; very friable; structureless, single grained; many roots; indistinct, smooth boundary.
A3	10-40	Dark brown to brown (7.5YR 4/4) sandy loam, with a faint trace of reddish brown (5YR 4/4) mottle and a little reddish brown staining along root traces; friable; structureless, single grained, many roots; diffuse smooth boundary.
B2	40-75	Dark brown to brown (7.5YR 4/4) sandy clay with a few, medium sized, faint reddish brown (5YR 4/4) mottles, friable; structureless, single grained; many roots; diffuse smooth boundary.
C	75-?	Light brown (7.5YR 6/4) weakly gleyed loamy sand with many, medium sized, distinct reddish yellow (5 YR 6/8) mottled

with some "Mn" concretion in formation; very friable; structureless, single grained; few roots - some inhibition to penetration due to high water table found at 105 cm.

Pedon 408.

Location: Latitude 8077800, Longitude 460000

Soil Suite: Rio Piray

Vegetation: Grassland, with many native tufted grasses, including Sporobilis spp.

Present Land Use: Pasture.

Horizon	Depth (cm)	Description
A11	0- 7	Very dark grayish brown (10YR 3/2) sandy loam with a faint trace of a "rusty" coloration along the root traces; friable; structureless, single grained; abundant roots; distinct smooth boundary.
A12	7-28	Dark brown (7.5YR 3/2) sandy loam with a distinct "rusty" coloration along some of the root traces; friable; very weakly developed, medium, blocky structure breaking down to single grains; many roots; diffuse smooth boundary.
B2	28-55	Dark brown to brown (7.5YR 4/2) sandy loam; very friable; structureless, single grained; many roots; indistinct smooth boundary.

C	55-?	Light brown (7.5YR 6/4) loamy sand with abundant medium sized, distinct strong brown (7.5YR 5/6) mottles and a strong brown colour along the root traces; very friable; structureless, single grained; few roots.

Pedon 409.

Location: Latitude 8083700, Longitude 473400

Soil Suite: Rio Piray

Vegetation: Cultivated pasture, including "Grama Negra" and "Bermuda" grasses

Present Land Use: Cultivated pastures.

Horizon	Depth (cm)	Description
A1p	0-10	Very dark grayish brown (10YR 3/2) sandy loam; friable; very weakly developed medium, granular structure breaking to single grains; abundant roots; distinct smooth boundary.
A12	10-40	Dark brown (7.5YR 3/2) sandy loam friable; very weakly developed, fine blocky structure breaking to single grains; many roots; indistinct smooth boundary.
B2	40-70	Brown (7.5YR 5/4) sandy clay loam with many fine to medium sized, faint, yellowish red (5YR 5/8) mottles and some soft "Mn" concretions; friable; very weakly developed, medium, blocky structure

		breaking to single grains; many roots; indistinct smooth boundary.
C	70-?	Brown (7.5YR 5/2) sandy loam, very weakly gleyed with abundant, medium sized, distinct, yellowish red (5YR 4/8) mottles; friable; structureless, single grained; some inhibition to root development due to a high water table which was seen at a depth of 120 cm.

Pedon 410.

Location: Latitude 8085800, Longitude 481700

Soil Suite: Rio Piray

Vegetation: Pasture, (Yaragua) ex sugar cane

Present Land Use: Pastures

Horizon	Depth (cm)	Description
A1p	0-12	Dark brown (7.5YR 3/2) fine sandy loam; friable; very weakly developed; fine blocky structure with some moderately developed, medium, granular structure breaking to single grains; many roots; indistinct smooth boundary.
A12	12-30	Dark brown to brown (7.5YR 4/4) fine sandy loam; friable; structureless, single grained; many roots; diffuse, irregular boundary.

B2	30-60	Strong brown (7.5YR 5/6) loamy sand with just a trace of brown (7.5YR 5/4) mottling; very friable; structureless, single grained; many roots; diffuse, smooth boundary.
C	60-?	Light brown (7.5YR 6/4) loamy sand with abundant medium sized, faint to distinct reddish yellow (7.5YR 6/6) mottles; friable; structureless, single grained; few roots.

Pedon 411.

Location: Latitude 8074600, Longitude 480600

Soil Suite: Rio Piray

Vegetation: Grasslands, including native tufted grasses, such as Sporobolis spp.

Present Land Use: Pastures

Horizon	Depth (cm)	Description
A11	0- 4	Dark brown to brown (10YR 4/3) loamy sand; very friable; some very weakly developed, medium, crumb structure, but largely structureless and single grained; many roots; distinct smooth boundary.
A12	4-30	Dark brown (7.5YR 3/2) loamy sand; very friable; structureless, single grained; many roots; indistinct smooth boundary.

AC	30-60	Brown (7.5YR 5/4) loamy sand; very friable; structureless, single grained, few roots; diffuse smooth boundary.
C	60-?	Strong brown (7.5YR 5/6) sand; friable; structureless, single grained; few roots.

Pedon 412.

Location: Latitude 8062000, Longitude 484100

Soil Suite: Rio Piray

Vegetation: Cultivated Yaragua pasture

Present Land Use: Pasturage

Horizon	Depth (cm)	Description
A1p	0-20	Dark brown (7.5YR 3/2) sandy loam; very friable; very weakly developed, fine, blocky structure breaking to single grains; many roots; indistinct smooth boundary.
A3	20-50	Brown (7.5YR 5/4) sandy loam with many fine sized, faint to distinct, yellowish red (5YR 4/8) mottles; friable; very weakly developed, medium, blocky structure breaking to single grains; many roots; indistinct smooth boundary.
B2	50-90	Brown (7.5YR 5/4) sandy loam with abundant reddish brown (5YR 4/4) fine sized distinct mottles, and a small amount of small soft "Mn" concretions; friable; structureless, single grained; indistinct smooth boundary.

C	90-?	Pale brown (10YR 6/3) weakly gleyed, loamy sand with abundant, medium, distinct reddish brown (5YR 4/4) mottles, and some soft, small "Mn" concretions; friable; structureless, single grained; few roots due to some inhibition caused by the high water table found at 90 cm.

Pedon 413.

Location: Latitude 8027800, Longitude 491300

Soil Suite: Rio Piray

Vegetation: "Pampa". Native tufted grasses

Present Land Use: Grassland

Horizon	Depth (cm)	Description
A11	0-5	Reddish brown (5YR 4/4) sandy loam; friable; weakly developed, fine subangular blocky structure breaking to single grains; many roots; indistinct smooth boundary.
A2	5-15	Yellowish red (5YR 4/6) sandy clay loam friable to firm; very weakly developed, medium, blocky structure breaking to single grains; many roots; indistinct smooth boundary.
B2	15-55	Yellowish red (5YR 4/8) sandy clay loam with many medium sized, distinct, red (7.5YR 4/6) mottles and some occasional sandy clay "lenses" specially in the lower

		part of the horizon, very dark gray in color (5YR 3/1); "Mn" concretions up to 1.5 cm in diameter common; firm; weakly developed, mediuim, blocky structure, breaking into single grains; an occasional medium sized rounded stone; many roots; indistinct smooth boundary.
B3	55-75	Red (5YR 4/6) sandy loam with many medium sized light brown mottles; friable; structureless, single grained; few roots; diffuse smooth boundary.
C	75-?	Yellowish red (5YR 4/6) to red (2.5YR 4/8) loamy sand, with just a trace of mottling; very friable; structureless, single grained; some fine sized rounded gravel sized particles; few roots.

Pedon 414.

Location: Latitude 8031000, Longitude 488000

Soil Suite: Rio Piray

Vegetation: Pampa. Native tufted grasses including Sporobolis spp.

Present Land Use: Extensive grasslands

Horizon	Depth (cm)	Description
A1	0- 5	Dark brown to brown (7.5YR 4/4) sandy loam; very friable; very weakly developed, fine, subangular blocky structure breaking

		to single grains; many roots; indistinct smooth boundary.
A3	5-25	Dark brown to brown (7.5YR 4/4) sandy loam; friable; structureless, single grained; many roots; indistinct smooth boundary.
B2	25-70	Reddish brown (5YR 4/4) sandy loam; friable; structureless, single grained; many roots; diffuse smooth boundary.
B3	70-100	Reddish yellow (7.5YR 6/6) loamy sand with abundant medium sized, faint mottles and occasional small (0.5 cm diameter) "Mn" concretions; friable; structureless, single grained; few roots; indistinct smooth boundary.
C	100-?	Light reddish brown (5YR 6/4) slightly gleyed; loamy sand with abundant, medium sized, faint, reddish brown (5YR 5/4) mottles; friable; structureless, single grained; few roots; the water table was found at a depth of 145 cm.

Pedon 415.

Location:	Latitude 4816000, Longitude 8032500
Soil Suite:	Rio Piray
Vegetation:	Pampa. Native tufted grasses common, but some "Grama Negra"
Present Land Use:	Grassland.

Horizon	Depth (cm)	Description
A11	0- 5	Reddish brown (5YR 4/4) loamy sand; very friable; very weakly developed, medium, blocky structure - almost structureless, single grained; abundant roots; indistinct smooth boundary.
A12	5-20	Yellowish red (5YR 4/6) sandy loam; very friable; structureless, single grained; many roots; diffuse smooth boundary.
A3	20-40	Yellowish red (5YR 5/6) loamy sand; very friable; structureless, single grained; many roots, diffuse smooth boundary.
B1	40-75	Yellowish red (5YR 6/6) loamy sand; very friable; structureless, single grain; many roots, indistinct smooth boundary.
B2	75-105	Red (5YR 5/6) sandy loam with many medium sized, faint reddish yellow (5YR 6/6) spots; some traces of carbon present; very friable; structureless, single grained; many roots; indistinct smooth boundary.
C	105-?	Yellowish red (5YR 4/6) loamy sand, friable; weakly developed, fine blocky structure breaking into single grains; few roots.

Pedon 416.

Loction: Latitude 8030000, Longitude 479000

Soil Suite: Rio Piray

Vegetation: Food garden - Maize

Present Land Use: Maize and food crop cultivation.

Horizon	Depth (cm)	Description
A1p	0-15	Dark reddish brown (5YR 3/4) sandy loam; very friable; structureless, single grained; abundant roots; distinct smooth boundary.
A2	15-35	Reddish brown (5YR 5/4) sandy loam; very friable; structureless, single grained; many roots; diffuse smooth boundary.
B2	35-90	Reddish brown (5YR 4/4) sandy clay loam; very friable; structureless, single grained; many roots; diffuse smooth boundary.
B3	90-140	Reddish brown (5YR 4/4) sandy loam; very friable; structureless, single grained; many roots; an occasional small piece of "carbon" seen; diffuse smooth boundary.
C	140-?	Reddish yellow (5YR 6/8) sandy loam with just a trace of yellowish red mottling; very friable; structureless, single grained; few roots.

Laboratory Methods

There is no specific information about the methods followed in doing the physical and chemical analysis of these pedons. The methods used for the chemical analysis were basically similar to those described by Mossin in "A Laboratory Manual of Chemical and Physical Methods for Soils and Plant Analysis." This manual is not available at the library of Utah State University. The details of the methods of analysis are not known.

Table 1. ANALYTICAL DATA PROFILE Nº 400

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 3	6.4	1.6	0.4	0.2	0.2	2.8	78
5 -15	6.2	0.6	0.1	0.2	0.1	1.7	53
20 - 30	6.1	0.1	0.1	0.1	0.1	1.1	42
50 - 60	6.1	0.2	0.2	0.1	0.1	1.4	34
75 - 85	6.1	1.5	0.4	0.2	0.2	3.1	75
125 -140	6.2	4.7	1.3	0.5	0.4	7.6	90

TEXTURE

(b)

% CLAY	% SILT	% SAND
15.2	3.0	81.8
13.0	3.0	84.0
2.4	3.0	94.6
15.2	5.1	79.7
19.5	7.3	73.2
24.1	7.2	68.7

Table 2. ANALYTICAL DATA PROFILE Nº 401

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	6.5	2.2	0.5	0.4	0.2	3.2	95
10 -20	6.2	1.1	0.2	0.2	0.1	2.4	67
35 -45	6.5	0.7	0.2	0.1	0.1	1.6	74
60 -75	6.5	0.3	0.2	0.1	0.2	2.0	40
100-110	6.5	0.6	0.1	0.1	0.2	1.7	60

TEXTURE

(b)

% CLAY	% SILT	% SAND
17.3	5.1	77.6
17.3	3.0	79.7
17.3	5.1	79.6
15.2	3.0	81.8
15.2	3.0	81.8

Table 3. ANALYTICAL DATA PROFILE Nº 402

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	7.7	16.6	5.3	0.7	0.3	9.9	
10 -25	7.4	2.6	0.8	0.2	0.1	3.7	98
35 -50	7.5	1.9	0.6	0.2	0.1	2.8	97
70 -85	7.3	1.6	0.6	0.2	0.1	2.7	93
105-120	6.6	1.1	0.2	0.2	0.1	2.2	71
155-170	7.2	1.1	0.2	0.2	0.08	1.5	97

TEXTURE

(b)

% CLAY	% SILT	% SAND
9.9	4.3	85.8
11.7	4.7	83.6
13.8	2.5	83.7
13.8	2.5	83.7
13.8	2.5	83.7
11.3	2.9	85.8

Table 4. ANALYTICAL DATA PROFILE Nº 403

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	7.7	14.2	1.1	0.6	0.2	8.0	-
10 - 20	7.6	4.2	1.8	0.1	0.3	5.0	
30 - 45	7.5	1.7	0.3	0.3	0.2	2.5	98
70 - 85	7.3	1.8	0.4	0.2	0.1	2.4	99
120 -145	7.4	1.8	0.4	0.4	0.1	3.1	89
160 -170	7.4	1.7	0.6	0.3	0.1	3.1	89

TEXTURE

(b)

% CLAY	% SILT	% SAND
11.3	5.1	83.6
13.4	2.9	83.7
11.3	5.1	83.6
13.9	3.6	82.4
13.9	3.6	82.4
13.9	3.6	82.4

Table 5. ANALYTICAL DATA PROFILE Nº 404

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	6.7	1.5	0.7	0.2	0.1	3.0	81
10 -25	5.2	0.6	0.2	0.2	0.1	2.4	44
35 -50	5.5	0.5	0.1	0.04	0.04	2.1	42
70 -85	5.8	0.1	0.1	0.04	0.04	1.7	23
100-115	5.9	0.4	0.1	0.1	0.1	1.6	42
130-140	6.3	0.2	0.3	0.1	0.1	1.4	56

TEXTURE

(b)

% CLAY	% SILT	% SAND
13.9	1.5	84.6
16.0	1.5	82.5
13.9	1.5	84.6
11.8	1.5	86.7
11.8	1.5	86.7
9.6	1.5	88.9

Table 6. ANALYTICAL DATA PROFILE Nº 405

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 3	6.5	2.1	0.4	0.3	0.1	4.0	72
3 -20	5.7	0.9	0.1	0.1	0.1	3.0	67
35 -50	5.6	0.3	0.1	0.1	0.1	2.5	19
70 -85	5.7	0.2	0.1	0.04	0.1	2.0	18
120-135	6.3	0.4	0.1	0.04	0.1	1.5	35
160-170	6.8	0.9	0.6	0.1	0.1	3.3	52

TEXTURE

(b)

% CLAY	% SILT	% SAND
13.9	3.6	82.5
15.0	4.3	80.7
15.0	4.3	80.7
10.7	2.1	87.2
6.4	2.1	91.4
12.8	4.3	82.9

Table 7. ANALYTICAL DATA PROFILE Nº 406

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	6.6	2.2	0.8	0.3	0.1	4.2	81
10 -20	5.7	0.9	0.1	0.2	0.1	2.4	54
40 -50	5.8	0.3	0.1	0.1	0.04	1.9	35
65 -75	6.0	0.1	0.2	0.04	0.1	1.9	35
100-115	6.5	0.5	0.2	0.2	0.1	1.2	71

TEXTURE

(b)

% CLAY	% SILT	% SAND
10.7	4.3	85.0
12.9	2.1	85.0
12.9	2.1	85.0
10.7	2.1	87.2
10.7	2.1	87.2

Table 8. ANALYTICAL DATA PROFILE Nº 407

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	6.2	1.6	0.7	0.2	0.1	4.1	61
15 -35	5.5	0.9	0.4	0.1	0.1	3.6	41
45 -55	5.3	0.7	0.3	0.1	0.1	5.8	19
100 -110	5.2	0.1	0.1	0.03	0.1	1.6	15

TEXTURE

(b)

% CLAY	% SILT	% SAND
12.8	6.4	80.8
17.1	4.3	78.6
22.2	5.6	72.2
11.5	1.4	87.1

Table 9. ANALYTICAL DATA PROFILE Nº 408

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	6.1	2.4	0.7	0.1	0.1	4.6	69
10 -20	5.5	1.8	0.5	0.1	0.1	4.1	60
35 -45	5.6	0.9	0.2	0.1	0.2	4.0	33
65 -80	5.5	0.8	0.2	0.03	0.1	2.7	41
100-115	5.7	0.5	0.3	0.1	0.1	1.9	54
150-160	6.6	0.6	0.1	0.03	0.1	1.0	47

TEXTURE

(b)

% CLAY	% SILT	% SAND
13.2	5.6	81.2
13.2	5.6	81.2
15.6	3.6	80.8
11.3	5.8	82.9
11.3	1.5	78.2
9.2	1.5	89.3

Table 10. ANALYTICAL DATA PROFILE Nº 409

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	6.3	4.8	1.4	0.6	0.2	7.3	88
10 -25	6.3	4.4	0.7	0.3	0.1	5.5	100
45 -60	6.1	3.5	0.7	0.3	0.2	5.4	83
75 -85	6.2	2.4	0.7	0.3	0.2	5.5	66
100-110	6.1	1.6	0.6	0.2	0.2	3.2	84
120-130	6.3	1.4	0.4	0.2	0.2	2.5	86

TEXTURE

(b)

% CLAY	% SILT	% SAND
17.7	7.9	74.4
18.9	7.9	73.2
26.8	7.5	65.7
20.3	5.4	74.3
16.1	3.2	80.7
13.9	1.1	85.0

Table 11. ANALYTICAL DATA PROFILE Nº 410

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 6	6.8	3.1	0.8	0.3	0.1	4.4	98
15 - 25	6.8	1.9	0.5	0.2	0.1	3.8	64
35 - 45	5.9	0.9	0.8	0.2	0.1	2.8	70
70 - 85	5.9	0.8	0.1	0.1	0.1	3.3	45
100-115	6.1	2.0	0.4	0.2	0.1	2.8	96
140-150	6.0	2.2	0.6	0.2	0.1	3.1	93

TEXTURE

(b)

% CLAY	% SILT	% SAND
11.8	7.5	80.7
16.1	3.2	80.7
13.9	3.2	82.9
13.9	3.2	82.9
13.9	3.2	82.9
14.6	4.7	80.7

Table 12. ANALYTICAL DATA PROFILE Nº 411

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 4	6.1	1.6	0.7	0.2	0.1	2.7	95
8 - 20	6.1	1.6	0.3	0.1	0.1	2.1	96
25 - 50	6.0	0.8	0.2	0.1	0.04	2.0	56
75 - 90	5.7	0.8	0.1	0.04	0.1	1.5	71
130-140	5.8	0.4	0.2	0.02	0.04	1.0	64

TEXTURE

(b)

% CLAY	% SILT	% SAND
12.4	2.6	85.0
10.3	2.6	87.1
10.2	2.6	87.2
10.3	2.6	87.2
8.1	2.6	89.3

Table 13. ANALYTICAL DATA PROFILE Nº 412

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	5.5	1.9	0.4	0.2	0.1	3.9	69
8 -20	5.5	1.3	0.4	0.1	0.1	3.6	51
25 -40	5.5	0.4	0.2	0.1	0.1	2.4	36
60 -75	6.6	0.5	0.3	0.2	0.2	2.3	45
110-120	6.8	0.8	0.3	0.1	0.1	1.4	87

TEXTURE

(b)

% CLAY	% SILT	% SAND
17.1	4.3	78.6
17.1	8.6	74.3
15.0	8.6	76.4
15.0	8.6	76.4
11.3	5.8	82.9

Table 14. ANALYTICAL DATA PROFILE Nº 413

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 3	6.6	3.4	1.3	0.7	0.1	5.5	99
6 -12	6.1	3.2	1.3	0.4	0.1	5.6	90
20 -30	6.4	4.6	1.0	0.6	0.2	7.6	87
40 -50	6.6	3.2	1.3	0.4	0.2	5.8	90
55 -65	6.9	2.8	0.9	0.3	0.2	4.2	99
80 -95	6.8	1.9	0.7	0.2	0.2	3.1	87
115-130	6.7	2.1	0.7	0.2	0.1	3.2	98

TEXTURE

(b)

% CLAY	% SILT	% SAND
17.8	5.8	76.4
24.2	5.8	70.0
26.3	7.9	65.8
24.2	3.6	72.2
16.1	4.3	79.7
13.9	2.1	84.0
13.9	2.1	84.0

Table 15. ANALYTICAL DATA PROFILE Nº 414

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 4	6.0	1.1	0.8	0.04	0.1	2.7	77
8 -20	6.4	0.7	0.4	0.2	0.1	2.1	69
30 -45	5.9	0.4	0.4	0.1	0.1	1.7	61
75 -90	5.9	0.2	0.3	0.1	0.1	1.1	56
110 -125	6.2	0.4	0.1	0.1	0.1	1.5	42
145 -155	5.9	0.7	0.4	0.1	0.1	1.5	89

TEXTURE

(b)

% CLAY	% SILT	% SAND
16.1	2.1	81.8
16.1	4.3	79.7
16.1	4.3	79.7
13.9	2.1	84.0
13.9	2.1	85.0
11.8	2.1	86.1

Table 16. ANALYTICAL DATA PROFILE Nº 415

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
0 - 5	6.2	1.6	0.6	0.3	0.1	3.0	84
8 -18	5.8	1.3	0.4	0.2	0.1	3.0	65
25 -35	5.8	0.8	0.5	0.1	0.1	2.1	65
45 -60	5.8	0.7	0.5	0.1	0.1	1.8	71
80 -95	6.1	2.5	0.5	0.2	0.2	4.6	75
115-130	6.5	3.5	1.1	0.3	0.1	5.8	87
170-180	6.7	5.9	1.4	0.3	0.4	8.2	97

TEXTURE

(b)

% CLAY	% SILT	% SAND
12.6	3.4	84.0
16.9	3.4	79.7
14.8	1.2	84.0
12.6	1.3	86.1
16.9	1.3	81.8
19.0	7.7	73.3
25.5	9.8	64.7

Table 17. ANALYTICAL DATA PROFILE Nº 416

(a)

SAMPLE DEPTH in cm.	pH	Exchange Data m.e. % oven dry soil (105°C)					
		Ca	Mg	K	Na	CEC	% BS
3 - 11	6.2	2.2	0.3	0.3	0.1	3.9	76
20 -30	6.0	1.0	0.4	0.1	0.1	2.3	74
40 -50	5.7	0.7	0.4	0.3	0.1	3.0	47
70 -85	5.4	1.4	0.3	0.2	0.1	3.7	70
100-115	5.4	0.7	0.3	0.2	0.04	4.4	34
160-170	5.8	0.9	0.2	0.1	0.1	2.1	63

TEXTURE

(b)

% CLAY	% SILT	% SAND
14.8	3.4	81.8
16.9	3.4	79.7
21.2	7.7	71.1
21.2	7.7	71.1
19.0	3.4	77.6
14.8	1.7	83.5

RESULTS AND DISCUSSION

Tables 18 and 19 show the results of the soil classification and the capability groups of the soils.

Pedon 400

This pedon is classified as fine loamy, mixed, hypethermic Aquic Udipsamments. The color of this pedon goes from dark brown to reddish grey. Its texture, from sandy loam to coarse sandy loam, with a particle size distribution of 19.6 percent of clay, 73.87 percent of sand, and 6.53 percent of silt. It is structureless, very friable, with roots until about 75 cm, some mottles and a drainage somewhat imperfect due to the presence of the water table at that depth.

The range of pH values is from 6.1 to 6.4, decreasing with depth. There is no problem of salinity (EC from 0.004 to 0.018 mmhos $\times 10^{-3}$).

Cation Exchange Capacity (CEC) values are very low through the profile. The values range from 1.7 to 3.2 me/100 g decreasing with depth. Base saturation of the samples ranges from 40 to 95 percent, and the exchangeable complex is dominated by calcium.

This soil occurs on a gently undulating topography. It has an udic moisture regime, and a hypethermic temperature regime.

Pedons 402, 411

These pedons are classified as sandy, mixed, hypethermic, Typic Ustipsamments. They are loamy sand textured soils, with a clay content of 9.5 to 13.8 percent, sand content of 83.7 to 87.9 percent, and 2.5 to 2.6 percent of silt. They are largely structureless, very

Table 18. Soil classification of the 17 pedons*

Pedon No.	Soil classification		
	Family	Subgroup	Order
400	Fine loamy, mixed, hypethermic	Aquic Udipsamments	Entisol
401	Sandy, mixed, hypethermic	Aquic Ustifluvents	Entisol
402	Sandy, mixed hypethermic	Typic Ustipsamments	Entisol
403	Sandy, mixed, hypethermic	Typic Ustifluvents	Entisol
404	Sandy, mixed, hypethermic	Aquic Ustipsamments	Entisol
405	Sandy, mixed, hypethermic	Aquic Ustifluvents	Entisol
406	Sandy, mixed, hypethermic	Aquic Ustisamments	Entisol
407	Sandy, mixed, hypethermic	Aquic Ustifluvents	Entisol
408	Sandy, mixed hypethermic	Aquic Ustifluvents	Entisol
409	Fine loamy, mixed, hypethermic	Fluventic Haplustolls	Mollisol
410	Sandy, mixed, hypethermic	Aquic Ustipsamments	Entisol
411	Sandy, mixed, hypethermic	Typic Ustipsamments	Entisol
412	Sandy mixed, hypethermic	Aeric Fluvaquents	Entisol
413	Fine loamy, mixed, hypethermic	Typic Ustifluvents	Entisol
414	Sandy, mixed, hypethermic	Typic Ustifluvents	Entisol
415	Sandy, mixed, hypethermic	Typic Ustifluvents	Entisol
416	Fine loamy, mixed, hypethermic	Typic Ustifluvents	Entisol

*Soil Survey Staff, 1975.

Table 19. Capability groups of the soils*

Pedon No.	Capability unit
400	IIIw-2
401	IIIw-2
402	IIe-4
403	IIe-2
404	IIw-4
405	IIw-2
406	IIw-4
407	IIIw-2
408	IIw-2
409	IIw-2
410	IIw-4
411	IIe-4
412	IIIw-2
413	IIIe-2
414	IIe-2
415	IIe-2
416	IIe-2

*Soil Conservation Service, USDA Agr. Handbook 210, 1961. Reprinted 1973.

friable. The pH values range from 5.7 to 7.7 decreasing with depth.

CEC range is from 1 to 9.9 me/100 g. Base saturation values range from 64 to 98 percent. The cation exchange complex is dominated by calcium.

Electrical conductivity is very low, showing no salinity problems.

The water table was not seen in the examined horizons. These soils occur on nearly level to gently undulating slopes, and are well drained. They have an ustic moisture regime, and hypethermic temperature regime.

Pedons 404, 406, 410

These pedons are classified as sandy, mixed, hypethermic, Aquic Ustipsamments and have sandy loam textures. Particle size distribution shows the clay content ranges from 11.4 to 13.9 percent with high sand content, 82.9 to 86.4 percent, and a very low silt content, 1.5 to 3.2 percent. Their structure is weakly developed, fine to medium crumb to blocky, breaking to single grains. They are very friable with a high water table (about 30 cm depth) showing faint to reddish yellow mottles. The pH values range from 5.2 to 6.8 decreasing with depth.

CEC values are very low, from 1.2 to 4.4 me/100 g. Base saturation in the top 10 cm is high (81-98%) deeper it changes abruptly, with values that range from 23 to 64 percent. These soils are moderately to well drained and occur on nearly level slopes.

Pedons 413, 416

These pedons are classified as fine-loamy, mixed, hypethermic, Typic Ustifluvents. These soils are light colored, reddish brown to yellowish red. Pedon 413 is too light in color and too thin to be a mollic epipedon. The base saturation is too high (87-98% to be an umbric epipedon.

Pedon 416 does not have such a high base saturation, but it is structureless, therefore the epipedon is ochric. Their particle size distribution shows high sand and clay values, being not coarse enough to be classified as Psamments.

For both soils CEC values range from 2.1 to 7.6 me/100 g. They do not show salinity problems, and have pH values from 5.4 to 6.8. They occur on a nearly level to gently undulating topography, and their drainage is from moderate to well. They have an ustic and hypethermic moisture and temperature regime, respectively.

Pedons 403, 414, 415

These pedons are classified as sandy, mixed, hypethermic, Typic Ustifluvents. These soils are deep and brown-reddish colored, mostly structureless, very friable, loamy sand textures, sand percent ranges from 82.5 to 83.9 percent, clay values from 13 to 14.8 percent, and silt values from 1.27 to 4.10 percent.

The water table is present at about 100 cm, mottles and "Mn" concretions are shown at that depth. The pH values range from 5.8 to 7.7 decreasing with depth. CEC values range from 1.8 to 8.2 me/100 g and calcium is the dominant cation. They apparently do not have salinity problems. They occur on nearly flat to gently undulating

topography and they are moderate to well drained, with an ustic moisture regime and hypethermic regime.

Pedons 401, 405, 407, 408

These pedons are classified as sandy, mixed, hypethermic, Aquic Ustifluvents. These soils are mostly the same as those described above; with the difference that the soils have a high water table, about 30 cm, showing strong brown to reddish brown mottles and "Mn" concretions at that depth.

Pedon 409

This pedon is classified as fine-loamy, mixed, hypethermic, Fluventic Haplustolls. This soil is moderately deep, has high base saturation (66-100%), dark colored, with very weakly developed medium granular structure, breaking to single grains, sandy loam to sandy clay loam texture, 21 percent clay, 73.6 percent sand, and 5.4 percent silt. It is very friable, with abundant roots, assuming it has enough organic matter content to be a mollic epipedon. The pH values range from 6.1 to 6.3, EC is very low, less than 0.054 mmhos x 10^{-3}.

From the analytical data this soil appears to be only very weakly leached, with CEC values from 2.5 to 7.3 me/100 g. Calcium is the dominant cation in the exchange complex.

This soil occurs on a nearly flat slope and is moderately well drained. It has ustic and hypethermic moisture and temperature regimes, respectively.

The water table is at 40 cm, showing yellowish red mottles and some "Mn" concretions.

Pedon 412

This soil is classified as sandy, mixed, hypethermic, Aeric Fluvaquents. This soil is deep and occurs on a level slope. Particle size distribution show high sand content (74.3-82.9%) 11.3 to 17.1 percent of clay, and about 7.7 percent of silt. Its structure is from very weakly developed, fine blocky to structureless. It is very friable and has a pH value that is the same for the first 40 cm, 5.5, and then increases with depth up to 6.8. This soil does not have salinity problems.

This soil appears to be moderately weathered, the analytical data would indicate that this soil is only weakly leached. CEC values range from 1.4 to 3.9 me/100 g. Calcium is the dominant cation in the exchangeable complex. To a depth of 20 cm, this soil begins to show reddish brown mottles, the water table is found at 90 cm.

ENGINEERING CLASSIFICATION OF THE SOILS

Two classifiction systems were used: UNIFIED system, based on the particle size distribution, plasticity index, liquid limit, and organic matter content. There are 15 classes (GW, GP, GM, GC, SW, SP, SM, SC, ML, CL, OL, MH, CH, OH, and PT), and we might have a combination of them. Example: SM-SC. This system is used by the Soil Conservation Service Engineers, the Department of Defense and others (American Society for Testing and Materials, 1974). The other system is AASHTO (American Association of State Highway [and Transportation] Officials, 1970). It classifies the soil according to those properties that affect use in highway construction and maintenance. There are 7 classes, from A-1 to A-7. Also, here, we might have a combination of those. Example: A-2-4. This system has been adopted by the American Association of State Highway Officials.

ENGINEERING INTERPRETATIONS

After estimating the engineering properties for each pedon, interpretations were made, rating the soils based on how favorable their properties are for their rated use. Tables 20 to 36 are an adaptation of Standard Soils Conservation Service Form 5.

The soil limitation ratings are:

- Slight; soil properties favorable for their rated use. Limitations, easy to overcome or modify.
- Moderate; soil properties somewhat unfavorable for the rated use. Limitations more difficult to overcome or modify.
- Severe; soil properties unfavorable for the rated use. Limitations too difficult to overcome or modify.

The soil suitability degrees are: good, fair, and poor. Their meanings are similar to those for the soil limitation ratings.

SUMMARY AND CONCLUSIONS

To write this report, I obtained the profile descriptions (field morphology) and the analytical tables of the soils from the report made by T. T. Cochrane, a British adviser in Tropical Agriculture in 1968. With these data and information acquired by a review of the literature, the classification was made on the 17 selected soils at the family level (Table 18) according to Soil Taxonomy (Soil Survey Staff, 1975). The following interpretations were then made:

- Table 19, fit the soils into a capability group, according to their characteristics.
- Tables 20-36, show the engineering classification and interpretations for each of the studied pedons.

If more information about Bolivia had been available, the written part of this report could have been more precise and complete. These soils are sandy, wet soils of a tropical region, with a good potential for cultilvation with moderate management practices.

Table 20, Soil properties and interpretations for pedon 400

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 400 Soil Classification Fine loamy, hypethermic Aquic Udipsamments

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0 - 15	Sandy loam - loamy sand (13-15% clay)	SC	A-2,A-4	0	100	100	80-85	15-20	20-25	5-10	5 - 15
20- 30	Sand (2.4% clay)	GP or GW	A-1	0	100	15-20	80-85	0 -5	NP	--	15,- 25
50-140	Coarse sandy loam-coarse sandy clay loam(15-24% clay	SM-SC	A-2,A-4	0	100	100	70-80	20-30	20-30	5-10	2.5- 5

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
0 - 15	0.11	6.1-6.5	0.1-0.2	NA	NA	low	45	B	3
20-30	0.03	6.1	0.1-0.4	NA	NA	low			
50-140	0.11	6.1	0.4	NA	NA	low			

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table, permeability	Severe; depth to seasonal water table	Moderate; depth to seasonal water table	Fair	Moderate; seasonal water table.

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Severe; seasonal water table	Severe; seasonal water table	Slight	Good	Good	Poor; texture

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	wetland	Rangeland
Moderate; texture	Moderate; texture	Moderate; texture	Moderate; texture	NR		NR	

Table 21. Soil properties and interpretations for pedon 401

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 401 Soil Classification Sandy, mixed, hypethermic Aquic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT > 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0 -45	Sandy loam (17.3% clay)	SM-SC	A-2	0	100	100	75-80	20-25	20-25	5-10	2.5 - 5
60-110	Sandy loam (15.2% clay)	SM-SC	A-2	0	100	100	52-54	81.8	20-25	5-10	5 -15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
0 -45	0.11	6.1-6.5	0.1-0.2	NA	NA	Low	55	B	3
60-110	0.11	6.5	0.2	NA	NA	Low			

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table	Severe; depth to water table	Moderate	Fair	Severe; seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Severe; depth to water table	Severe; depth to water table	Slight	Good	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	wetland	Rangeland
Moderate; wetness	Moderate; wetness	Moderate; wetness	Moderate; wetness	NR		NR	

Table 22. Soil properties and interpretations for pedon 402

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 402 Soil Classification Sandy, mixed, hypothermic Typic Ustipsamments

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE				LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
					4	10	40	200			
0 -25	Loamy sand (9.9-11.7% clay)	SM	A-2-4	0	100	100	85-90	10-15	NP	--	1.5 - 5
35-120	Loamy sand (13.8% clay)	SM	A-2	0	100	100	80-85	15-20	NP	--	

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
0 -25	0.08	7.4-7.8	0.3	NA	NA	Low	140	A	2
35-120	0.11	6.6-7.5	0.1	NA	NA	Low			

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Moderate; depth to water table	Moderate; permeability	Moderate; texture	Slight	Fair	Severe; texture

DWELLINGS WITHOUT BASEMENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF		
			ROADFILL	SAND AND GRAVEL	TOPSOIL
Slight	Slight	Slight	Good	Good	Poor; texture

RECREATION USE LIMITATION FOR				POTENTIAL AS WILDLIFE HABITAT	
CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	Openland Woodland	wetland Rangeland
Moderate; texure	Moderate; texture	Moderate; texture	Moderate; texture	NR	NR

Table 23. Soil properties and interpretations for pedon 403

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 403 Soil Classification sandy, mixed, hyperthermic Typic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT > 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-45	Loamy sand - Sandy loam (11-13.4% clay)	SM	A-2,A-4	0	100	100	84	16	NP	--	5 - 15
70-170	Sandy loam (13.9% clay)	SM	A-2	0	100	100	83	17	NP	--	5 - 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP	
0 - 45	0.11	7.5-7.7	0.2-0.3	NA	NA	Low	110	A	2	
70-170	0.11	7.3-7.4	0.1	NA	NA	Low				

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; permeability	Severe; depth to seasonal water table	Moderate; permeability	Fair	Moderate; seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Slight	Moderate; seasonal water table	Slight	Good	Good	Poor; texture

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	Wetland	Rangeland
Moderate; texture	Moderate; texture	Moderate; texture	Moderate; texture	NR		NR	

Table 24. Soil properties and interpretations for pedon 404

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N°404 Soil Classification sandy, mixed, hypethermic Aquic Ustipsamments

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT > 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-50	Loamy sand-sandy loam (14 - 16% clay)	SM	A-2,A-4	0	100	100	82-85	15-18	NP	--	5 - 15
70-140	Loamy sand (9.6-11.8% clay)	SM	A-2	0	100	100	87	13	NP	--	5 - 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP	
0-50	0.11	5.1-6.7	0.04-0.1	NA	NA	Low	50	B	2	
70-140	0.08	5.6-6.5	0.04-0.1	NA	NA	Low				

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORPTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table, permeability	Severere; depth to seasonal water table	Moderate	Fair	Severe; texture

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Moderate; depth to water table	Severe; depth to water table	Slight	Good	Good	Poor; texture

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	Wetland	Rangeland
Moderate; texture, wetness	Moderate; texture, wetness	Moderate; texture, wetness	Moderate; texture, wetness	NR		NR	

Table 25. Soil properties and interpretations for pedon 405

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 405 Soil Classification sandy, mixed, hypethermic Aquic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT > 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-50	Sandy loam (14-15% clay)	SM	A-2-4	0	100	100	81-83	17-19	20-25	5-10	5 - 15
70-85	Loamy sand (10.7% clay)	SM	A-2-4	0	100	100	87	13	NP	--	5 - 15
120-135	Sand (6.4% clay)	SP,SM	A-3	0	100	100	92	8	NP	--	15 - 25

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
0-50	0.11	5.6-6.5	0.1	NA	NA	Low	50	B	3
70-85	0.11	5.7	0.1	NA	NA	Low			
120-135	0.08	6.3	0.1	NA	NA	Low			

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table, permeability	Severe; depth to seasonal water table	Moderate ; permeability	Poor; texture	Severe; texture

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Moderate; depth to water table	Severe; depth to water table	Slight	Good	Good	Poor; texture

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	werland	Rangeland
Moderate; wetness	Moderate; wetness	Moderate; wetness	Moderate; wetness	NR		NR	

Table 26. Soil properties and interpretations for pedon 406

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 406 Soil Classification sandy, mixed, hypethermic Aquic Ustisamments

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT > 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-115	Loamy sand (11-13% clay)	SM	A-2	0	100	100	85-87	13-15	NP	--	5 - 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
0-115	0.11	5.7-6.6	0.1	NA	NA	Low	40	B	2

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table, permeability	Severe; depth to seasonal water table, permeability	Moderate; depth to seasonal water table	Fair	Severe; depth to seasonal water table, texture

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Severe; depth to water table	Severe; depth to water table	Slight	Good	Good	Poor; texture

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland Woodland	wetland Rangeland
Severe; wetness	Severe; wetness	Severe; wetness	Severe; wetness	NR	NR

Table 27. Soil properties and interpretations for pedon 407

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N°407 Soil Classification sandy, mixed, hypethermic Aquic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 9 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-35	Sandy loam (13-17% clay)	SM	A-2-4	0	100	100	80	20	20-25	5-10	5 - 15
45-55	Sandy clay (22.2% clay)	SC	A-7	0	100	100	72	28	20-25	5-10	2.5- 5

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP	
0-35	0.11	5.5-6.2	0.1	NA	NA	Low	50	B	3	
45-55	0.08	5.3	0.1	NA	NA	Low				

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table, permeability	Severe; depth to seasonal water table	Moderate; permeability	Fair	Severe; depth to seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Severe; seasonal water table	Severe; depth to water table	Slight	Good	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland Woodland	wetland Rangeland
Moderate; wetness	Moderate; wetness	Moderate; wetness	Moderate; wetness	NR	NR

Table 28. Soil properties and interpretations for pedon 408

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 408 Soil Classification sandy, mixed, hypethermic Aquic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 8 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-115	Sandy loam (11-15% clay)	SM	A-2-4	0	100	100	78-83	17-22	20-25	5-10	5 - 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP	
0-115	0.11	5.5-6.1	0.1	NA	NA	Low	55	B	3	

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table, permeability	Severe, depth to seasonal water table	Moderate; permeability	Fair	Severe; depth to seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Moderate; depth to water table	Severe; depth to water table	Slight	Good	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland Woodland	Wetland Rangeland
Moderate; wetness	Moderate; wetness	Moderate; wetness	Moderate; wetness	NR	NR

Table 29. Soil properties and interpretations for pedon 409

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 409 Soil Classification fine loamy, mixed, hypethermic, Fluventic Haplustolls

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-25	Sandy loam (18% clay)	SM-SC	A-2	0	100	100	74	26	25-30	5-10	5 - 15
45-60	Sandy clay loam (27% clay)	SC	A-2-6	0	100	100	66	34	30-35	10-15	1.5- 5
75-130	Sandy loam (14-20% clay)	SM-SC	A-2	0	100	100	75-85	15-25	20-30	5-10	5 - 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP	
0-25	0.11	6.3	0.1	NA	NA	Low	120	A	3	
45-60	0.17	6.1	0.2	NA	NA	Low				
75-130	0.11	6.1-6.3	0.2	NA	NA	Low				

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORPTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Moderate; depth to water table	Moderate; depth to water table	Moderate; permeability	Slight	Fair	Moderate; depth to seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Slight	Moderate; depth to water table	Slight	Good	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	Wetland	Rangeland
Slight	Slight	Slight	Slight	NR			NR

Table 30. Soil properties and interpretations for pedon 410

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 410 Soil Classification sandy, mixed, hypethermic, Aquic Ustipsamments

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 8 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-25	Fine sandy loam (12-16% clay)	SM	A-4	0	100	100	80-83	17-20	20-25	5-10	1.5 -2.5
35-150	Loamy sand (14% clay)	SM	A-2	0	100	100	83	17	NP	--	5 - 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
0-25	0.17	6.8	0.1	NA	NA	Low	50	B	3
35-150	0.11	6.0	0.1	NA	NA	Low			

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table	Severe; depth to seasonal water table	Moderate	Fair	Severe; depth to seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Moderate; depth to water table	Severe; depth to water table	Slight	Good	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland Woodland	wetland Rangeland
Moderate; wetness	Moderate; wetness	Moderate; wetness	Moderate; wetness	NR	NR

Table 31. Soil properties and interpretations for pedon 411

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 411 Soil Classification sandy, mixed, hypethermic, Typic Ustipsamments

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-90	Loamy sand (10-12% clay)	SM	A-2	0	100	100	85-90	10-15	NP	--	5 - 15
130-140	Sand (8.1% clay)	SP-SM	A-3	0	100	100	90	10	NP	--	15 - 20

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP	
0-90	0.11	6.1	0.1	NA	NA	Low	140	A	2	
130-140	0.08	5.8	0.04	NA	NA	Low				

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORPTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Slight	Severe; permeability	Moderate; texture	Slight	Fair	Severe; texture

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Slight	Slight	Slight	Good	Good	Poor; texture

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland Woodland	wetland Rangeland
Moderate; texture	Moderate; texture	Moderate; texture	Moderate; texture	NR	NR

Table 32. Soil properties and interpretations for pedon 412

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 412 Soil Classification sandy, mixed, hypethermic, Aeric Fluvaquents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-20	Sandy loam (17.1% clay)	SM-SC	A-2	0	100	100	74-80	20-26	20-25	5-10	2.5 - 15
25-75	Sandy loam (15% clay)	SM-SC	A-2	0	100	100	76	24	20-25	5-10	5 - 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP	
0-20	0.11	5.5	0.1	NA	NA	Low	90	A	3	
25-75	0.11	5.5-6.6	0.1-0.2	NA	NA	Low				

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table	Severe; depth to seasonal water table	Slight	Fair	Severe; soil drainage class

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Slight	Moderate; depth to water table	Moderate; soil drainage class	Slight	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	wetland	Rangeland
Moderate; wetness	Moderate; wetness	Moderate; wetness	Moderate; wetness	NR		NR	

Table 33. Soil properties and interpretations for pedon 413

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 413 Soil Classification fine loamy, mixed, hypethermic, Typic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 9 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-3	Sandy loam (17.8% clay)	SM-SC	A-2	0	100	100	76	24	20-25	5-10	2.5 - 5
6-65	Sandy clay loam (24-26% clay)	SC	A-2-6	0	100	100	65-75	25-35	30-35	10-15	1.5 - 5
80-170	Loamy sand (14-16% clay)	SM	A-2	0	100	100	80-85	15-20	NP	--	

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP	
0-3	0.11	6.6	0.1	NA	NA	Low	50	A	3	
6-65	0.17	6.1-6.9	0.2	NA	NA	Low				
80-170	0.11	6.8	0.1	NA	NA	Low				

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table	Severe; depth to seasonal water table	Moderate	Fair	Severe; depth to seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Severe; depth to water table	Severe; depth to water table	Slight	Good	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	Wetland	Rangeland
Moderate; wetness	Moderate; wetness	Moderate; wetness	Moderate; wetness	NR		NR	

Table 34. Soil properties and interpretations for pedon 414

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 414 Soil Classification sandy, mixed, hyperthermic, Typic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT 8 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE				LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
					4	10	40	200			
0-45	Sandy loam (16.2% clay)	SM-SC	A-2	0	100	100	80	20	20-25	5-10	5 - 15
75-125	Loamy sand (13.9% clay)	SM	A-2	0	100	100	85	15	NP	--	1.5- 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
0-45	0.11	5.9-6.4	0.1	NA	NA	Low	145	A	3
75-125	0.11	5.9-6.2	0.1	NA	NA	Low			

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Moderate; flooding	Moderate; depth to water table	Severe; permeability	Moderate	Fair	Moderate; depth to seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF		
			ROADFILL	SAND AND GRAVEL	TOPSOIL
Slight	Moderate; depth to water table	Slight	Good	Good	Good

RECREATION USE LIMITATION FOR				POTENTIAL AS WILDLIFE HABITAT			
CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	Openland	Woodland	wetland	Rangeland
Moderate; flooding	Moderate; flooding	Moderate; flooding	Slight	NR		NR	

Table 35. Soil properties and interpretations for pedon 415

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 415 Soil Classification sandy, mixed, hypethermic, Typic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT > 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
0-130	Loamy sand- sandy loam (13-19% clay)	SM	A-2	0	100	100	70-90	10-30	NP	--	5 - 15

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
0-130	0.11	5.8-6.2	0.1	NA	NA	Low	105	A	2

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORPTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Severe; depth to water table	Severe; depth to water table	Severe; depth to seasonal water table	Moderate	Fair	Severe; texture

DWELLINGS WITHOUT BASEMENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Slight	Moderate; depth to water table	Moderate; flooding	Good	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	Wetland	Rangeland
Moderate; texture	Moderate; texture	Moderate; texture	Moderate; texture	NR		NR	

Table 36. Soil properties and interpretations for pedon 416

SOIL PROPERTIES AND INTERPRETATIONS

Pedon N° 416 Soil Classification fine loamy, mixed, hypethermic, Typic Ustifluvents

ESTIMATED ENGINEERING PROPERTIES

DEPTH (CM)	USDA TEXTURE	UNIFIED	AASHO	FRACT > 3 CM (PCT)	PERCENT OF MATERIAL LESS THAN 3 CM PASSING SIEVE 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (CM/HR)
3-30	Sandy Loam (15-17% clay)	SM-SC	A-2	0	100	100	80-85	15-20	20-25	5-10	2.5 - 5
40-85	Sandy clay loam (21.2% clay)	SC	A-2-6	0	100	100	70-75	25-30	30-35	10-15	1.5 - 5
100-170	Sandy loam (15-19% clay)	SM-SC	A-2	0	100	100	75-85	15-25	20-25	5-10	

DEPTH (CM)	AVAILABLE WATER CAPACITY (CM/CM)	SOIL REACTION (pH)	EXCH. SODIUM (PCT)	SALINITY	POTENTIAL FROST ACTION	SHRINK - SWELL POTENTIAL	WATER TABLE DEPTH (CM)	HYD. GRP	WIND EROSION GROUP
3-30	0.11	6.0-6.2	0.1	NA	NA	Low	140	A	3
40-85	0.17	5.4-5.7	0.1	NA	NA	Low			
100-170	0.11	5.4-5.8	0.1-0.2	NA	NA	Low			

INTERPRETATIONS OF SOIL LIMITATION RATINGS & DOMINANT SOIL FEATURES AFFECTING USE FOR

SEPTIC TANK ABSORTION FIELDS	SEWAGE LAGOONS	TRENCH TYPE SANITARY LANDFILLS	AREA TYPE SANITARY LANDFILLS	COVER AREA TYPE SANITARY LANDFILLS	SHALLOW EXCAVATIONS
Moderate; depth to water table	Moderate; depth to water table	Severe; depth to seasonal water table	Moderate	Fair	Moderate; depth to seasonal water table

DWELLINGS WITHOUT BASENENTS	DWELLINGS WITH BASEMENTS	LOCAL ROADS AND STREETS	SUITABILITY AS A SOURCE OF ROADFILL	SAND AND GRAVEL	TOPSOIL
Moderate; depth to water table	Severe; depth to water table	Moderate; flooding	Good	Good	Good

RECREATION USE LIMITATION FOR CAMP AREAS	PICNIC AREAS	PLAYGROUNDS	PATH AND TRAILS	POTENTIAL AS WILDLIFE HABITAT Openland	Woodland	werland	Rangeland
Moderate; flooding	Moderate; flooding	Moderate; flooding	Slight	NR		NR	

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