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ETL-0254, Terrain analysis procedural guide for soil, February 1981

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FEBRUARY 1981

RMY CORPS OF ENGINEERS
EER TOPOGRAPHIC LABORATORIES
BELVOIR, VIRGINIA 22060

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This report is one in a series of terrain analysis procedural guides being developed in support of the Topographic Support System (TSS). It was written specifically for a U.S. Army terrain analyst and presents the step-by-step methods needed for extracting, reducing, and recording soil information on a factor overlay and supporting data table.

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PREFACE

This guide for soils is one of a series of Analysis and Synthesis Guides to be produced. After some modifications, the guides will be published as Department of Army manuals. For this reason, critical comments and suggestions are requested by the authors.

The published guides in this series are

Number	Authors	Title	AD Number
ETL-0178	Jeffrey A. Messmore Theodore C. Vogel Alexander R. Pearson	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR VEGETATION (Report No. 1 in the ETL Series on Guides for Army Terrain Analysts)	AD-A068 715
ETL-0205	Theodore C. Vogel	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR ROADS AND RELATED STRUCTURES (Report No. 2 ...)	AD-A080 021
ETL-0207	James Tazelaar	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR GEOLOGY (Report No. 3 ...)	AD-A080 064
ETL-0220	Alexander R. Pearson Janet S. Wright	SYNTHESIS GUIDE FOR CROSS-COUNTRY MOVEMENT (Report No. 4 ...)	AD-A084 007
ETL-0247	Roland J. Frodigh	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR CLIMATE (Report No. 5 ...)	AD-A095 158

This study was conducted under DA Project 4A762707A855, Task C, Work Unit 11, "Military Geographic Analysis Technology."

The authors wish to express their appreciation to Mr. Allen H. Reimer, Terrain Analysis Center, for his technical assistance in preparing this report.

This study was done under the supervision of A. C. Elser, Chief, MGI Data Processing and Products Division; and K. T. Yoritomo, Director, Geographic Sciences Laboratory.

COL Daniel L. Lycan, CE was the Commander and Director and Mr. Robert P. Macchia was Technical Director of the Engineer Topographic Laboratories during this report preparation.

CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. Customary Units of Measurement used in this report can be converted to metric (SI) as follows:

Multiply	BY	To Obtain
inches	25.4	millimeter
feet	30.48	centimeter
miles	0.6093	kilometer
acres	0.405	hectare
ounces	28.57	gram
gallons	3.785	liter
Fahrenheit degrees*	5/9	Celsius degrees, Kelvin

---

*To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula:

$$C = (5/9)\ (F-32)$$

To obtain Kelvin (K) readings, use formula:

$$K = (5/9)\ (F-32) + 273.15$$

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Terrain Analysis Procedural Guide For Soil

I. INTRODUCTION

A. Purpose

The purpose of this guide is to provide the terrain analyst with procedures for (1) Deriving specific information on soil when field sampling is impossible and a soil scientist is not available, and (2) Presenting this information on a factor overlay and data table (figures 1 and 2). The soil factor overlay and data table present estimates of most probable USCS (Unified Soil Classification System) soil types, their characteristics, and distribution.

B. Background

The type of soil and its moisture condition affect such Army tasks as road construction, building foundation determination, construction site selection, construction material location, foxhole excavation, and cross-country movement. Some soils can bear more weight than others, some are easier to dig into, some become quagmires after too many vehicle passes. Prior knowledge of the soil to be encountered facilitiates military planning.

There is an endless variety of soil worldwide because soil is formed by the interaction of many factors such as geology, climate, biological acitivity, topographic position, and time. To describe, classify and map soil is then a very difficult task, normally requiring the knowledge and experience of soil scientists and exhaustive field sampling. In the absence of a soil scientist and access to the field for sampling however, the terrain analyst can produce an acceptable soil factor overlay by examining maps, other factor overlays, lab analyses, boring logs, and literature. The reliability of the resulting soil factor overlay will vary with the reliability of the sources used and the analyst's ability to correlate and combine the sources correctly.

C. Data Elements

The following data elements are necessary to determine the characteristics of the soil and its moisture condition. The information for these elements will be derived by the analyst from available sources:

1. Soil Profile. Description of the soil with depth, including the following:

   a. Horizon - identification of soil layers.

   b. Depth - depth ranges for each horizon in meters.

   c. Unified Soil Classification System (USCS) symbol - identification of soil type for each horizon with 1 of the 15 USCS symbols.

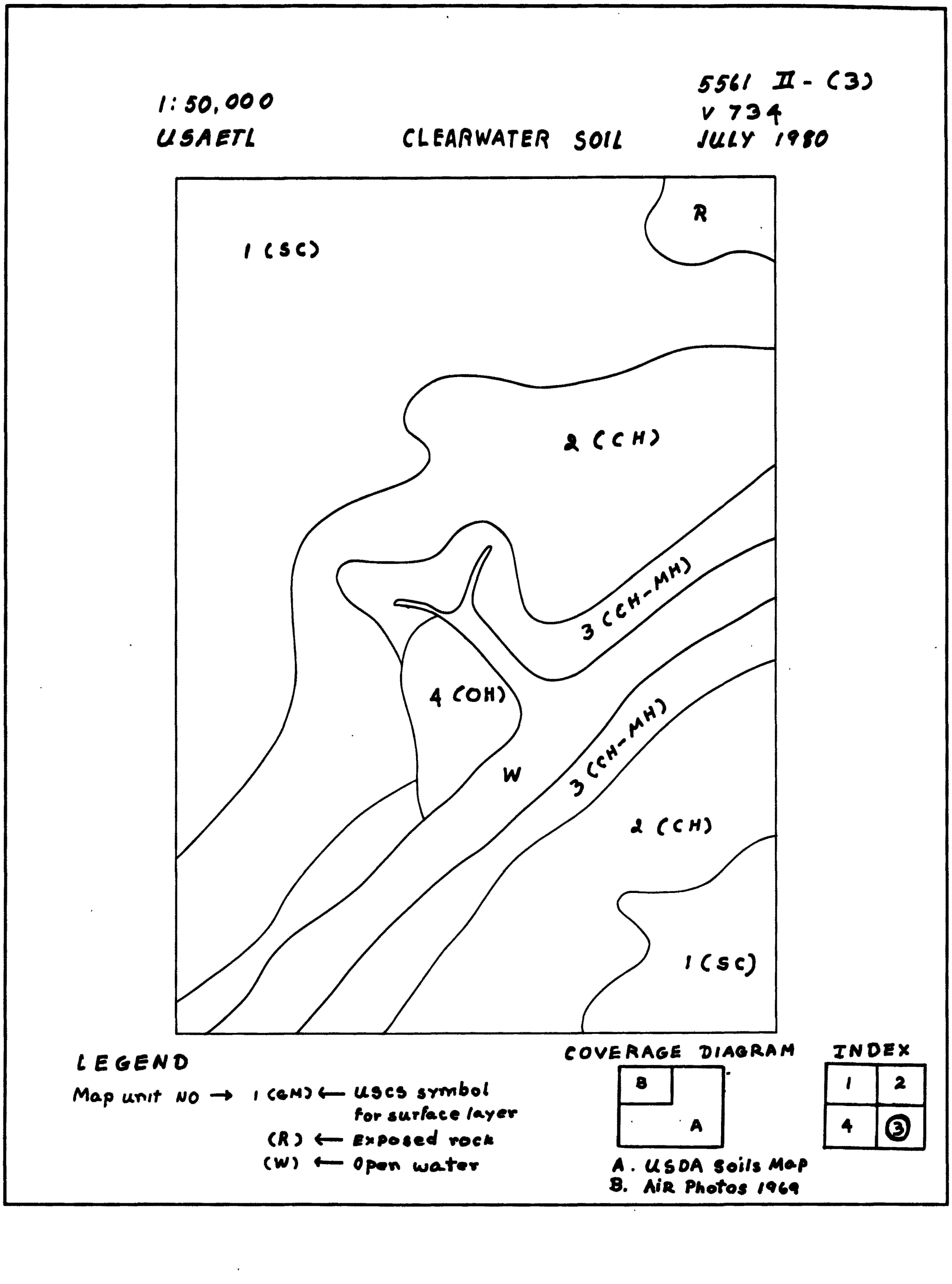

Figure 1. Sample Soil Factor Overlay

Soil Data Table

Map Unit Number	Soil Profile			Depth to Bedrock (M)	State of Ground												Stoniness (%)	RCI		Remarks
	Horizon	Depth (M)	USCS Symbol		J	F	M	A	M	J	J	A	S	O	N	D		Wet	Dry	
1	A	0-.3	SC	1.2	S	S	S	F	M	W	D	D	D	M	W	F	0	82T*	100T	These data are based on field sampling
	B	.3-.9	SM																	
	C	.9-1.2	SM																	
2	A	0-.15	CH	1.2	S	S	S	F	M	W	D	D	D	M	W	F	5	95	110	Stoniness varies; lower elevations tend to be stonier
	B	.15-.9	SC															80	102	
	C	.9-1.2	SP															N/A	N/A	
3	A	0-.5	CH-MH	1.8	S	S	S	F	M	W	D	D	D	M	W	F	15	85	150	
	B	.5-.9	MH															85	130	
	C	.9-1.8	MH															85	130	
4	—	?	OH	?	S	S	S	F	M	W	D	D	D	M	W	F	0	35	N/A	

* T values are best guesses.

Figure 2. Sample Soil Data Table

2. Depth to Bedrock. Total thickness of soil in meters.

3. State of Ground. Average monthly moisture condition of soil.

4. Stoniness. Estimated number of stones of a given diameter per volume of soil, which may be expressed as a percentage of the volume.

5. Rating Cone Index (RCI). An onsite or estimated value of soil strength derived from the cone index multiplied by the remolding index.

II. SOURCES

Seldom will a single source provide all the information required for the data elements. The orderly examination and comparison of different sources will most likely be needed to deduce the most probable soil type and distribution. As many as possible of the following types of sources should be collected and analyzed for the area of interest.

A. Maps.

1. Soil. The desirable scale for these and all other source maps is 1:50,000. If necessary, maps of other scales can be converted to 1:50,000 as described in appendix A. Soil maps are produced by various organizations for specific purposes. For example, engineering firms may produce soil maps for a road-building project, government agencies may produce soil maps for agricultural purposes or land-use planning, or academic institutions may produce soil maps for special studies.

The classification systems used on soil maps will usually vary with the producing agency and the purpose of the maps. The systems must be translated into the Unified Soil Classification System (USCS), which is the system used by the military. However, if a reliable and complete soil map exists that uses the USCS, it can simply be redrawn according to the Soil Factor Overlay format. Additional data searching may be necessary, however, to fulfill all the data element requirements.

2. Topography. Some features symbolized on topographic maps, such as vegetation, can provide clues to soil characteristics. Also, contours and land-use patterns can help define landforms and soil types; however, these latter aspects of topographic maps will not be treated in this guide.

Topographic maps are usually produced by national government agencies at varying scales. However, the standard military topographic maps produced by NATO countries are at the 1:50,000 scale.

3. Geology. Geologic maps are produced by government agencies, engineering or mining firms, academic institutions, and others at varying scales and for varying purposes. Depending on the purpose, geologic maps

may or may not be useful for soil analysis. Those maps that treat surficial or glacial geology would be the most useful because sometimes the surface geology can provide clues to the identity of soil.

4. Vegetation. In some instances, vegetation can be used as an indicator of a specific soil type. For these circumstances, military maps with symbolized vegetation, species distribution maps, or other vegetation maps may be helpful. Again, government agencies, private firms and academic institutions may be producers of such maps.

5. Climate. Climate maps provide data on annual variations in temperature and moisture conditions. Of special interest is information concerning the state of ground, e.g. wet, dry, moist, or frozen.

B. Factor Overlays. The following factor overlays, compiled by following procedures in other terrain analysis guides*, may be useful.

1. Landform. The Landform Factor Overlay, prepared from the Surface Configuration Guide, is a basic source. If possible, it should be completed before the Soil Factor Overlay is attempted. Landforms generally provide more reliable clues to the identity of soil than geology or vegetation.

2. Geology. If the Geology Factor Overlay and associated tables (prepared from the Terrain Analysis Procedural Guide for Geology) are completed, they should be used with available geologic maps.

3. Vegetation. If the Vegetation Factor Overlay and associated tables are completed, they should be used in conjunction with available vegetation maps.

4. Climate. If the Climate Factor Overlay and associated tables are completed, they should be used in lieu of other climatic data.

C. Special Reports. Reports like laboratory soil analyses, field test reports, boring logs, and well logs often provide much of the information required for the data elements for specific point locations. The soil characteristics at that point can be extrapolated to the surrounding area.

1. Laboratory Soil Analyses. These reports vary in format, but they often include information like grain-size distribution, plasticity, rating cone index (RCI), and the USCS symbol. An example of a laboratory analysis showing grain size is given in figure 3. Such analyses might be part of studies conducted by national or local governments, engineering firms, military agencies, land-use planning offices, and academic institutions, or they may be available from data collected by soil laboratories.

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* The procedures were outlined in Reports 1 through 5 of this series.

SIEVE ANALYSIS

Submitted by SFC Delosier   Date performed 10 Sep 1962

Description of sample Yellow white gravelly sand with a small amount of Silt Fines.

Test performed by:

1. SP-5 DILLON
2. E-3 COKER
3.
4.
5.

Wt. original sample 4000 gm.

Wt after prewashing 3865 gm.

Washing loss 135 gm.

$\frac{3955}{4000} \times 100 = 98.9\%$

Sieve or screen	Sieve Opening (mm.)	Wt. of sieve (gm.)	Wt. of sieve & sample (gm.)	Wt. retained on sieve (gm.)	Passing sieve		
					Weight in (gm.)	Percent	
*				0	3964	100	Gravel 36.9%
2"	50.8	634.1	679.1	45	3919	98.9	
1½"	38.1	598.9	649.9	51	3868	97.6	
1"	25.4	540.9	646.9	106	3762	94.9	
¾"	19.1	608.5	707.5	99	3663	92.4	
¼" (No. 3)	6.35	488.5	1368.5	898	2765	69.8	
No. 4	4.76	510.2	773.2	263	2502	63.1	Sand 58.6%
No. 10	2.00	476.4	1254.4	778	1724	43.5	
No. 40	0.42	377.9	1404.9	1027	397	17.6	
No. 60	0.25	366.7	615.7	249	448	11.3	
No. 100	0.149	320.6	456.6	136	312	7.9	
No. 200	0.074	303.9	435.9	132	180	4.5	Fines 4.5%

Wt. retained in pan .45 gm.

Washing loss 135 gm.

Pan total 180 gm.

Total weight of fractions 3964 gm.

Error=Original Wt. - Total Weight of fractions
36 gm
0.9%

*Maximum particle size (measured)
Prepared for use at USAES

Figure 3. Laboratory Soil Data

2. Soil Field Test Reports. These reports also vary in format, often including information on stoniness, depth to bedrock, and soil profile as well as information similar to that in laboratory soil analyses. An example of a field test report is given in figure 4. These reports may be available from the same sources listed in C.1.

3. Logs. Boring logs and well logs are listings or drawings of the sequence of earth materials that were penetrated during drilling. Boring logs are made during exploratory drilling for engineering projects to determine whether the earth will provide support for a planned structure. These logs might be obtained from local highway departments, engineering firms, or military engineers that have worked on projects in the area of interest. A sample boring log is given in figure 5.

Well logs are often made during exploratory drilling for water, oil, or gas. Information such as soil profile, depth to bedrock, and stoniness may be determined from such logs. Well logs might be obtained from oil or water companies, or municipal water agencies.

D. Literature. Literature reports are published by academic institutions, government agencies, or private firms that discuss any of the soil-related subjects above (soil, topography, geology, vegetation).

III. ANALYSIS CONCEPT

Often, one or more of the sources listed above will not be available. Those that are available must be examined, and information selected from them must be used in accordance with the procedures in this guide.

Probably, no single source will provide all of the soil information required. In fact, most of them will not give the required information directly. Therefore, each source must be examined to determine what soils probably exist under the conditions described by the source. Then, lists of probable soils are made from each source. The soil common to all lists is considered the most probable soil for the area of interest. The boundaries of the soil are drawn and identified on the Soil Factor Overlay. The specific soil characteristics represented by the data elements listed in section I.C. are described on the Soil Data Table.

The Soil Factor Overlay and the Soil Data Table will be stored in a data base from which they can be retrieved as needed and used to accomplish specific tasks. For example, they may be used to determine the best sites for building construction or to construct terrain products like cross-country movement and cover and concealment maps (figure 6).

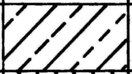
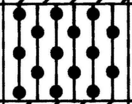
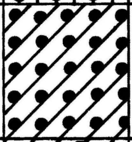
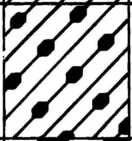
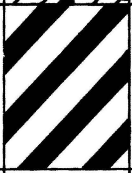
The orderly data search required to develop the Soil Factor Overlay and Soil Data Table should follow the analysis sequence given in the following Procedural Outline section. It is likely that one or more of the analysis steps may be omitted because of lack of sources.

REPORT OF FOUNDATION AND BORROW INVESTIGATION

SITE Airfield Jamock TYPE EXPLORATION Hasty DATE 10 April

BORING NO. 4 LOCATION 20 + 00 GROUND ELEV. 236

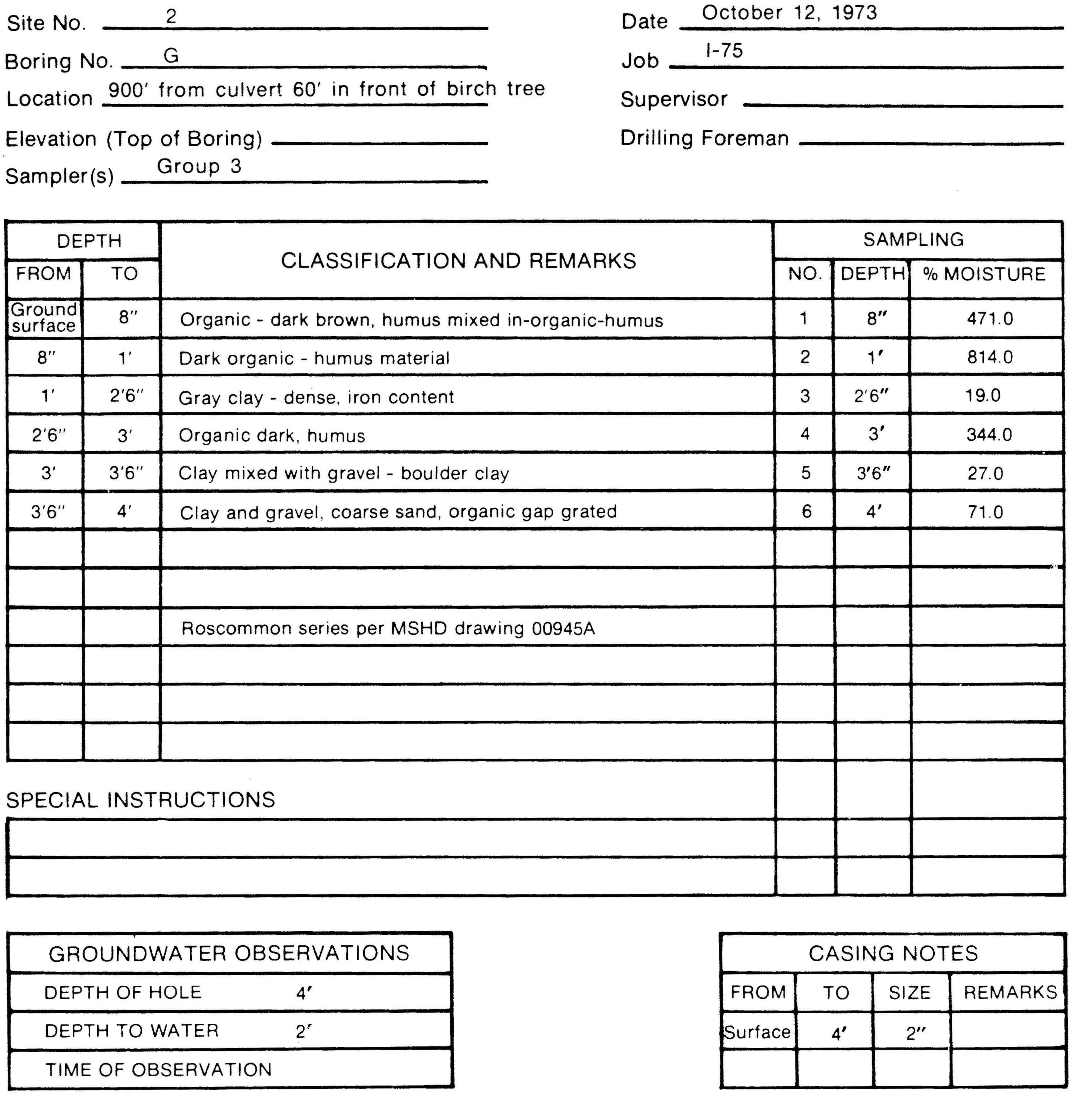
PURPOSE OF EXPLORATION Determine soil profile along the centerline of runway.

DEPTH BELOW SURFACE	ELEV.	SAMPLE NO, TYPE & DEPTH	GRAPHIC LOG	GROUP SYMBOL	DESCRIPTION, TEST DATA, & REMARKS
1'	235	No. 10 at ½'		OH	Brown and very plastic. Typical topsoil of the area.
2½'	233.5	No. 11 at 2'		SM	Fine sandy soil with high percentage of silt. Light tan color.
4½'	231.5'			SC	Coarse sandy soil with a plastic binder material. Light reddish color.
6½'	229.5'	No. 12 at 5'		GC	Clayey gravel, high cohesion, sticky. Compact and very moist. Gravel heavily weathered and well rounded.
9'	227'			CH	Brown, sticky clay with very high plastic qualities. Same material as found in boring No. 1 from 5 Ft. down. Bottom of hole.

Depth to Water Table 3 ft.

Submitted by Cpl Mc Gurk

Figure 4. Field Test Data



Site No. 2

Boring No. G

Location 900′ from culvert 60′ in front of birch tree

Elevation (Top of Boring)

Sampler(s) Group 3

Date October 12, 1973

Job I-75

Supervisor

Drilling Foreman

DEPTH		CLASSIFICATION AND REMARKS	SAMPLING		
FROM	TO		NO.	DEPTH	% MOISTURE
Ground surface	8″	Organic - dark brown, humus mixed in-organic-humus	1	8″	471.0
8″	1′	Dark organic - humus material	2	1′	814.0
1′	2′6″	Gray clay - dense, iron content	3	2′6″	19.0
2′6″	3′	Organic dark, humus	4	3′	344.0
3′	3′6″	Clay mixed with gravel - boulder clay	5	3′6″	27.0
3′6″	4′	Clay and gravel, coarse sand, organic gap grated	6	4′	71.0
		Roscommon series per MSHD drawing 00945A			

SPECIAL INSTRUCTIONS

GROUNDWATER OBSERVATIONS	
DEPTH OF HOLE	4′
DEPTH TO WATER	2′
TIME OF OBSERVATION	

CASING NOTES			
FROM	TO	SIZE	REMARKS
Surface	4′	2″	

Figure 5. Boring Log Data

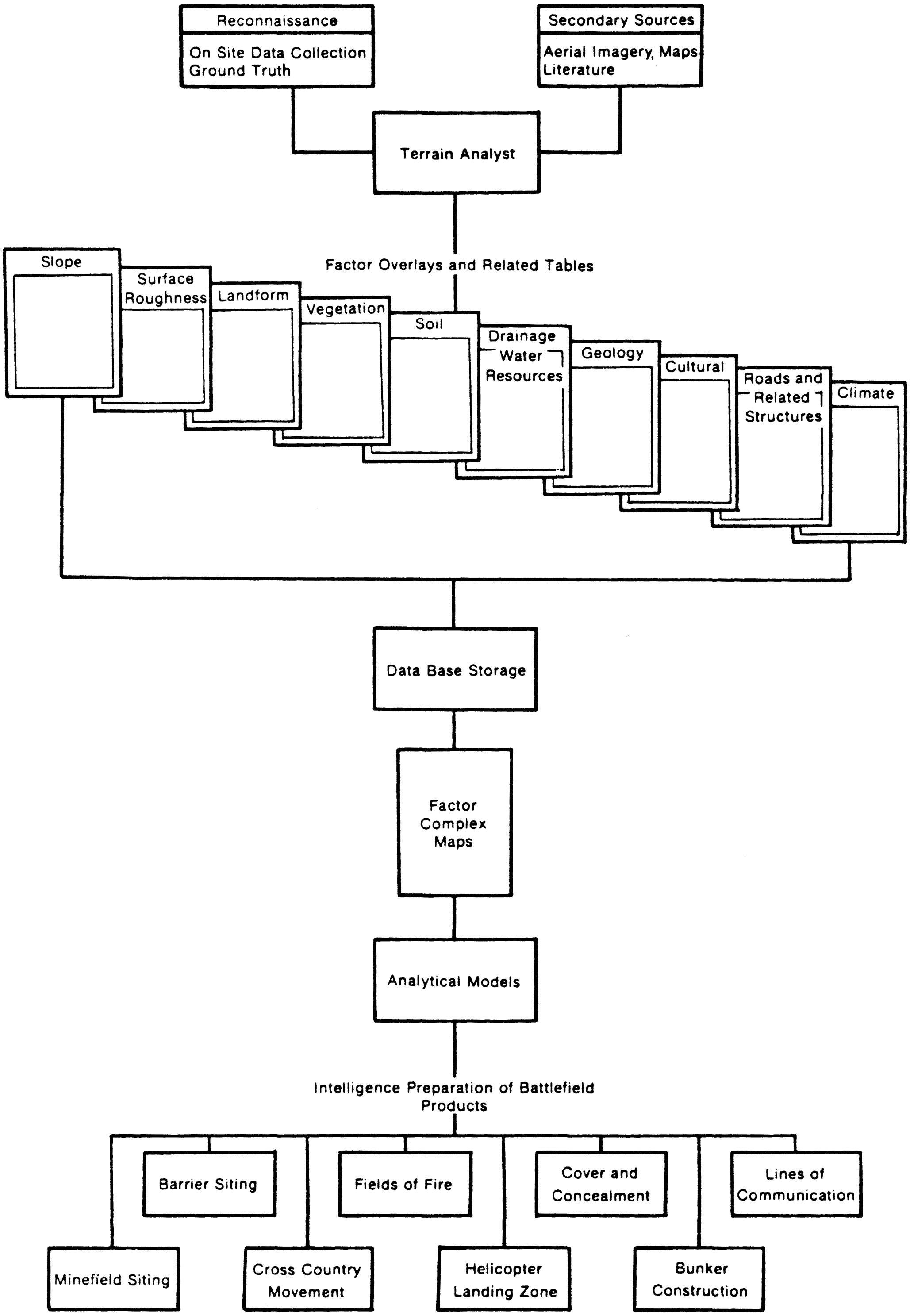


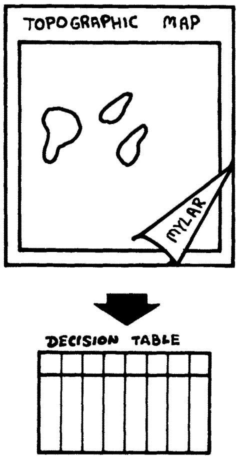
Figure 6. Production and Use of Factor Overlays and Related Tables

IV. PROCEDURAL OUTLINE

1. Collect and examine available soil maps. If a reliable soil map* exists for the area of interest that contains all the information required for the data elements, further data searching or analysis of other sources is NOT necessary. In this case proceed now to Appendixes. A and B for reformatting and addition of required marginal information.

2. Gather all other available sources described in Part II of this guide.

3. Pull out the 1:50,000 scale topographic map(s) covering the area of interest. Place a sheet of frosted mylar over the map(s). Trace boundaries of symbols of interest and assign appropriate T-codes to these areas using Table 1. Record T-codes and associated soil types in the Decision Table.



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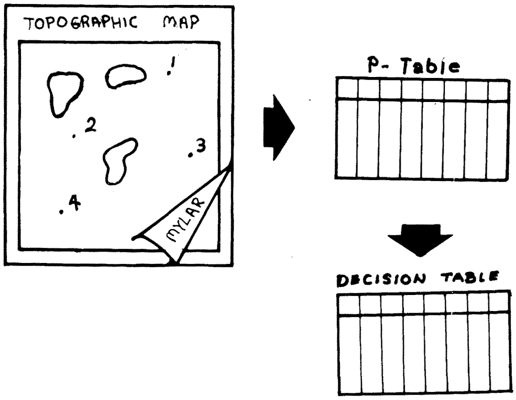
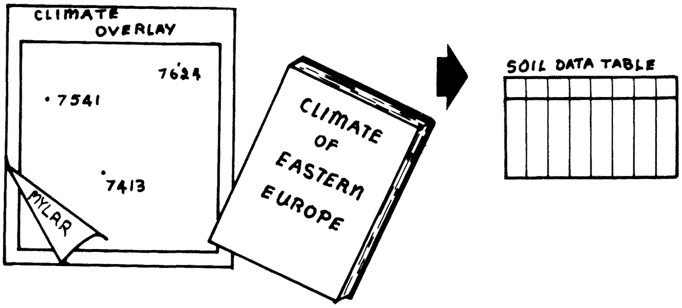
*A reliable soil map, for the purposes of this Guide, is one derived from actual field surveys and printed at a scale of 1:50,000 or larger.

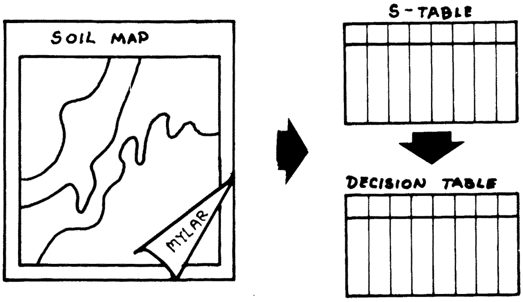
4. Plot locations of well logs, soil samples and so on for which lab analyses or field test reports are available. Record appropriate soil characteristics on the Point Source Table (P-Table) and enter findings on the Decision Table.



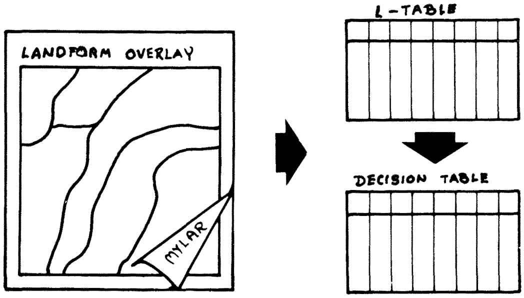
5. Consult the Climate Factor Overlay or appropriate literature to determine the climate for the area of interest and the state of ground. Record this information on the Soil Data Table.



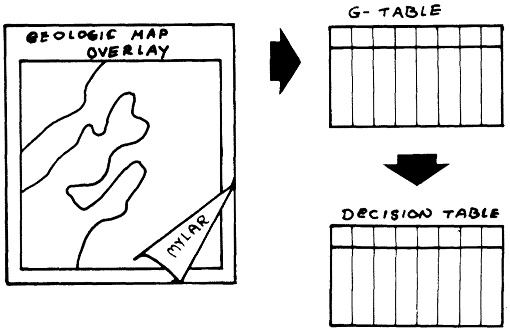
6. Pull out the soil map(s). Translate the given soil classification(s) into the Unified Soil Classification System. Trace the soil boundaries onto the mylar overlay. Record probable soil(s) information on the Soil Table (S-Table). Consolidate findings on the Decision Table.



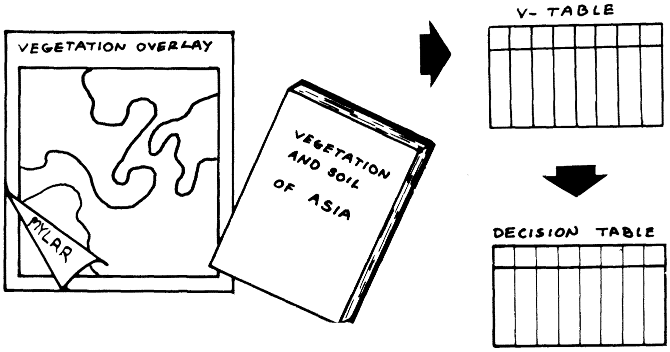
7. Pull out the Landform Factor Overlay. Trace landform boundaries onto the mylar sheet. Determine landform-soil associations. Record probable soil(s) on the Landform Table (L-Table). Consolidate findings on the Decision Table.



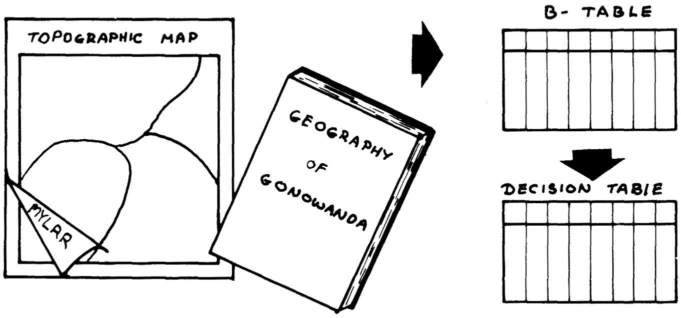
8. Pull out the Geology Factor Overlay or Geologic Map(s) of the area of interest. Look for clues to soil(s). Draw soil boundaries on mylar sheet. Record probable soil information on the Geology Table (G-Table). Consolidate findings on the Decision Table.



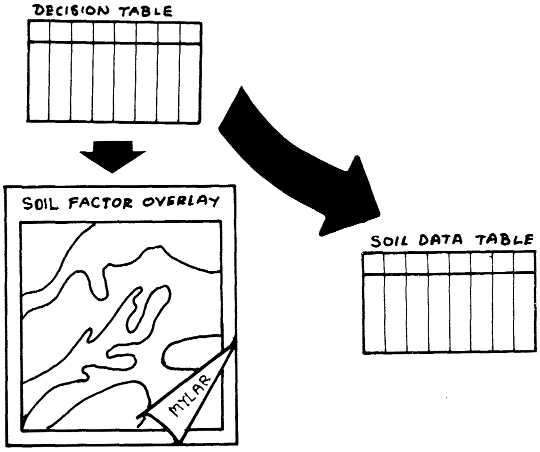
9. Pull out the Vegetation Factor Overlay or Vegetation Map(s), and literature. Examine the literature for instances where the occurrence of a specific type of vegetation is indicative of a particular soil or soil group in the area of interest. Draw the boundaries of any such vegetation soil association on the mylar sheet and record the probable soil(s) on the Vegetation Table (V-Table). Consolidate findings on the Decision Table.



10. Examine remaining literature for additional soil information. Draw soil boundaries on the mylar overlay. Refer to topographic maps for location information. Record information in the Literature Table (B-Table) and consolidate findings on the Decision Table.



11. On a new sheet of mylar, redraw soil boundaries based upon soil information derived from the Decision Table. Complete the Soil Factor Overlay and Data Table according to instructions.



V. ANALYSIS AND COMPILATION PROCEDURES

A. Gather Sources

1. Gather all available soil maps covering the area of interest. Examine their scales and legends. Extract those at 1:50,000 or larger scale that use the Unified Soil Classification System (USCS). If any of these are based on field surveys, they may be used as the Soil Factor Overlay base. For scale or projection adjustments that may be required, refer to appendix A. Further data analysis or extraction may be unnecessary if the above soil map(s) can produce all the information required by the data elements.

2. Gather all other available sources described in section II.

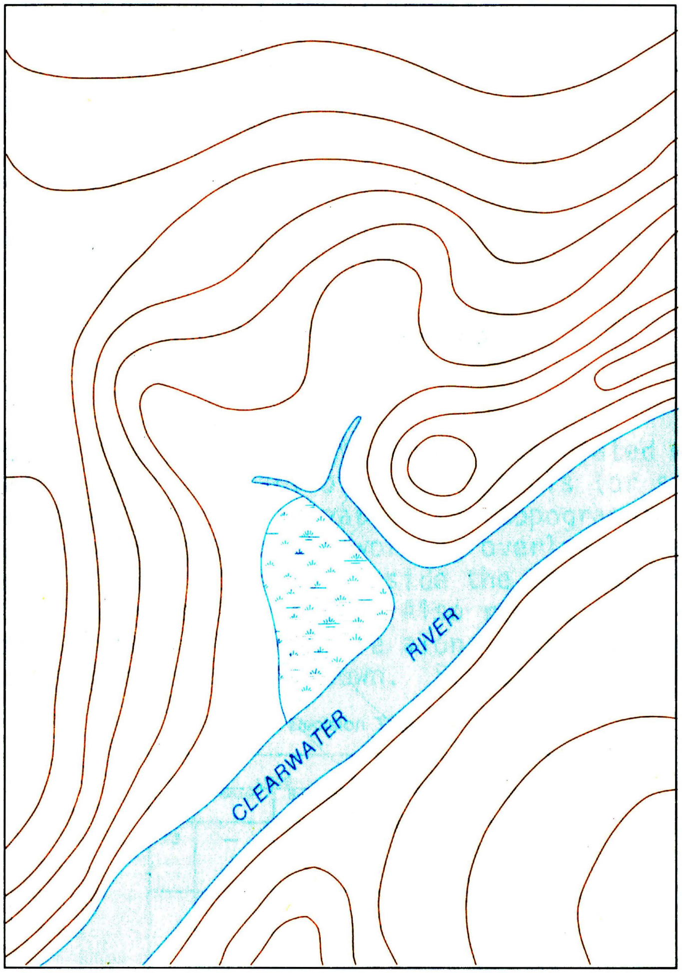
B. Examine Topographic Map(s)

1. Pull out the topographic map(s) that cover the area of interest (figure 7). A scale of 1:50,000 or larger is preferred with a fine contour interval (preferably at least 20 feet in areas of low relief).

2. Cover the selected topographic map with a clean sheet of mylar. Punch register or tape them together. If the area of interest does not cover the entire map area, outline the area of interest on the mylar in black pencil, and note the longitude and latitude or UTM coordinates at the corners. Otherwise, trace the topographic map neatlines onto the mylar. Trace the map name and number.

3. Trace the boundaries of all open water bodies (lakes, ponds, double-line streams) in black pencil, and label with a "W" as shown in figure 8.

4. Set up a Decision Table like the one shown in figure 9. This table will be used throughout the analysis and is used to organize the soil data as it is compiled on the working overlay. The various codes found at the top of the columns correspond to sources of soil information as follows: T-Code, Topographic maps; P-Code, Point source data; S-Code, Soil maps; L-Code, Landform information; G-Code, Geology information; V-Code, Vegetation data; B-Code, Literature information.



1:50,000 TOPOGRAPHIC MAP

Figure 7. Sample 1:50,000 Topographic Map

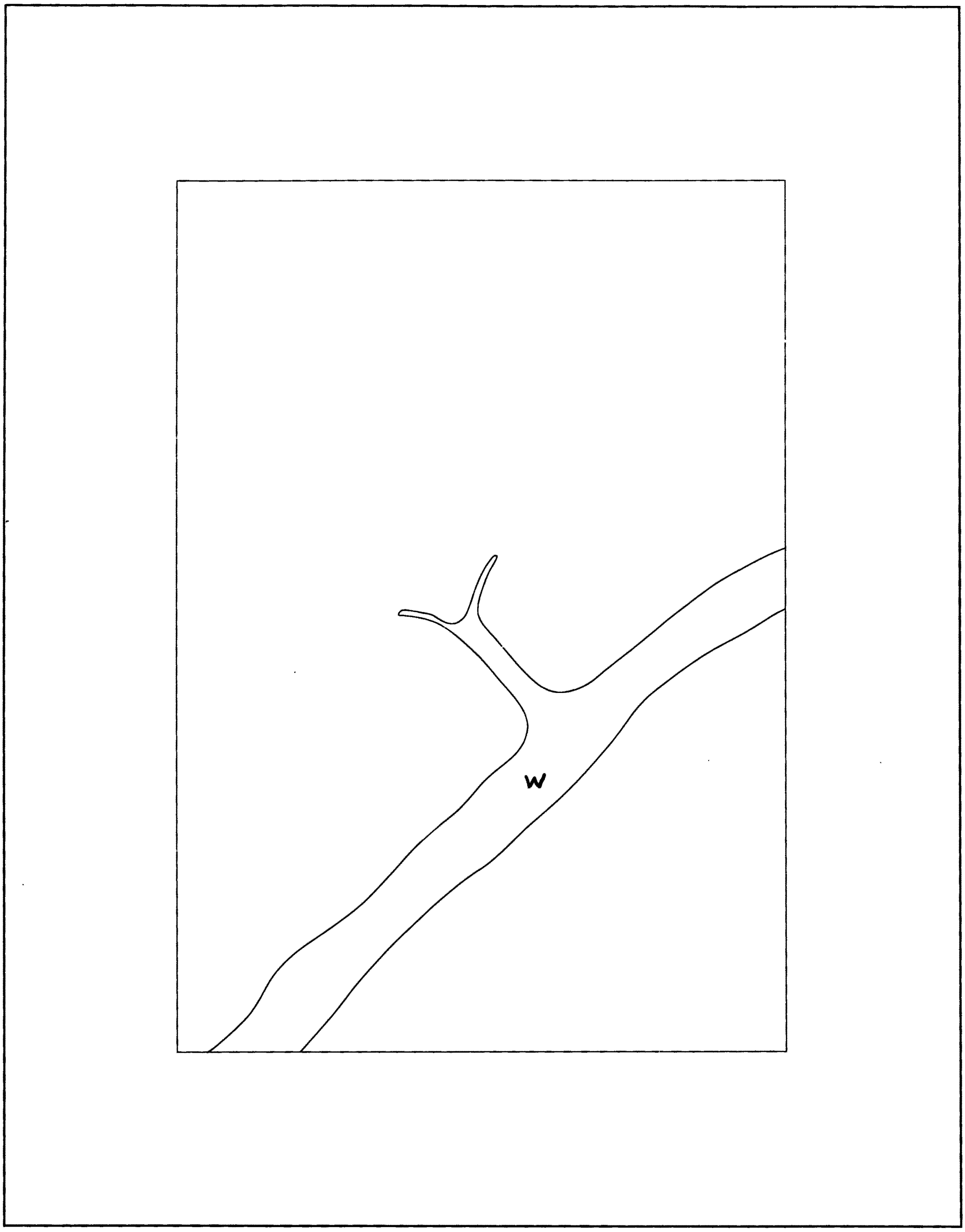


Figure 8. Working Overlay After Preliminary Topographic Map Analysis

Decision Table

T Code	USCS		P Code	USCS		S Code	USCS		L Code	USCS		G Code	USCS		V Code	USCS		B Code	USCS	
	Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols

Figure 9. Decision Table Format

5. Study Table 1 for soils commonly associated with symbols found on topographic maps. If any of these symbols (or similar symbols representing the same features) appear on the topographic map, enclose them with a black pencil line on the working overlay. Record the symbol number or T-Code, e.g. T1, T2, etc., inside the enclosed space on the working overlay as shown in figure 10. Also record the symbol number in the T-Code column of the Decision Table along with associated USCS soil types and horizon information, if known. See sample entry below.

Decision Table

T Code	USCS		P Code	USCS	
	Horizon	Symbols		Horizon	Symbols
T3	—	Pt,OH,CH MH,OL			

C. Review Special Laboratory Reports, Laboratory Analyses, Well Logs, and Boring Logs

1. Pull out all soil laboratory reports, logs, and other materials

TABLE 1. TOPOGRAPHIC MAP SYMBOLS AND ASSOCIATED SOILS

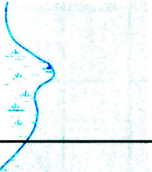
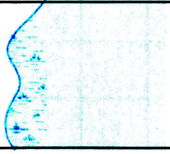
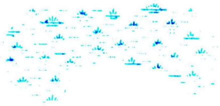
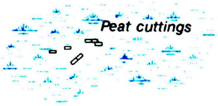
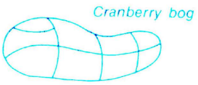
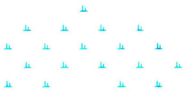
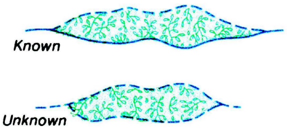
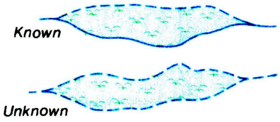
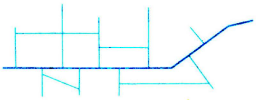
Symbol #	U.S. Army Topographic Map Symbols	Commonly Associated Soils
T1	 Marsh in tidal waters.	Horizon (A) Pt (B) OL, OH, MH
T2	 Marsh in nontidal waters	Pt, OH, CH, MH, OL
T3	 Swamp	Pt, OH, CH, MH, OL
T4	 Peat Bog	Pt
T5	 Peat Cuttings	Pt
T6	 Cranberry Bog	Pt, OH, CH, MH, OL
T7	 Rice fields	Pt, OH, CH, MH, OL
T8	 Mangrove	Pt, OH, CH, MH, OL
T9	 Nipa	Pt, OH, CH, MH, OL
T10	 Perennial Single line ditch (major & minor) used to drain swamps and inundated areas	Pt, OH, CH, MH, OL

TABLE1. (CONTINUED). TOPOGRAPHIC MAP SYMBOLS AND ASSOCIATED SOILS

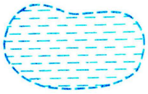
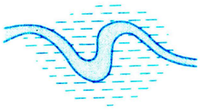
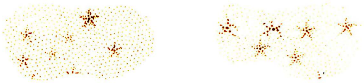
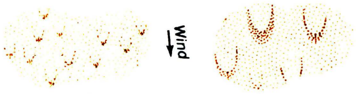
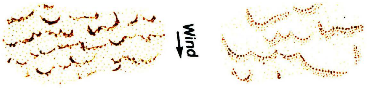
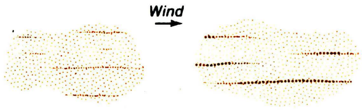
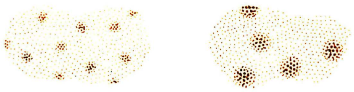
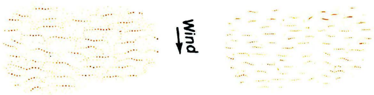
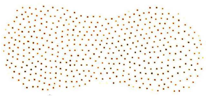
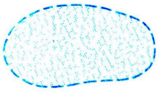
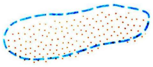
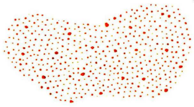
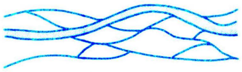
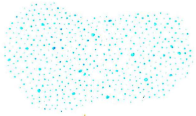
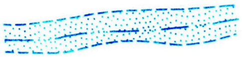
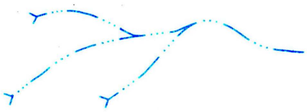
Symbol #	U.S. Army Topographic Map Symbols		Commonly Associated Soils
T11		Land subject to controlled inundation	Pt, OH, CH, MH, OL
T12		Land subject to natural inundation	Pt, OH, CH, MH, OL
T13		Star dunes	SP
T14		Crescent dunes	SP
T15		Ripple dunes	SP
T16		Longitudinal dunes	SP
T17		Sand Mounds	SP
T18		Transverse dunes	SP
T19		Wet sand	SP
T20		Sand	SP

TABLE 1 (CONTINUED). TOPOGRAPHIC MAP SYMBOLS AND ASSOCIATED SOILS

Symbol #	U.S. Army Topographic Map Symbols		Commonly Associated Soils
T21		Sebka	ML, CL, MH, CH, SM, SC
T22		Playa	ML, CL, SM, SC, MH, CH
T23		Gravel	GP
T24		Braided Channel	SP, GP
T25		Orchard	SP, SM, SC, GM, GC
T26		Moraine	See Table 2 and consult Section D to determine climate.
T27		Single line intermittent or dry stream (wadi or wash)	GP, SP, GM-GC, SM-SC, CH, CL
T28		Double line dry stream or wadi	GP, SP, GM-GC, SM-SC, CH, CL
T29		Disappearing stream	Humid Tropical A ML-CL A ML-CL, ML, CL, GM B CH B CH, MH, GC, GM C CH C CH, MH, GC, GM Unspecified A ML-CL, ML, CL, GM C CL, CH, MH, ML,CH-MH,ML-CL
T30		Dissipating stream	GW, GP, SW, SP

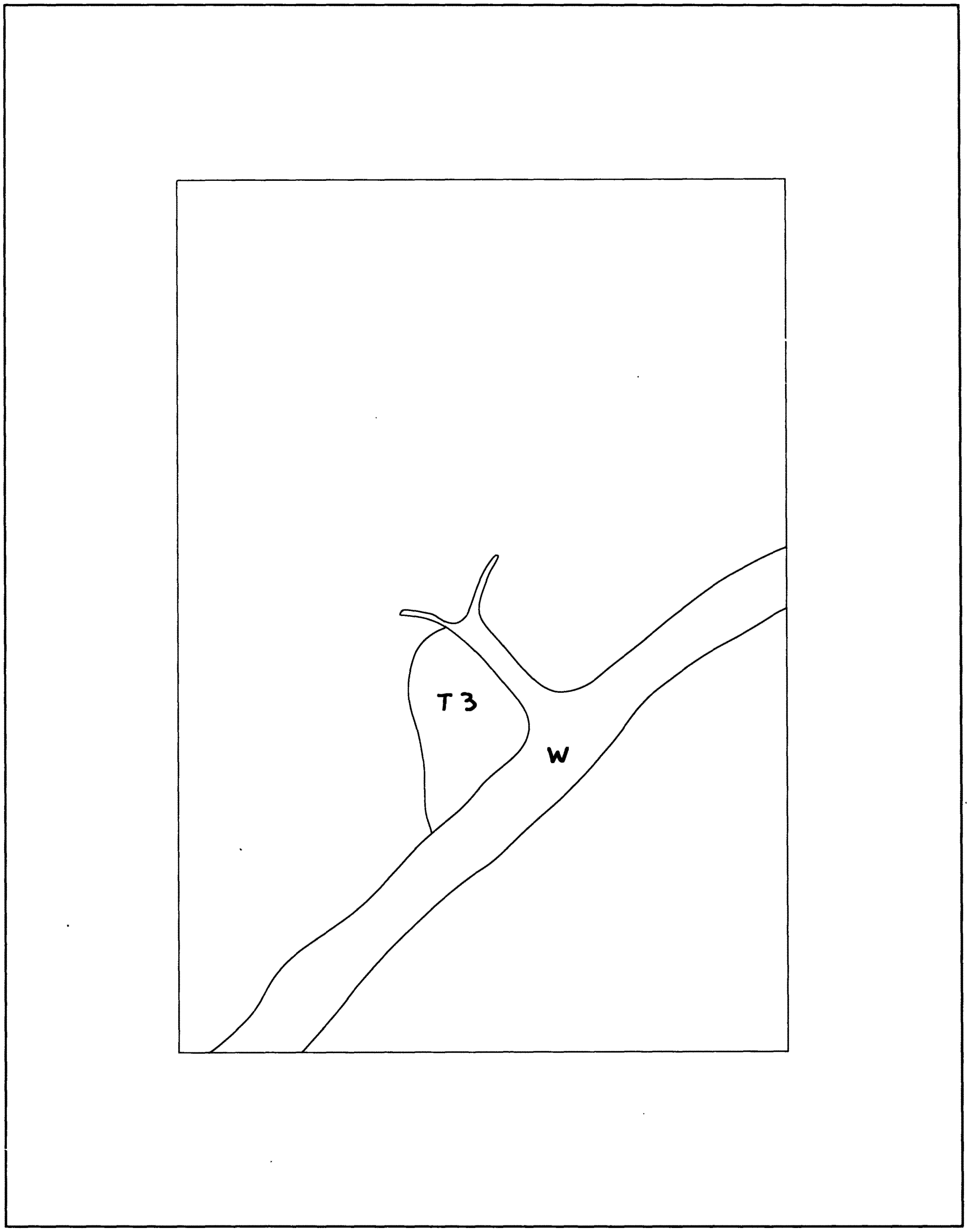


Figure 10. Working Overlay After Completion of the Topographic Map Analysis

collected earlier in section II. (If none are available, proceed now to section D.)

2. Examine these sources and select for further use those that provide all or part of the information required by the data elements.

3. On a separate sheet of mylar, make a Point Source Data Table (P-Table). See sample below.

P - Table

Point I D Code	Source	Soil Profile				Depth to Bedrock (M)	State of Ground												Stoniness (%)	RCI		Remarks
		Horizon	Depth (M)	USCS Symbols	Description of Layers		J	F	M	A	M	J	J	A	S	O	N	D		Wet	Dry	

4. Taking each of the useful sources one at a time, plot the locations of the field sampling sites, testing sites, boring sites, or other sites on the overlay, which is still registered to the topographic map, by drawing a black dot at the site location (figure 11). (Use the longitude and latitude for the sites that are usually given in the source.) Beside each dot write a black identification code (P-Code) beginning with the letter P and followed by a number. Starting with P1, number the sites consecutively from top to bottom and left to right.

5. Fill in as much of the Point Source Data Table as is possible for each site from the information presented in the source as shown in the following sample entries.

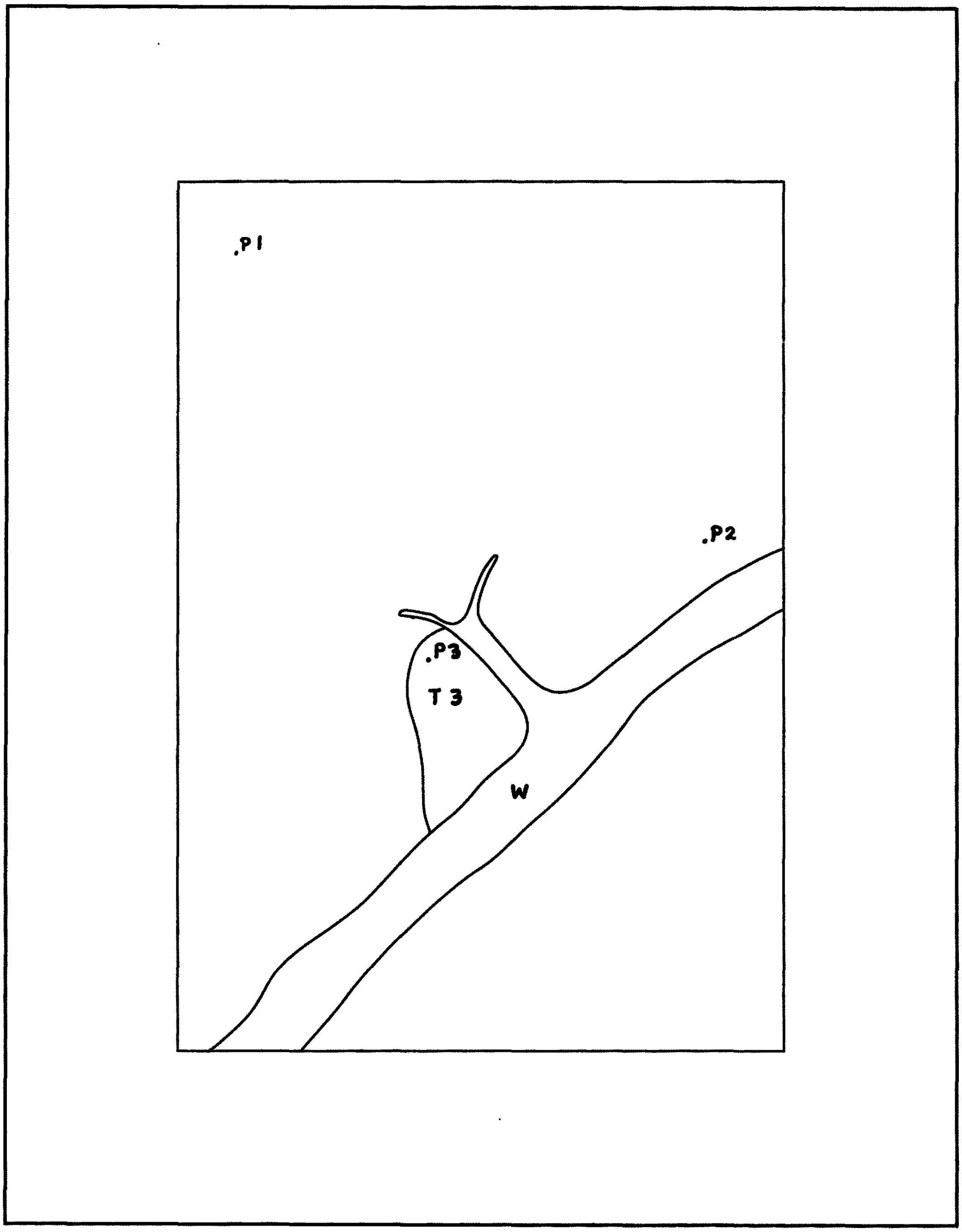


Figure 11. Working Overlay After Topographic Map and Point Data Analyses

a. Point Identification Code.

Simply record the identification codes for each data point on the overlay (figure 11). Begin with P1.

P - Table

Point I.D. Code	Source
P1	

b. Source.

Record the name, date, and authoring agency of the source for each point.

P - Table

Point I.D. Code	Source	Soil Profile	
		Horizon	Depth (M)
P1	Well Log #64 Oct 3, 1971 Richfield Drilling Co.		

c. Soil Profile.

Horizon. Soil horizons are distinctive layers of soil that vary in thickness from the surface down to bedrock. Some sources may refer explicitly to horizons, usually labeling them A, B, or C. In this case, list the letters one at a time, filling in the next columns for each.

Other sources may refer to soil layers or may show differing layers down from the surface. They may or may not give names to these layers. Often, names like surface, subsurface, and parent material may be used. Whatever names may be given, use those names in the horizon column, filling in the next columns in the Soil Profile section immediately after listing the name. If no names are given for the soil layers, simply put a dash in the column.

If, however, no idea of horizons or layering is given and the soil is referred to as a single undifferentiated unit, write "unspecified" in the horizon column.

Be sure, especially on the well logs, that only soil (unconsolidated material) is noted here. Underlying layers of bedrock should be ignored.

P - Table

Point I.D. Code	Source	Soil Profile	
		Horizon	Depth (M)
P1	Well Log #64 Oct 3, 1971 Richfield Drilling Co.	–	

d. Depth.

Record the depth, or a description like shallow or thick, for each soil layer. If possible, provide the mean depth of the uppermost layer measured in meters from the soil surface to the bottom of the layer. Use zero to indicate the soil surface, e.g. 0-0.6. Measure the mean depth of each succeeding layer from the bottom of the overlying layer, e.g. 0.6-0.9.

If soil layers are not discussed, but general thickness of soil is, record that general or overall thickness in meters in the Depth column and be sure that "unspecified" is recorded in the Horizon column.

P - Table

Point I.D. Code	Source	Soil Profile		
		Horizon	Depth (M)	
P1	Well Log #64 Oct 3, 1971 Richfield Drilling Co.	–	0-0.6	
		–	0.6-0.9	
		–	0.9-1.2	

e. USCS Symbol.

Record the Unified Soil Classification System (USCS) symbol(s) for each soil horizon or layer, or for the total soil if layers are not discussed.

If the source gives no USCS symbol(s), leave this column blank until the next column is completed.

P - Table

Point I.D. Code	Source	Soil Profile		
		Horizon	Depth (M)	USCS Symbols
P1	Well Log #64 Oct 3, 1971 Richfield Drilling Co.	–	0-0.6	
		–	0.6-0.9	
		–	0.9-1.2	

f. Description of Layers.

(1) Some sources will describe the soil layers with descriptive terms like sandy, loamy, silty, and others. Record these terms in this column opposite the soil layer to which these terms refer.

(2) Other sources may assign a soil symbol, such as sil, from another soil classification system, which may be listed alone or in addition to descriptive terms. Record all symbols and terms given. After the symbol, also record the abbreviation of the classification system's name, e.g. sil (USDA). List all abbreviations with the spelled-out name below the table. If possible, find in the source the definition of the other systems' symbols used, and record this definition in the description of layers column.

P - Table

Point I.D. Code	Source	Soil Profile			
		Horizon	Depth (M)	USCS Symbols	Description of Layers
P1	Well Log #64 Oct 3, 1971 Richfield Drilling Co.	–	0-0.6		A-7 (AASHO)
		–	0.6-0.9		A-1 (AASHO)
		–	0.9-1.2		A-1 (AASHO)

(3) Compare these symbols and descriptive terms with the USCS symbols and descriptions given in figures 12 through 18. Search for USCS symbols that match the symbols' descriptions listed under Description of Layers. Record these USCS symbols in parenthesis under the USCS column, followed by an E to show that the USCS symbols are estimates.

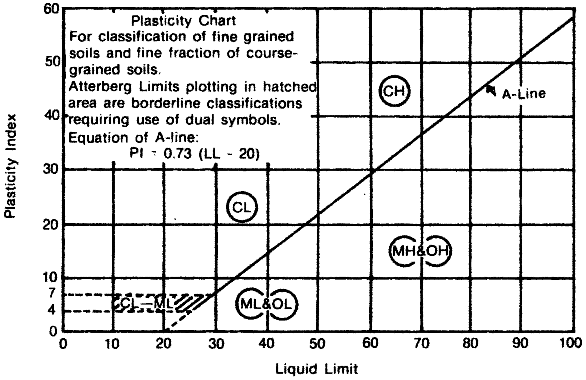
It is important to realize that there does not exist a direct correlation between the USCS and other classification systems; that is, A-1 soil in the AASHO system could be an SP, SP-SM, GW, SM, GP, GW, GM, or GC soil in the USCS System. For this reason, all the USCS symbols must be listed in parenthesis under the USCS column followed by an E.

Another complicating factor that must be recognized is that descriptive terms for soil in a specific classification system represent precise ranges in particle size. This is not itself a problem, however, the precise particle-size ranges differ among classification systems. For example, a "silty clay" in the USDA (United States Department of Agriculture) system might be simply a "clay" in the FAA (Federal Aviation Administration) system (figure 15), but both could be either a "silt" or "clay" in the USCS, depending on plasticity and compressibility characteristics. Therefore, before assigning USCS symbols, it is important to try to find the definitions of the descriptive terms and match these definitions to those of the USCS symbols. Definitions of the USCS symbols are found in figures 12, 13, and 14. Comparision of USCS particle sizes with sizes of some other systems used in the United States is found in figure 15.

P - Table

Point I.D. Code	Source	Soil Profile			
		Horizon	Depth (M)	USCS Symbols	Description of Layers
P1	Well Log #64 Oct 3, 1971 Richfield Drilling Co.	–	0-0.6	SC, CL, MH, CH, ML- CL	A-7 (AASHO)
		–	0.6-0.9	SP, SP-SM, GW, SM, GP, GM, GC	A-1 (AASHO)
		–	0.9-1.2	Same as above	A-1 (AASHO)
P2	Ace Soil Survey Sample # 20 June 6, 1950 Ace Soil Survey Inc.	–	0-0.15	(CL, ML-CL, CH, MH) E	loam, clay
		–	0.15-0.9	(GC, SW, SC) E	Coarse sand, wet
		–	0.9-1.2	(SP, GP) E	very wet sand w/ fine gravel intermixed

Major Divisions			USCS Symbols	Typical Names	Classification Criteria		
Coarse-Grained Soils More than 50% retained on No. 200 sieve*	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean Gravels (Little or no fines)	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve GW, GP, SW, SP More than 12% pass No. 200 sieve GM, GC, SM, SC 5% to 12% pass No. 200 sieve Borderline classification requiring use of dual symbols	C_U D_{60} D_{10} Greater than 4 (From Grain Size Distribution Curve) $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-clay mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above "A" line and plasticity index greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands (Little or no fines)	SW	Well-graded sands and gravelly sands, little or no fines		C_U D_{60} D_{10} Greater than 6 (From Grain Size Distribution Curve) $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below "A" line on plasticity chart or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols e.g., SM-SC
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above "A" line on plasticity chart and plasticity index greater than 7	
Fine-Grained Soils 50% or more passes No. 200 sieve*	Silts and Clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and Clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
Highly Organic Soils			PT	Peat, muck, and other highly organic soils			



Plasticity Chart

For classification of fine grained soils and fine fraction of course-grained soils.

Atterberg Limits plotting in hatched area are borderline classifications requiring use of dual symbols.

Equation of A-line:

PI = 0.73 (LL - 20)

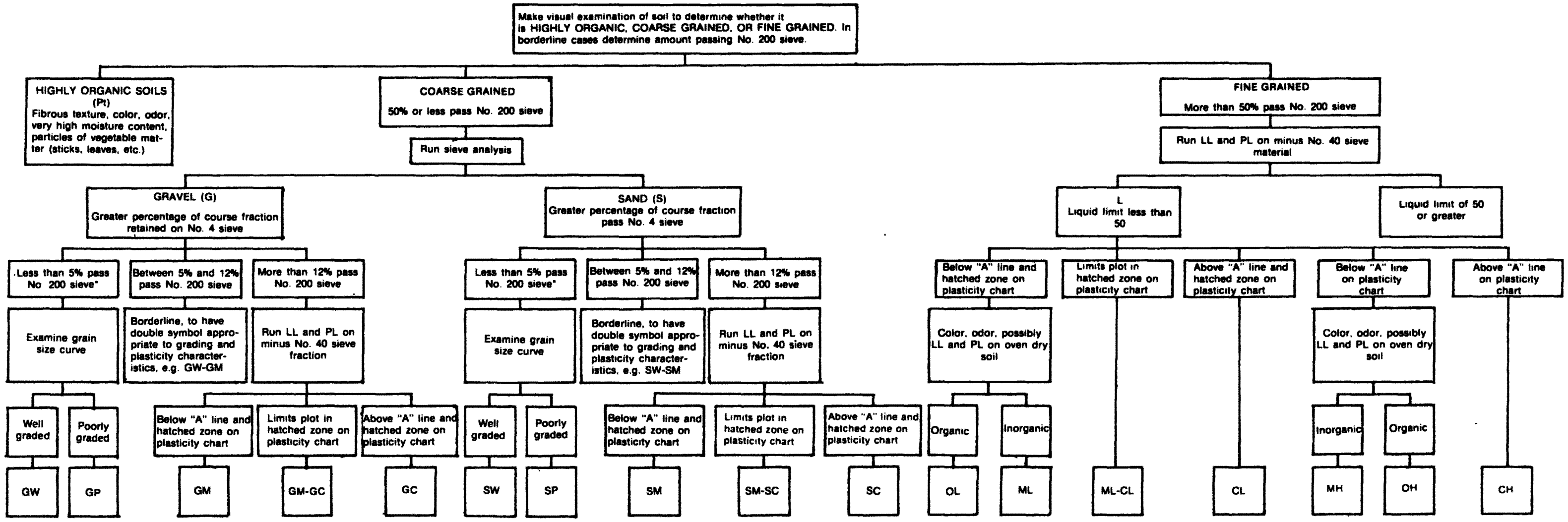
*Based on the material passing the 3-in. (75-mm.) sieve

Figure 12. Unified Soil Classification System Criteria

(This table may be used as a guide in classifying soils for which no engineering test data are available. The symbol > means "greater than;" the symbol < means "less than.")

USDA texture class and symbol	Unified symbol	AASHO symbol	Soil properties related to classifications
Clay; silty clay "C"; sic"	CH	A-7	High shrink-swell clays.
	MH	A-7	Mica, iron oxide, kaolinitic clays.
	CL	A-7	Low LL. Generally <45 pct clay.
Silty clay loam "sicl"	CL	A-7	Low LL. Plastic. (A-6 if clay <30 pct).
	ML-CL	A-7	Low LL. Mod. plastic. (A-6 if clay <30 pct).
	CH	A-7	High LL. High shrink-swell clays.
	MH	A-7	High LL. Mica, iron oxide, kaolinitic.
Clay loam "cl"	CL	A-6 or A-7	Low LL. Plastic.
	ML-CL	A-6	Low LL. Moderately plastic.
	CH	A-7	High LL. High shrink-swell clays.
	MH	A-7	High LL. Mica, iron oxide, kaolinitic.
Loam "1"	ML-CL	A-4	Moderately plastic (A-6 if clay >21 pct).
	CL	A-6	Plastic (A-4 if clay <22 pct).
	ML	A-4	Low plasticity (A-7 if clay >21 pct).
Silt loam "sil"	ML—CL	A-4	Moderately plastic (A-6 if clay >21 pct).
	ML	A-4	Low plasticity (A-7 if clay >21 pct).
	CL	A-6	Plastic.
Silt - "si"	ML	A-4	Low plasticity.
Sandy clay "sc"	CL	A-7	Fines >50 pct.
	SC	A-7	Fines 50 pct or less.
Sandy clay loam "scl"	SC	A-6	Plastic. Fines 36-50 pct.
	SC	A-2-6	Plastic. Fines 35 pct or less.
	CL	A-6	Plastic. Fines >50 pct.
Sandy loam "sl"	SM	A-2-4 or A-4	Low plasticity.
	SC	A-2-4	Plastic.
	SM-SC	A-2-4	Moderately plastic.
Fine sandy loam "fsl"	SM	A-4	Nonplastic. Fines 50 pct or less.
	ML	A-4	Nonplastic Fines >50 pct.
	ML-CL	A-4	Moderately plastic. Fines >50 pct.
	SM-SC	A-4	Moderately plastic. Fines 50 pct or less.
Very fine sandy loam "vfsl"	ML-CL	A-4	Moderately plastic.
	ML	A-4	Low plasticity.
Loamy sands "ls"; "lfs" "lvfs"	SM	A-2-4	Nonplastic. Fines 35 pct or less.
	SM-SC	A-2-4	Moderately plastic. Fines 35 pct or less.
	SM	A-4	Low plasticity. Fines >35 pct.
	ML	A-4	Little or no plasticity.
Sand; fine sand "s"; "fs"	SP-SM	A-3	Fines approx. 5-10 pct.
	SM	A-2-4	Fines approx. >10 pct.
	SP	A-3	Fines <5 pct.
Very fine sand "vfs"	SM	A-4	Low plasticity.
	ML	A-4	Little or no plasticity.
Coarse sand "cs"	SP; GW	A-1	Fines <5 pct.
	SP-SM	A-1	Fines 5-12 pct.
	SM	A-1	Fines 13-25 pct.
	SM	A-2-4	Fines >25 pct.
Gravel, "G" 50 pct passes No. 200 50 pct of coarse passes No. 4 sieve	GP; GW	A-1	Fines <5 pct.
	GM or GC	A-1	Fines 5-25 pct.
	GM or GC	A-2	Fines 26-35 pct.
	GM	A-4	Fines >35 pct.
	GC	A-6	Fines >35 pct.

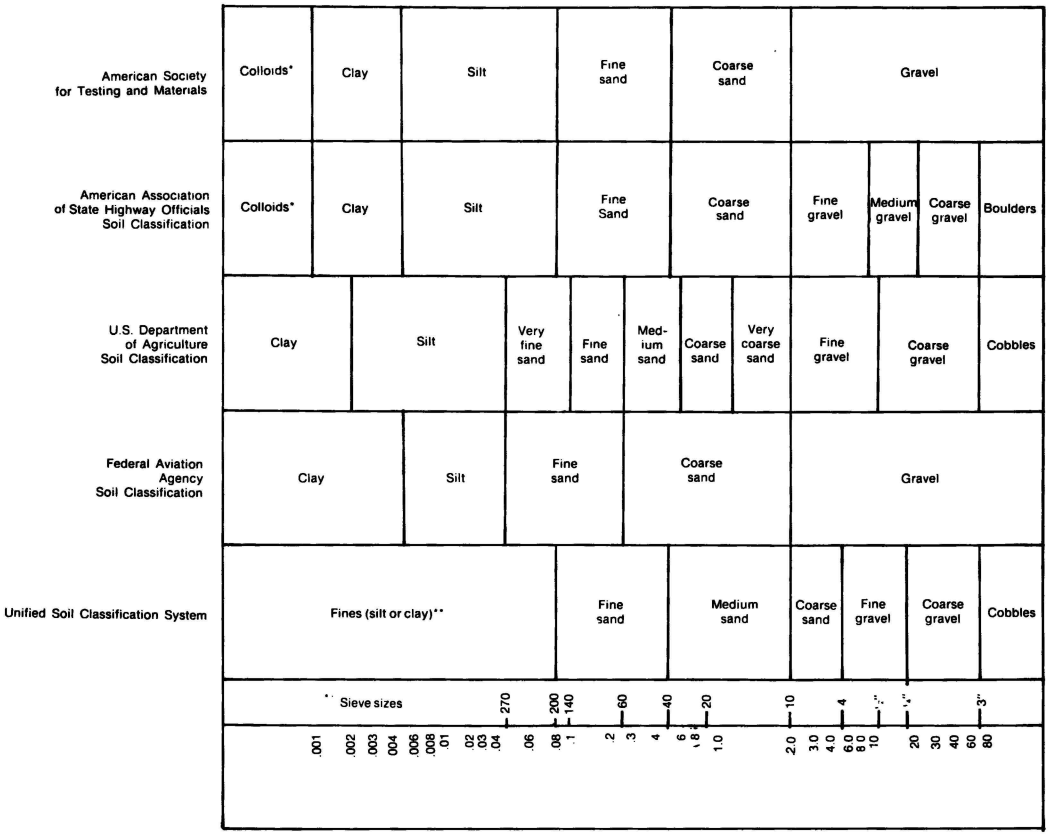
Figure 13. General Relationship of Systems Used for Classifying Soil Samples



Note: Sieve sizes are U.S. Standard.

*if fines interfere with free draining properties use double symbol such as GW-GM, etc.

Figure 14. Auxiliary Laboratory Identification Procedure for the Unified Soil Classification System



*Colloids included in clay fraction in test reports.

**The L.L and P.I. of "silt" plot below the "A" line on the plasticity chart and the L.L. and P.I. for "Clay" plot above the "A" line (Figure 11).

Modified from "PCA Soil Primer," Portland Cement Association, 1973.

Figure 15. Comparison of Particle Size Limits for Selected Soil Classification Systems

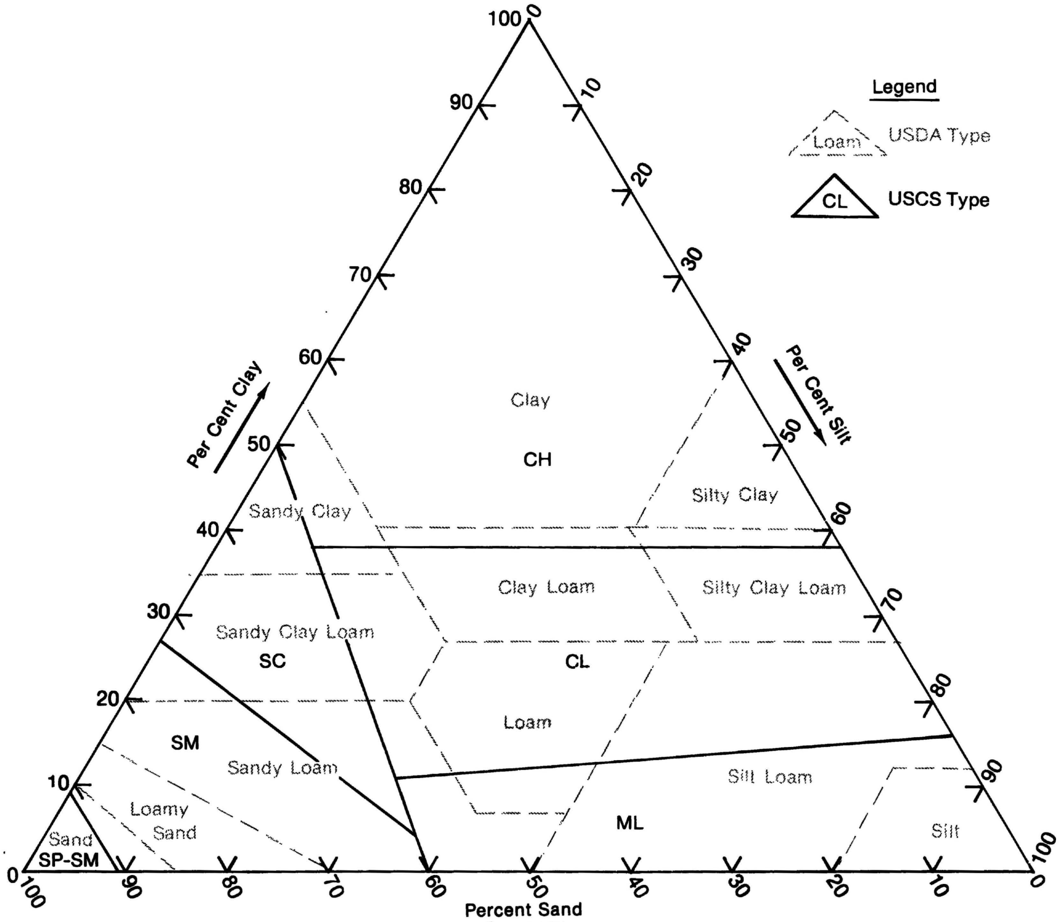


Figure 16. Guide for Comparing USDA and USCS Soil Types (Source: Trafficability of Soils. Soil Classification: TM 3-240; Waterways Experiment Station; 1961.)

General classification	Granular materials (35 per cent or less of total sample passing No. 200)							Silt-clay materials (More than 35 per cent of total sample passing No. 200)			
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5, A-7-6
Sieve analysis, per cent passing:											
No. 10	50 max.										
No. 40	30 max.	50 max.	51 min.								
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40:											
Liquid limit				40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		NP	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.*
Group Index**	0		0	0		4 max.		8 max.	12 max.	16 max.	20 max.

Classification procedure with required test data available, proceed from left to right on chart; correct group will be found by process of elimination. The first group from the left into which the test data will fit is the correct classification.

*P.I. of A-7-5 subgroup is equal to or less than L.L. minus 30. P.I. of A-7-6 subgroup is greater than L.L. minus 30.

**See group index formula for method of calculation. Group index should be shown in parentheses after group symbol as: A-2-6(3). A-4(5). A-6(12), A-7-5(27), etc.

Figure 17. The American Association of State Highway Officials (AASHO) Soil Classification Chart

		Mechanical analysis					
			Material finer than No. 10 sieve				
	Soil group	Retained on No. 10 sieve*	Course sand passing No. 10, retained on No. 60	Fine sand passing No. 60, retained on No. 270	Combined silt and clay passing No. 270	L.L.	P.I.
		per cent	per cent	per cent	per cent		
Granular	E-1	0-45	40+	60-	15-	25-	6-
	E-2	0-45	15+	85-	25-	25-	6-
	E-3	0-45	—	—	25-	25-	6-
	E-4	0-45	—	—	35-	35-	10-
	E-5	0-45	—	—	45-	40-	15-
Fine Grained	E-6	0-55	—	—	45+	40-	10-
	E-7	0-55	—	—	45+	50-	10-30
	E-8	0-55	—	—	45+	60-	15-40
	E-9	0-55	—	—	45+	40+	30-
	E-10	0-55	—	—	45+	70-	20-50
	E-11	0-55	—	—	45+	80-	30+
	E-12	0-55	—	—	45+	80+	—
	E-13		Muck and peat—field examination				

*Classification is based on sieve analysis of the portion of the sample passing the No. 10 sieve. When a sample contains material coarser than the No. 10 sieve in amounts equal to or greater than the maximum limit shown in the table, a raise in classification may be allowed provided the course material is reasonably sound and fairly well graded.

Modified from "PCA Soil Primer," Portland Cement Association, 1971

Figure 18. The Federal Aviation Administration Classification of Soils for Airport Construction.

g. Depth to Bedrock.

Record the depth of soil from the surface down to bedrock. This depth of the soil may be referred to as the overburden, which may be stated explicitly in the source or may be obtained by adding the depths of soil layers from the Depth column in the table. If there is no information for this data element, leave the column blank.

P - Table

Point I.D. Code	Source	Soil Profile				Depth to Bedrock (M)
		Horizon	Depth (M)	USCS Symbols	Description of Layers	
P1	Well Log #64 Oct 3, 1971 Richfield Drilling Co.	–	0-0.6	SC, CL, MH, CH, ML-CL	A-7 (AASHO)	1.2
		–	0.6-0.9	SP, SP-SM, GW, SM, GP, GM, GC	A-1 (AASHO)	
		–	0.9-1.2	Same as above	A-1 (AASHO)	
P2	Ace Soil Survey Sample #20 June 6, 1950 Ace Soil Survey Inc.	–	0-0.15	(CL, ML-CL, CH, MH) E	loam, clay	1.2
		–	0.15-0.9	(GC, SW, SC) E	Coarse sand, wet	
		–	0.9-1.2	(SP, GP) E	very wet sand w/ fine gravel intermixed	

h. State of Ground (S-O-G).

For each month of the year, note whether average ground conditions are wet (W), dry (D), moist (M), frozen (F), or snow-covered (S) (see definitions of these terms in section V, D). This information may or may not be available in these sources.

Point I.D. Code	Depth to Bedrock (M)	State of Ground											
		J	F	M	A	M	J	J	A	S	O	N	D
P1	1.2	S	S	S	W	W	M	D	D	D	M	F	S
P2	1.2	S	S	S	W	W	M	D	D	M	F	S	S

i. Stoniness.

Estimate the percentage volume of stones greater than 25 cm in diameter within each soil layer, if information on stoniness is given. If no information is given, draw a dash in the column.

j. RCI.

Record the RCI (Rating Cone Index) values for each soil layer for wet and/or dry conditions, if given in the source. If no information is given, draw a dash in the column.

k. Remarks.

Record any significant, brief comments about the soil pertaining to characteristics like stickiness, slipperiness, and suitability for specific engineering purposes. Also, narrative information describing state of ground may be recorded in this column.

Point I.D. Code	Stoniness (%)	RCI	Remarks
P1	10	-	sticky when wet
			-
			-
P2	0	-	-
			-
			-

6. Examine the overlay as shown in figure 11. If a P-Code falls within a previously bounded T-Code area, record in the appropriate row of the Decision Table that P-Code, its horizons and USCS symbols (found in the P-table). Record P-Codes that do not fall within T-Code areas in other rows of the table. See the example shown below (data taken in part from figure 11).

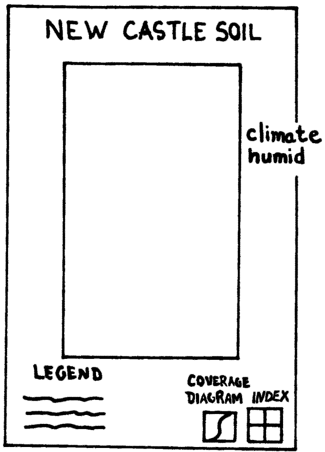
Decision Table

T Code	USCS		P Code	USCS	
	Horizon	Symbols		Horizon	Symbols
T3	—	Pt,OH,CH MH,OL	P3	—	Pt
			P2	— — —	CL,ML-CL, CH,MH GC,SW,SC SP,GP
			P1	— — —	SC,CL,MH,CH ML-CL SP,SP-SH.GW SM,GP,GH,GC Same as above

D. Determine the Climate and State of Ground

1. Pull out the Climate Factor Overlay and Data Tables, or use any map or literature that describes the climate of the area of interest.

2. Examine the climate sources to determine the general climate classification for the area of interest, for example, tropical rainforest, humid subtropical, etc. If a single climate type dominates the area of interest, record that climate in the margin of the soil overlay as shown:



If more than one climate type is encountered, as might be found in areas of high relief, draw the boundaries of the climates on the overlay. In black, label each section with the climate type.

3. Examine the Climate Factor Overlay and Data Tables as well as background literature for the area of interest to determine state of ground (S-O-G). The five categories* for state of ground are

a. Wet (W) - pore space almost or completely filled with water
b. Dry (D) - pore space essentially free of water
c. Moist (M) - intermediate between wet and dry
d. Frozen (F) - pore space frozen, binding ground into solid mass (note the depth in cm to which the ground is frozen in the Remarks column of the Soil Data Table)
e. Snow-covered (S) - surface appears white

As the climatic data and background literature are examined, keep in mind the parameters listed below that affect S-O-G.

Soil

a. Surface conditions (bare? litter?)

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* Wet, dry, and moist categories describe the state of ground from the surface to a depth of at least 40 cm.

    b. Grain size or texture
    c. Permeability
    d. Organic content
    e. Mineral composition

Topography

    a. Physiographic position (does location cause precipitation to accumulate or runoff?)
    b. Slope

Vegetation

    a. Natural (forest? savanna?)
    b. Cultivated (row crops? root crops?)

Climate

    a. Temperature (min, max)
    b. Precipitation (frequency, intensity, amount, type)
    c. Humidity
    d. Wind

4. Study the following four examples that serve to illustrate the state of ground categories and the parameters that must be considered in order to arrive at S-O-G.

Example #1

Location: Central Poland (Warsaw)

Climate Classification: Humid Continental, Cool Summer

Topography (General Landform): Nearly level to rolling plains

Slope Range: 1 to 3 percent

Soils: Silty sand (SM) overlying sandy or gravelly glacial till. Good internal soil drainage.

Vegetation: Cultivated (wheat, barley, sugar beets)

Climatic Data:

	J	F	M	A	M	J	J	A	S	O	N	D
Mean Precip.	1.3	0.9	1.0	1.4	2.1	2.3	3.3	2.8	1.7	1.4	1.5	1.3
Mean daily max temp.	30	32	41	54	67	72	75	73	65	54	40	32
Mean daily min temp.	21	23	28	38	48	53	56	55	48	41	32	25
Mean # of days w/snow	11	10	8	2	<.5	0	0	0	0	1	5	9

Based upon analysis of the above data, along with general knowledge of the area, the following S-O-G estimates have been made:

J	F	M	A	M	J	J	A	S	O	N	D
S,F	S,F	W	M	M	M	M	M	M	M	M	M

Remarks: Chiefly moist from about mid-April through about mid-December. Ground in winter is generally frozen and snow-covered followed by a period of wet (saturated) soil conditions of approximately a month (mid-March through mid-April).

Example #2

Location: Djakarta, Java (Indonesia)

Climate Classification: Tropical Rainforest

Topography (General Landform): Nearly level low lying plains with some natural terraces.

Slope Range: Generally less than 2 percent

Soil: Plastic clay (CH)

Vegetation: Cultivated (rubber, cane sugar plantations)

Climatic Data:

	J	F	M	A	M	J	J	A	S	O	N	D
Mean Precip.	11.8	11.8	8.3	5.8	4.4	3.8	2.5	1.7	2.6	4.4	5.6	8.0
Mean daily max temp.	84	84	86	87	87	87	87	87	88	87	86	85
Mean daily min temp.	74	74	75	75	74	73	73	74	74	74	74	74

Based upon analysis of the preceding data along with general knowledge of the area, the following S-O-G estimates have been made:

J	F	M	A	M	J	J	A	S	O	N	D
W	W	W	W	W	M	M	M	M	M	W	W

Remarks: Chiefly wet late October through May; June through early October primarily moist, except for short wet periods 2 to 4 times per month.

Example #3

Location: Rodhos, Rhodes (Greece)

Climate Classification: Mediterranean or Dry Summer Subtropical

Topography (General Landform): Area of low flat to rolling surface interrupted by streams; interstream areas generally less than 500 feet above adjacent valley bottoms.

Slope Range: Generally less than 10 percent

Soils: Silty clay (CL), clayey sand (SC), silty sand (SM)

Vegetation: Cultivated (orchards, vineyards), natural (pastureland)

Climatic Data:

	J	F	M	A	M	J	J	A	S	O	N	D
Mean precip.	5.6	3.5	2.0	1.1	0.4	0.2	0.1	0.1	0.2	2.9	3.9	5.5
Mean daily max temp.	70	72	84	82	94	99	104	108	99	93	81	75
Mean daily min temp.	25	27	34	42	46	50	59	63	50	46	32	23

Based upon analysis of the above data, along with general knowledge of the area, the following S-O-G estimates have been made:

J	F	M	A	M	J	J	A	S	O	N	D
W	W	M	M	D	D	D	D	D	M	M	W

Remarks: Ground is generally moist from mid-October through mid-November, wet from December through mid-February, followed by a general drying period that lasts through the warm summer months.

Example #4

Location: Central USA (Peoria, IL)

Climate Classifications: Humid Continental, Warm Summer

Topography (General Landform): Nearly level to gently sloping uplands

Slope Range: 1 to 5 percent

Soils: Inorganic silts (ML), Inorganic clays (CL), Good internal soil drainage

Vegetation: Cultivated (corn, soybeans)

Climatic Data:

	J	F	M	A	M	J	J	A	S	O	N	D
Mean precip.	1.8	1.8	2.8	3.5	3.9	3.8	3.8	3.1	3.7	2.5	2.3	2.0
Mean daily max temp.	32	36	48	61	72	82	86	84	77	65	49	36
Mean daily min temp.	16	19	29	41	51	60	65	63	55	44	32	21
Mean snowfall	6.6	4.7	4.6	0.6	T*	0.0	0.0	0.0	0.0	0.1	2.3	6.0

Based upon analysis of the above data, along with general knowledge of the area, the following S-O-G estimates have been made:

J	F	M	A	M	J	J	A	S	O	N	D
S,F	S,F	W	W	M	M	M	M	M	M	M	S,M

Remarks: Ground is usually snow-covered for varying lengths of time from the latter part of December to mid-March. Little or no snow accumulation from month to month.

5. Record the state of ground for each month in the Soil Data Table. If conditions warrant, more than one S-O-G category may be recorded for one month, for example, S,F. Narrative information such as that found in the Remarks section of the examples may be included in the Soil Data Table Remarks column.

Depending on conditions, state of ground can vary within a climatic region. For this reason, after the final soil map unit boundaries

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* T represents Trace, i.e. either rain or snow.

have been established on the overlay, check to see if state of ground for one or more months should be changed to reflect ground conditions for each specific map unit.

E. Examine Soil Map(s)

1. Pull out the soil map(s) gathered in section V, A. If necessary, adjust the scale to 1:50,000 as described in appendix A. (If there are no soil maps, proceed to section V, F.) Study the legend and any accompanying tables and text to become acquainted with the soil classifications used.

2. Make an S-Table like the following:

S - Table

S-Code	Source's Soil Symbol	Source's Title Date Field Check	Soil Profile				Depth to Bedrock (M)	State of Ground												Stoniness (%)	RC1		Remarks
			Horizon	Depth (M)	USCS Symbols	Description of Layers		J	F	M	A	M	J	J	A	S	O	N	D		Wet	Dry	
S1	C1	USDA Soil Survey. Oct. 1968 Field Checked	A	0-15	MH	Kaolinitic	?													0			
			B	.16-46	MH	Kaolinitic	?													0			
			C	.46-?	MH	Kaolinitic	?													0			

3. For each soil type presented on the map, assign a code beginning with S and followed by a number. Start with S1.

4. For each code, enter the information required on the S-Table as outlined below:

a. S-Code: Record S1 first.

b. Source's Soil Symbol: Record the soil symbol in the source that the S-Code represents.

c. Source's Title/Date/Field Checked: Record the title, authoring agency, and date of the source. Also, indicate if the source map was field checked.

d. Soil Profile:

(1) Horizon: If the source describes the soil by layers, each layer may be identified with a letter, such as A, B, or C, or with a descriptive term, such as surface or subsurface. Record in this column

the layer identifiers the source uses (see the preceding S-Table example). Descriptions of each layer will be recorded in the next columns. If the source does not refer to layers with a name but describes the soils at certain given depths, place dashes in this column. If the source does not discuss layers at all, record "unspecified" in this column.

(2) Depth: If the source gives the depths for soil layers, record them in the depth column opposite the layer indicated in the preceding column.

(3) Description of Layers: See section C.5.f.(1), (2).
(4) Estimated USCS symbols: See section C.5.f.(3).
(5) Depth to Bedrock: See section C.5.g.
(6) State of Ground: See section C.5.h.
(7) Stoniness: See section C.5.i.
(8) RCI: See section C.5.j.
(9) Remarks: See section C.5.k.

5. Place the working overlay over the 1:50,000-scale soil map. Try to register them by matching longitude/latitude or other grid values or by landmarks such as bodies of water. If the soil map projection is compatible with that of the overlay, the two should register fairly easily. If the soil map projection is not compatible, the overlay will have to be frequently re-positioned during analysis so that at a minimum, the immediate area being analyzed is registered.

6. Trace in black pencil, the boundaries of all soil map units and areas of exposed bedrock from the map onto the overlay (Brown is used in this guide for illustration purposes but is not necessary in actual compilation). Label the areas of exposed bedrock not classified as soil with an "R". Label in black pencil all other areas with the S-Code assigned to that soil. See figure 19.

7. As new bounded areas are created by overlapping map units, identify these new areas with an appropriate string of identifiers. For example, in an area where topographic symbol unit T4 and soil map unit S1 overlap, assign the following identifiers, T4S1.

8. If Part B was skipped, set up a working Decision Table like that shown in figure 9. Otherwise continue to the next step.

9. Examine the overlay as shown in figure 19. If a P-Code or T-Code fall within an S-Code area, record in the Decision Table that P-Code and/or T-Code, its horizons and USCS symbols (found in the P-Table). Also record the S-Code, its horizons and USCS symbols (found in the S-Table) on the Decision Table. See the following sample entries.

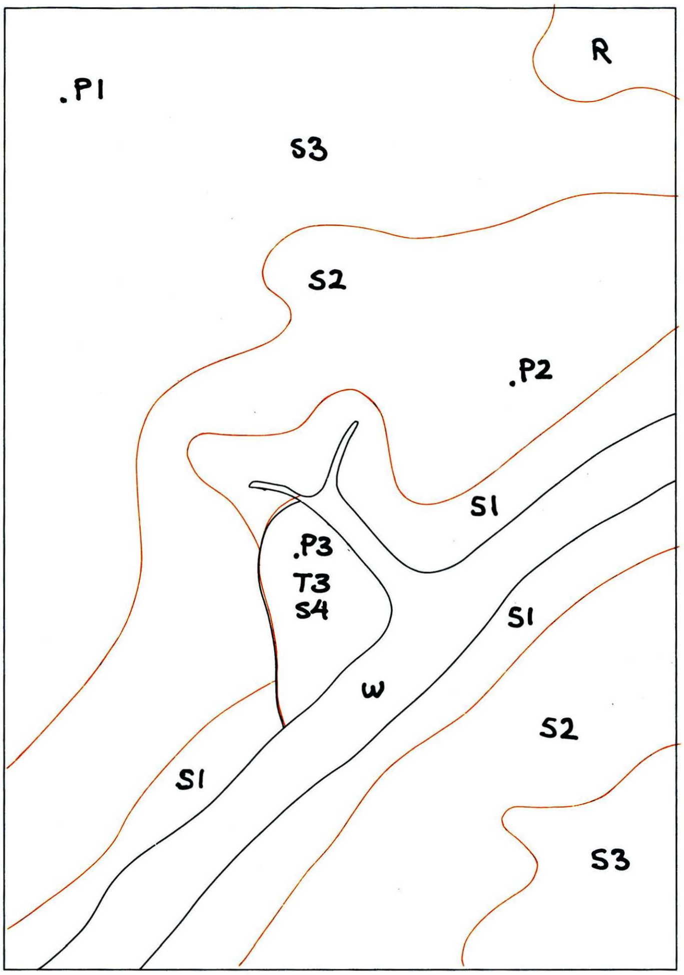

Figure 19. Working Overlay After Topographic Map, Point Data and Soil Map Analyses

Decision Table

T Code	USCS		P Code	USCS		S Code	USCS	
	Horizon	Symbols		Horizon	Symbols		Horizon	Symbols
T3	—	Pt,OH,CH MH,OL	P3	—	Pt	S4	—	OH,OL, Pt
			P2	— — —	CL,ML-CL, CH,MH GC,SW,SC SP,GP	S2	A B C	CH SC SP
			P1	— — —	SC,CL,MH,CH ML-CL SP,SP-SM,GW SM,GP,GM,GC Same as above	S3	A B C	SC SM SM
						S1	A B C	CH-MH MH MH
						S2	A B C	CH SC SP
						S3	A B C	SC SM SM

F. Analyze Landforms

1. Pull out the Landform Factor Overlay from the items collected previously in section A (If there is no Landform Factor Overlay, prepare one using the Surface Configuration Guide*).

2. Register the overlay on top of the Landform Overlay. Trace the Landform boundaries in black (red is used in this guide for illustration purposes, but is not necessary in actual compilation). If any lines nearly coincide with lines already on the overlay, make them coincide. Leave two separate lines if the space between them is greater than one-fourth of an inch. See figure 20.

3. Set up an L-Table like the one shown below.

L - Table

L Code	Landform & Climate	USCS	
		Horizon	Symbols
L1	Flat lying Sedimentary Subtropical	—	CL, ML, CH MH ML-CL SC, GM, SM
L2	Terrace	—	ML, SC GW, GP
L3	Flood Plain	—	PT, OH CH, MH OL, CL

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* The Terrain Analysis Procedural Guide for Surface Configuration is currently being prepared.

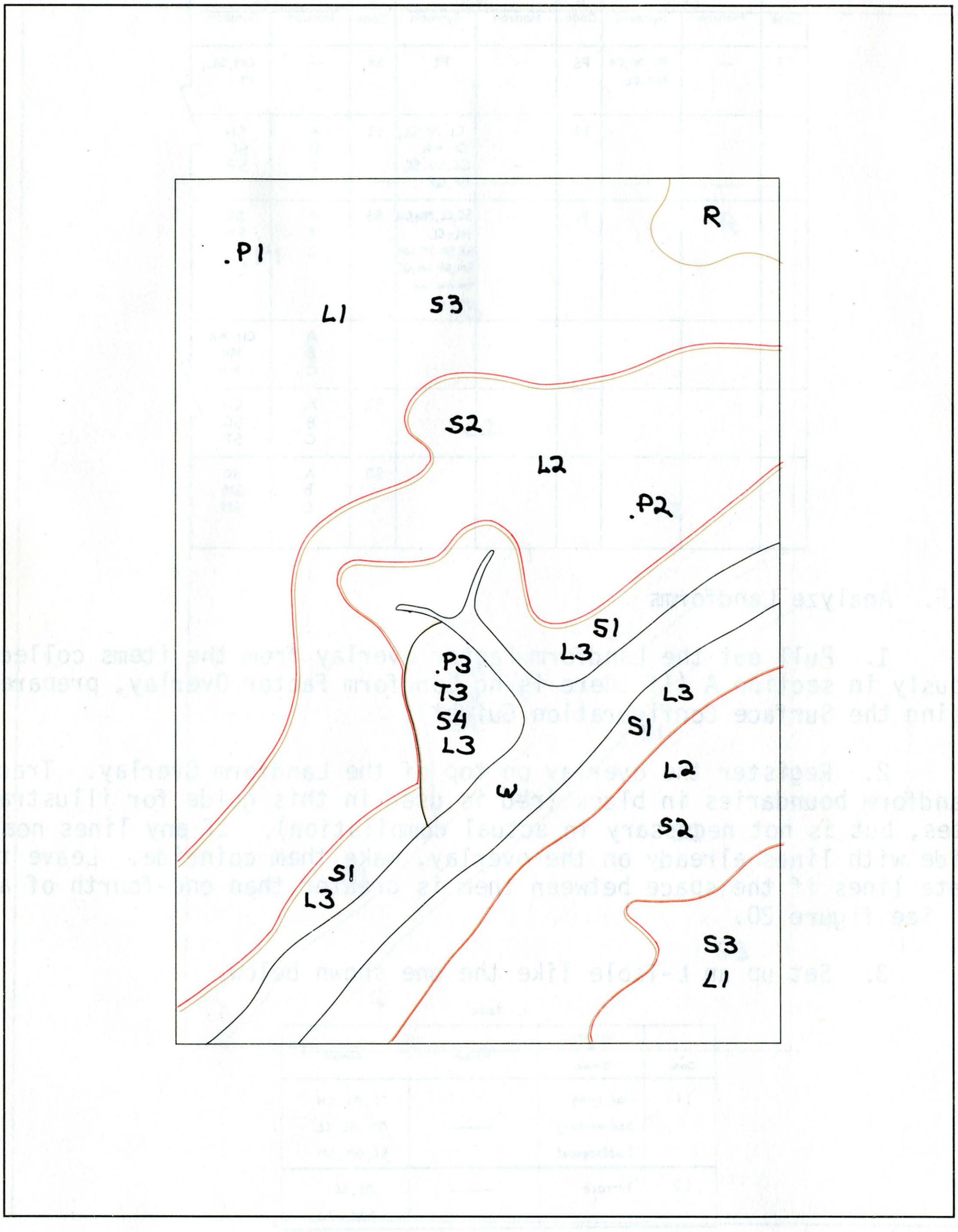


Figure 20. Working Overlay After Topographic Map, Point Data, Soil Maps, and Landform Overlay Analyses.

4. Assign a code to each different landform presented on the Landform Overlay. Begin with the letter L followed by a number, starting with L1.

5. As new bounded areas are created by overlapping map units, identify these new areas with an appropriate string of identifiers. For example, in an area where topographic symbol unit T4, soil map unit S1, and landform map unit L2 overlap, assign the following identifiers, T4S1L2.

6. Look in table 2, Landforms and Commonly Associated Soils, to find the Landforms that have been coded on the overlay. Note their commonly associated soils. Record each landform's soil horizons and USCS symbols in the L-Table. When climate has an effect on the soil selected, refer to section D to find the general climate of the area of interest, and then choose the soils associated with that climate.

7. Record on the Decision Table all L-Codes that overlap other code areas or points. Record the L-Codes and USCS symbol information in the row with these other codes as shown below.

Decision Table

T Code	USCS		P Code	USCS		S Code	USCS		L Code	USCS	
	Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols
T3	—	Pt,OH,CH MH,OL	P3	—	Pt	S4	—	OH,OL, Pt	L3	—	Pt,OH CH,MH, OL,CL
			P2	— — —	CL,ML-CL, CH,MH GC,SW,SC SP,GP	S2	A B C	CH SC SP	L2	—	ML,SC GW,GP
			P1	— — —	SC,CL,MH,CH ML-CL SP,SP-SM,GW SM,GP,GM,GC Same as above	S3	A B C	SC SM SM	L1	—	CL,ML CH,MH, ML-CL,SC GM,SM
						S1	A B C	CH-MH MH MH	L3	—	Pt,OH CH,MH, OL,CL
						S2	A B C	CH SC SP	L2	—	ML,SC GW,GP
						S3	A B C	SC SM SM	L1	—	CL,ML, CH,MH, ML-CL,SC GM,SM

TABLE 2. LANDFORMS AND COMMONLY ASSOCIATED SOILS*

Landform/Bedrock	Climate	Commonly Associated Soils	
		Horizon	USCS Symbol
Sandstone	unspecified	surface (A) parent material (C)	SM, SM-SC, ML. SP, SW SM, SM-SC, GM, SC, GC, ML
	humid	A B C	SM SM, GM SM-GM
Shale	unspecified	surface (A) parent material (C)	CH, CL, CL-CH ML, CL, MH, CH, CL-CH, SC, CL-SC, GC
	semi-arid or humid	A B C	CL, CH CL, SC, CL-SC CL, SC
Limestone	unspecified	surface (A) parent material (C)	ML-CL, ML, CL, GM CL, CH, MH, ML, CH-MH, ML-CL
	tropical	lower horizons (B&C)	CH, MH, GC, GM
	humid	A B C	ML-CL CH CH
Interbedded, sandstone, shale, limestone			
Flat-lying	unspecified	unspecified	CL, ML, CH, MH, ML-CL, SC, GM, SM
Tilted	unspecified	unspecified	ML, MH, ML-CL

*Derived from D.S. Way, Terrain Analysis: A Guide to Site Selection Using Aerial Photographic Interpretation, 2nd Ed, McGraw-Hill Book Co., N.Y. 1978 and modifications to Way made by A. Reimer, ETL-TAC, 1979 & O. Mintzer, Ohio State, 1979.

TABLE 2 (CONTINUED). LANDFORMS AND COMMONLY ASSOCIATED SOILS

Landform/Bedrock		Climate	Commonly Associated Soils	
			Horizon	USCS Symbol
Intrusive	Granitic rock*	unspecified	surface (A)	SM, ML. SC, ML-CL
			subsurface (B)	SC, CH, CL, CL-CH
	Granite	humid	A	SM, ML, CL
			B	SC
			C	SC, CL
Extrusive Basaltic & Volcanic		humid tropical or subtropical	A	ML, CL
			B	CH, MH
			C	ML-MH, MH, CH
		arid	A	ML-CL, ML, GM
			B	CH, CL, MH, ML-CL, GC
Slate		unspecified	unspecified	GM, GC, GM-GC
		humid	A	SM
			B	SM, ML-CL
			C	SM, GM
Schist		humid	A	SM, SC
			B	MH-CH
			C	SM, ML-CL, ML
Gneiss		humid	A	SM, SM-SC, ML-CL, ML
			B	MH, CH, SC
			C	SM, ML, CL, MH-CH, ML-CL, MH, CH
Glacial Till/Ground Moraine		humid/ derived from soft sedimentary rock	A	ML, CL, ML-CL, OL
			B	CL, CH, CL-CH
			C	CL, CH, ML
				Note: A very much wider range of texture is possible as in North Central U.S.A.

*Granitic rock includes rhyolite porphyry, trachyte porphyry, dacite porphyry, basalt porphyry, augitite porphyry, granite, syenite porphyry, syenite, diorite porphyry, diorite, gabbro porphyry, gabbro, pyroxenite porphyry, pyroxenite, periodotite.

TABLE 2 (CONTINUED). LANDFORMS AND COMMONLY ASSOCIATED SOILS

Landform/Bedrock	Climate	Commonly Associated Soils	
		Horizon	USCS Symbol
Glacial Till/Ground Moraine	humid/ derived from igneous - metamorphic rock (crystalline)	A	SM, ML, SC
		B	SM, ML
		C	SM, ML, GM
			Note: A very much wider range of texture is possible as in the North Central USA
Glacial Moraines	humid/ derived from soft sedimentary rock	A	CL, ML, CL-CH, CH, GM, GC
		B	CL, CH, GC
		C	CL, CH, GC
	humid/ derived from igneous-metamorphic rock (crystalline)	A	SM-SP
		B	GW, GC-GP, SC-SP
		C	SM-SC, SW, SP, GM, GC, SM, SC
Drumlins	unspecified/ derived from soft sedimentary rock	surface or subsurface (A or B)	ML, ML-CL, GM, GC
		C	CL, GM, GC
	humid/ derived from igneous-metamorphic rock (crystalline)	A	GM-GC, SM
		B	GM-GC, SM
		C	GM, SM-SC, ML
Eskers	unspecified	unspecified	GM, GM-GC, GP, SP, GW, SW, SW-SM
Kames	unspecified	unspecified	GP, SP, GP-GM, GM, GM-GC, SM-SC, SP-SM, SM

TABLE 2 (CONTINUED). LANDFORMS AND COMMONLY ASSOCIATED SOILS

Landform/Bedrock	Climate	Commonly Associated Soils	
		Horizon	USCS Symbol
Glacial Outwash	unspecified	unspecified	GW, SW, GP, SP, GM, SM CL, GM-GC
Silt/Clay Lakebeds	unspecified	A B C	ML-CL, CH CL-CH CL-CH, ML-CL, MH-CH
Sandy Lakebeds	unspecified	unspecified	SM, ML, ML-MH, ML-CL
Sand Dunes		no horizons	SP
unstabilized	unspecified		
stabilized	unspecified	surface (A) parent mat. (C)	SM, SP SP
Loess deposits	unspecified	unspecified	ML, ML-CL, CL
	semi-arid	A B C	ML-CL ML-CL ML-CL
Flood Plains			
braided channels	unspecified	unspecified	GW, SP
point bars	unspecified	unspecified	SW, SP, GW
natural levees	unspecified	unspecified	SM, ML
slack water	unspecified	unspecified	ML, CL, MH, CH, MH-CH
swamps, depressions	unspecified	unspecified	OL, OH, PT, ML, CL, CH
terrace	unspecified	surface subsurface	ML SC, GW, GP
Deltas	unspecified	surface (A) subsurface (B)	ML, CL, MH, CH GP, SP, GM, GC, SM, SC, GM-GC
Arc delta			
	humid	A B C	ML absent GM-GC

TABLE 2 (CONTINUED). LANDFORMS AND COMMONLY ASSOCIATED SOILS

Landform/Bedrock	Climate	Commonly Associated Soils	
		Horizon	USCS Symbol
Bird's-foot delta	unspecified	A B C	OH CH-OH CH
Alluvial fans	unspecified	unspecified	GP, SP, SW, GW, GM, GC, SM, SC, ML, CL
	semi-arid	A B C	GM-SM SM, ML GM, SM, ML
Valley fills	unspecified	unspecified	GP, SP, GW, SW, GM, GC, SM, SC, CL, ML, CL-CH, CH
	semi-arid	A B C	SM SM ML-SM, SM, GM, SM, ML
Continental alluvium	unspecified	unspecified	CL, SC, CL-CH, CH
	semi-arid	A B C	CL CL CL
Playas	unspecified	unspecified	ML, CL, SM, SC, MH, CH
Swamps, Bogs & Marshes	unspecified	unspecified	PT, OH, CH, MH, OL
Coastal Plain Uplands	unspecified	surface (A) subsurface (B)	SM, SP-SM SM, SC, SP-SM
	humid	A B C	SM SC, SM SC, SM

TABLE 2 (CONTINUED). LANDFORMS AND COMMONLY ASSOCIATED SOILS

Landform/Bedrock	Climate	Commonly Associated Soils	
		Horizon	USCS Symbol
Coastal Plain Depressions	unspecified	unspecified	OL, ML, CL, ML-CL, MH, CH, OH, PT
Beach Ridges	unspecified	surface (A) subsurface (B)	SM, GM SP, GP, GP-GM, SP-SM, SW
	humid	A B C	SM Absent SP, SM
Tidal Marsh	unspecified	surface (A) subsurface (B)	PT OL, OH, MH
Mud Flat	unspecified	unspecified	CH, CH-MH, CH-OH
Sand Flat	unspecified	unspecified	SP

G. Examine Geology.

1. Pull out the Geology Factor Overlay with Tables and geologic maps gathered earlier in section A. If none are available, go now to section H.

2. Examine the legend on the geologic map or Overlay and Tables, and search for the following:

a. Descriptions of soil or soil characteristics required to fulfill data element requirements.

b. Presentations of Quaternary deposits.

c. References to unconsolidated material.

d. References to the types of bedrock listed below (when bedrock appears near the surface).

(1) Sandstone.

(2) Shale.

(3) Limestone.

(4) Granite.

(5) Basalt.

(6) Volcanic.

(7) Slate.

(8) Schist.

(9) Gneiss.

e. Reference to the glacial features listed below.

(1) Glacial till.

(2) Ground moraine.

(3) Glacial moraines.

(4) Drumlins.

(5) Eskers.

(6) Kames.

(7) Glacial outwash.

(8) Silt/clay lakebeds.

(9) Sandy lakebeds.

3. Set up a G-Table like the one shown below. Assign a code to each potential source of soil information, as outlined in 2a-e above, beginning with the letter G and followed by a number. Start with G1. Record the code in the G-Table.

G - Table

G Code	Source Symbol	Source Title Agency Date	Soil Profile				Depth to Bedrock (M)	State of Ground												Stoniness (%)	RCI		Remarks
			Horizon	Depth (M)	USCS Symbols	Description of Layers		J	F	M	A	M	J	J	A	S	O	N	D		Wet	Dry	

4. Translate the information found in Step 2 for each G-Code into USCS symbols:

a. Examine descriptions of soil or soil characteristics. Compare the descriptions with the USCS symbols (See section C.5.f.). Assign each described soil one or more USCS symbols.

b. Quaternary deposits are the most recent geological deposits and often include unconsolidated deposits of sands and gravels. Again, match the description of these deposits as closely as possible to those of USCS symbols as done in section C.5.f. Assign each Quaternary unconsolidated deposit one or more USCS symbols.

c. Geologic maps may not refer to Quaternary deposits, but simply to unconsolidated deposits. Brief descriptions of these deposits are usually given. Match the descriptions with those of USCS symbols as done in section C.5.f. Assign each type of unconsolidated deposit one or more USCS symbols.

d. If any of the listed rock are presented on the geology map and are shown to occur as the surface bedrock, refer to table 2 to find commonly associated soils.

e. If any of the listed glacial features are presented on the map and are shown to occur at the surface, refer to table 2 to find their commonly associated soils.

5. Fill in the G-Table as completely as possible with the information derived in Step 4. Follow section E.4. as a guide to completing the G-Table. Substitute references to all S-Codes with G-Codes.

6. If the Geology Overlay or geologic map is at a scale of 1:50,000, register the overlay on top of it (if the source is not at a scale of 1:50,000, refer to appendix A). Trace in black the areas that were G-Coded in Step 2 (Blue is used in this guide for illustration purposes, but is not necessary in actual compilation). If any new lines almost coincide with lines already drawn on the overlay, make them coincide unless they are more than one-fourth of an inch apart, in which case draw separate lines.

7. Examine the working overlay (figure 21). Note those areas where G-Codes overlap any T-Code, P-Code, S-Code, or L-Code areas. When a G-Code overlaps another coded area, record the G-Code on the Decision Table in the row in which the overlapped areas are found. See the sample Decision Table entries below. Opposite each G-Code recorded in the table, note the horizon and USCS symbols for that G-Code. The G-Codes that do not overlap other codes should be listed in a separate row.

Decision Table

T Code	USCS		P Code	USCS		S Code	USCS		L Code	USCS		G Code	USCS	
	Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols
T3	—	Pt,OH,CH MH,OL	P3	—	Pt	S4	—	OH,OL, Pt	L3	—	Pt,OH CH,MH, OL,CL	G1	—	Pt,ML CL,SC
			P2	— — —	CL,ML-CL, CH,MH GC,SW,SC SP,GP	S2	A B C	CH SC SP	L2	—	ML,SC GW,GP			
			P1	— — —	SC,CL,MH,CH ML-CL SP,SP-SM,GW SM,GP,GM,GC Same as above	S3	A B C	SC SM SM	L1	—	CL,ML, CH,MH, ML-CL,SC GM,SM			
						S1	A B C	CH-MH MH MH	L3	—	Pt,OH CH,MH, OL,CL	G1	—	Pt,ML CL,SC
						S2	A B C	CH SC SP	L2	—	ML,SC GW,GP			
						S3	A B C	SC SM SM	L1	—	CL,ML, CH,MH, ML-CL,SC GM,SM			

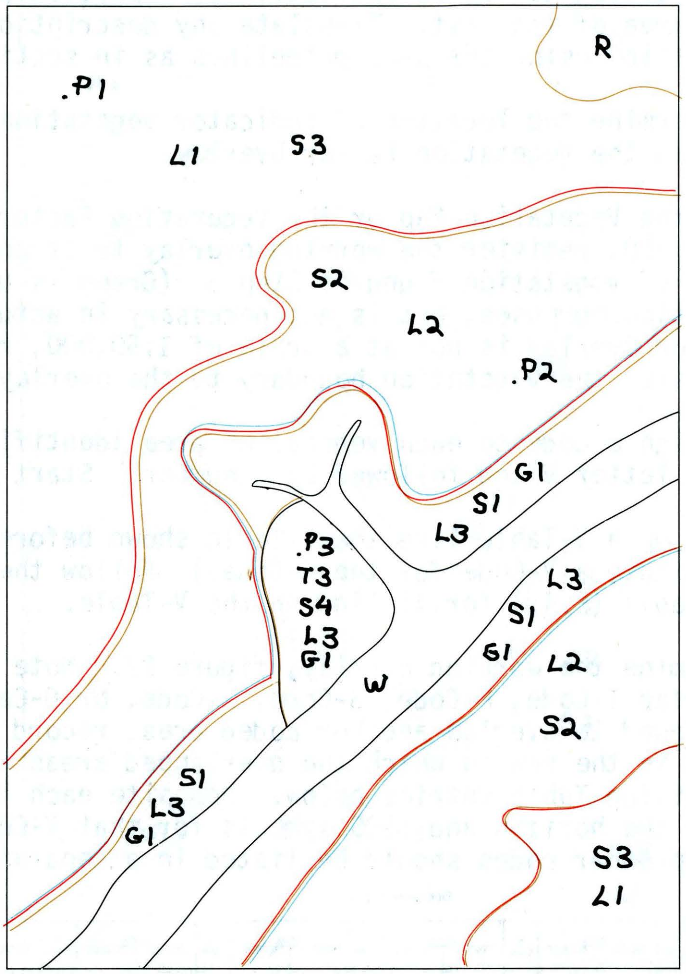


Figure 21. Working Overlay After Topographic Map, Point Data, Soil Map, Landform and Geology Overlay Analyses.

H. Check Vegetation Indicators

1. Pull out the Vegetation maps, or the Vegetation Factor Overlay with Data Tables, and any literature discussing vegetation collected earlier in section A (If none exists, continue NOW to section I).

2. Examine the literature for instances where the occurrence of a specific type of vegetation is indicative of a particular soil or soil group in the area of interest. Translate any description of such soil into USCS notation using the same guidelines as in section C.5.f.

3. Determine the location of indicator vegetation on the Vegetation Map or on the Vegetation Factor Overlay.

4. If the Vegetation Map or the Vegetation Factor Overlay is at a scale of 1:50,000, register the working overlay to it and trace in black the boundary of vegetation found in Step 3 (Green is used in this guide for illustration purposes, but is not necessary in actual compilation). If the Map or Factor Overlay is not at a scale of 1:50,000, refer to appendix A to transfer the vegetation boundary to the overlay.

5. Assign a code to each vegetation area identified in Step 2, beginning with the letter V and followed by a number. Start with V1.

6. Set up a V-Table like the G-Table shown before. (In the first column substitute a V-Code for the G-Code.) Follow the directions listed for the S-Table (E.4.) for filling in the V-Table.

7. Examine the working overlay, figure 22. Note those areas where V-Codes overlap T-Code, P-Code, S-Code, L-Code, or G-Code areas. When a V-Code is found to overlap another coded area, record the V-Code on the Decision Table in the row in which the overlapped areas are found. See the sample Decision Table entries below. Opposite each V-Code recorded in the table, note the horizon and USCS symbols for that V-Code. V-Codes that do not overlap other codes should be listed in a separate row.

Decision Table

T Code	USCS		P Code	USCS		S Code	USCS		L Code	USCS		G Code	USCS		V Code	USCS	
	Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols
T3	—	Pt,OH,CH MH,OL	P3	—	Pt	S4	—	OH,OL, Pt	L3	—	Pt,OH CH,MH, OL,CL	G1	—	Pt,ML CL,SC			
			P2	— — —	CL,ML-CL, CH,MH GC,SW,SC SP,GP	S2	A B C	CH SC SP	L2	—	ML,SC GW,GP						
			P1	— — —	SC,CL,MH,CH ML;CL SP,SP-SM,GW SM,GP,GM,GC Same as above	S3	A B C	SC SM SM	L1	—	CL,ML CH,MH, ML-CL,SC GM,SM				V1	—	CL, MH
						S1	A B C	CH-MH MH MH	L3	—	Pt,OH CH,MH, OL,CL	G1	—	Pt,ML CL,SC			
						S2	A B C	CH SC SP	L2	—	ML,SC GW,GP						
						S3	A B C	SC SM SM	L1	—	CL,ML, CH,MH, ML-CL,SC GM,SM						

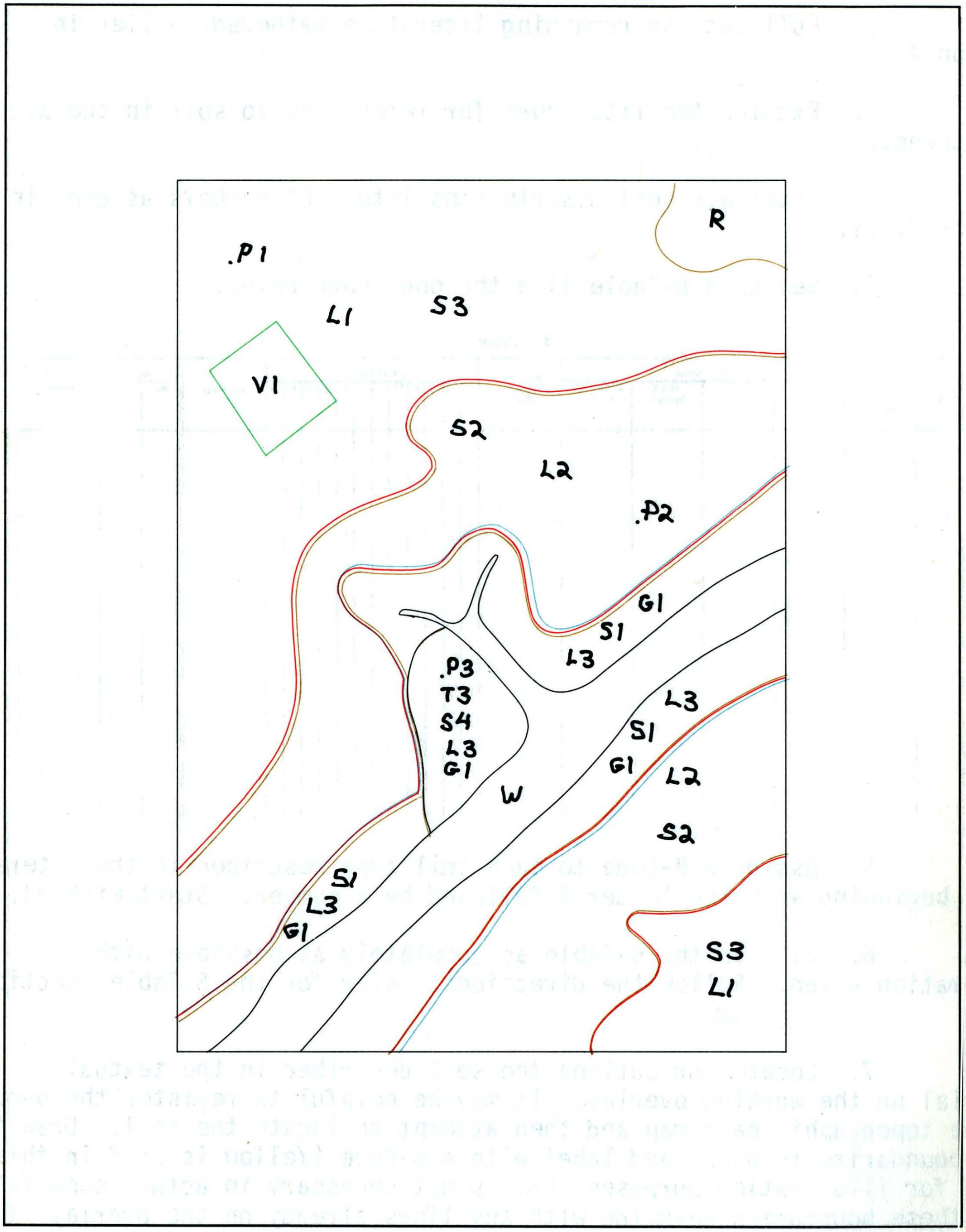


Figure 22. Working Overlay After Topographic Map, Point Data, Soil Map, Landform, Geology, and Vegetation Overlay Analyses.

I. Examine Literature

1. Pull out any remaining literature gathered earlier in section A.

2. Examine the literature for references to soil in the area of interest.

3. Translate soil descriptions into USCS symbols as done in section C.5.f.

4. Set up a B-Table like the one shown below.

B - Table

B Code	Source Title Agency Date	Soil Profile				Depth to Bedrock (M)	State of Ground												Stoniness (%)	RCI		Remarks
		Horizon	Depth (M)	USCS Symbols	Description of Layers		J	F	M	A	M	J	J	A	S	O	N	D		Wet	Dry	

5. Assign a B-Code to each soil type described in the literature, beginning with the letter B followed by a number. Start with B1.

6. Fill in the B-Table as completely as possible with the information given. Follow the directions listed for the S-Table (section E.4.)

7. Locate and outline the soil described in the textual material on the working overlay. It may be helpful to register the overlay to the topographic base map and then attempt to locate the soil. Draw the soil boundaries in black and label with a B-Code (Yellow is used in this guide for illustration purposes, but is not necessary in actual compilation). Make these boundaries coincide with any lines already on the overlay if they are less than one-fourth of an inch apart.

8. Examine the working overlay, figure 23. Note those areas where B-Codes overlap T-Code, P-Code, S-Code, L-Code, or G-Code areas. When a B-Code is found to overlap another coded area, record the B-Code on

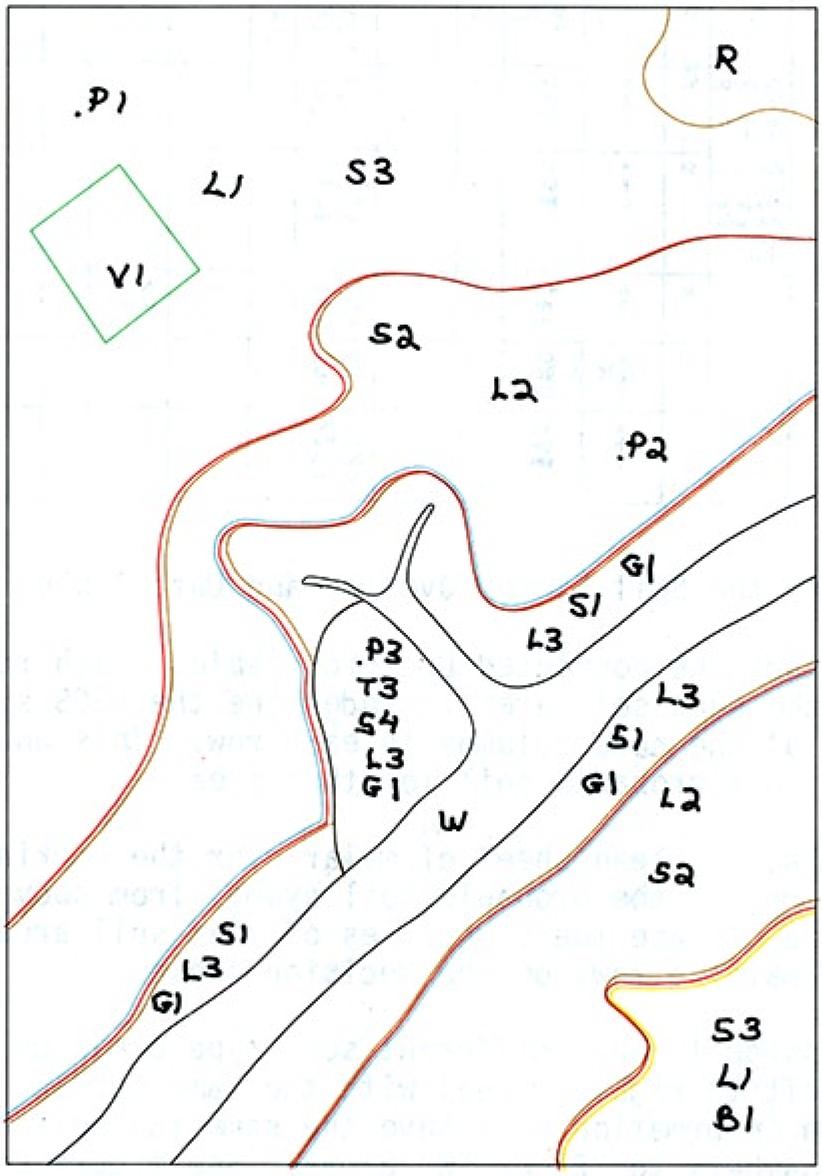


Figure 23. Working Overlay After Topographic Map, Point Data, Soil Map, Landform, Geology, Vegetation and Literature Analyses.

the Decision Table in the row in which the overlapped areas are found. See the sample Decision Table entries below. Opposite each B-Code recorded in the table, note the horizon and USCS symbols for that B-Code. B-Codes that do not overlap other codes should be listed in separate rows.

Decision Table

T Code	USCS		P Code	USCS		S Code	USCS		L Code	USCS		G Code	USCS		V Code	USCS		B Code	USCS	
	Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols		Horizon	Symbols
T3	—	Pt,OH,CH MH,OL	P3	—	Pt	S4	—	OH,OL, Pt	L3	—	Pt,OH CH,MH, OL,CL	G1	—	Pt,ML CL,SC						
			P2	— — —	CL,ML-CL, CH,MH GC,SW,SC SP,GP	S2	A B C	CH SC SP	L2	—	ML,SC GW,GP									
			P1	— — —	SC,CL,MH,CH ML-CL SP,SP-SM,GW SM,GP,GM,GC Same as above	S3	A B C	SC SM SM	L1	—	CL,ML CH,MH, ML-CL,SC GM,SM				V1	—	CL, MH			
						S1	A B C	CH-MH MH MH	L3	—	Pt,OH CH,MH, OL,CL	G1	—	Pt,ML CL,SC						
						S2	A B C	CH SC SP	L2	—	ML,SC GW,GP									
						S3	A B C	SC SM SM	L1	—	CL,ML, CH,MH, ML-CL,SC GM,SM							B1		MH,ML-CL

J. Prepare the Soil Factor Overlay and Data Table

1. Study the completed Decision Table. Each row contains descriptions of the same soil areas. Underline the USCS symbol(s) that appear(s) in all of the code columns in each row. This underlined symbol(s) represent(s) the most probable soil for that area.

2. Place a clean sheet of mylar over the working soil overlay. In black pencil, record the probable soil symbol from above in parenthesis over the soil area. Trace the boundaries of that soil area in black. Repeat for the remaining rows on the Decision Table.

3. Assign to each different soil type a map unit number from top to bottom, left to right. Areas with the same surface soil type and identical horizon information will have the same map unit number. Do not assign map unit numbers to "R" or "W" areas. See figure 24.

4. Beginning with map unit one, fill in the Soil Data Table. Refer to the Code tables for the required information for the Data Elements. Compare and combine information from the Code tables to fill in the Data Table. See figure 25.

If discrepancies in information exist among Code table information or among codes in the Decision Table, select information for the Data Table according to reliability statements recorded on the Code tables (e.g. anything field-checked is probably reliable) or to the following reliability sequence.

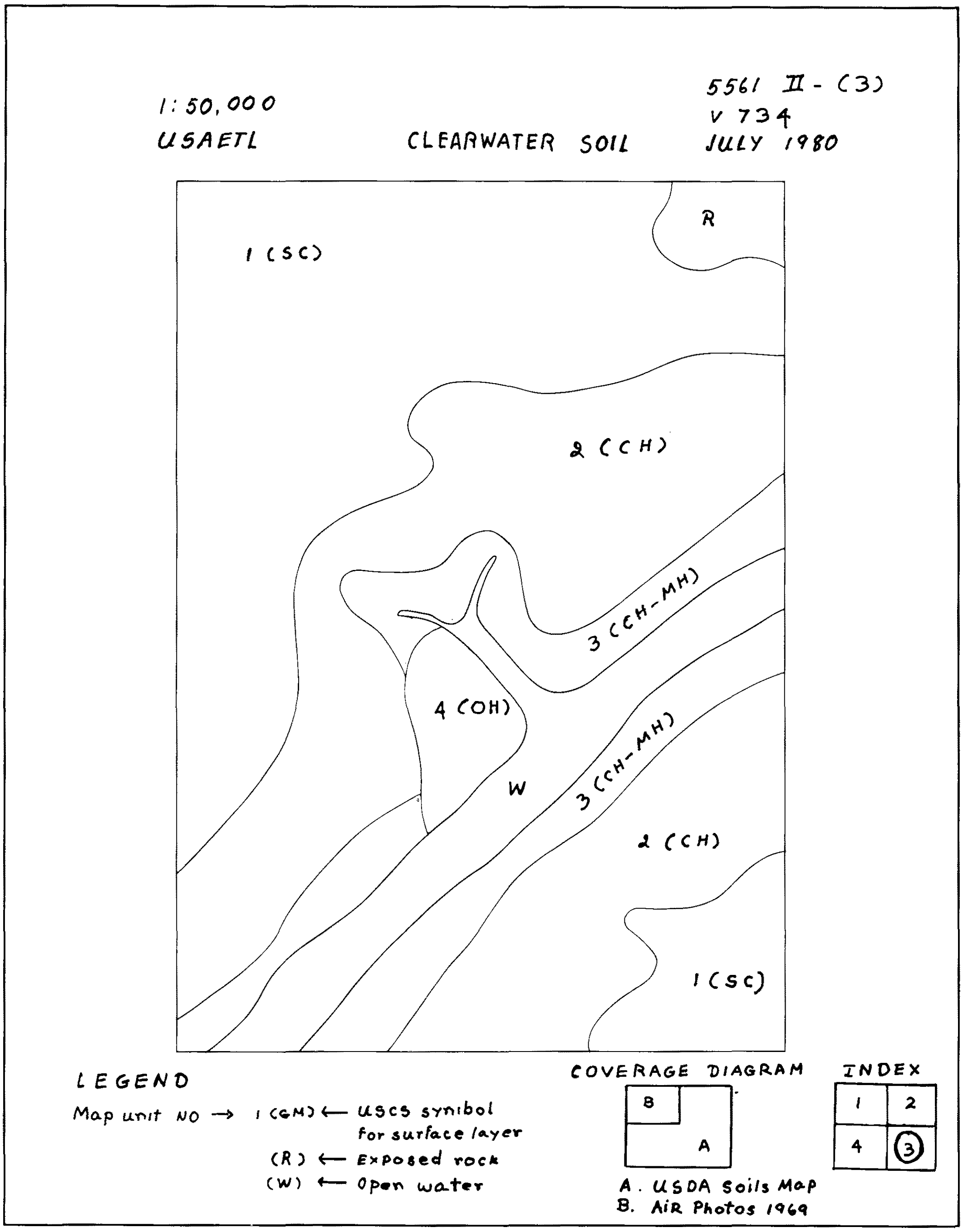


Figure 24. Completed Soil Factor Overlay

Soil Data Table

Map Unit Number	Soil Profile			Depth to Bedrock (M)	State of Ground												Stoniness (%)	RCI		Remarks
	Horizon	Depth (M)	USCS Symbol		J	F	M	A	M	J	J	A	S	O	N	D		Wet	Dry	
1	A	0-.3	SC	1.2	S	S	S	F	M	W	D	D	D	M	W	F	0	82T*	100T	These data are based on field sampling
	B	.3-.9	SM																	
	C	.9-1.2	SM																	
2	A	0-.15	CH	1.2	S	S	S	F	M	W	D	D	D	M	W	F	5	95	110	Stoniness varies; lower elevations tend to be stonier
	B	.15-.9	SC															80	102	
	C	.9-1.2	SP															N/A	N/A	
3	A	0-.5	CH-MH	1.8	S	S	S	F	M	W	D	D	D	M	W	F	15	85	150	
	B	.5-.9	MH															85	130	
	C	.9-1.8	MH															85	130	
4	—	?	OH	?	S	S	S	F	M	W	D	D	D	M	W	F	0	35	N/A	

* T values are best guesses.

Figure 25. Completed Soil Data Table

Most reliable	P-Code
	S-Code
	T-Code
	L-Code
	G-Code
	V-Code
Least reliable	B-Code

That is, if the P-Code Table shows a GW soil and the G-Code Table shows a CL soil, the GW soil would be recorded on the Data Table, unless two or more other codes also show a CL soil. In the latter situation, the accuracy of the P-Code information would be suspect, and the CL soil would be recorded on the Data Table.

5. If none of the Code Tables provide information on RCI, refer to table 3 of approximate RCI values for wet and dry seasons to find a value. Record this value followed by a T on the Data Table.

6. Finish the Soil Overlay and Data Table according to the specifications in appendix B.

TABLE 3. USCS SOIL SYMBOLS WITH CORRESPONDING APPROXIMATE RCI VALUES FOR WET AND DRY SEASONS

USCS Symbol	RCI*	
	Dry Season	Wet Season
GW	N/A	N/A
GP	N/A	N/A
GM	100+	72
GC	100+	90
GM-GC	100+	81
SW	N/A	N/A
SP	N/A	N/A
SM	100+	82
SC	100+	82
SM-SC	100+	82
ML	100+	55
CL	100+	46
ML-CL	100+	51
OL	46	46
MH	100+	83
CH	100+	90
OH	40	40
Pt	35	35

*These values are best guesses and should be used ONLY in the absence of more reliable information.

APPENDIX A

METHODS FOR TRANSFERRING INFORMATION FROM SOURCE MATERIALS OF DIFFERING SCALES

When the source maps are a different scale, the boundaries to the overlay must be transferred by one of the following methods:

1. Photographically enlarge or reduce the source maps to the overlay scale, and then trace the boundaries of areas of interest onto the overlay. This method requires access to a large copy-camera and a photographic laboratory which may not always be possible.

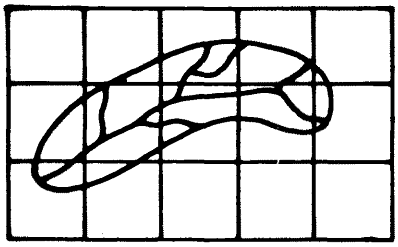
2. Use a reflecting projector to project the source map onto the overlay at the same scale, and then trace the boundaries. In tracing the boundaries, fold the map and work on it in small sections.

3. Use a sketchmaster or Zoom Transferscope to transfer the boundaries. However, these instruments can accommodate only small sections of the map. In addition, they can be used only when the scale difference is small.

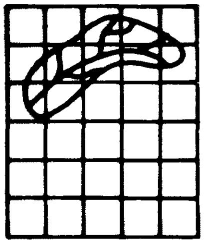
4. Where available, a pantograph may be used.

5. As a last resort, the boundaries may be transferred by using a system of squares similar to the following examples:

MAP SCALE 1:25,000
SIZE OF SQUARES 1 cm



OVERLAY SCALE 1:50,000
SIZE OF SQUARES 0.5cm



This method of transferring detail is very slow and should be used only when revising or completing small areas on the overlay.

APPENDIX B. SPECIFICATIONS FOR THE PREPARATION OF SOIL FACTOR OVERLAYS

A. INTRODUCTION

1. The purpose of this appendix is to specify the methods of recording the results of the soil analysis in the form of a factor overlay and data table.

2. The soil products will consist of two parts: (1) An overlay registered to a standard 1:50,000 scale map and (2) An accompanying data table describing conditions within each area on the overlay.

3. When a standard 1:50,000 scale map is not available to use as a base for the overlay, a base map at another scale may be used. If the base map selected exceeds 26 by 34 inches (66 by 86 cm), it will be subdivided and two or more overlays prepared.

4. The data tables will be prepared on material of the same type and size as the overlay.

B. SOIL FACTOR OVERLAY

1. An example of a factor overlay is shown in figure 24. Specifications for the format of the overlay are provided in figures B1 and B2.

2. The following limited information is presented on the factor overlay:

   a. Area Boundaries.

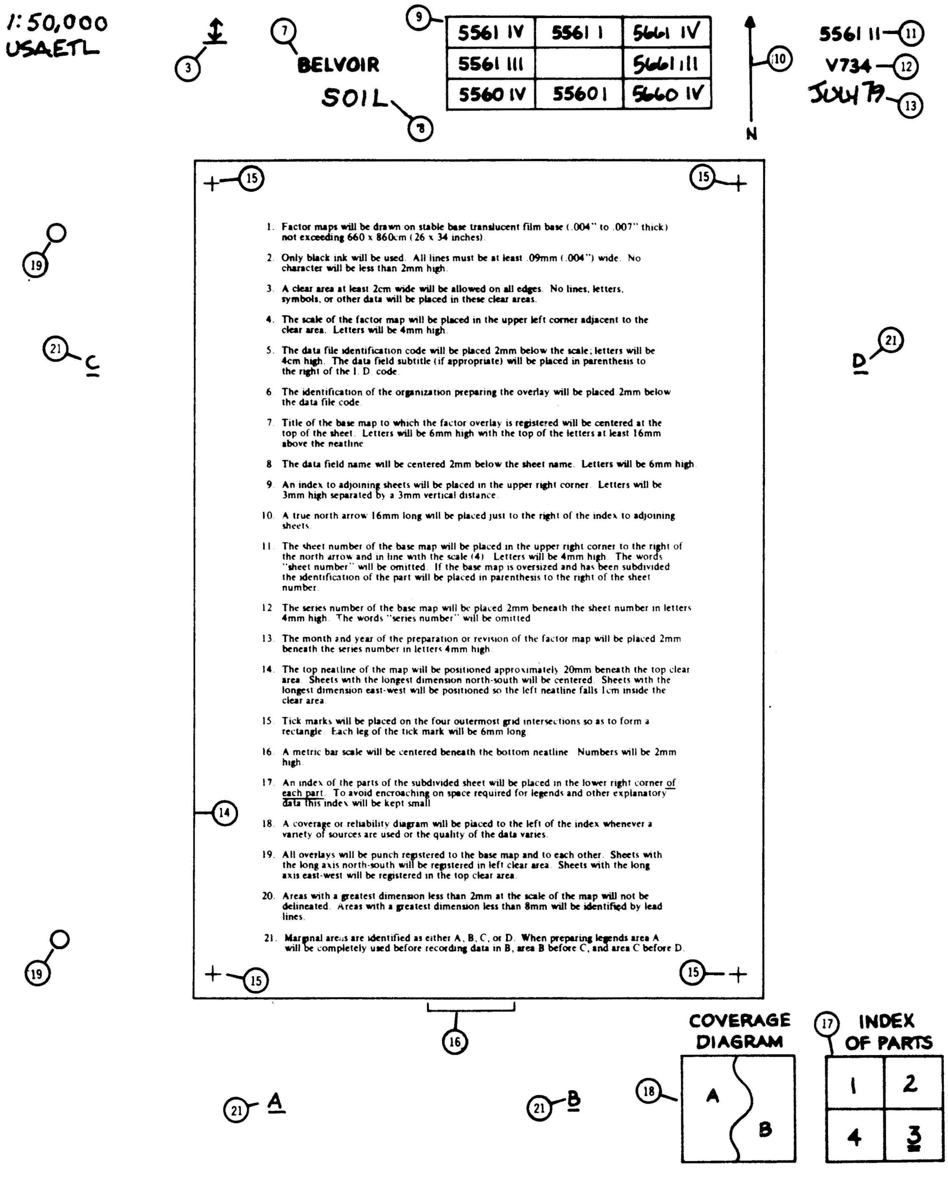
   b. Area Identification number.

   c. USCS symbol for the surface horizon.

3. Area boundaries will enclose each map area containing the same soil. Boundaries will be drawn approximately 0.2 mm wide with either black ink or black fine-line pencil. Boundaries will not cross water bodies or double line streams. Areas with any dimension greater than 2 mm will be shown.

4. Map areas will be assigned identification numbers. Areas having the same surface soil and identical soil profiles will be assigned the same identification number.

5. The Unified Soil Classification System symbols for the Surface horizon will be shown for all soil areas. Areas of exposed bedrock will be indicated by the letter "R". Areas of open water will be identified by the letter "W".



1. Factor maps will be drawn on stable base translucent film base (.004" to .007" thick) not exceeding 660 x 860cm (26 x 34 inches).

2. Only black ink will be used. All lines must be at least .09mm (.004") wide. No character will be less than 2mm high.

3. A clear area at least 2cm wide will be allowed on all edges. No lines, letters, symbols, or other data will be placed in these clear areas.

4. The scale of the factor map will be placed in the upper left corner adjacent to the clear area. Letters will be 4mm high.

5. The data file identification code will be placed 2mm below the scale; letters will be 4cm high. The data field subtitle (if appropriate) will be placed in parenthesis to the right of the I. D. code.

6. The identification of the organization preparing the overlay will be placed 2mm below the data file code.

7. Title of the base map to which the factor overlay is registered will be centered at the top of the sheet. Letters will be 6mm high with the top of the letters at least 16mm above the neatline

8. The data field name will be centered 2mm below the sheet name. Letters will be 6mm high.

9. An index to adjoining sheets will be placed in the upper right corner. Letters will be 3mm high separated by a 3mm vertical distance.

10. A true north arrow 16mm long will be placed just to the right of the index to adjoining sheets.

11. The sheet number of the base map will be placed in the upper right corner to the right of the north arrow and in line with the scale (4). Letters will be 4mm high. The words "sheet number" will be omitted. If the base map is oversized and has been subdivided the identification of the part will be placed in parenthesis to the right of the sheet number.

12. The series number of the base map will be placed 2mm beneath the sheet number in letters 4mm high. The words "series number" will be omitted

13. The month and year of the preparation or revision of the factor map will be placed 2mm beneath the series number in letters 4mm high.

14. The top neatline of the map will be positioned approximately 20mm beneath the top clear area. Sheets with the longest dimension north-south will be centered. Sheets with the longest dimension east-west will be positioned so the left neatline falls 1cm inside the clear area.

15. Tick marks will be placed on the four outermost grid intersections so as to form a rectangle. Each leg of the tick mark will be 6mm long.

16. A metric bar scale will be centered beneath the bottom neatline. Numbers will be 2mm high.

17. An index of the parts of the subdivided sheet will be placed in the lower right corner of each part. To avoid encroaching on space required for legends and other explanatory data this index will be kept small

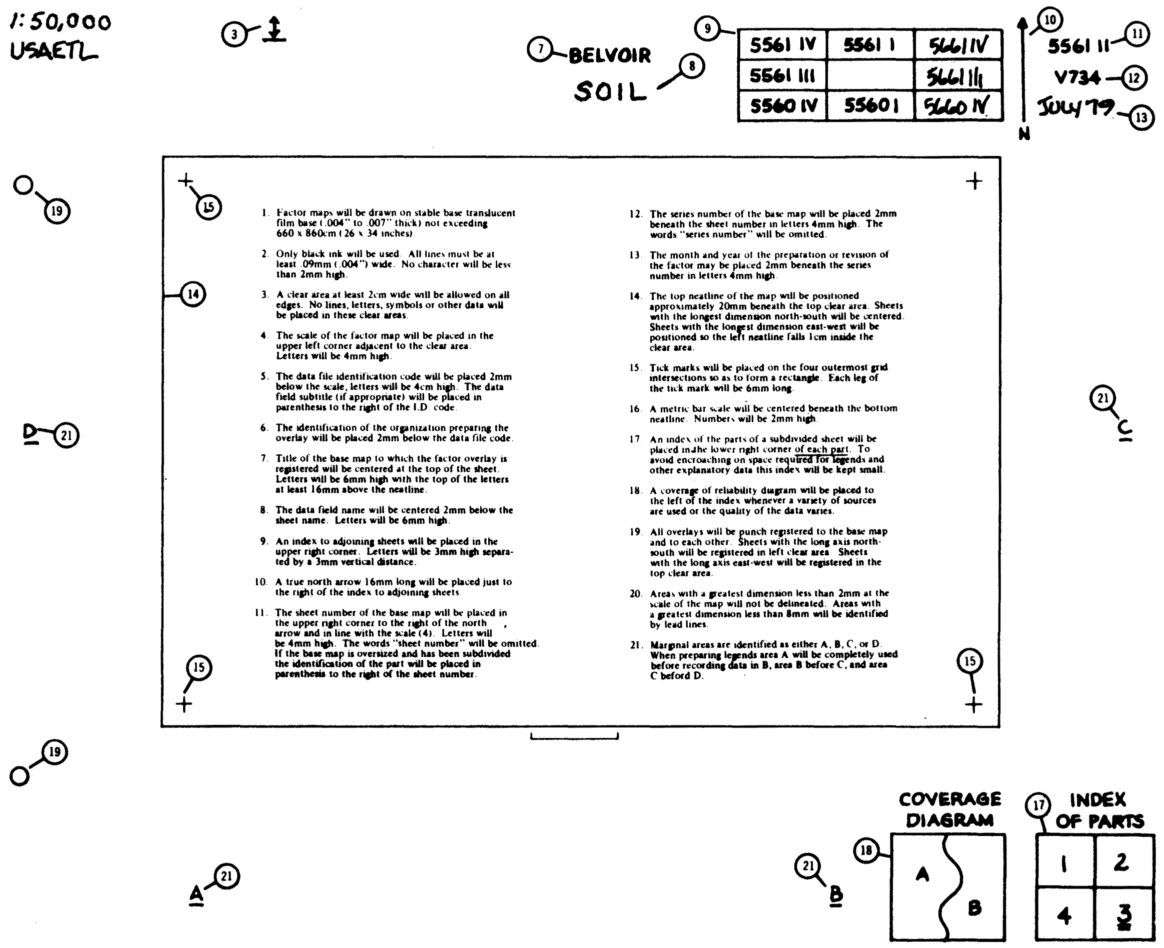
18. A coverage or reliability diagram will be placed to the left of the index whenever a variety of sources are used or the quality of the data varies.

19. All overlays will be punch registered to the base map and to each other. Sheets with the long axis north-south will be registered in left clear area. Sheets with the long axis east-west will be registered in the top clear area.

20. Areas with a greatest dimension less than 2mm at the scale of the map will not be delineated. Areas with a greatest dimension less than 8mm will be identified by lead lines.

21. Marginal areas are identified as either A, B, C, or D. When preparing legends area A will be completely used before recording data in B, area B before C, and area C before D.

Figure B1 . Format for Factor Overlays With Long Axis N-S



1. Factor maps will be drawn on stable base translucent film base (.004" to .007" thick) not exceeding 660 x 860cm (26 x 34 inches).
2. Only black ink will be used. All lines must be at least .09mm (.004") wide. No character will be less than 2mm high.
3. A clear area at least 2cm wide will be allowed on all edges. No lines, letters, symbols or other data will be placed in these clear areas.
4. The scale of the factor map will be placed in the upper left corner adjacent to the clear area. Letters will be 4mm high.
5. The data file identification code will be placed 2mm below the scale, letters will be 4cm high. The data field subtitle (if appropriate) will be placed in parenthesis to the right of the I.D. code.
6. The identification of the organization preparing the overlay will be placed 2mm below the data file code.
7. Title of the base map to which the factor overlay is registered will be centered at the top of the sheet. Letters will be 6mm high with the top of the letters at least 16mm above the neatline.
8. The data field name will be centered 2mm below the sheet name. Letters will be 6mm high.
9. An index to adjoining sheets will be placed in the upper right corner. Letters will be 3mm high separated by a 3mm vertical distance.
10. A true north arrow 16mm long will be placed just to the right of the index to adjoining sheets.
11. The sheet number of the base map will be placed in the upper right corner to the right of the north, arrow and in line with the scale (4). Letters will be 4mm high. The words "sheet number" will be omitted. If the base map is oversized and has been subdivided the identification of the part will be placed in parenthesis to the right of the sheet number.
12. The series number of the base map will be placed 2mm beneath the sheet number in letters 4mm high. The words "series number" will be omitted.
13. The month and year of the preparation or revision of the factor may be placed 2mm beneath the series number in letters 4mm high.
14. The top neatline of the map will be positioned approximately 20mm beneath the top clear area. Sheets with the longest dimension north-south will be centered. Sheets with the longest dimension east-west will be positioned so the left neatline falls 1cm inside the clear area.
15. Tick marks will be placed on the four outermost grid intersections so as to form a rectangle. Each leg of the tick mark will be 6mm long.
16. A metric bar scale will be centered beneath the bottom neatline. Numbers will be 2mm high.
17. An index of the parts of a subdivided sheet will be placed in the lower right corner of each part. To avoid encroaching on space required for legends and other explanatory data this index will be kept small.
18. A coverage of reliability diagram will be placed to the left of the index whenever a variety of sources are used or the quality of the data varies.
19. All overlays will be punch registered to the base map and to each other. Sheets with the long axis north-south will be registered in left clear area. Sheets with the long axis east-west will be registered in the top clear area.
20. Areas with a greatest dimension less than 2mm at the scale of the map will not be delineated. Areas with a greatest dimension less than 8mm will be identified by lead lines.
21. Marginal areas are identified as either A, B, C, or D. When preparing legends area A will be completely used before recording data in B, area B before C, and area C beford D.

Figure B2. Format for Factor Overlays With Long Axis E-W

6. Map unit numbers and letters will be at least 3.2 mm high (typewriter size), arranged as follows:

Map Area No. 22 (GP) USCS symbol

When an overlay area is too small for the number and codes, they may be placed in an adjacent larger area, and a lead line should be used to indicate the area described.

7. When a variety of sources have been used to prepare the overlay and the reliability varies throughout the sheet, a coverage diagram must be provided to indicate which sources have been used for each area of the overlay (figures B1 and B2).

8. If an oversize, non-standard base is subdivided into two or more overlays, each part will be numbered and an index to the parts will be provided (See figures B1 and B2).

C. DATA TABLE

1. An example of a soil data table is given in figure 25.

2. The data table will be prepared in black ink or black fine-line pencil on the same type and size material as the factor overlay so as to permit ozalid reproduction.

3. Column headings and entries will be neatly hand-lettered. The black letters will be no smaller than 3.2 mm. Column separator lines must be at least 0.2 mm wide.

4. Column Entries.

a. Map unit identification numbers will be entered in the first column. They will be arranged in the column in numerical sequence from top to bottom.

b. Soil Profile:

(1) HORIZON: Each horizon, or layer, of the soil profile will be identified by a capital letter. Letters will be assigned alphabetically from the surface layer downward.

(2) DEPTH: The mean depth of the A horizon is measured in meters from the soil surface to the bottom of the horizon. Zero is used to indicate the soil surface, e.g. 0 - 0.5. The mean depth of each succeeding layer is measured from the bottom of the overlying layer, e.g. 0.5 - 1.1.

(3) USCS SYMBOL: The Unified Soil Classification Symbol will be recorded for each horizon.

c. Depth to Bedrock: Depth to bedrock will be recorded to the nearest tenth meter. Use SURF when the bedrock is located at the surface.

d. State of Ground: An entry will be made for each month of the year starting with January. Each entry will consist of a code indicating the prevailing surface condition for the month, i.e. wet (W), dry (D), moist (M), frozen (F), snow-covered (S).

e. Stoniness: Record an estimate of the percentage volume of stones greater than 25 cm in diameter within each soil layer.

f. Rating Cone Index (RCI): Record the RCI value for each soil layer for wet and/or dry conditions. If the RCI value is taken from table 3, record a T after the value, e.g. 85T.

g. Remarks: Record brief comments about the soil pertaining to characteristics like stickiness, slipperiness, and suitability for specific engineering purposes. Also, narrative information describing state of ground may be recorded in this column.

APPENDIX C.

U.S. GOVERNMENT AND OTHER AGENCIES WHERE SOURCE MATERIALS CAN BE OBTAINED

LIBRARY OF CONGRESS

Misc. Maps	Chief, Photo Duplications Service Library of Congress 10 First Street, S.E. Washington, D.C. 20540
Misc. Maps	Geography and Maps Division Library of Congress Washington, D.C. 20540 Telephone: (202) 370-1261

NATIONAL ARCHIVES AND RECORDS SERVICE

Maps & Cartographic Records	Cartographic Archives Division National Archives and Records Service Washington, D.C. 20408 Telephone: (202) 523-3062

U.S. GEOLOGICAL SURVEY

Glaciologic Data	World Data Center - A: Glaciology U.S. Geological Survey 1305 Tacoma Ave. South Tacoma, WA 98402 Telephone: (206) 593-6506
U.S. Land Use Data	Dr. James R. Anderson Chief Geographer U.S. Geological Survey, Mail Stop 115 Reston, VA 22092 Telephone: (703) 860-6344
Current & Historical Topographic Maps	National Cartographic Information Center U.S. Geological Survey 507 National Center Reston, VA 22092 Telephone: (703) 860-6045 (Topographic maps, historical topographic maps)

DEPARTMENT OF AGRICULTURE

Soil Conservation Service
Independence Ave., S.W.
Washington, D.C. 20408
Telephone: (202) 447-4543

(U.S. County Soil Survey Maps)

APPENDIX D. BIBLIOGRAPHY

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APPENDIX E. GLOSSARY

A HORIZON	Uppermost layer of soil. Top soil.
AGGREGATE OF SOIL	Soil material that is separable by mechanical means.
ALLUVIAL FAN	A fan-shaped feature composed of alluvium; where a steep mountain canyon emerges into an open valley or onto a plain where the gradient of a stream valley decreases abruptly.
ALLUVIUM	Unconsolidated surface material that has been transported by water and deposited in another location.
ALTITUDE	The vertical distance between a point and a datum surface or plane, usually mean sea level.
AQUIFER	A water-bearing stratum of rock or unconsolidated material.
AZONAL SOILS	Any group of soils that do not have a well-developed profile.
B HORIZON	A layer of soil that has considerable weathering and a high mineral content, but contains comparatively less organic matter than the A horizon above it.
BARCHAN DUNE	A crescent-shaped moving sand dune.
BASALT	An extrusive volcanic rock.
BED	A layer of rock that is recognizable from adjacent layers.
BEDROCK	The mass of rock buried under gravel, sand, or soil, or exposed at the surface.
BENCH	A small terrace-like formation formed along river and stream valleys or shorelines.
BOG	A swamp or wetland filled with organic material.
BOULDER TRAIN	A series of rock knobs and/or large boulders found along the line of glacier movement.

C HORIZON	The layer of the soil horizon often below the B horizon that may consist of altered parent material, accumulated soluble salts, gley, or cemented particles.
CHERNOZEM	One of the world's largest soil groups characterized by a high calcium carbonate content.
CLAY	Fine-grained material with plastic properties; refers to a soil particle size that often differs among soil classification systems.
COHESION	The force holding a solid or liquid together, owing to attraction between like molecules.
COLLUVIUM	Surface materials, rock bits, soil, etc., found at the foot of a slope or cliff owing to the force of gravity.
COMPACTION	The decrease in the volume of surface materials resulting from continuous deposition of additional materials.
CONSOLIDATION	The process whereby loose or uncompacted surface materials become firm and coherent.
CONTACT METAMORPHISM	The changing of one rock type to another along the margins of igneous intrusive or extrusive materials.
CRYSTALLINE ROCKS	Rock consisting of closely fitted mineral crystals rather than of cemented grains or volcanic glass, e.g. most metamorphic and igneous rocks.
DEFLATION	The removal of soil material by the wind.
DEFORMATION	Any change in the original formation of a landform or rock strata.
DENUDATION	The removal and relocation of surface materials by wind and water action.
DESERT	An arid region in which the vegetation has adapted to low rainfall (less than 20 inches per year).

DIFFERENTIAL WEATHERING	The variation in the breakdown of rock owing to variations in the hardness of the rock materials.
DIKE	A tabular body of igneous rock oriented transverse to the structure of adjacent rocks.
DRIFT	Any surface material, rock, soil, etc., that has been transported by glacial action.
DRUMLIN	A long, narrow hill with a steep slope on one side and shallow slopes on the others; formed during continental glaciation.
DUFF	Organic material in various stages of decomposition that forms the Ao layer of the soil profile.
ELUVIATION	The movement of soil particles, in solution, from one depth to another within the soil profile.
END MORAINE	A ridgelike formation of drift formed along the terminus of a glacier.
EOLIAN SOIL MATERIAL	Small soil particles that have been transported and deposited by the wind.
EROSION	The wearing away of the land surface by detachment and transport of soil and rock materials through the action of moving water, ice, waves, and wind.*
ESTUARY	A body of water where fresh river water mixes with salt water; usually where a river empties into a sea.
EXFOLIATION	The breaking or peeling of rock surfaces in concentric sheets.
FAULT	A fracture in the earth's crust, accompanied by a displacement of one side with respect to the other.
GNEISS	A type of foliated metamorphic rock with no specific composition.

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* Strahler, 1963

GRANITE	A visibly granular, crystalline rock of interlocking texture, composed essentially of feldspar and quartz.
GROUND WATER	Subsurface water located below the water table.
HARDPAN	A hardened soil layer in the lower A horizon or in the B horizon caused by cementation of soil particles. The hardness does not change appreciably with changes in the moisture content.
HUMMOCK	A rounded, conical knoll or small hill.
HUMUS	Dark brown to black well-decomposed organic material formed from the remains of plants and animals; forms some soil surfaces.
INTRAZONAL SOILS	One of the world's major soil groups with a well-developed profile that reflects the influence of topography, parent material, or age rather than vegetation or climate.
JOINT	A fracture or parting in a rock mass.
LAVA	Either fluid or solid rock that is the result of volcanic activity.
LEVEE	Either a manmade or natural raised bank that confines a stream channel.
LIQUID LIMIT	The moisture content at which a soil passes from the plastic to the liquid state.
LITHIFICATION	The process that converts newly deposited sediments into rock.
LOAM	A soil texture class.
MARL	Soft and unconsolidated calcium carbonate, usually mixed with varying amounts of clay or other impurities.
MARSH	Shallow flooded areas that support a vegetative cover of reeds, rushes, and sedges.

MASS MOVEMENT OR MASS WASTING	A general term for a variety of processes by which large masses of earth material are moved by gravity either slowly or quickly from one place to another; includes avalanches, landslides, earth flowage, soil creep, and solifluction.
MESA	A table-like formation bounded on at least one side by a steep cliff.
METAMORPHIC ROCK	Rock derived from the alteration of pre-existing rock (sedimentary, igneous, or metamorphic) caused by pressure, heat, or infiltration of other materials.
MONADNOCK	An isolated hill or mountain surrounded by flatter terrain; it is a relict of an older terrain surface that was eroded away.
MUCK	Highly decomposed organic material in which the original plant parts are not recognizable; usually dark in color.
MUSKEG	A wet area found in subarctic climates that is similar to a bog.
ORGANIC SOIL	A general term applied to a soil (or to a soil horizon) that consists primarily of organic matter, such as peat soils, muck soils, and peaty soil layers.
OUTCROP	The emergence of bedrock at the surface.
OUTWASH	Surface materials that have been removed from the terminus of a glacier by water and deposited elsewhere.
OVERBURDEN	A surface material that has formed or been deposited over another type of soil or rock formation.
PARENT MATERIAL	The horizon of the soil profile from which the surface or A horizon is formed, usually, but not always, the C horizon.
PEAT	A dark brown to black substance made up of decomposed plant remains.
PEAT BOG	A bog containing peat.

PEDIMENT	A sloping plain located at the foot of a mountain range.
PERMAFROST	Permanently frozen ground.
PHYSIOGRAPHIC PROVINCE	A unit of terrain having distinctive landform characteristics.
PLASTICITY	The property of the fine-grained portion of a soil containing clay that permits it to be remolded without crumbling or rupturing, to be deformed by pressure and to remain deformed when pressure is released.
PLASTIC LIMIT	The water content at which a soil changes from the semisolid to the plastic state.
PLAYA	The flat or nearly flat low part of an enclosed basin or temporary lake without outlet; also known as a dry lake.
PODZOL SOIL	A major soil group characterized by a highly leached A horizon that is low in iron and lime.
POROSITY	The ratio of the total volume of interstices in a rock or soil sample to its total sample.
SALINA	A salt marsh or pond located adjacent to the sea, but not open to the sea.
SALT PAN	Any flat area or natural depression where water can collect, evaporate, and leave a deposit of salt.
SCREE	A mound or area of rock fragments located at the base of a cliff or along a slope.
SOLIFLUCTION	The downhill movement or creep of soil that is saturated with water.
SWAMP	An area of continuously saturated ground, supporting vegetation of predominantly woody plants whose root systems are adapted to prolonged submergence. (Sometimes used as synonymous with "marsh," but here differentiated on the basis of its woody vegetation.)
SWELL-AND-SWALE TOPOGRAPHY	Low, gentle hill and valley topography associated with continental glacial ground moraine.

TIDAL MARSH	A marsh located along the shoreline of large bodies of water that is alternately submerged and laid bare by the tides.
TILL	Glacial drift deposited directly by ice, without transportation or sorting.
TOP SOIL	A general term applied to the A horizon of the soil profile.
VALLEY TRAIN	Sand and gravel deposited in a valley by glacial melt-water.
VARVED CLAY	Alternating layers of clay and coarser textured material.
VOLCANO	An opening in the earth's surface from which molten material, gases, and other material are expelled.
WEATHERING	The disintegration of rock into soil by its exposure to the elements of wind, rain, temperature fluctuations, and other climatic elements.
ZONAL SOIL	A soil that has a well-defined soil profile, usually a mature soil.