Mapping and Characterization of the Soils on the University of Arizona Maricopa Agricultural Center

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INTRODUCTION

The Maricopa Agricultural Center (MAC) is a University of Arizona research and demonstration farm located three miles east of Maricopa and three miles north of the Casa Grande-Maricopa Highway in Pinal County, Arizona. The farm is 770 hectares (2100 acres) in size, and the elevation is 358 meters (1175 feet). Figure 1 is a field map of MAC Farm which lists the legal description for the land and gives the Universal Transverse Mercator (UTM) grid notations for the section corners (half-section corners for part of the farm). This map also shows field numbers and field boundaries.

Data collected on MAC farm should be spatially referenced to the UTM coordinates. The numbers reported in this paper are averages of several measurements made by us to identify farm boundaries. UTM coordinate numbers are expressed in meters north and east of reference points noted on U.S. Geological Survey Topographic Maps. It is difficult to absolutely identify coordinates to the nearest meter; however we believe these are accurate. All soils data collected by these authors are referenced to the coordinates listed in Figure 1.

The response of crops grown on this farm are greatly affected by the physical, chemical and biological characteristics of the soils. Therefore, it is essential that the nature, properties, and distribution of the soils be known. This paper presents soil characterization data about MAC Farm soils that should be very useful in helping researchers understand plant responses on the farm.

The MAC Farm was acquired in January, 1983 and field studies and collection of soil samples to map and characterize the soils began in May, 1984 and continued until January, 1987. We initially sampled and described five (5) soil profiles on the research part of farm (Section 20), and they were sent to the National Soil Survey Laboratory in Lincoln, NE for detailed analyses. In January of 1987 six (6) additional soil profiles were described and sampled on the demonstration part of the farm (Sections 17, 18, and 19), and selected analyses were completed on these pedons. The lab procedures used to characterize these soils are described in Soil Survey Investigation Report #1.

Many soil borings to depths of 1.0-1.5 meters were made throughout the farm and appropriate notes and observations recorded. Over 800 Ap surface horizon samples (0 to 30cm depth) were collected on a grid system, and selected analyses were completed on these samples. The soil map of the farm and a display of soil properties, notably the texture of the surface soil horizon, is presented in this paper. The methodology and terminology used to prepare the soil map follows the National Cooperative Soil Survey guidelines as presented in the National Soils Handbook, the Soil Survey Manual, and Soil Taxonomy.

The Soil Map of MAC

Three soil series, Casa Grande, Trix, and Shontik have been mapped on the farms. Table 1 lists the soil map unit name and the taxonomic classification for each soil series. Two of the mapping units are identified as an association of two soil series, which means the soils are geographically associated but we were not able to map them separately at the mapping detail used to complete the map presented in this paper.

Table 1. List of soil mapping unit names and the taxonomic classification of the soil series.

Map Unit Symbol	and Name	Classification of the Soil Series
CG	Casa Grande soils, reclaimed	Casa Grande - fine-loamy, mixed, hyperthermic Typic Natrargids
SH-CG	Shontik-Casa Grande association, reclaimed	Shontik - fine-loamy, mixed, hyperthermic Natric Camborthids
TR	Trix soils, reclaimed	Trix - fine-loamy, mixed (calcareous), hyperthermic Typic Torrifluvents
TR-CG	Trix-Casa Grande association, reclaimed	

Many factors affect soil formation and ultimately the physical, chemical, and biological properties of a soil. Two factors in particular have greatly affected the properties of the MAC farm soils: 1- the geologic history of these soils and 2- the agricultural development, especially land-leveling and soil reclamation activities.

Soils of the MAC Farm have formed on a relict basin floor of Pleistocene age, which has been partly affected by Holocene age (recent) alluvium deposited adjacent to the Santa Cruz Wash. Water movement through this area in the recent past was very slow and of low energy, resulting in a depositional rather than erosional environment near the Santa Cruz channel. Fine textured recent alluvium makes up the upper horizons of the Trix soil, which has been deposited on older soil material. The Casa Grande soil has not been affected by the deposition of recent alluvium, and it's characteristics are different from the Trix. The historic shallow, braided channels of the Santa Cruz Wash have subsequently been channelized into one large channel, and it now serves as a drain for irrigation tail waters as well as carrying overland flood waters.

All soils on the farm were strongly saline and sodic prior to agricultural development. Evidence of this chemical toxicity can be found adjacent to the farm in native areas where the sodium absorption ratios range from 20 to 40, and the electrical conductivity of the saturation extract range from 15 to 40 deciSiemens per meter. Salinization of this area probably occurred during early or mid-Holocene, and it appears to be a function of a fluctuating water table present in these soils during that time period. Although these soils have been successfully reclaimed, they retain some residual characteristics that require continuous monitoring. For this reason the taxonomic classification reflects this situation, but our soil map unit names does indicate that they have been reclaimed.

We identified four mapping units on the farm (Figure 2), and this map may suggest that the soils are uniform in properties. This is somewhat misleading because the soils have been significantly altered from their original conditions through extensive land leveling operations and various soil reclamation treatments. The Casa Grande (CG) and Trix (TR) mapping units are the most uniform; however the other two units are an association of two major soils. Additional field work would be required to determine which soil is present at a given location in these two mapping units. We estimate that the composition of the Trix-Casa Grande (TR-CG) association, reclaimed mapping unit is about 65% Trix soil, 25% Casa Grande soil, and 10% inclusions of other similar soil series. The Shontik-Casa Grande (SH-CG) association, reclaimed mapping unit is 70% Shontik soils, 15% Casa Grande soils, and 15% inclusions of other similar

soil series. The Casa Grande soils, reclaimed and the Trix soils, reclaimed are comprised 85 to 90% of these soils, with minor inclusions of other similar soil series.

The texture of the surface Ap horizons on MAC farm (0-30 cm depth) are sandy loam, sandy clay loam, or clay loam. Figure 3 shows the distribution of these three classes on the farm. The linear boundaries are related to existing field boundaries, and abrupt changes in surface textures have been created through the land-leveling process. The Trix soil has either a clay loam or sandy clay loam surface,and it is higher in organic matter and therefore darker in color than the other two soils. The Casa Grande surface is usually a sandy loam or sandy clay loam texture, whereas the Shontik soil has a sandy loam surface. The Shontik soil surface is more sandy than the Casa Grande, usually having from 65-75% (or more) sand content. Figures 4 and 5 are maps showing the absolute percentages of sand and clay in the surface horizon (0-30 cm) for the entire farm.

Description of the Soil Series

A soil map does not preclude the need for site-specific evaluations of the soil which are commonly needed on research study plots. However, it is useful to have some general descriptive information about the three soils mapped on the farm.

Presented below are some descriptive information about each soil, and Table 2 summarizes selected soil characterization data for each soil. Future papers will include more detailed information on these soils, but these numbers can be helpful, if used judiciously. We have included data for the major horizons and ranges are given rather than specific numbers. If a single number is required, an average of the two values would be an appropriate number to use.

The Casa Grande soil is a deep, well drained slowly permeable soil formed in old alluvium. On the MAC Farm this soil typically has a brown to reddish brown sandy loam or sandy clay loam surface horizon from 0-30 cm deep. The subsoil horizon from 30 to 60 cm is usually a reddish brown sandy clay loam, which increases in calcium carbonate content with depth. Below this horizon at a depth of 60 to 100 cm is a horizon enriched with calcium carbonate (calcic horizon), which also has a sandy clay loam texture. The depth to the calcic horizon varies from 25 to 100 cm in depth, but commonly occurs between 50 and 80 cm in depth.

The Trix soil is a deep, well drained very slowly permeable soil whose upper horizons are formed in fine textured recently deposited alluvium, which in turn overlies Casa Grande soil material.

Typically this soil has a dark brown clay loam or sandy clay loam surface horizon 0-30 cm deep. The upper subsurface horizon ranges from 30 to 100 cm deep, and it typically averages about 75 cm deep. It has similar characteristics as the surface horizon (Table 2). Underlying this horizon is Casa Grande soil material, and it has properties similar to that described for the subsurface horizons of the Casa Grande soils.

The Shontik soil is a deep, well drained moderately to moderately rapid permeable soil found in sandy alluvium. It has a brown sandy loam surface horizon 0-30 cm deep, and is usually higher in sand content than the Casa Grande surface horizon. The subsoil horizons extend from 30 to 100 cm or more, and are very similar to the surface horizons, also having a sandy loam texture (Table 2). There are no enrichments of calcium carbonate in this soil above 100 cm; however it is present at deeper depths.

SUMMARY

This paper has presented a soil map and described the characteristics of the MAC Farm soils. Because characteristics of a soil are strongly related to soil texture, we have summarized the MAC Farm data in relationship to soil horizon textural properties. Table 2 gives the numerical ranges of selected soil properties for the major soil horizons, and it does this by soil series and by soil depth. Therefore, if one knows the textural properties of the study site and the soil depth, it is possible to get reasonable numerical values for the bulk density and soil porosity, water holding capacity, organic matter, cation exchange capacity, and calcium carbonate content. We have not included data on pH, soluble salt content, and the sodicity condition of MAC soils. These parameters are highly variable from year to year and even within a growing season, so site-specific analyses must be made if these parameters are needed. Future papers will further describe and characterize MAC soils, as there is much yet to be learned.

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Table 2. Soil characterization data for the MAC Farm soils.

SOIL MAPPING UNIT SYMBOL	TEXT. CLASS	Depth cm	Sand %	Clay %	Bulk Density g/cm^3	Total Pore Space %	% Water-Weight Basis* -.1 Bar	-.33 Bar	-.15 Bar	Organic Matter %	$CaCO_3$ %	CEC meq/100g
SH	SL	0- 30	65-75	10-15	1.40-1.60	40-47	17-23	14-19	6.6- 7.0	.4- .6	2- 5	8-10
SH	SL	30-100	65-75	10-15	1.40-1.60	40-47	17-23	14-19	6.6- 7.0	.1- .2	4- 6	7- 9
CG	SL,SCL	0- 30	55-65	15-22	1.40-1.60	40-47	16-22	12-18	7.0- 9.0	.5- .7	3- 5	9-13
CG	SL,SCL	30- 70	55-65	15-22	1.50-1.65	38-43	16-22	12-18	7.0- 9.0	.1- .3	4-20	8-12
CG	SCL	0- 30	45-55	22-27	1.45-1.55	42-45	18-23	16-19	10 -10.5	.8-1.2	3- 5	13-16
CG	SCL	30-100	45-55	22-27	1.45-1.55	42-45	18-23	16-19	10 -10.5	.2- .4	5-20	12-15
TR	SCL	30-100	45-55	22-27	1.45-1.55	42-45	18-23	16-19	10 -10.5	.6- .8	3- 6	15-18
TR	CL	0- 30	25-45	27-40	1.40-1.55	42-47	21-27	18-24	13.5-15.5	1.2-1.5	2- 3	24-27
TR	CL	30- 70	25-45	27-40	1.40-1.55	42-47	21-27	18-24	13.5-15.5	.5-1.0	2- 3	22-26

*Note: % Water (Weight Basis) X Relative Bulk Density = % Water on Volume Basis

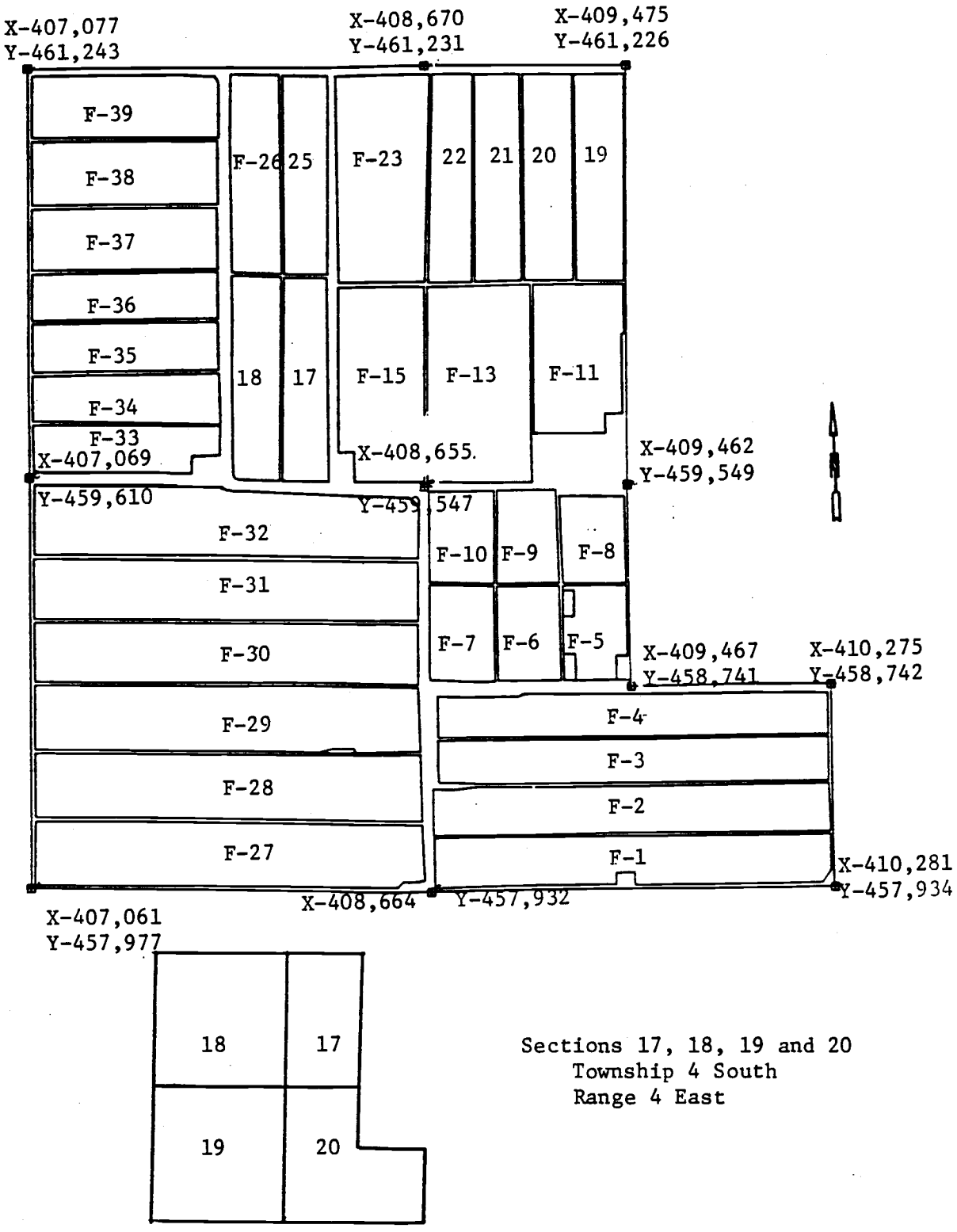


Figure 1. Field map of the Maricopa Agricultural Center.

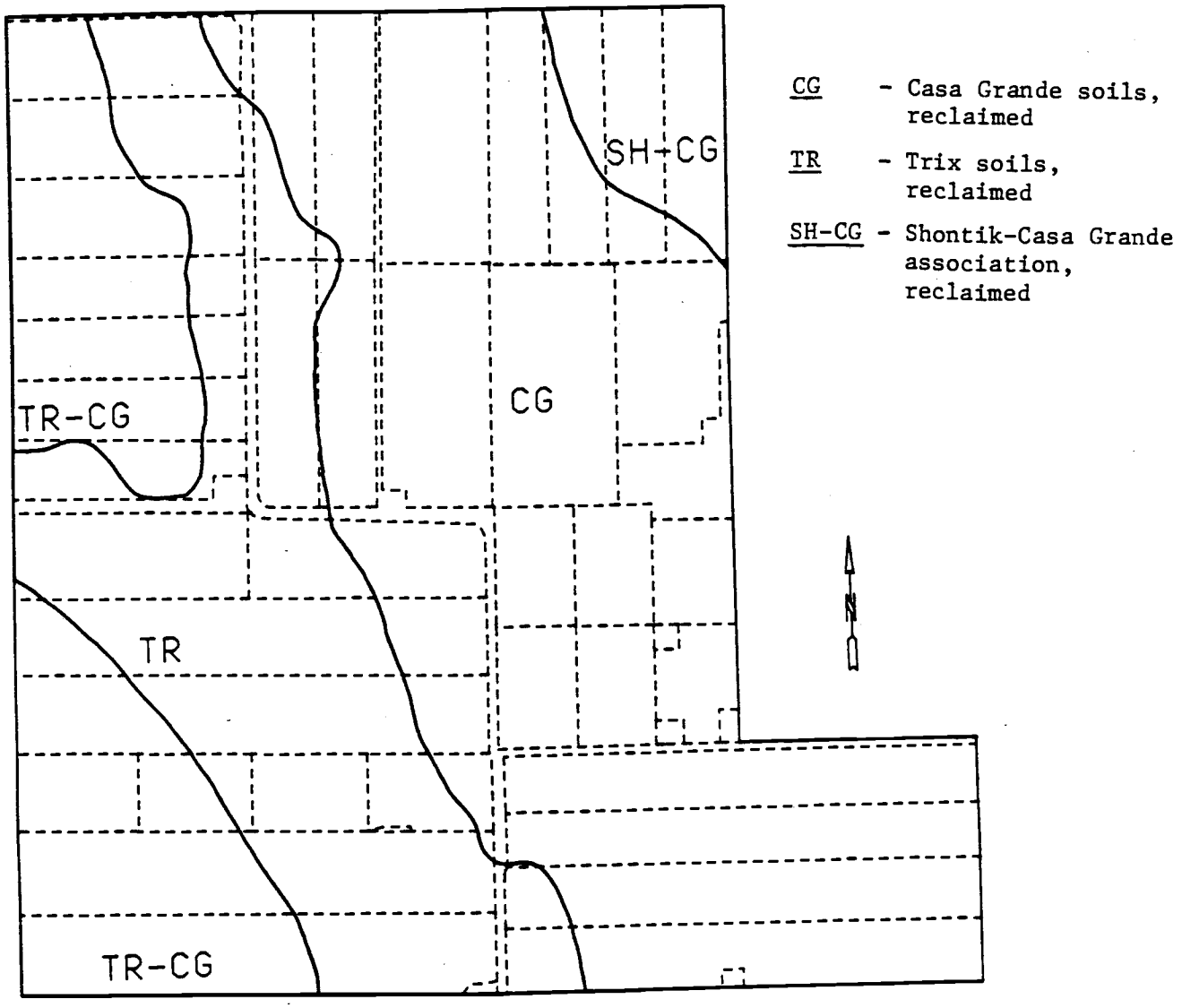


Figure 2. Soil map of the Maricopa Agricultural Center.

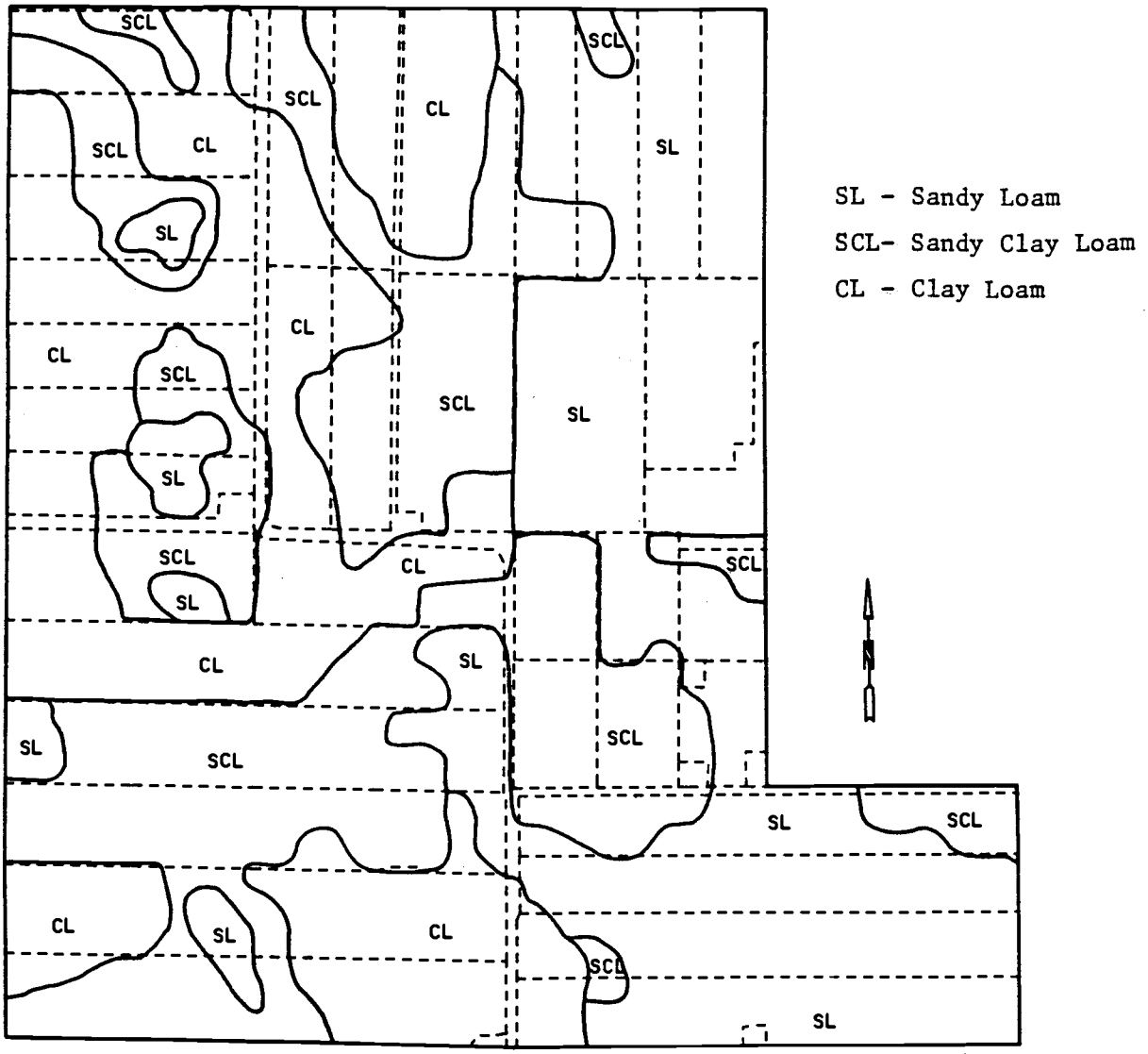


Figure 3. Surface textural map of the Maricopa Agricultural Center.

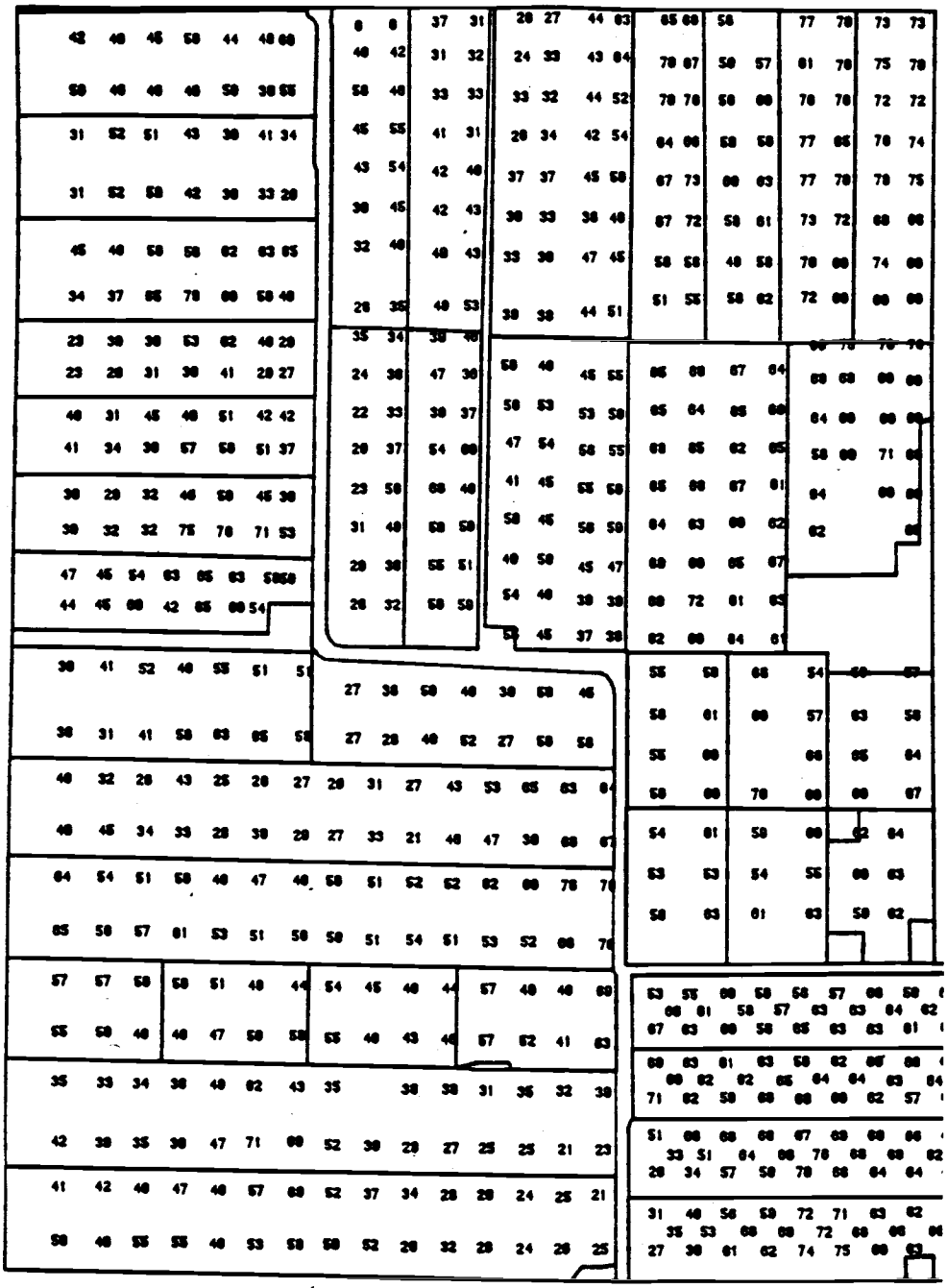
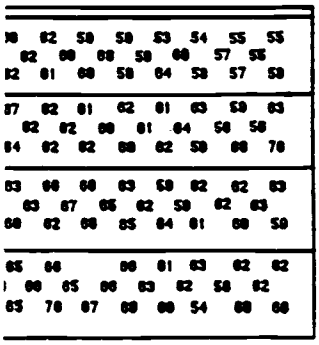


Figure 4. Percent sand in the surface Ap horizon (0 - 30 cm depth).



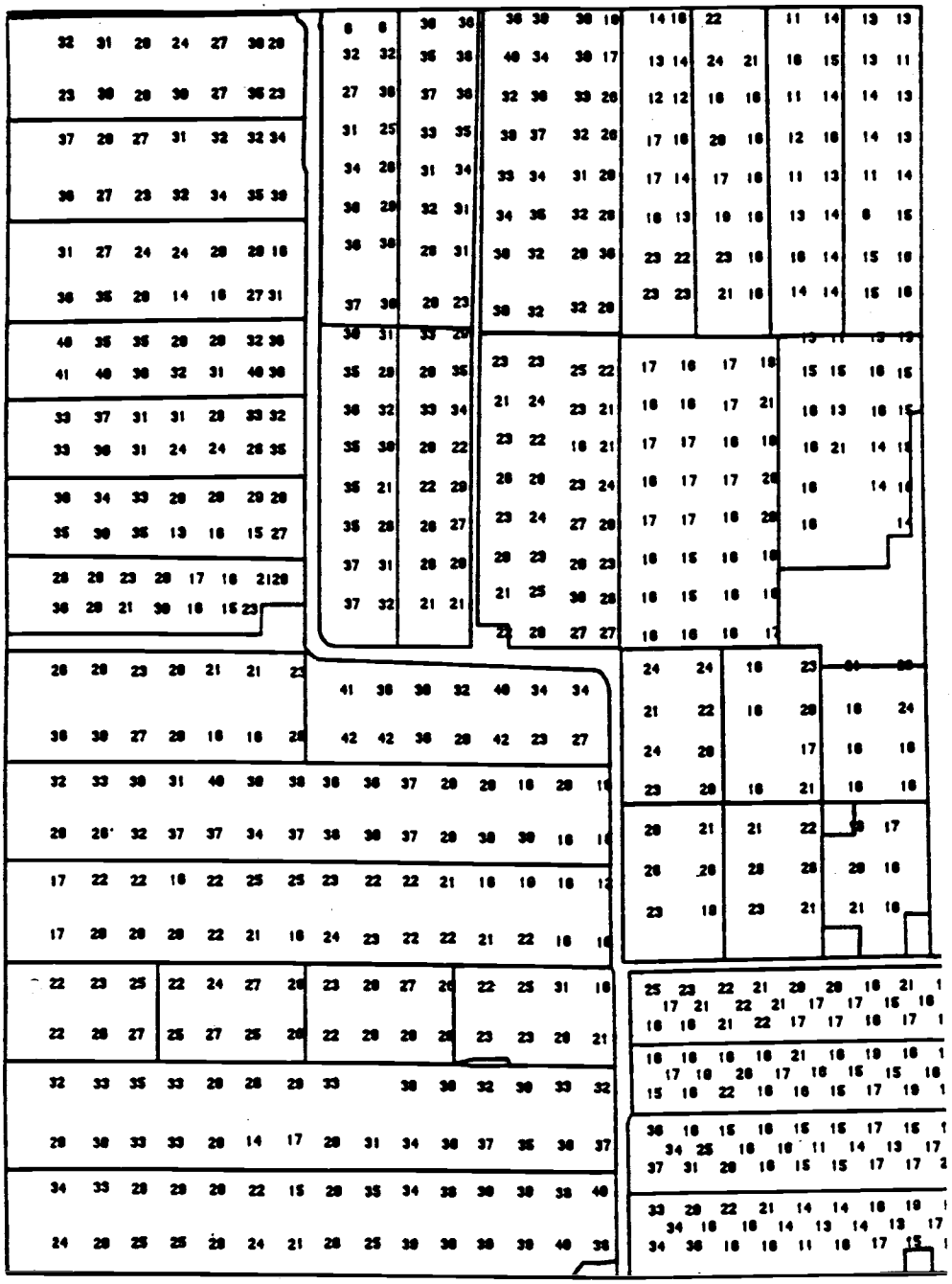


Figure 5. Percent clay in the surface Ap horizon (0-30 cm depth).