NATIONAL COOPERATIVE SOIL SURVEY

Soil Survey Conference Proceedings

Lincoln, Nebraska
July 24-28, 1989

Proceedings **of** National Cooperative Soil Survey Conference

Lincoln, Nebraska.

July 24-28, 1989

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NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
Lincoln Hilton Hotel - Lincoln, Nebraska
July 24-28, 1989

NCSS - SETTING THE COURSE

Monday - July 24

lo:oo a.m. - 12:oo p.m.	Registration	
12:oo p.m. - l:oo p.m.	Lunch	
	Chairman David T. Lewis	
l:oo p.m. - 1:15 p.m.	**Welcome**	August J. Dombusch, Jr. Director of Midwest National Technical Center, USDA-SCS Lincoln, Nebraska
1:15 p.m. - 2:oo p.m.	Intro. Remarks and Report on Soil Survey Activities in the United States	Richard W. Arnold Director, Soil Survey Division USDA-SCS, Washington, DC
2:00 p.m. - 2:30 p.m.	Report on Soil Survey Activities in Canada	William W. Pettaplece Ag. Canada Ottawa, Ontario, Canada
2:30 p.m. - 3:00 p.m.	BREAK	
3:oo p.m. - 3:45 p.m.	Conventions Used in Soil Taxonomy	John E. Witty Nat. Ldr. for Soil Classification USDA-SCS, Washington, DC
3:45 p.m. - 4:oo p.m.	New Horizon Subscript for Vertlc Properties	Warren C. Lynn Soil Scientist, NSSL USDA-SCS, Lincoln, NE
4:oo p.m. - 4:30 p.m.	Bureau of Land Hgt. Report	Colln W. Volgt Soil Scientist USDI-BLM, Washington, DC
4:30 p.m. - 5:oo p.m.	Report on Soil Survey Activities in Mexico	Martin Arguljo Head, Soil Survey in the National Water Commission
5:oo p.m.	ADJOURN	

National Cooperative Soil Survey Conference

Tuesday - July 25

Chairman.- William E. Roth

TASK FORCE MEETINGS

8:00 a.m. - 8:30 a.m.	U.S. Bureau of Indian Affairs	Mark Bradford Soil Scientist USDI-BIA
8:30 a.m. - 9:30 a.m.	SMSS Report	Hari Eswaran, Project Leader USAID, Washington, DC
9:30 a.m. - 10:00 a.m.	BREAK	
10:00 a.m. - 11:30 a.m.	Group 1--Extrapolation of Soil Survey Data Group 2--Awareness of Soils a.8 a Resource Group 3--Accuracy and Reliability of Soil Survey Information	
11:30 p.m. - 12:30 p.m.	LUNCH	
12:30 p.m. - 2:30 P.m.	Group 1--Extrapolation of Soil Survey Data Group 2--Awareness of Soils as a Resource Group 3--Accuracy and Reliability of Soil Survey Information	
2:30 p.m. - 3:00 p.m.	BREAK	
3:00 p.m. - 4:30 p.m.	Group 4-Development and Use of Soil Quality Standards Group 5--Land Evaluation Group 6--Utility of Soil Landscape Units	
4:30 p.m. - 5:30 p.m.	Group 4--Development and Use of Soil Quality Standards Group 5-Land Evaluation Group 6-Utility of Soil Landscape Units	
5:30 p.m.	ADJOURN	

Wednesday - July 26

Chairman - Joe D. Nichols

8:00 a.m. - **8:30** a.m.	**U.** S. Forest Service Report	Peter E. Avers Soil Resource Program Manager USDA-FS, Washington, DC
8:30 a.m. - 9:00 a.m.	Report on Canadian Interagency Soil Interpretations Committee	William W. Pettapiece Ag. Canada Ottawa, Ontario
9:00 a.m. - **9:30** a.m.	South Agricultural Experiment Station Report	South Representative
9:30 a.m. - 10:00 **a.m.**	BREAK	
10:00 a.m. - **10:30** a.m.	Report on Soil Characterization Standards	Ellis G. Knox Rational Leader for Soil Survey Investigations, NSSC, USDA-SCS Lincoln, Nebraska

TASK FORCE MEETINGS (CONT.)

10:30 a.m. - 12:00 p.m.	Group **7--Soils** Changed by Management Group 8--Soil Quality Standards	
12:00 **p.m.** - 1:00 p.m.	LUNCH	

Chairman - Ronald D. Yeck

l:oo p.m. - **4:30** p.m.	Tour of National Soil Survey Center, Midwest **NTC**	
4:30 p.m.	**ADJOURN**	
Evening -	Group dinner planned. Featured speaker	David **Howe** Editor, Nebraska Farmer Lincoln, Nebraska

National Cooperative Soil Survey Conference

Thursday - July 27

	Chairman - C. Steven Holzhey	
8:00 a.m. - 9:30 a.m.	Conference Steering Committee Mtg. (runs concurrent with the following Task Force meetings)	

TASK FORCE MEETINGS (CONT.)

8:00 a.m. - 9:30 a.m.	Group 9--The Model Soil Survey Group 10--Adequacy of Soil Survey Information Delivery System	
9:30 a.m. - 10:00 a.m.	**BREAK**	
10:00 a.m. - 10:30 a.m.	Soil Landscape Hierarchy	Frederick F. Peterson Renewable Resources Center University of Nevada - Reno
10:30 a.m. - 11:00 a.m.	Northeast Agricultural Experiment Station Report	John C. Sencindiver West Virginia University Morgantown, WV
11:00 a.m. - 11:30 a.m.	Database Development	David L. Anderson National Leader for Soil Survey Databases, NSSC USDA-SCS, Lincoln, Nebraska
11:30 a.m. - 12:00 p.m.	Water Quality Issues and Soil Survey	Edgar H. Nelson Assoc. Dep. Chief for Technolog USDA-SCS, Washington, DC
12:00 p.m. - 1:00 p.m.	**LUNCH**	
	Chairman - Wayne H. Hudnall	
1:00 p.m. - 1:30 p.m.	West Agricultural Experiment Station Report	Chien-Lu Ping Agricultural & Forestry Experiment Station, University of Alaska-Fairbanks
1:30 p.m. - 2:30 p.m.	GIS Applications Report	George M. Rohaley National GIS Coordinator USDA-SCS, Washington, DC
		Don Eagleton U.S. Forest Service Washington, D.C.
		Dan Tippy USDI - Bureau of Land Management, Washington, DC
		Kelley Warner U.S. Geological Survey Washington, D.C.
2:30 p.m. - 3:00 p.m.	BREAK	

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3:oo p.m. - 3:30 p.m.	Midwest Agricultural Experiment Station Report	David T. Lewis Department of Agronomy University of Nebraska - Lincoln
3:30 p.m. - 4:oo p.m.	Task Force Report - Extrapolation of Soil Survey Data	
4:oo p.m. - 4:30 p.m.	Task Force Report - The Lack of Public and Government Awareness of Soils as a Resource	
4:30 p.m. - 5:oo p.m.	Task Force Report - Thi Accuracy and Reliability of Soil Survey Information	
5:00 p.m.	ADJOURN	

Steering Committee Members

- Richard W. Arnold, Permanent Chairman
- Peter E. Avers, USFS Member
- Colin W. Voigt, BLM Member
- Chien-Lu Ping, Agriculture Experiment Station Member
- David T. Lewis, Agriculture Experiment Station Member
- John T. Ammons, Agriculture Experiment Station Member
- John C. Sencindiver, Agriculture Experiment Station Member
- Gary B. Muckel, SCS, Regional Head of Soils Staff
- James R. Culver, SCS. Regional Head of Soils Staff (Vice Chairman)
- Joe D. Nichols, SCS. Regional Head of Soils Staff
- Karl H. Langlois, SCS, Regional Head of Soils Staff
- Thomas E. Calhoun, SCS, NHQ Member
- C. Steven Holzhey, SCS, NSSC Member
- Rodney F. Harner, SCS. NSSC Member

National Cooperative Soil Survey Conference

Friday - July 28

Chairman - Peter E. Avers

8:00 a.m. - 8:30 a.m.	Report on NCSS Interface with the World Community on World Concerns	Richard W. Arnold
8:30 a.m. - 9:00 a.m.	Task Force Report - Land Evaluation	
9:00 a.m. - 9:30 a.m.	Task Force Report - The Utility of Soil Landscape Units	
9:30 a.m. - 10:00 a.m.	**BREAK**	
10:00 a.m. - 10:30 a.m.	Task Force Report - Interpreting and Documenting Soils Changed by Management	
10:30 a.m. - 11:00 a.m.	Task Force Report - The Development and Use of Soil Quality Standards	
11:00 a.m. - 11:30 a.m.	Task Force Report - The Model Soil Survey	
11:30 a.m. - 12:00 p.m.	Task Force Report - The Adequacy of Soil Survey Information Delivery Systems	
12:00 p.m. - 1:00 p.m.	LUNCH	

Chairman - Rodney F. Harner

1:00 p.m. - 1:30 p.m.	Task Force Report - The Needs of Users of Soil Survey Information as Far as its Reliability and Methods of Presentation	
1:30 p.m. - 2:00 p.m.	Closing	Richard W. Arnold

DISPOSITION *OF NCSS* TASK FORCE REPORTS

by the
1909 National Cooperative Soil Survey Conference
Steering Committee

1. band Evaluation

   The report was accepted by the NCSS *Steering* Committee for incorporation into the Proceedings.

2. Utility of Soil Landscapes

   The report was accepted by the NCSS Steering Committee for incorporation into the Proceedings. The report was also referred to the committee working on pilot projects.

3. Interpreting and Documenting Soils Changed by Management

   The report was accepted by the NCSS Steering Committee for incorporation *into* the Proceedings. The report was also referred to the regional soil survey conferences for their consideration.

4. The Development and Use of Soil Quality Standards

   The report was accepted by the NCSS Steering Committee for incorporation into the Proceedings. The report was also referred to the regional soil survey conferences for their consideration.

5. The Model Soil Survey

   The report was accepted by the NCSS Steering Committee for incorporation into the Proceedings. Follow-up is required by a group consisting of SCS, BLM, USFS, and University representatives. The group will study the potential locations and develop items to be implemented. The first meeting is scheduled for November, 1989.

6. The Adequacy of Soil Survey Information Delivery Systems

   The report was accepted by the NCSS Steering Committee for incorporation into the Proceedings.

7. The Needs of Users of Soil Survey Information in terms of Reliability and Methods of Presentation of Data

   The report was accepted by the NCSS Steering Committee for incorporation into the Proceedings.

a. Extrapolation of Soil Survey Data

   The report was accepted by the NCSS Steering Committee for incorporation into the Proceedings.

9. The Lack of Public and Governmental Awareness of Soils as a Resource

   The report was accepted by the NCSS Steering Committee for incorporation into the Proceedings. The report was also referred to the regional soil survey conferences for their consideration. The Steering Committee recommends implementation of the recommendations where appropriate.

10. The Accuracy and Reliability of Soil Survey Information

   The report was accepted by the NCSS Steering Committee for incorporation into the Proceedings. The report was also referred to the committee working on pilot projects.

EXTRAPOLATION OF NATIONAL COOPERATIVE SOIL SURVEY DATA

Task Force I
CARLL. **GLOCKER**
Chairperson

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C. L. **Glocker,** Soil Scientist, NSSQA, NSSC, SCS, Lincoln, NE

Users of information from the National Cooperative Soil Survey have continually made demands for kinds and amounts of soil information far beyond our capacity to supply that information. We are not likely to reduce this gap in the near future since our facilities are limited and a computer's capacity to create new demands are virtually limitless. Therefore, some assessment of the kinds of information we (NCSS) are supplying and of the results of manipulated information is in order.

This Task Force tried to deal with four charges: (1) What are we doing well: (2) what are users needs; (3) what are we doing that doesn't seem to be productive: and (4) what should we be doing in the future?

As we began discussions, it became apparent that we needed better definitions of what it is we are presenting as soil data (information). Just what is data? How does that definition relate to what is presented as soils data? One viewpoint expressed is that we are not honest in telling which of our data (information) are factual (data?), and which ones are interpretation, that is, information derived from guidelines. Data, it was decided, is something that is observed, measured impartially and recorded. Information is everything else. Field notes, laboratory analyses, and even points on a soil delineation are data. However, what we present is almost always information. For example, the clay loam Btl horizon reported in the typical pedon of a published report is data: the clay loam reported in the estimated soil properties significant to engineering is information. It is a summation of all the laboratory data, field observations, and field notes collected during the course of the survey. This kind of information is accurate but has had one step added, professional judgement. If enough data had been collected to report some degree of reliability, it could be reported as data. This kind of logic can be applied to almost every item of soils information. The only true data reported seems to be typical pedons and soil characterization data for selected pedons.

The Task Force recommends that its name be changed to Extension of National Cooperative Soil Survey Information.

INFORMATION

Charge 1--What are we doing well? We in NCSS have supplied a definitive set of soil information to a wide variety of users. Information has ranged from professional judgement, as in degree of limitation and management factors for locating soil absorption fields to plotting data points for a world map of surface soil textures. The expanding number of resource soil scientists will ensure that this information is as precise as can be supplied at the local level without the tremendous burden of actual data collection. Professional judgements are accurate and effective for delivering interpretations. The research soil scientists have been effective in developing models that will calculate numerical values for unavailable data points. The normal process seems to be one of using the relationships of a variety of known data points to calculate a desired data point. Models such as WEPP, Drainmod, Water Quality, and EPIC have shown that these kinds of determinations can be made with more accuracy than might be expected. See the attached paper that summarizes the results of three such models. We in the National Cooperative Soil Survey cannot keep up with these kinds of demands. **This** kind of study seems to indicate that **"keeping up"** while important, is not an absolute necessity if the present **dataset** is sound.

Charge a--What are users needs? This charge quickly evolved into two prime questions. The first most obvious is what kinds of information (data) should the National Cooperative Soil Survey be preparing for distribution? Secondly, what kinds **of** information do we need to obtain **from the** users before we begin answering the first question? Our discussion used the points made in Charge 1 as a jumping off point. **Even** if we can't keep up with the users that seem to be able to accurately generate what they need with algorithms, we can help them immensely by filling in the gaps in our relational data base. Two actions would have immediate affect. We should complete as many **SOI-8** forms as possible so that data on hand and not in the system can be entered. We should plan and carry out as fast as money and staff allow, soil characterization studies on an **MLRA** basis. Series selected would be those that do not have complete databases and are representative of that **MLRA.** Thus local, regional, and national data would be collected simultaneously.

Another effective tactic would be to increase the number of standard points supplied as a regular part of the information base. We seem to be especially short on information that reports the temporal properties of soil. For example, permeability or even more important now, infiltration rates are not reported by time of year or moisture content. As a result, runoff must be determined empirically. Rain on frozen soil or on a **hyperthermic** calcareous surface soil virtually oven dried by the sun, have infiltration rates approaching zero. Permeability rates given on the **SOI-5** might suggest moderate or moderately rapid. This rating is of no consequence if rain comes during the time of zero infiltration.

Great benefit would also be derived from making standard points such as cation exchange capacity, sodium adsorption ratio and calcium carbonate equivalent. more available.

Another facet investigated by the Task Force was the need for obtaining certain kinds of information from users. We decided that it is important to have some of the following information if we are to decide what new kinds of information we should be developing. Some of these items suggest the framework for both old and new information. Six kinds of needs were identified.

1. Determine users minimum decisionmaking area. We must find out what is the smallest acreage or area he can or will manage. The kinds, amounts, and precision of soil information depends on, and can be referenced to, areas less than 1 acre or as large as the planet.

2. Determine objectives of the user. Obviously, we can be of maximum benefit if we help users towards their specific goal. Sometimes, we might discover that soil survey information can't help users get to where they want to go.

3. Obtain enough information from the user to determine if the need is for taxonomic kinds of data or map unit information. Confidence limits change drastically between these two. We must decide which of these are pertinent to the user.

4. Determine if the user has researched all information available from other sources, such as geology, climate, transportation, and economics. This will place our information in the proper perspective and at the same time assess the resolve of the user to gather facts needed.

5. Find out what management techniques are to be applied. This will help us to refine our reply to users limits.

6. Determine if planning and use are to be operational or general. Operational on the ground use requires our information set to be pragmatic. General planning information sets should be more philosophical.

Charge 3--What are we doing that doesn't seem to be productive? This charge didn't receive much discussion. To date, we have been reacting successfully to needs and demands. Thus, we do not work towards goals that don't have a given purpose.

Charge 4--What should we be doing in the future? After much discussion, the committee decided that the following items needed to be addressed if we are to remain current and at the same time improve our delivery system.

1. Fill in the present gaps in the data base. Some series lack complete interpretations. Many soil series lack any hard data from which sound interpretations can be made. Completion of SOI-8 forms, an ambitious sampling and characterization program, and thorough evaluation of data sets are needed. These will help to reduce the number of interpolations and extrapolations presently used and at the same time bring data sets up to a common denominator.

2. Add more standard points. This item was discussed earlier. Areas that could be of great benefit are those that report time of year depandent properties, and new interpretations for areas such as off-road vehicles and dust prevention. The recently revised SOI-5 is a step in the right direction. However, it is probably adding items that should have been on the SOI-5 right from the start.

3. Define the origin of the information item. Describe in some detail how this item was determined. For instance, is it from 15 measured tests using a standard laboratory procedure or is it a professional judgement based on a summarization of a series of soil and landscape observations?

4. Quantify our product. As much as possible, we should report our results in terms that are measureable such as volume, scale, percentage, or number. Volume here refers to liters and cubic centimeters, and also to the amount of soil or parts thereof, for example, one complete pedon sampled and analysed per 5000 acres of soil series.

5. Define the delivery system. We must do a better job of defining the data elements. Just what is meant by SAR, permeability, or degree of limitation for foundations for low buildings? Most of these have a definition, but it cannot be traced back to the data sets or inference systems used.

6. Define the logic systems used. Our present database of soil information has three levels of abstraction. Hone of these are even hinted at when information is presented. We have recorded data (from the field and laboratory), results of professional judgement and derived values (obtained by systematic standard manipulation). It is important that we identify what is observed or measured (methodology), where it is observed or measured and what is inferred, estimated, interpolated, or extrapolated.

7. Define the landscape that the soil occupies, both surface and subsurface. Proper description of the location of a taxonomic unit will integrate it into the "ecosystem.' Landscape relationships described in hard numbers will go a long way in expediting the application of whole-earth type evaluations and actions. Programs such as WEPP, regularly calculate values for surface configuration that could have been collected as data during the soil survey. Programs that evaluate water movement through the soil and into the materials below would benefit also from measured rather than calculated datasets. Surface stratigraphy could have been measured, evaluated, and plotted during the regular mapping process. Many survey areas have some of these kinds of data already. Much is either lost or archived at the conclusion

of a survey. Update procedures for soil surveys in the United States need to contain a landscape surface stratigraphy component.

8. Integrate data of various cooperators and disciplines. This process has begun. We are working with the various landgrant universities to put all of our datasets into one mutually accessible database. Other sources of information and data could be the Forest Service, Bureau of Reclamation, Bureau of Indian Affairs, Corps of Engineers, and some state agencies. Biologists, ecologists, range conservationists, and engineers have data useful to the National Cooperative Soil survey.

Committee Report Presented to the National Cooperative Soil Survey Conference in Lincoln, Nebraska
July 24 - 28, 1989

ISSUE: Low level of public and government awareness that soil is a base resource.

CLARIFICATION: There appears to be a lack of understanding in the public and federal sectors of the key role that the soil resource plays in land use and management decisions. The factors that influence land use and management decisions are usually a reflection of what a soil's physical and/or chemical behavior allow. Keeping this in mind, it is difficult to understand why some landowners, managers, and planners are not committed to gathering and analyzing soil information. Tough land management decisions in the future will hinge on wildlife, *vegetative* management, and water quality issues, each of which have capabilities and limitations defined by the native soil of the area. To ensure a valid understanding of an area's potential, soil information analysis must be a precursor to land use or management decisions. We as professionals in soil science understand the role soil information plays in land use decisions, but are we effectively presenting this in our survey work and documents which we produce?

BACKGROUND: Awareness of the importance of soil information is not a particularly new subject for the national cooperative soil survey (NCSS) Conference. At the 1977 NCSS Conference, R.M. Davis Administrator, USDA-SCS, stressed the need for information to be readily accessible and in a form usable to non-soil scientists. 'Our challenge is to . . . help research agencies plan their work to provide valid information for the whole spectrum of soils that we recognize.' In 1983, the question of visibility, value, and use of soil information was underscored by the creation of the NCSS 'Image Committee." Although following the common thread of soil survey use and importance this group focused on the role of the NCSS as an action agent in the process of making soil surveys more responsive to user needs. It is difficult to draw a direct correlation between past NCSS initiatives and this examination of soil survey utility and the value users put on it. Although rooted in NCSS history, the unique aspect of this effort lies in identifying and supporting ways in which soil survey can gain recognition from non-soil scientists that soil capability is pivotal to all land use actions.

CURRENT SITUATION: After reviewing different soil surveys, it becomes apparent that the importance of soil and its relationship to other pieces of the ecosystem puzzle is addressed in most surveys in the public arena. There are no obvious reasons why soil surveys do not garner broad based recognition from decision makers and special interest groups. Currently, our field mapping, and publication processes allow for designing surveys to meet user needs and contain explanations on Ecosystem/Soil relationships. Unfortunately, having a good description of the role of soil in a survey does not ensure that the survey user will read it. The inquiry now becomes one of: are the statements defining soil value/relationships appropriately placed in the document? Should we augment the existing information in the survey publication?

RECOMMENDATION: First of all, let's focus on the audience that a soil survey is intended for. Originally,, it was taken or granted that our user groups were technically skilled and had • oll "sense." This fact held until fairly recently when public and private groups started to generally take an interest la the management and fate of the lands around them. The public awareness of general environmental issues ham taken the soil survey out of the technical document realm and placed it in the hands of the lay person. Special interest groupr as well as concerned iadividualr are asking questions about soil, its use, capabilities, and worth. Although specific suggestions are a bit premature at this level of Inquiry, the following points are offered • e reed material for future efforts focusing on recognition of the roil as the base resource.

1. Implement existing standards and guidance for field iavolvement of local aud regional special interest organizations during the mapping of an area. Possibly a aariea of nontechnical field reviews could be used to help lay persons underetaad soil survey.

2. Develop standards and guidance to supplement the presentation of a completed survey document to the users with a series of public seminars focusing oa soil/ecosystem relationship8 of that area.

3. Publish "lay" pamphlets that explain and illustrate basic soil iaterpretatioae and the ways in which soil propertier effect the ecosystems they support. Review existing soil survey pamphlets and update to reflect new soil survey uses, wildlife, etc.

4. Review the layout and format of soil survey publicationa with regard to utility to lay persona. Specifically, considers (A) using an illustration similar to the "how to use this soil survey" to explain soil ecosystem relationships, (B) using an executive summary describing survey area and soil capabilities to begin document, (C) identifying to the user that slope, landform, vegetation, etc., are contained la the map unit along with the pcdon description.

5. Special efforts must be made during mapping and publication of soil surveys to develop outreach programs that support end interface with all levels of the educational system.

6. The NCSS needs to strengthen its link with public affairs staffs in federal agencies.

7. Eetabliah regional networks to focus and desiminate skills and abilities of NCSS cooperatora. Identify regional tech notes that could support and explain the importance of soil survey.

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ISSUE PAPER

THE ACCURACY AND RELIABILITY OF SOIL SURVEY INFORMATION

PREPARED FOR
NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
LINCOLN, NEBRASKA
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EXECUTIVE SUMMARY

Many task forces and standing committees of the National Cooperative Soil Survey have dealt with the issue of accuracy and reliability of soil survey information over the past decade. While many of these committees have made significant progress, as we enter into the next generation of soil survey the only firm consensus on the topic of assessing the soil survey accuracy and reliability is that it must be assured.

Soil survey deals with variability, both in soil properties and their distributions in time and in space and also with the variability of landscape features which also vary in time and space. Consequently, we deal with uncertainty of models. This uncertainty gives rise to different concepts of reliability. We have made great strides in defining the soil population. We have placed boundaries on our soils in order to separate one from another. We have identified the landscapes on which these soils occur and determined the proportions and variability of the soils which occur on these landscapes. Our ability to provide reliable estimates of the variability of soil properties and associated soil interpretations has proceeded less rapidly.

There is a risk associated with providing the interpretations contained in a soil survey. This is no different than any other discipline. However, the natural variability of the soil environment does not allow for simple assessment of this risk. Risk assessment will require the collection of large volumes of data. Risk assessment is a desirable goal but must await improvements in collection, analysis, and tabulation of data which is collected in soil survey.

This task-force developed a number of specific charges, which we hoped would begin to document many of the methodologies available in assessing the accuracy and reliability of soil surveys. In retrospect, many of the charges have gone unanswered. However, it is hoped that the comments and theory presented by the members of this task-force have moved the National Cooperative Soil Survey off center, and on the right tract toward providing reliable estimates of the accuracy of the information which we are providing the public.

INTRODUCTION

The future is rapidly approaching for soil survey. current advancements in technology and transfer of information are stretching the limits of traditional survey procedures. The public is demanding the best and most detailed information we can supply about the soil resources. We are proud of the job we have done in the past, and rightly so. The development of prediction models driven all or in part by soils data will continue to test the limits of our ability to gather and predict accurate data on soil properties. However, many of us vacillate when we see the scope to which our soil information is being applied. Why is that so?

This task-force has attempted to recognize the shortcomings of our own discipline and realize how we might be able to assist other scientists and interested groups in gaining data, knowledge and understanding of the complexities of the soils of this world. We must build on past efforts to maintain the accuracy and reliability of soil survey information and improve upon them if we are to meet the demands being placed on us from an increasingly sophisticated public.

With the current sampling techniques at our disposal, constraints imposed by costs, and inherent complexities of soil landscapes, error in soil resource inventories is unavoidable. Even if a soil scientist does a perfect job in delineating a map unit, variation in that delineation will inevitably exist. Cline believed there were several factors which caused this:

First, the predictive value of landscapes is not perfect. Many of the surface features which are used to separate soils in the field are so subtle that even the most skillful mappers cannot map them precisely. Some soil boundaries are not marked by surface features which can be detected.

Second, traditional sampling intensity for verifying predictions is completely inadequate in a statistical sense. It allows reasonable accuracy at a somewhat realistic cost only because the predictive value of the landscape is as good as it is. This assumes, of course, that mappers are trained and adept at landscape interpretation, an assumption that occasionally falls short.

Third, sampling which is conducted in traditional soil survey programs is commonly biased. Soil scientists do not choose sites for the verification of their landscape models at random. Soil scientists are aware that less characteristic landscapes are present, and may probe a few of these areas to get an idea of the variability. At current levels of funding we simply cannot examine the soil at enough places to insure that our biased sample is not misleading. Soil scientists are still evaluated primarily on the quantity of acres mapped. Unfortunately, our ability of quantify the variability of our soil maps has progress as a somewhat slower rate.

This taskforce has addressed many of the issues pertaining to accuracy and reliability of soil survey information. However, we recognize there are many others. It is our hope that other individuals will continue to test and build upon this work and continue to develop methodologies and infrastructures to insure that soil surveys of the future supply accurate and reliable information to a growing and more demanding public.

As with other disciplines, data are the basis by which accuracy and reliability are assessed. The appropriate collection, analysis, and presentation of soil survey data are measures of the effectiveness of the delivery of soil survey information. Our discussion of accuracy and reliability of soil survey information has been divided into these three categories.

A. Data Collection

Time and cost of gathering data need to be weighed carefully against the benefits from analysis of these data. There must be a demonstrable need for the results of such studies. If Such Studies are undertaken an attempt Should be made to collect data on as many 'soil characteristics as possible. This will make accurate determinations of estimated soil properties and the variability of these properties easier.

Methodologies for gathering data on the accuracy and reliability of soil survey information are well documented. Transects, random point observations, cluster sampling, and systematic sampling all have proven useful to soil survey programs. There is not necessarily one best method for all instances. However, one generalization can be made. These methods, with few exceptions, have been under-utilized. There have been and continues to be instance where map units have been correlated and published with little or no data on the variability of the unit. While gathering transect or other reliable data has been recommended in the past, most often these recommendations have not evolved into requirements or standards. Gathering of data on map unit composition should be part of the mapping process, with two related objectives: (1) improved quality control in the design of map units and in the delineation of same; and (2) improved documentation of map unit composition for the benefit of the user.

Transects have been the most preferred method for gathering data pertaining to taxonomic variability of map units. As time and funding permit soil scientists have traditionally assessed the quality of their soil maps and their map unit descriptions by transecting the landscape and recording the taxonomic components they encounter. These components either fall outside or inside their concept for that landscape. The definitions of what is considered similar or dissimilar to the concept of that map unit are contained in various supporting soil survey references. The definitions are vague, perhaps intentionally so, and allow the mapper flexibility in designing map units to fit the landscape model of that survey area.

While assessing the composition of the soils within a map unit, soil scientists also evaluate the variability of the soil's characteristics. Presently, the concept of the modal pedon is used to describe the central concept of the soil as it occurs in the survey area. In theory, this may be an adequate method to portray the pedon. In practice, however, it has caused some problems. This same modal pedon is used to interpret the entire polypedon as well as the entire map unit. The use of the mode to interpret soil map units has made assessing map unit variability the major constraint in proper interpretation of map units. Cyclic variations of the pedon as well as included 'other' soils are not taken into account in current methods of interpreting map units. Interpretations are made for areas of land and should not be controlled by pedon-to-pedon variation.

Other sampling may be conducted to supplement map unit variability information. However, time seldom permits systematic sampling studies or other labor intensive studies which could prove invaluable in assessing the variability of representative landscapes. Much data is collected in the course of a soil survey. Pedon descriptions, field notes, transect8 and laboratory data need to be compiled and entered into permanent data bases. If possible, these data should he geo-referenced. Assessing the variability of those estimated soil properties used in developing soil interpretations and ultimately the variability of the interpretations themselves may be possible if we carefully record and document those data which we are already collecting. As much effort. needs to be expended on accurately defining the limits of a soil map unit as is directed toward defining the limits and characteristics of the soil series.

The accuracy of the soil map itself is also important. Wherever possible, line placement and map unit design should be based on discernible landscape features. In some areas, where soil-landscape relationships are either too complex to be distinguish or absent all together, grid sampling or the use of geophysical techniques such as ground-penetrating radar may facilitate the placement of a soil boundary. Many of the problems pertaining to map accuracy have arisen from poor map unit design. Knowledge of the correlation between soils and their landscapes commonly is gained by repeated experience during mapping. However, basic training in soil-geomorphic relationships is often limited, not only within the NCSS but also at many of the academic institutions supplying soil scientists to produce soil maps.

Scale is very important in determining which data are important in assessing accuracy and reliability of soil survey information. Information used to assess the variability of a segment of a slope will necessarily be different from that needed to characterize a major land resource area. However, in order to extrapolate our approach to interpreting detailed soil maps to other scales, good working models must be developed and used during the course of a soil survey. Extrapolation and interpolation build on the degree of reliability of working models of soil property-landscape segment relationships. They gives us a procedure for evaluating the significance of variability that is observed, measured and interpreted.

Another source of data on the variability of soil map unite are high intensity soil (HIS) maps. These maps are being developed in many areas of the country by certified professional soil consultants. These maps could be reviewed, used and incorporated into soil survey data wherever possible.

Anyone involved in the National Cooperative Soil Survey program may contribute valuable knowledge and assistance in the development and implementation of quality assurance programs. However, concern as to who gathers these data should be secondary to the standards by which these data are collected. As data begins to be collected, standards must be developed and raised to the level commensurate with other earth science research. By rewarding project leaders and other workers for quality as well as quantity, accuracy and reliability will necessarily be increased.

B. Data Analysis

There is a widespread belief within our profession that something is fundamentally wrong with soil maps and no one can figure out how to fix it. Is there a possibility that there is nothing wrong with soil maps and the perception that there is a problem is a result of a poor conceptual model of how we interpret map unite? One symptom of this problem is the obsession with variability in map unite. Recently, no technical meeting has been complete without a discussion of transects and new computer programs to calculate statistics. There is unending discussion of how information about map unit variability can be presented in soil survey reports. Over the last decade, numerous work groups and committees have been formed to examine the problem of map unit variability and inclusions. Despite all of this discussion, there is no consensus within the National Cooperative Soil Survey on sampling or analysis methodologies. We are still having the same arguments and discussions that were going on fifteen years ago.

Because most variation within soil delineations is cyclic or continuous, using the modal profile to interpret the map unit has worked, simply because the modal profile chosen in most cases also happened to be the 'mean' profile. Therefore, using the modal soil to name and interpret map units has not caused problems in interpretations.

However, thinking about doing it has caused severe problems. Trying to cope with the theoretical problems in using the mode to make interpretations about a population has caused great inefficiency. There has been a perceived need to totally characterize map unit variability and account for non-modal inclusions only because we have been trying to make an unsuitable concept work. The obsession with map unit variability and all of the concern about inclusions and taxonomic purity are the result of conceptual, not technical deficiencies. The use of the mode to interpret map unite has made map unit variability the major issue in interpreting soils.

Before data is quantified there must be a demonstrable or anticipated need for the results statistical analysis of the data will produce. Statistical analysis of a map unit's taxonomic composition assists in the definition and description of the map unit. It does not improve our assessment of the accuracy of soil interpretations of that map unit. A method of evaluating the accuracy and reliability of those soil properties which are used in rating a map unit for a specific use must be developed.

For several reasons the degree of the difference among map unit interpretations and between concepts of naming soil map units and the included dissimilar soils is not closely controlled over the soil survey program. One reason is, although map units are designed in part on the basis of interpretive characteristics, they are also designed to separate soils that differ in taxonomic placement. Many taxonomic criteria have a strong genetic component. Not all of the genetic criteria that are applied to a soil survey necessarily pertain directly to interpretive differences for that survey. Furthermore, within a given soil survey area the differences between soils with respect to differentiating taxonomic criteria, may be quite small. As a consequence, some of the map unit separations within a soil survey that are based on taxonomic criteria may have few, if any, interpretive differences from other map units.

The distinction between taxonomic purity of map units and quality or precision of a soil survey is an important one. Cline stated, "The quality of a soil survey should be measured in terms of the amount and accuracy of the information it provides as a basis for judgements about soil potentials and behavior for land use. A map unit may have only 40 percent taxonomic purity or classification accuracy but have 90 percent interpretive accuracy."

We might improve the accuracy and reliability of soil survey interpretations by developing new techniques for rating soils that better account for the complexity of the soil system. Assessing interpretive purity depends on the management objectives. There is no way soil surveys can address all possible management objectives. However, one possible solution is to improve the concept and definition of similar and contrasting (dissimilar) soils. By defining similarity or contrast on the basis of fundamental soil properties, i.e. depth, texture, coarse fragments, etc., map unit descriptions could express the degree of contrast with each of the included soils. Because the contrasts are based on properties that affect most interpretations, the user would have a better idea of the implications for management.

There are many data analysis procedures which are applicable to evaluating variability of soil taxa. Numerous studies are reported in the literature. A clear distinction should be made between results which analyze within map unit variability and those which analyze between map unit variability. The distinction should be made entirely clear to the user of the information.

Transect methods are the most useful in gathering information on soil landscape relationships and taxonomic composition of map units. In quantifying taxonomic composition of map units binomial analysis of the results appeals to a large number of people. Parametric and non-parametric analysis are preferred for analysis of specific soil properties.

C. Data Presentation

The accuracy of soil maps includes not only the accuracy of the soil boundaries, but also the accuracy and detail of the definitions of map units and the validity of their names measured against the standards we establish for nomenclature. We must recognize that the pattern of soils in nature is fixed. We must adapt our conventions of naming map units to fit the natural landscape. One of the easiest ways to improve the quality and accuracy of the information in a soil survey report is the use of identification legends that accurately reflect the natural variability of the soil-landscape. This implies that we know what the mappable landscapes contain. In most cases, however, we do not know this in quantitative terms. If mappable landscapes are mixtures of soil taxa, we must say so. When studies are undertaken to quantify map unit variability the relative proportions of multitaxa map units on identification legends increase at the expense of consociations. Once quantitative data are available we will be able to accurately define map units and those soils which are included in them. This will ultimately improve the accuracy and reliability of soil survey information.

Map unit composition data which have been collected and analyzed in an 'acceptable' manner should be appropriate to present it in a tabular format in a published soil survey report. In some instances, this has already been done. Soil map units should continue to describe the taxonomic component(s) contained within them. However, new concepts need to be developed to describe the variability around the modal concept. Tabular data pertaining to taxonomic composition and variability have progressed further than the presentation of interpretative purity.

The interpretive tables contained in soil survey reports predict soil interpretations of taxa, not map units. Additionally, these interpretations are based on estimated soil properties of the dominant soil(s), allowing for little or no variation or interaction among and between variables. A user of the interpretive tables contained in a soil survey report has a right to believe that a consociation, which may be 49 percent inclusions, will behave in its entirety as we say the taxon for which it is named will behave. Even allowing for the greatest feasible precision of soil maps, the accuracy and reliability of soil surveys can be improved most by developing better techniques for interpreting map units rather than the taxa contained within.

We need to accept interpretation of map units rather than taxonomic units as the basis for providing soil potential information to soil survey users. This cannot be accomplished however, without quantitative data on the composition of map units, especially the variability of those soil properties on which our interpretations are based.

Alternative methods of assessing and conveying the accuracy and reliability of soil survey information are available. Geographical information systems, improvements in prewritten soil manuscript material, and descriptive formats for conveying soil variability information to the user all have merit. The emphasis being placed on global warming and water quality have prompted many modelers to seek 'representative values' for many of the estimated soil properties. The use of representative values, variability and confidence levels of these values would aid modelers as well as provide an initial effort in conveying and understanding of interpretative variability of soil properties to the users of soil survey information.

An important aspect of maintaining soil survey accuracy is the development and staffing of basic soil service positions within the National Cooperative Soil Survey. Knowledge from well trained soil scientists, who developed descriptive soil-landscape models and criteria to consistently separate map units in the field will increase the reliability of the soil survey program. This knowledge is just as valuable, if not more so, than any statistical procedure.

RECOMMENDATIONS

1. Members of the National Cooperative Soil Survey should undertake studies of the methodologies on soil variability, relating the time (and consequently money) to gather information versus the level of accuracy attained. Such studies provided baseline information *on* the cost effectiveness of assessing soil variability.

2. Members of the National Cooperative Soil Survey should develop and document their methodology for evaluating reliability of the map unit interpretations which they are providing to the public.

3. The National Cooperative Soil Survey should report the reliability of the map unit interpretations which are developed and published in soil survey reports. Reliability, in this instance, means the probability level and the accuracy statement of each interpretation.

4. This task-force recognizes the critical role the Resource Soil Scientist plays in transferring accurate and reliable soil information to users. The quantification of the reliability of soil survey information supports the position. of the Resource Soil Scientist. The National Cooperative Soil Survey should continue their support of these critical positions and encourage the development, and where possible, acceleration of staffing of Resource Soil Scientist positions.

EXECUTIVE SUMMARY

THE DEVELOPMENT AND USE OF SOIL QUALITY STANDARDS

As a way to address responsibilities to maintain or improve soil resources, some NCSS agencieshave used the concept of "soil quality standards.

Soil quality standards are defined as:

Stated conditions or threshold values for soil properties or soil conditions that indicate the health, quality, or productive potential of a soil.

Soilquality standards relate to physical and chemical management activities and help to evaluate the effort of management actions. Soil quality standards are developed by relating soil properties to soil response such as plant productivity. Standards are measurable, are use specific and apply to an area where management can or is being applied.

Application of soil quality standards requires sampling and monitoring the properties as they change from management. Evaluation of the staudardisaninherentpartofthisprocess.

Soilquality standards serve as a tool for soil management and this tool needs to be further developed. The terms "quality" and "standard" caused some confusion and attention is needed on terminology.

NCSS members recognize and define soil properties aud relate these properties to soil response and are, therefore, uniquely qualified to provide input to the development of standards.

RECOMMENDATIONS:

The NCSS through regional committee further explore kinds of standards and develop proposed guidelines for their development with close attention to terminology.

The NCSS national steering committee suggests to SSSA a one-day symposium at the annual ASA meeting in 1990 on soil quality standards.

INTRODUCTION:

When applying management on a soil, how do we know when we have improved ordegraded the soil? Establishing threshold values toevaluate our management actions may help. Establishment of soil quality standards for waluating soil disturbances has been used by some agencies as a management tool.

As soil survey progresses into the twenty-first century, most of the soil resources in the United States will be inventcried. Soil surveys will concentrate on refining and applying this soil resource information. As areas become more intensively used, the effects of use will become more important to a expanded clientele for both on and off site evaluations.

As we evaluate soil temporal properties and soil conditions and relate these to management practices, we will be better prepared to assist land users in understanding the effects of their decisions on the resource.

Chemical, biological, and hydrologic soil properties can be affected by soil management practices. Soil erosion alters the surface structure and organic matter content. Some mechanical practices reduce soil pore size. Fertilizer and pesticide applications, heavy metals, and animal and toxic waste disposal affect soil chemical, physical and biological properties. If we are to apply management practices to the soil, we must be prepared to monitor the effects of our actions. We must be able to respond to warning signals from within the soil before we degrade the soil resource for the intended and unexpected uses. Within the soil survey, soil quality standards may serve as iniicatoror threshold values for chemical and physical changes within the soil.

The National Cooperative Soil Survey should be involved in the issue of soil quality standards because the members represent the one group that recognizes and defines soil properties, the variability of these soil properties both vertically and horizontally and provides a geographical perspective in relation to other resources.

CURRENT USE AND NEEDS:

Some agencies within the National Cooperative Soil Survey have used soil quality standards as part of their soil management responsibilities. The USDA Forest Service, for example, has been monitoring soilquality for the last few years. This agency considers soil quality monitoring a systematic process by which data are collected to determine if soil management objectives have been achieved.

The major purpose has been to maintain or improve inherent long-term soil productivity. To monitor soil quality, the FS has developed arbitrary soil. quality standards for soil disturbances. Changes in soil properties in relation to these standards are evaluated to adjust forest management plans and practices.

Soil management changes may improve or damage the soil or raise or lower the inherentcapacityofthe soil to support growth of specified plants. Changes to soils may be physical, chemical, biological or hydrologic; short term or long lasting; insignificant or significant. The USFS defined significant changes in productivity of the land to be indicated by changes in soil properties that are expected to result in a reduced productive capacity over the planning horizon. Areductionof15 percent ininherent soil productivity was selectedbythis agency as a basis for setting threshold values for measurable or observable soil properties or conditions based on their research and current technology. The threshold value is to serve as an early warning signal of reduced productive capacity.

The Forest Service has used increased bulk density, decreased macropore space, and disturbance of surface organic matter to establish soil quality standards.

Changes in inherent productivity in agricultural areas are more difficult to measure because of the variables of management. Close ties of productivity and soil properties are not all well established.

The soil Conservation Service has attempted to monitor soil quality change by relating crop yield to topsoil thickness, change in tilth and water infiltration, bulk density, and organic carbon.

The Soil Conservation Service has used soil loss tolerance as an acceptable rate of loss of the soil surface. The soil loss tolerance has not been tied to a percentage loss of productivity but as a basis for sustained productivity. Soil loss tolerance "T" does not directly relate to a changed soil property and therefore is not totally a soil quality standard where used this way. This factor has been used as criteria for determining whether a practice or set of practices are essential to meet resource management needs based on predicted soil loss.

Other soil characteristics have also been used as soil quality standards. Productivity changes for specific crops have been related to increments of measurable electrical conductivity and have been used to determine the need for leaching and other conservation practices.

Quality standards for water and air have been established . Water quality, like soil, must be specified as to purpose or use. Water quality is determined from a water quality standard, set for specific uses whether for irrigation, fish habitat or human consumption. Once degraded both soil and water may lose their inherent capacity to provide their previous benefits.

Soil quality standards can also be set for specific uses. The lowering of a water table may enhance crop production but be detrimental to the soil use as wetland.

David Boose, a scientist with the Environmental Defense Fund has suggested the idea of a "Clean Soil Act" comparable to the "Clean Water Act" and "Clean Air Act". Mr. Boose pointed out that regulations pertaining to soils focus primarily on hazardous-waste disposal and cleanup requirements with the concerns being from chemical exposure through either leaching or volatilization. However exposure directly to contaminated soil occurs through contact with dust and ingestion of soil from root crops and animals or foul that ingest the soil.

Many banks and investors are asking for a clean bill of health for the soil on properties before they invest or repossess those properties. The condition of the soil is important to them because of environmental liabilities.

Scientists working at EPA's Environmental Research Laboratory in Corvallis, Oregon have begun to address the role of the soil resource in support of environmental quality. In addition to drawing attention to the value of clean soil as a resource (traditionally the focus has been on air and water quality), the need for establishment of soil quality criteria is being examined. Current research has involved soils as a medium that may help to ameliorate environmental concerns. For example, the soil is considered important for buffering the acidity of throughflow water to reduce the effects of acidic deposition on surface waters. Interest within EPA centers on contaminants such as nitrates, heavy metals, pesticides, organic and toxic wastes that relate to safety and human health issues of soil use (e.g. agriculture) or that relate to the quality of surface and ground water.

Formulas have been proposed for calculating the safe limits of additions of heavy metals when sensitive crops are grown with sludge applications. Zinc, copper, and nickel from applications of sludge have been shown to damage some crops . Cation exchange capacity and pH are the most common soil properties affecting mobility of heavy metals. The concern about heavy metals relates to the direct toxic effects on plants and also on the similar effects of plant uptake on human or animal consumption. Zinc and cadmium appear to be mobile. Cadmium is of particular concern because it accumulates in plants at levels dangerous to the human and animal consumers. Chromium, lead, and phosphorous are generally immobile to what limit is not known. Soils low in colloids such as sands have indicated mobility of generally immobile heavy metals.

The Bureau of Land Management has used soil quality standards to indicate soil condition. Threshold values assumed as critical to soil productivity warn managers about effects of the implemented practices. They have omcentrated in four soil characteristics: soil water, soil air, soil nutrition, and soil erosion. Management practices are evaluated in relation to these characteristics tied to potential productivity.

The condition of the soil is also evaluated by BLM soil scientists to determine the timing for practices. For example, soil water is evaluated on site to determine if range seeding should be implemented. A threshold amount of stored water is assumed necessary for a successful planting. Overall the intent is to show the manager the current condition of the soil and the effects of management decisions, and to work with the manager to provide management alternatives with the least degradation.

CLARIFICATION OF DEFINITIONS

To explore the extent to which the NCSS can or should be involved in soil quality standards, we first should clarify definitions and intended use.

Soil quality standards have keen defined in the following ways:

-Any defined basis for comparing changes in soil condition that could affect a soil's capacity or suitability for a specified use. (usually a numerical expression but can also be a qualitative expression)

-Stated conditions or threshold values for soil properties or soil conditions that indicate the health, quality, or productive potential of a soil.

-Level at which the soil cannot suffer additional change without showing significant adverse effects and/or irreversible damage.

Assumptions:

It is intended that soil quality standards be site specific.

Soil quality standards are intended for areas where management is being applied or can be applied.

Soil quality standards are use specific.

Soil quality standards are not intended to be a rating or limitation scheme for a particular use. (Soil potentials and soil interpretations are different concepts.)

NEEDS FOR DEVELOPMENT AND USE OF SOIL QUALITY STANDARDS

Development needs:

A) Review of literature, research investigations, unpublished reports, and other information about soil properties and their effects on proposed uses. Information on health and safety concerns from direct use of soil material and the affect on other resources is needed. A clear relationship between the soil property and use response is needed.

B) Background information about agency policies and procedures that may affect the practical ability to meet the standard.

C) Our ability to measure or consistently evaluate the standard.

D) Increased interdisciplinary skills with knowledge about the standard in question.

E) Clear management objectives to which the soil standards relate.

Use needs:

A) Establishment of procedures for sampling and monitoring to determine whether standards are reasonable and are being met. The soil quality standard is the threshold value, such as 15% reduction in productivity to be expected from a set of soil property changes. Procedures to evaluate these soil properties are available. These define not only specific soil properties but the transecting techniques as well.

B) Supporting policy and regulatory or contractual provisions for implementing the practices that affect the soil quality standard.

The following represent potential uses of soil quality standards:

-monitoring the productive capacity of forests, if standard closely related to forest growth.

-evaluating the success or failure of farm, range or forest management practices.

-evaluating damage done to a soil.

-evaluating the timing for practice application.

-evaluating when a soil is no longer suited for a particular use.

-determining when a soil is unfit for use because of human or animal health concerns.

-estimating the nutrient status of a soil.

-monitoring the loading of sludge, animal waste, heavy metals, salts, pesticides or toxic material to a soil.

-evaluating compliance to soil loss restrictions on construction sites.

-monitoring to show where excess or unneeded management inputs are being applied.

-evaluating the threshold soil conditions that precede chemical damage to water quality.

-evaluating soil resilience or soil recovery rate.

These different names or terms were found to be used for soil quality S - S :

- soil productivity protection standards
- soil condition
- soil tolerance limits
- surface soil protection standards
- soil fragility
- soil vulnerability

The following list was gathered as advantages to using soil quality standards:

-Provides agencies a basis to evaluate changes in soil condition due to management practices.

-Trends in soil condition can be monitored.

-Leads to data banks for sharing information about effects of specific soil management practices on soil conditions.

-Meet the legal requirements to document significant changes in productivity capacity.

-Provides a tool to monitor land use effects.

-Can be tied to state or local regulations for cross compliance.

-Provide a consistent means of communication among managers and the public about the quality of land management.

-Provides a means of demonstrating compliance with soil management objectives.

-Provide a measure of how well we are conserving our soil resources and protecting the quality of our environment.

-Provide a means to show where problems might occur and where management practices need to be changed.

Data needed to set standards:

Data needs vary with the particular standard; professional judgment may be satisfactory in some cases, well documented responses such as plant growth parameters or human health and soil properties may be required in other cases..

Certainly public involvement will be needed. Proposals will need to be published in the Federal Register for comment.

Who should set standards:

Land managers, land owners, scientists, government regulators, environmental groups, and the general public should be involved in setting standards. The mix of who should set standards depends on the kind of standard, its geographical and jurisdictional applicability, and who it will affect. Standards on soil loss, nutrient and pesticide treatment, or waste loadings may require a different mix. Some standards should or at least have the flexibility to be localized. Soil loss tolerance for example is a nationally established standard but for forest and range use more restrictive limits are often set.

Procedures to set standards could be established on a national level to store and provide data and provide a clearinghouse for arbitration to maintain consistency and prevent duplication. A multi-agency/department framework could lead an effort to establish standards for the nation's soil resources.

Why should NCSS be involved?

Members of NCSS have the understanding and recognize the need. They have the expertise in the soil properties arena, in sampling techniques and in the understanding of the geographic variability and presentation.

CONCLUSION:

Soil quality standards may not presently be critical, but if we wait until they are crucial, other groups or the courts will set limits for soil use. More than likely NCSS would then be left out. It is now important for NCSS is to establish dialog and work with our publics in identifying and accumulating data that will be helpful in establishing soil quality standards.

RECOMMENDATIONS:

1. The NCSS through Regional Committees, further explore kinds of standards and develop proposed guidelines for their development with close attention to terminology.

2. The NCSS steering committee suggest to SSSA a one day symposium at the annual ASA meeting in 1990 on soil quality standards.

Presented to the National Work Planning Conference of the National Cooperative Soil Survey July 1989 Lincoln, Nebraska.

7/31/89
The Development and Use of Soil Quality Standards Task Force
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LAND EVALUATION 1/

An issue paper prepared for the National Cooperative Soil Survey (NCSS) Conference, July 24-28, 1989 in Lincoln, Nebraska.

EXECUTIVE SUMMARY

Land evaluation is defined and twenty-three operational evaluation systems are listed. These systems are valuable but opportunities arise for improving or replacing them as needs change and new technologies become available. The task force and conference participants identified thirty emerging applications (national needs), a dozen new technological capabilities, twenty-three characteristics of effective systems, and seventeen proposed actions. The top ten actions as ranked by forty conference participants are as follows: 1) accelerate use of electronic data transfer, map display, and information delivery; 2) promote the use of land resource databases and GIS technology for examination of processes that control relationships between soil attributes, climate, vegetation, geologic material, and landscape position; 3) provide soil scientists and associates with training in database management, land evaluation, GIS, GPS, and expert system technology: 4) begin saving all data from each soil observation point by means of electronic data records and precise global positioning system technology: 5) identify minimum data sets for land evaluation: 6) improve land evaluation systems for traditional as well as emerging applivations; 7) evaluate alternative methods of compiling and merging climatic and geologic data with soils data for effective land evaluation systems: 8) develop appropriate expressions of confidence for soil evaluations: 9) begin testing microcomputer-based land evaluation systems at scales appropriate for counties, watersheds, and farm fields; test some order 1 soil surveys for farms; 10) NCSS should participate in the initiation and administration of competitive matching funds for land evaluation pilot projects in cooperation with the NSF, EPA, NASA, and the proposed National Institute of Agricultural Science.

1/ Compiled by Gerald A. Nielsen, Dept. of Plant and **Soil** Science, Montana State Univ., **Bozeman, MT** with ideas from Jim Berry, Systems Entomologist, USDA-ARS, Montana State Univ.; J. G. Bockheim, Professor of Forest Soils, Univ. of Wisconsin; Thomas Collins, Regional Soil Scientist, U.S. Forest Service, Utah; Gordon Decker, State Soil **Scientist,** USDA-SCS, Montana; James Duke, Botanist, USDA-ARS, Maryland: Cliff Montagne, Soil Scientist, Montana State Univ.: Pierre Robert, Soil Scientist, Univ. of Minnesota: John Wilson, Geographer, Montana State Univ.: Lloyd Wright, Land Use Planner, USDA-SCS, Washington, DC.

DEFINITION

Land evaluation as related to the NCSS mission could be defined as "the process of estimating the potential of land for alternative kinds of use" (Dent and Young, 1981). Evaluation is only meaningful if the use is specified. The purpose is to identify inputs and management practices needed, estimate production and other benefits, and predict consequences of the environmental changes.

LAND EVALUATION SYSTEMS

Following is a list of established systems.

Capability Classes (I, II, etc.)

Soil Potentials

FCC (Fertility Capability Classification)

LESA (Land Evaluation and Site Assessment)

Forest and Range Habitat Types

Range Sites

Soil Capability/Watershed Condition Assessment (Forest Service)

CHAMPS (Computerized Habitat Analysis and Multiple Use Prescription System)

FAO
- Land suitability classification
- AEZ - Agro-Ecological Zones
- LECS - Land Evaluation Computer System

All of the FAO systems are adapted primarily for developing countries.

Canadian
- CLI - Canada Land Inventory: macroscale soil capability system.

European
- U.K. land evaluation system: regional scale.
- TULIS - Land Information System of Tascany; regional.
- EEC - Land Evaluation System

China
- Land Resource Evaluation System; regional guide for soil improvement.

Columbia
Evaluation system for taxation.

Other
ALES - (Cornell) Agricultural Land Evaluation System: suited for developing countries.
CRIES - (Michigan) Comprehensive Inventory and Evaluation System: suited for developing countries.
PI - (Minnesota) Productivity Indexes; initial screening for Reinvest in Minnesota (RIM) Program.
CER - (Minnesota) Crop Equivalency Ratings.
MAPS - (Montana) Agricultural Potentials System; 150 land and climate data layers.
VirGIS-FARMPLAN-VALUES - (Virginia) Geographic Information System and expert system.

Summary Statement

These land evaluation systems serve specific needs, solve different problems, and operate at different scales. Opportunities arise for changing or replacing these systems as national issues change and new technologies become available. The systems, old and new, depend partly on the kind of data the NCSS generates.

ESTABLISHED APPLICATIONS

Description of the many established applications of land evaluation systems is beyond the scope of this paper. Some major applications are the following: 1) conservation planning, 2) land use planning, 3) tax assessment, 4) forest site evaluation, 5) site selection for subdivisions, industrial facilities, and agricultural developments, 6) waste disposal site evaluation, and 7) locating sources of earth materials for construction.

EMERGING APPLICATIONS

Reviews of the popular press and media, scientific journals, and congressional record, and visits with colleagues have revealed some exciting opportunities for applying NCSS products through established or new land evaluation systems. Following are some key words and phrases that identify emerging applications:

1) Global habitability.

2) Atmospheric CO2 and the greenhouse effect.

3) Acid rain impacts.

4) Deforestation/reforestation.

5) Drought and desertification.

6) National, regional, and local competitiveness, comparative advantage.

7) Irrigation water management.

8) Land degradation.

9) Erosion, sedimentation, mass movement, flooding.

10) Water quality.

11) Wetland and riparfan inventoriea.

12) Endangered species and habitat mapping.

13) Alternative cropping system identification.

14) Identification of sites for alternative crops (canola and safflower examples).

15) Weed vulnerability mapping (knapweed or toadflax examples).

16) Sustainable agriculture.

17) Research site selection.

18) Research extrapolation strategies.

19) Prudent application and fate of agricultural chemicals.

20) Farming soils, not fields; e.g., Montana, Minnesota, Washington.

21) Prescription farming; e.g., Illinois, SOIL PLAN.

22) Precision farming.

23) On-farm geographic information systems.

24) Urban applications.

25) Rehabilitation and restoration.

26) Parke, wildlands, and wilderness planning.

27) Yield prediction and potentials.

28) Prediction of plant communities.

29) Multi-resource planning.

30) Transmigration, resettlement.

To be most effective, NCSS data (maps and tables) must be efficiently interfaced with geographic information systems which include land and climate attribute data from other sources including aerial and space remote sensing technology.

NEW TECHNOLOGICAL CAPABILITIES

The following technological capabilities can improve the NCSS contribution to land evaluation systems and their uses:

1) Geographic information systems.

   SSIS and APPL7, Minnesota and Iowa
   GRASS
   MOSS
   ARC/INFO
   Intergraph
   AUTOCAD
   SPANS
   pMAP ($900)
   OSUMAP ($60)
   IDRISI ($100)

2) Microcomputers and workstations with expanded graphics and storage capabilities.

3) Global positioning system (GPS).

   In the 1990's GPS systems will allow the following enhancements in soil survey products and their uses: a) precise geodetic referencing of base maps, b) precise location of soil examination sites, c) precise (2 cm) navigation of field implements in relation to soil management maps, d) precise application of fertilizer and other agricultural inputs based upon soil conditions, e) increased demand for order 1 soil surveys and a tool to help make them.

4) Digital terrain models.

   NCSS data and digital elevation models (DEM) can be combined in geographic information systems with hydrological models such as WEPP, RUSLE, CREAMS, AGNPS, and land management models such as SPUR.

5) Natural resource databases.

The NCSS soil databases will be in much greater demand when they are combined in **GIS's** with detailed digital terrain data, long-term climatic data, and current weather data. These combinations are now possible, but haven't been accomplished. RAWS, **SNOTEL, NOAA,** CD ROM files from U.S. West, are potential sources of climate data and weather data that could enhance the value of NCSS products.

6) Relational database management systems.

Software and application systems now available for microcomputers (e.g., R-base) appear to be useful for managing NCSS data at the county level.

7) Spatial statistics.

New statistical tools will determine appropriate observation and sampling intensities and provide an objective method for extending soil attribute data from points to areas. Stochastic analyses allow for mixture of deterministic and random processes.

8) Remote sensing.

Multi-spectral aerial and space remote sensing, especially CIR photography, videography, and thermal sensing provide commercially available products that enhance the land evaluation possibilities of NCSS. Geonex-Verde Technologies, Inc. of Watsonville, CA, is producing commercially viable products for evaluation and management of agricultural lands.

9) Crop-growth and land management simulation models.

Some simulation models require soil attribute data that could be acquired from NCSS products. Example models include: **CERES, COMEAX, CREAMS** . . .

10) **Expert** systems.

Expert systems provide a friendly, easily understood means of presenting land evaluation information to technicians and the public. Interactive expert systems allow for questions, manipulation of data, answers, and illustrations when "help" is requested.

11) Farm and watershed-scale geographic information systems/models.

Ultimately NCSS data will provide land attribute data for simulation models, process models, and expert systems with results displayed on three-dimensional, multi-color images of landscapes that can be displayed on video monitors or delivered as a computer printout. Landscape 'parameters, such as slope gradient and slope length, will be extracted automatically.

Summary Statement

In view of changing technologies and issues related to land evaluation, what should the NCSS be doing to strengthen its programs and make its products more useful? Are we exploring new paradigms?

CHARACTERISTICS OF AN EFFECTIVE SYSTEM

The following characteristics are suggested as being appropriate for any future NCSS land evaluation systems.

1) Derived from knowledge of how soil landscape systems function.

2) Matches land attributes with appropriate uses.

3) Increases comparative advantage, efficiency, competitiveness, and profit of commercial clients.

4) Increases awareness of environmental opportunities and constraints.

5) Ultimately improves or maintains environmental quality.

6) Is easy to use, maintain, and enhance.

7) Is easy for the public to understand.

8) Allows for manipulation of values and discovery of relationships.

9) Allows for the expression of "fuzzy" boundaries.

10) Is easy to interface with new models.

11) Facilitates pedotransfer functions where specific data (e.g., hydraulic conductivity) are lacking.

12) Is used and operated by both public and private groups and individuals.

13) Provides expressions of accuracy and map unit purity.

14) Provides confidence level for interpretations.

15) Facilitates interaction among diverse disciplines and interest groups.

16) Permits rapid exploration of alternative land uses.

17) Allows for local flexibility but is compatible with national and international systems so that national and global evaluations are possible.

18) Allows public participation in decisions based on knowledge of land attributes.

19) Advances public knowledge of earth processes.

20) Demonstrates the implications of policies and the impacts of laws.

21) Leads to a net improvement in quality of life through knowledge of land systems.

22) Is portable among operating environments.

PROPOSED ACTIONS

These actions are ranked in order of priority based upon a vote of forty Conference participants. Actions received from 68 to 5 weighted index points. All actions were supported by at least some participants.

1) Accelerate use of electronic data transfer, map display, and information delivery.

2) Promote the use of land resource databases and GIS technology for examination of processes that control relationships between soil attributes, climate, vegetation, geologic material, and landscape position.

3) Provide soil scientists and associates with training in database management, land evaluation, GIS, GPS, and expert system technology.
4) Begin saving all data from each soil observation point by means of electronic data records and precise global positioning system technology.

5) Identify minimum data sets for land evaluation.

6) Improve land evaluation systems for traditional as well as emerging applications.

7) Evaluate alternative methods of compiling and merging climatic and geologic data with soils data for effective land evaluation systems.

8) Develop appropriate expressions of confidence for soil evaluations.

9) Begin testing microcomputer-based land evaluation systems at scales appropriate for counties, watersheds, and farm fields: test some order 1 soil surveys for farms.

10) NCSS should participate in the initiation and administration of competitive matching funds for land evaluation pilot projects in cooperation with NSF, EPA, NASA, and the proposed National Institute of Agricultural Science.

11) Compile information on the climatic and soil requirements of plants, including weeds.

12) Develop an NCSS appeal to NSF for advancing the fundamental knowledge base of soil landscape systems.

13) Identify teams dealing with the complex systems of soil survey, GIS, GPS, spatial statistics, modeling, and land evaluation.

14) Provide current (dated) soil interpretations and land evaluation materials separate from soil maps and inventory data.

15) Apply systems approach to identifying land evaluation objectives; avoid finding the best way to do something that shouldn't be done at all.

16) Encourage innovative approaches to land evaluation at the field office level and allow for diversity in computer hardware and software.

17) Explore means of incorporating more socioeconomic components.

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Task Force Report

UTILITY OF SOIL LANDSCAPE UNITS TO THE NATIONAL COOPERATIVE SOIL SURVEY

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EXECUTIVE SUMMARY

The task force addressed the question about how we can incorporate more landscape information into future soil surveys. Two general problems surfaced. First, communications are hindered by a lack of well defined and universally understood terms. Second, little progress is being made because we are hesitant to produce a product until we know what the potential user needs, and the potential user does not know if he can use a product until he sees an example of it.

Specifically, the task force addressed these factors: need for a new kind of survey, its objectives, the level of sophistication of anticipated users, the general approach (field-integrated versus model-integrated), the elements or entities mapped, the depth observed in mapping, the kind of base map and scale, the methodology. and the uniformity of coverage over the country. In general, the task force suggested that the surveys should be similar within similar large areas (Major Land Resource Areas), but could vary considerably among various large areas. We debated to what extent we should continue to integrate a host of information in the field, as we now do, versus contributing a layer of information to a Geographical Information System and integrating the information in computer models. The consensus of the task force was that we are not ready yet to integrate the information with these models. One suggested method of conducting the survey was to define a typifying soil landscape (landform) unit, describe it in detail using block and cross-section diagrams, and describe how other areas of the same map unit vary from the typifying one. A scale of 1:24,000 should be seriously considered, but different scales should be tested. The map should be geometrically correct and could be presented on a topographic base, an air photo base, or only electronically.

The task force had three main recommendations: 1) Current surveys should make better use of the terminology already defined, 2) a manual should be produced to help people describe landforms and landscapes, and 3) pilot projects should be established in the field to test these ideas and provide the potential user a product to consider. The first can be implemented soon, the second is intermediate, and the third is a long-term project.

CHARGE

The charge from Dr. Arnold to the task force was to determine how the soil survey might carry out the following objective:

> The Soil Survey has to be based on a solid foundation of soil-landscape relationships, objective descriptions and measurements, well-kept records and documentation of the soils universe, and the coupling of our basic information with their translations and interpretations into meaningful statements that contribute to desirable solutions and answers for the users and consumers.

COMMITTEE DELIBERATIONS

In my initial letter to some potential task force members, I posed the following questions to be addressed:

A. Do we need a new kind of survey?
B. How do you visualize a soil-landscape survey?
    1. Map--scale and type of base map.
    2. Description of map units
    3. How can we show the relation of one soil landscape unit to others?
C. How uniform across the country should the new product be?
D. How extensive should the coverage be?
E. Where does modeling fit in?
F. How can geographic information systems be used to develop and deliver the landscape information?
G. Should we continue to update surveys in about the same way we have been doing them?
H. Would the new product be useful to the taxpayers?
I. Can you suggest references to be used to develop a field manual?
J. Other concerns.

Task force members put a great deal of thought and effort into their responses. Predictably, they had different ideas of how best to get more landscape information into the survey. I summarized the responses and sent the summary, correspondence from each member, and some of the supporting material that they contributed to each member. After that I had further correspondence and phone calls from some of the members.

For the Lincoln conference, I prepared a summary of the contributions of the task force and outlined some questions to be addressed there. More than half of the task force members attended all or part of this conference. This report represents the deliberations of the task force prior to the conference and the discussions of two groups during the conference.

One of the main problem in the deliberations was semantics. Different people have different ideas about the meaning of many of the terms used. This problem is especially acute in the realm of landscape analysis where the existing terminology is not well defined, and where the whole matter of scale is so important. For example. one person might use the term *plain* to refer to an area a few acres in size, and the listener or reader might visualize an area that is hundreds of square miles in size. This problem underlies recommendation two of the task force, to produce a manual that defines terms and helps people describe landforms.

Need

It was generally agreed that there is a need for a survey that depicts landscape/landform information to a greater extent than is shown in current surveys, especially those in agricultural areas. Some did not agree with the statement the "there is a need for a soil-landscape survey". The disagreement seemed to be more with what they picture as a "soil-landscape survey' than with the idea that there is a need for this kind of information. In this report, the term "soil-landscape survey" is used in a very general sense--some kind of survey that integrates soil profile information with soil landform/landscape information. The specifics remain to be decided.

Another problem is of the "Catch-22" variety. Some insist that we cannot produce a soil-landscape survey until we know what the needs of the user are. On the other hand, the potential user does not know if he can make use of a product until he sees an example of it. It is apparent that we need to make a move to get off dead center. We must try to create a product that potential users can test and suggest improvements. This problem relates to recommendation 3. for pilot field projects.

Objective

Before the conference, some argued that the starting point of any new or redirected effort should be to state the objectives of the survey--what the user (not necessarily the soil scientist) wants the information for. Others believe that landscape characteristics are a basic property of the soil system, with many applications. Designing the survey for existing applications may limit its usefulness for potential new ones.

This question was debated at the conference. The general consensus was that the objective should be stated at two levels--a general one to give the overview, and specific ones that give some examples of uses of the survey, but that do not limits its use.

User Level

In preparing any kind of document or report, we have a general idea of the degree of knowledge or sophistication of the intended reader or user of the report. Some believe that the new survey should satisfy primarily the needs of the sophisticated users, planners, environmental scientists, etc., and we do not need to make a major effort to provide something new to the traditional high school grad. This idea was debated at the conference. The consensus was that the new effort should be aimed at a higher level than the current reports.

Approach

The task force included mainly individuals with a traditional soil survey background. It also include a modeler, and some who had a good appreciation of modelling. Predictably, the task force suggested a wide range of ideas of how a new effort should be approached. The following discussion, which probably does not adequately represent either view, is an attempt to compare and contrast these views.

Field-integrated approach:

In this approach, the soil scientist first gathers all the available information about the survey area--soils, geology, geomorphology, native vegetation, etc. He also has a good understanding of how Soil Taxonomy, which integrates much information about soil properties, relates to the soils of the area. He then integrates *the information in his/her mind while doing the field mapping* and presents the information as an area on a map (map unit) and a description of that unit. A properly designed, well described, and accurately classified map unit conveys the needed information. As more kinds of information are represented by the inventory, more map units are described. This concept emphasizes proper design of the map unit and the relation of taxonomic units and map units.

Proponents emphasize field observations and integration of them. In many areas there are not enough "layers" of information available to drive the models. Also some of the information from models might not be sufficiently accurate. For example, they believe that current digital elevation models may not supply accurate enough topographic information; a field scientist can supply better information. Also, current models are not well enough developed to represent all the interactions one observes in the field.

Model-integrated approach:

In another approach, soil information is one component of the resource information available to the user. Each kind of information may be entered into a separate layer of a geographic information system. The layers might include soil profile information, elevation, kinds of geologic material, vegetation, etc. *Computer models are used to integrate all this information to* produce an answer to a particular question. Soil scientists would provide mainly point (pedon) information, because the topographic information comes from digital elevation models. Models can integrate the point information into ares information.

In the field-integrated approach, one person integrates all the information and represents it in map units. Proponents of the model-integrated approach argue that the amount of information that must be integrated is too great for one person to process without a computer. The different kinds of information should be supplied by specialists in a specific ares (a. g., geology by geologists). They further argue that if we try to build all kinds of information into map units for all possible uses, their number will become astronomically large, and their usefulness zero. Now, soil mappers spend much time determining their location on the base map and mapping topography. These things can be determined from global positioning systems and digital elevation models.

During the conference, the consensus was that we are not ready yet to depend on models to integrate all the various kinds of information that the field soil scientist uses.

Elements mapped

Correspondents and conference participants agreed that more landscape information is needed, but they had different ideas about the elements or entities that should be mapped. The following were suggested:

A. Geomorphic surfaces
B. Soil-landscapes
C. Soil-landforms
D. Soil associations
E. Land types
F. Ecological land types
G. Soilscapes
H. Point landforms (analogous to point pedons)

The question might be as much in semantics as in actual differences in what should be mapped. Perhaps, if the individuals who suggested these various elements were asked to map homogeneous areas of land in the field, the areas they would delineate would be more similar to each other than what they called the things they were mapping.

Depth considered

Some pointed out that there is a large deficit in our knowledge about the "unsaturated zone", or the zone between the soil (about 1.5 m) and the aquifer or the "true geologic material". They argued that any new survey should describe materials to depths of several meters.

Arguing against the need for deeper observations is like arguing against apple pie. For the sake of discussion, we raised the following question: If a given amount of money is available, should we make more deep observations in a small area or cover a larger area with shallower observations?

Conference participants generally opted for deeper observations.

Base map

Many emphasized the need to do new survey on **planimetrically-** correct base maps. Some correspondents favored topographic maps and others favored air photos. Some questioned if hard copies of the new surveys should be printed. Instead, they should be furnished only electronically, and then the question of a base map is a moot point. If the soil-landscape map is geometrically correct, base maps could be readily interchanged.

Scale

The **1:24,000** topographic map is becoming the common denominator for supplying several many kinds of environmental information **.This** scale is compatible with the kind of landscape information most users need. Several correspondents favored this scale for a soil-landscape survey. Some, however, favored a larger scale for agricultural areas. They argued that more, rather than less, detail will be needed for future surveys in farm areas.

A discussion developed concerning the optimum scale to show **soil-** landscape relations. **The** goal is to show the relationships among different soils and landforms. and a large-scale map might not show this relationship as well as one around **1:24,000.** This question needs to be studied in the field.

Methods

One suggested method for carrying out the survey is characterize a typifying soil-landscape (soil-landform) unit. This unit would be the minimum size that shows the common variability of soil and **landform** features. It would be analogous to the typifying pedon of current soil surveys or to the unit cell of a crystal. The typifying unit would be described by a block diagram and several cross section diagrams that show the relationship of soil horizons to the parent materials. The basic investigations required to characterize the unit would be similar to the transects made during many current surveys. In addition to providing information about the composition of the map unit, as in current surveys, the proposed method will show where in ***the landscape*** the various kinds of soils occur. Statements would also be made about how delineations of the map unit in other parts the survey area vary from the typifying unit, analogous to statements about the range of characteristics of pedons and the inclusions in map units of current surveys.

Uniformity of coverage

Some believed that one of the strong points of the soil survey has been its relative uniformity. A person who has used a survey in one area can use a survey in another area fairly effectively because they are similar. Also, a soil with the same name has the same properties wherever it occurs. If each survey is different, this would be difficult to do. They maintain that we need a fair degree of uniformity in a new product.

Others thought that the kind of map should depend on the needs of the local users--produce whatever they want. The conditions in forest land in the West are so much different from the conditions in farmland of the Midwest or East that a much different kind of survey is needed.

The consensus was that we should try to maintain a fair degree of uniformity within similar areas, such as a Major Land Resource Area, but allow different products in different areas.

RECOMMENDATIONS

1. *The landforms of pedon description sites and map units should be accurately described using terminology defined in the Glossary of Landforms and Geologic Terms (National Soils Handbook, 607), The Glossary of Geology (American Institute of Geology), Geomorphology (Ruhe), Landforms of the Basin and Range province (Paterson, Nevada AES Tech Bul. 28), or other locally understood terminology.*

This is a short-range goal. It essentially says that in many surveys we can do a better job with the tools at hand. It can be implemented through the normal channels of soil survey supervision and quality control.

2. *A new manual should be prepared to show people how to identify and describe landforms and landscapes.*

This is an intermediate range goal. It addresses the problem of poor communication due to poorly defined terms. The goal is that this manual will help us describe landforms and landscapes like the Soil Survey Manual has helped us describe morphological features. The task force suggests that the leadership for developing the manual be with the SCS Field Investigations Staff (FIS).

3. Pilot projects to produce soil surveys that clearly depict landscape features should be established in a high-intensity use area (agriculture) and in a low-intensity area (forestry or range).

This is a long-range goal. We should produce something in the field that we can demonstrate to potential users to learn if that type of product is helpful to them. This process will require several iterations. The leadership should also be with the FIS. The detailed contributions of members of this task force should be used to help plan the project. These contributions are too voluminous to include with this report, but they have been made available to the FIS.

4. *The issues* and *recommendations* should be *considered at regional NCSS conferences.*

These conferences could elaborate on the regional needs. Arrangements might be made to produce a manual (recommendation 2) that fits the individual region.

National Cooperative Soil Survey Conference
July 24 -28, 1989

Executive **Summary:** Soils Changed by Management

The task force on Interpreting and documenting soils changed by management is made up of 10 members. Each member submitted written responses to this task prior to the conference and further discussion continued at a break out session on July 26. The following **summorizes** those comments and **recommendations.**

COMMENTS

Four major areas of management induced change to soils were identified: soil changed by crop management: soils changed by irrigation; soils changed by drastic disturbance: and soils changed by drainage. The formal discussion focussed primarily on crop management and drastic disturbance changes.

The discussion of crop management changes focussed on erosion or **overwash** effects on soils; changes in soil chemical properties: seasonal use dependent soil properties and organic matter enrichment by long-term agriculture. It was noted that significant changes to soils are made through acid fertilizer use, liming, seasonal surface and near surface property changes and different cropping systems. They all effect the use and interpretations made of soils.

Discussion of drastic disturbance included those management changed soils altered through deep ripping or plowing, cuts and fills, dredging, and surface mining and **reclaimation.**

RECOMMENDATIONS

1. **Docummenting** change. General agreement by all that soil survey probably cannot address all levels of soil modification. The framework for documenting and interpreting both (a) short term changes or temporal properties and (b) long term changes or longer than the life of the survey needs to be made.

   (a) One of the principle needs is to construct a plan to handle use-dependent temporal information at a level of detail significant to the major models for erosion, chemical **ammendment** fate, etc. A data collection program in West Texas has proven successful and could be adopted for use in other areas.

   (b) Another need is the documentation of change made to the soils physical or chemical makeup that influences its behavior. Continued vigil to document soils modified after soil survey completion needs to be stressed. Procedures or other structural framework should suggest and support to what degree we document change (ie. do we consider only those properties normally identified in mapping).

2. Recommend that NCSS classify a few soils where sludge and chicken manure added as Mollisols. Collection of data to define levels of P for an Anthropic epipedon is needed.

3. Recommend that NCSS identify under what conditions the soil survey data applies. Different cropping systems should present differences in the data.

4. Recommend that NCSS improve procedures to document management altered soil. Possibly a special section specifically for this could be included as a supplement to the Soil Survey Manual or included in the National Soils Handbook.

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Task Force Report on Interpreting and Documenting Soils Changed By Management

for the

Cooperative Soil Survey Conference
Lincoln, Nebraska
July 24-28, 1989

MEMBERS:

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OBJECTIVES

The charge put forth to this task force was to present the best ideas, thoughts, concerns and possible directions that would be useful in guiding soil survey in the years ahead. Comments and recommendations are designed to assist in the planning and implementation process by creating awareness, supporting allocations and appropriations, maintaining the solid foundation of our science, and improving the innovative and creative ways of bringing our knowledge to those who need it and are able to effectively utilize it in making wise use of our resources.

I. Soils Changed by crop management.

A. Erosion or **overwash** effects.

All too commonly discussion of erosion effects on soils doesn't get much beyond concluding that erosion is bad. Erosion is undesirable, and control thereof should always be a priority, but we must also evaluate kind and degree of erosion effects much more thoroughly than has been the practice.

Resource use potential is a function of what is left rather than how it came to be so. How it came to be so is relevant to understanding how current soils relate to each other and to understanding what will happen to other soils if allowed to erode. Hence let's be diligent to retain the conceptual relationship between eroded and uneroded soils which were once much alike, but focus on what is left when attempting to evaluate and manage the eroded soil, rather than just on the fact that it is eroded.

Consider, at one extreme, a soil which in its undamaged state has a high quality A horizon underlain by an adverse B horizon. An example would be the Clarence soils (Aquic Argiudolls; fine, illitic, mesic) of east central Illinois. Clarence typically has a silty clay loam surface rich in organic matter, underlain by a silty clay B horizon (average clay content of the control section is 50 to 60 percent). When Clarence erodes, not only do you loose a high quality A horizon, but the underlying B horizon material is so high in clay that the soil is no longer suitable for row crop agriculture once the A horizon is gone. The damaged soil is not rebuildable under current technology, short of hauling new topsoil in.

The on-site consequences of erosion are quite different from the above on soils like Fayette series (Typic Hapludalfs; fine-silty, mixed, mesic). Fayette has a rather mediocre silt loam surface, relatively low in organic matter and a silty clay loam B horizon. The Fayette A horizon is worth trying to save, but the consequences of losing it are not nearly as serious as losing the Clarence A. Exposure of the Fayette B horizon to the surface through erosion will degrade the tilth and make management somewhat more difficult than on the uneroded Fayette. Even when all of the A horizon is gone, however, one is still left with a quality soil. Erosion does damage Fayette, but unlike eroded Clarence, eroded Fayette will still be a productive soil which can be improved over time through careful management.

Many soils fall somewhere between those two extremes in terms of the way they are affected by erosion. In all cases erosion control must be a priority concern, both because of effects on the soil and because of off-site effects. Different control strategies might be appropriate for the above two soils, however, and more attention to the way in which individual soils are affected by erosion will put conservationists in a position to devise the most effective strategy for each site.

Chris Smith remarked that we need to mention and officially acknowledge that erosion is not always negative as far as on-site considerations are concerned. Off-site is another matter. We must define why we are concerned with erosion in our discussions.

Similar principles apply for the effects of overwash. Overwash which is high quality material might not detract from and could even improve soils, though it might destroy the crop which is there at the time the overwash is delivered and render the area temporarily incapable of supporting machine traffic. Low quality overwash, such as excessively sandy' materials, would degrade any soil whose properties were superior to that of the overwash.

B. Changes in soil physical properties.

1. Compaction due to tillage and machine traffic.

2. Effects of cropping on soil structure. There seems to be a need to identify under what conditions soil properties exist. Example - bulk density, organic matter, etc. should be tied to cropping systems.

C. Changes in soil chemical and biochemical properties.

1. Effects of tillege and cropping.

Warren Lynn remarked that pH changes the suite of organisms that populate the soil. Clearing and cultural practices change soil layer organism populations, ie. earth worms. fungi and bacterial population changes.

2. Effects of liming and fertilizer usage on chemical properties.

Del Fanning reports that liming is causing conversion of some ultisols to Alfisols, which he refers to as cultural Alfisols.1 Some Dystrochrepts are also being converted to Eutrochrepts.

Dave Lewis reports that additions of NH4+ based fertilizer is lowering pH levels in Nebraska soils. Calcareous zones have also moved into deeper layers. This has also been identified in Oklahoma and needs to be looked at a little more. The idea of reclassifying those areas has been considered, but not done at present.

Chris Smith remarked that permanent changes should be handled at higher levels of taxonomy, and transient levels as a map unit phase.

3. The crop removal factor.

Increase of saline/alkali soils in Montana and ND seem to be in areas where fallowed land exists. Irrigation may decrease this salinity.

D. Subsidence of organic soils caused by drainage and cropping.

Aeration resulting from drainage and tillage of organic soils for crop production accelerates decomposition of organic matter. The resulting shrinkage can lower the surface to where the drainage system must be deepened, and can deplete the organic soil where it is relatively thin over mineral material. The rate of shrinkage can be reduced by periodic flooding, or by carefully maintaining the water table at the minimum depth needed for each time period.

Subsidence in other soils where the dissolution of gypsum, carbonate and the melting of ice lenses occur is of major importance to recognize.

E. Management related temporal properties.

Bob Grossman argues for the need to construct a plan to handle use-dependent temporal information at a level of detail significant to the major models for erosion, chemical amendment fate, etc. Should these characteristics be modeled from invariant properties to the exclusion of measurement and generalization of these measurements in standard soil survey output? We have measurement procedures for crust, roughness, cover, etc. Bulk density of the tillage zone changes through the cropping season. Grossman and Pringle2 have reported on a program in West Texas that provides much more information on bulk density and other quantities.

A well developed use-dependent temporal data system could reduce the variability commonly associate with individual soils by separating out the effects of season and management. Soil property values relevant to a particular process or problem could be derived for the particular time and use conditions appropriate. In summary, the idea is to confine data to specified time and use conditions in order to enable greater specificity.

G. Surface horizon thickening or organic matter enrichment by long-term agriculture.

How many cultivated soils in the US and elsewhere have anthropic epipedons? How should they be classified. Del Fanning suggests that they should be placed in Mollisols, though they are now excluded.

The classification of Anthropic epipedons as Mollisols should be made only if other soil properties classify as Mollisol. John Whitty remarked that the Anthropic epipedon definition in Soil Taxonomy is not correct. It was suggested that the P factor of 250ppm is off by a factor or 10 or so, but that no data exists to determine what the levels should be. Anthropic epipedons could apply to areas where sludge and chicken manure are added.

II. Soils changed by irrigation.

A. Cut and fill effects of grading and leveling are considered under disturbed soils.

B. Chemical and physical effects related to quality of irrigation water.

1. Accumulation of soluble salts.
2. Elevated pH and consequent micronutrient effects.
3. Dispersion of soil clays.

C. Irrigation related soil profile modification.
   1. Translocation of soil constituents by irrigation water.
   2. Irrigation induced organic matter enrichment.

D. Wind erosion damage on irrigated soils.

E. Effects on soils of flooding for rice production. (Contributed by Dr. H. Don Scott, University of Arkansas)

Flooding of soil results in changes in several soil physical, chemical and microbiological properties that influence the quality of a soil as a medium for plant growth. The nature, pattern, and extent of the changes depends on the physical and chemical properties of the soil and the duration of submergence. Flooded or waterlogged soils have high water contents, and as a result, have restricted ges exchange between the soil and the atmosphere. The amounts of oxygen and nitrogen in soil are roughly inversely proportional to the soil water content on a volume basis, and thus, waterlogged soils are characterized by the absence or near absence of oxygen and nitrogen. Flooding, thus restricts soil aeration, resulting in depressed oxygen and nitrogen availability to plant roots and soil microorganisms.

Under flooded conditions in the field, oxygen and nitrogen are gradually reduced by downward transport in the soil profile with the moving water'. upward movement through bubbles, and by extraction by plant roots, nodules and soil microorganisms. If the soil contains sufficient organic matter and is microbiologically active, waterlogging will be followed by the disappearance of oxygen and the reduction of the soil. The rate of reduction is directly related to the amount of fresh organic matter present, soil temperature, microorganism and plant root activity, soil chemical status, and the duration of the flooded condition. Oxygen diffusing into a flooded soil may be consumed as a result of (i) microbial respiration where it is used as an electron acceptor, (ii) chemical oxidation of reduced ions such as Fe and Mn, (iii) biological oxidation of NH4 and carbon, and (v) oxidation of sulfides. Given sufficient flood duration these processes result in the development of an oxidized layer at the soil surface. The thickness of this layer represents a balance between oxygen diffusion into the soil and its consumption chemically and biochemically.

Flooding also affects the thermal properties of the soil. Saturated soil has higher albedo values, heat capacities, thermal conductivities and thermal diffusivities. Usually wet soils are cooler than dry soils which impacts the rates of gaseous transport, chemical and biochemical changes, release of nutrients, production of physiologically active organic compounds, and plant growth.

Prolonged flooding destroys soil structure by disrupting the aggregates. The breakdown of aggregates is a result of reduction in cohesion with the increase in water content, deflocculation of clay as a result of dilution of the soil solution, pressure of entrapped air. stresses caused by uneven swelling, and destruction of cementing agents. Flooding decreases water movement in soils of low permeability because of dispersion of soil particles, swelling aggregate destruction, and perhaps clogging of pores by microbial slime. In nonswelling soils, flooding increases internal drainage by increasing hydraulic conductivity. Flooded soils **are** characterized by increased concentrations in the soil solution of reduced ions such as **$Fe2+$, $Mn2+$, $NH4+$,** and **$S2-$.** These ions subsequently become more available for plant uptake. The physical-chemical status of a flooded soil system has been characterized by the oxidation-reduction potential **(Eh)** which is a measure of the electron availability. Values of Eh are dependent on soil properties such as **pH,** Fe and **Mn** content, and previous history of anaerobiosis. In general, reduction increases as Eh decreased. However, due to the complexities of soils, the relation between Eh and elemental concentration is not unique.

Frequently, under anaerobic conditions organic substrates are not decomposed completely to carbon dioxide. Incompletely oxidized intermediate and end products can. therefore, accumulate in waterlogged soils. These compounds, which include lactic acid, ethylene, ethanol, acetaldehyde and aliphatic acids, may be present in abnormally high concentrations under anaerobic conditions and may affect plant growth.

Warren Lynn added that wetland rice cultural practices internationally and domestically may differ. An international soil correlation meeting to be held in Louisiana and Texas will be scheduled in 1990.

III. Soils changed by drastic disturbance.

A. Deep ripping or plowing.

Various forms of deep **tillage** have been practiced on extensive areas in some regions. The effects are in some instances primarily disruption, temporary or permanent, of soil horizons. such as duripans. Varying amounts of mixing of material among horizons is also likely, and in some instances the mixing is such that diagnostic horizons are obliterated.

Soil performance effects.

Taxonomic significance.

The 1967 NTWPC in New Orleans recommended that:

Soils with original diagnostic horizons mixed by ripping, deep plowing, etc., sufficiently to destroy the original normal sequence. but not to the extent that the fragments or parts of the horizons can no longer be identified, will be classified in the suborder Arents of the order. Entisols.

1. The soils are to be recognized as Named soils and classified with existing or new series.

2. Naming of mapping units will follow conventions presently in use.

3. The position of fragments of diagnostic horizons within the soil profile and the nature of these fragments should be considered as criteria for soil series.

4. The geographic extent of Arents is to be limited to the areas where disturbance or mixing originally occurs.

B. Cuts and fills related to field leveling or construction.

(The following draws heavily on Terry Cook's comments).

On fairly level lands on the West Coast, extensive areas have been leveled using laser equipment to establish dead flat fields. Wet basin land areas originally having native salt grass species and vet land vegetation has been drained, reclaimed, and individual fields leveled; leaving thick cut and fill areas. These soils today are not salty and have been completely reshaped from their native state.

In moderately to strongly sloping (3-15 or 20%) extensive areas with abrupt argillic horizons, duripsns, etc., within a depth of 40 inches, have been leveled to <1% slopes. The results are O-15 foot cuts at one end of a field, possibly only minor alteration in the center, and up to z-15 foot fills at the other end of the field. When duripans have been destroyed, removed, and deposited over extensive areas; the classification, interpretations, and use and management that have been used in the past are irrelevant. New criteria need to be developed to furnish the user of soil survey information with adequate data to provide proper planning alternatives.

Another part of “shaped soils” are those areas of soils on slopes of >15% up to >50% that are cut and filled for housing pads. These areas have been cut to several feet into the bedrock or consolidated material and then filled to make level pads for building sites. This practice takes place in other countries as they cut terraces on very steep slopes to grow local crops, such as, rice, beans, cassava, etc. As an example, much of the island of Java in Indonesia has been manipulated by terracing. The description of the soils, criteria for interpretations, and soil behavior is totally different than “old traditional’ methods or procedures.

Construction related cuts and fills produce conditions very similar to those following strip mining, where similar geologic materials end up exposed to the surface.

Soil performance effects.

Taxonomic significance.

The 1967 NTWPC in New Orleans recommended that:

> Shaped soils should be considered as phases of soil taxonomic units resulting from smoothing, leveling, and grading in which:
>
> A. Diagnostic horizons required within pedons have not been destroyed or interrupted, or
>
> B. Diagnostic horizons have not been buried to depths of more than 20 inches.

The **use** of shaped phases of soils, because of present standards and criteria for soil classification, will therefore be limited in most instances to the soils in orders in which smoothing, grading, or leveling operations are not apt to destroy features diagnostic for any of the soils involved in **more** than 50 percent of the area under consideration.

For materials consisting of mechanical mixtures of **sola** and parent materials from soils without discernible fragments of diagnostic horizons, and artificial fills with no diagnostic horizons or buried diagnostic horizons if they are buried deeper than 20 **inches, or** if they are buried to depths between 12 and 20 inches and the thickness of the buried **solum** is less than half the thickness of the overlying deposits, they recommend:

> . ..be classified in the **Fluvent** and Orthent suborders of the order Entisols.

A. The soils are to be recognized as **Named soils** and classified with existing or **new** soil series if characteristics enable classification at this level of the system.

B. Naming of mapping units will follow conventions presently in use.

The 1967 committee recommended excluding hauled (moved) materials from **Arents,** but did not specifically provide a place for those which may have “discernible fragments of diagnostic horizons.’

The 1969 committee meeting in Charleston, South Carolina, basically confirmed the position of the 1967 committee, but added that hererogenous **earthy** material with a wide range of texture and/or other characteristics, from cut and fill or other operations, be treated as a miscellaneous land type rather than attempting to classify them.

C. Landfills.

Land fills have some similarities to construction fills and mine soils, but differ because of the buried refuse. Decomposition of the refuse over time commonly causes differential settlement at the surface. Seepage from the fills is also commonly contaminated by materials'from the refuse. Generation of volatile gases is common on these sites and causes an explosion hazard in any structures built on them which can trap those gases.

D. Land construction with dredged materials or land exposure through diking and drainage.

Soils built by extending the land with dredged sediments commonly have a high n-value and consequent low bearing strength. Marine sediments might also develop sulfuric horizons unless precautions are taken to prevent that.

The Dutch have been highly successful in exposing new land for productive agriculture through diking and drainage.

E. Surface mining and reclamation.

a. Coal.

b. Other minerals, clay, topsoil, sand/gravel, limestone, and shale.

Characteristics of reclaimed land are more a function of reclamation practices and available materials for soil construction than of the mineral being mined. There are rather considerable differences in Illinois between reclaimed coal strip mine lands and reclaimed limestone quarry lands, but those differences are almost totally a result of differences in the applicable reclamation laws.

The first step in evaluating, interpreting, or documenting minesoils regardless of the mineral being mined is to begin with thorough premining analyses of the soil and rock overburden. Knowledge of premining soil series and geology including lithology. mineralogy, and geochemistry will help in the prediction of minesoil properties and evaluation of land use suitability. Richard M. Smith has written extensively on this subject. Overburden analyses will help to determine if the original topsoil should be saved or if a better substitute is available. A horizons are thin in Appalachian coal fields and are commonly removed in the forest clearing operations in preparation for mining. Then the "topsoil" which is stockpiled and saved is actually B and C horizons and **some** Cr materials.

F. Chemical soil problems.

1. Toxic materials.

John Sencindiver points out that mining may expose pyritic materials which develop acidity upon weathering. These acid products become acid mine drainage **(AMD)** when leached by precipitation. **AMD** is the biggest environmental problem faced by the coal industry in West Virginia and much of Appalachia. Establishment of vegetation is generally no longer a problem. Acid minesoils and poor vegetation establishment occur on only a very small proportion of the mine sites, today. When these acid problems do occur. they generally only affect a small portion of any site. Operators **are** required by law to bury and/or treat acid materials and most are doing a good job of this.

Well-vegetated sites may still have a major **AMD** problem, and many studies have been conducted on this problem. **Bactericides** have been used to control the **Thiobacillus** organisms, but these treatments are generally short-lived. Clay seals and synthetic (PVC) seals over acid materials have been tried. Clay seals may leak if not applied properly and PVC liners are very expensive.

The most promising treatment currently being studied in West Virginia is rock phosphate. WW professors in geology and chemical engineering have been studying this treatment process for several years. They are now in the process of establishing some scale model backfill piles on surface mines where different rates of rock phosphate will be applied. The phosphate in the rock phosphate reacts with ferric iron in the system and removes this iron so that it is not available to oxidize pyrite. Removal of Fe drastically reduces pyrite oxidation.

2. Base-rich soil materials.
   a. High calcium soil materials.
   b. Soil materials high in gypsum.
   C. **Sodic** soil materials.
   d. Saline soil materials.

3. Managing soil fertility.

G. Soil physical problems.

Physical properties of minesoils always vary from those of the pre-mine soils, and properties of topsoiled minesoils differ from those which were not topsoiled.3,4,5 Hnottavange and Sencindiver have reported changes in the pore-size distribution when soils are disturbed.6 Minesoil macropores drained by gravity flow were 57% (by volume) less than macropores of the native soils. Also, microporosity (1000-90um) was 35% less for the minesoils.

Extreme textures, excessively sandy or clayey, and excessive rock fragments can be controlled by careful selection of suitable materials for soil construction, where suitable materials are available. It is generally safe to assume materials available from the pre-mine soils will assure that the constructed soil can be as good texturally as the original soil. Alternative materials in the overburden might be as good or better, texturally, than those of the natural soil. Similar principles apply where the concern is duripan, petrocalcic, or ironstone materials.

Physical problems associated with dispersed clay are a consequence of the chemical nature of the materials used in soil construction. Again, material selection is the key. where non-sodic materials are available. Some related problems might not be avoidable. For example, even when sodic materials are carefully segregated and buried in the substratum, piping might become a problem as water moves through and mobilizes dispersed clay from the sodic layers.

The other, and perhaps most challenging, physical problem is structural in nature. It is a combination of high bulk density/low porosity, high soil strength, and lack of a macropore network. It results from lack of or disruption of natural soil structure and either severe compaction of the materials during soil construction, or failure to disrupt masses of high-strength, high-bulk density material from deep in the over burden as it is being moved and placed in the new soil.

Work in Illinois and elsewhere has made it clear that natural soil structure is not essential for a soil to be productive, so long as modest soil strength and an adequate macropore network can be established artificially. Such is not easily accomplished, however.
The most conspicuous success in Illinois is where a mine has dug material from the highwall with a bucket-wheel excavator, transported it around the pit by belt, and placed in with a spreader which was able to control placement such that only minimal smoothing was needed after placement. The resulting soil commonly has an artificial

(fritted) structure and has proven to be productive for row crops.7

The equipment used at that mine is so inflexible, that it is not likely to be used for a significant portion of acreage mined, and hence is not an adequate solution to the problem. There is reason to believe, however, that similar results can be accomplished with well planned rear-dump truck handling system. Truck traffic should be confined to the base level to avoid **compaction** of soil material after placement.8

The other alternative is to alleviate compaction through some form of deep **tillage** after the new soil is in place. The problem with this approach is the depth to which treatment is necessary. Many options are available for loosening soils through **tillage** to a depth of 45 cm or so. There are a few **tillage** options which have proven successful to **90cm,** but natural soils in the central corn belt commonly support root systems down to 120cm or 150cm.

Early attempts to till to more than **100cm** in these soils were not very successful. At those depths one tended to get plastic flow around the **tillage** instrument and no significant physical improvement of the soil. A recently designed machine looks quite promising for **tillage** to about **120cm.** It employs a two-lift **tillage** approach and imparts a very considerable vertical lift component to the lower soil materials. Field crop productivity experiments are underway in Illinois to evaluate several available **tillage** options. Early results look promising, but it is certainly too early to conclude that the problem has been solved.

H. Slope stability on reclaimed soils.

1. Erosion.

2. Mass movement.

Glenn **Kelley** reports that most spoil material will eventually move down slope if it is placed on slopes of 20 to 25 percent or greater, particularly when spoil is placed **on outslopes** with little toe-slope support.

3. Importance of soil materials on slope % and length (grouping guidelines needed). Slope length should be kept to a minimum, but often difficult to get operators to understand this.

I. Management techniques.

1. Cropping sequence/rotation.

Keith **Huffman** suggests that quick-catch cover crops be seeded immediately to stabilize slopes against erosion. Rye works well for this purpose · **in** Ohio. Introduction of deep rooted legumes will then enhance soil structure development and provide for infiltration and improved air/water relationships. A seeding mixture should be selected to fit the site and the planned use.9 A time of two to three years should be devoted to low intensity use with no or minimal harvesting of hay or pasturing.

2. Hybrid or variety selection.

Hybrid screening studies **have** revealed that those hybrids which perform best **on** natural soils do not necessarily perform best on minesoils. No hybrid has been found, however, which will adequately tolerated the physical and chemical problems **common** to many minesoils.

3. Identifying fertility needs.

4. Dealing with 'hot spots."

5. Residue management.

J. Classification of disturbed soils.

John **Sencindiver** contends that classification of minesoils needs further study and evaluation. Most minesoils in eastern U.S. have been classified as Typic Udorthents. Seven **minesoil** series have been developed in West Virginia and others originating in surrounding states are recognized in West Virginia. All of these series are loamy-Skeletal, mixed, **mesic** Typic Udorthents. The only difference in classification of the series at the family level comes at the soil reaction category. These minesoils **are** acid, **nonacid,** or calcareous. John contends that we need some means of identifying minesoils at a classification level higher than series. For example, Janelew silt loam, loamy-skeletal. mixed, calcareous, **mesic** Typic Udorthent does not tell the reader that Janelew is a minesoil. One must read the description of Janelew to determine that. A new term such as Spolents, Spolic Udorthents, or some other term would assist in documenting and interpreting minesoils.

Illinois initially classified a couple of **minesoil** series as **Arents,** because of the presence of identifiable fragments of diagnostic horizons from the pre-mine soil. Those fragments did represent a fairly small portion of the total soil volume and the regional cotrelators at the time argued for reclassifying them as Orthents. They wanted to use Arents only when the fragments of diagnostic horizons were at least 202 by volume. That didn't seem like a very big issue to us at the time so we agreed. It became a much bigger issue, however, when a year or two later we were asked (by regional correlators) to delete all reference to fragments of diagnostic horizons in soil descriptions for a publication (or change the classification), because Orthents weren't supposed to have any. The more contentious among us argue that we either need to abide by the class criteria and classify all soils vith such fragments as Arents, or change the criteria so that some minimum percent by volume is officially part of the class concept. A third alternative is to follow John's suggestion above and set up a new suborder for drastically disturbed soils. Above all, we should be free to describe the soils as we find them, rather to make them fit a predetermined class concept.

The concern over how to handle Arents is not new. The committee on criteria for classification and nomenclature of made soils at the National Technical Work-Planning Conference in New Orleans in 1967 recommended that

> ..“the recognition of Arents be confined to soils mixed in place so that fragments of a diagnostic horizon transported by dump truck to a new area would not be the basis for the recognition of Arents in the new site. In addition, a significant number of fragments of a diagnostic horizon should be present to justify the classification of Arent."

The definition of Arents was never adjusted to provide for those suggestions, but the above recommendation might well have been behind the 20% rule-of-Thumb. Perhaps the solution is to develop a procedure whereby recommendations from national committees would be either 1) formally accepted, in which case any needed adjustments to class concepts, etc. would be made, or 2) rejected, in which case no one would feel obliged to attempt implementation of something at variance with current class definitions, etc.

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9 Evangelou, V.P. and R.I. Barnhisel. 1982. Revegetation guide for surface-mined land in Kentucky. University of Kentucky, College of Agriculture, Cooperative Extension Service. AGR-95.

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RECOMMENDATIONS

1. Docummenting change. General agreement by all that soil survey probably cannot adddress all levels of soil modification. The framework for documenting and interpreting both (a) short term changes or temporal properties and (b) long term changes or longer than the life of the survey needs to be made.

> (a) One of the principle needs is to construct a plan to handle use-dependent temporal information at a level of detail significant to the major models for eroseion, chemical ammendment fate, etc. A data collection program in West Texas has proven successful and could be adopted for use in other areas.

(b) Another need is the documentation of change made to the soils physical or chemical makeup that influences its behavior. Continued vigil to document soils modified after soil survey completion needs to be stressed. Procedures or other structural framework should suggest and support to what degree we document change (ie. do we consider only those properties normally identified in mapping).

2. Recommend that NCSS classify a few soils, where sludge and chicken manure added, as Mollisols. Collection of data to define levels of P for an Anthropic epipedon is needed.

3. Recommend that NCSS identify under what conditions the soil survey data applies. Different cropping systems should present differences in the data.

4. Recommend that NCSS improve procedures to document management altered soil. Possibly a special section specifically for this could be included as a suplement to the Soil Survey Manual or included in the National Soils Handbook.

NCSS TASK FORCE

THE NEEDS OF THE USERS OF SOIL SURVEY INFORMATION: Reliability and Methods of Presentation

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EXECUTIVE SUMMARY

This task force was charged with recommending ways of making soils information reliable and complete for a broad spectrum of users. These users represent abroad, diverse array of professional and organizational needs for soil survey data and information. Land resource managers need to know how soils may affect the elements they can control. At another part of the spectrum, scientists want a detailed data set.

A user normally works with a limited set of controllable elements. Reports should be designed to address those elements. Managers are interested in spatial displays that show where outputs can be obtained, how soil affects the amount of inputs needed and outputs produced, risks assessment for opportunities and consequences, how uncertainties affect controllable elements, windows of management opportunity during a time period (year, etc.), and alternative ways to manage the land. Display and account for soil variability by documenting expected effects (individual, cumulative, local, and off-site) on inputs and outputs.

Educational programs for users and providers **of survey** information need to be strengthened. Many users need to know more about soil concepts and how basic soil properties affect their particular land management interests. Providers of soils data and information generally need a better background in techniques of understanding and meeting user needs. These educational needs can be met by upgrading some existing programs and developing new programs.

Successful long term land use is dependent on maintaining soil quality. However, soils are part of a landscape and land use depends not only on soils but also on **landform** and other environmental characteristics. Therefore it is necessary to integrate soils data with other environmental data. This integration may be done during a soil survey or through use of independently acquired data sets. Facilitate soil mapping by implementing appropriate remote sensing technologies to identify vegetation and other land characteristics. Maintain geographic accuracies of mapping through the use of global positioning systems.

Use computer and communications technology to make soil data available to end users on line, magnetic media, or paper as needed. Develop and implement analytical tools based on data bases, geographic information systems, and expert systems to facilitate preparation and presentation of reliable data and reports. Start or enhance research and development programs to implement these systems. Support development of PC software for data analysis by users in agriculture, forestry, range management, etc. Emphasize flexible, user friendly communication and data exchange among cooperators.

I. INTRODUCTION

The stated mission of the Soil Survey Division is to "Assist mankind in understanding and wisely using soil resources to achieve and sustain adesirable quality of life..." Our approach to carrying out this task traditionally has been to identify, classify, map, and interpret soils, with most financial and human resources directed towards a "once **over"** mapping of the United States. Although soil survey **"products"** have long been available to cooperating agencies and the public, less time and fewer staff have been committed to keeping this information current and assisting users in its proper application.

A traditional following of soil survey users has developed over the years that supports the present content and format of soil survey reports and information. At the same time, increasing population and mobility of the population has developed new, increasing and often conflicting demands on land use and management. Land use analysis involving soil potentials and limitations is often urgent and may involve different levels of detail or reliability than'currently presented as well as different interpretations than traditionally presented (Brinkman 1989, Buol and Hooper 1989).

It is the dynamic nature of the soil survey and user needs that motivated the establishment of this Task Force. If we wish to uphold our fine reputation for providing the most critical information for land use planning and management, then our programs and presentation of products must adapt: stagnation and complacency will only make the soil survey antiquated and unused.

An emerging group of potential soil survey users along with many traditional users find present soil survey publications containing inadequate data and poorly organized for timely analysis of land use conflicts and alternatives at the level of detail needed. They need soil survey information that will help them get from the present land conditions to some desired future condition. This new user community needs a broader spectrum of data and information than exists in present manuscripts.

As we approach our goal of having many "modern" soil surveys nearing completion or being completed, it has become increasingly clear that program emphasis must change. Updating older surveys, providing current soil survey products to a soils-data hungry public, and assisting users in the proper application of maps, interpretations, and databases must be addressed in current and future survey work.

Although the reliability needed by soil survey users today varies with intended applications, all users require a consistent degree of reliability that can be expected at various levels of analysis. Some users have found the utility of the soil survey maps and reports to be very limited and interpretations outdated. For example, much of the existing data that is being used for forestry tables has not been collected using correct methods. When one State Soil Scientist was asked about site index information he guessed that most of the interpretations where made in the 1950'6. This raises concern about the reliability of this information.

Intensity of mapping needs to be carefully evaluated before work begins and existing surveys need periodic review to determine when they should be.updated. Many soils maps do not have the required detail needed for commercial natural resource management. All too often agricultural lands have an order 2 survey while surrounding lands are mapped at order 3 or 4. In today's economic situation, intensive natural resource management requires a level of soil data that is commensurate with data needed for agricultural management.

This task force will recommend ways of managing information so that it is reliable, complete, and useable by soil aurvey users. Our recommendations will be based on an examination of users and their needs for soil survey information. Some of these needs will affect the way surveys are conducted, so this task force is also making recommendations concerning aspects of a soil inventory. Specific recommendations follow the summary.

In most cases the Task Force members are in agreement with the analysis and recommendations that follow. Where there are conflicting views, an attempt is made to represent differing opinions because, all too often, a radical opinion may be unilaterally treated as right or wrong. These disagreements highlight subjects that need more discussion to find innovative solutions.

II. USER CHARACTERIZATION AND NEEDS

User needs for soil survey information are almost as numerous as soil series. Some audiences have been identified and targeted - farmers, ranchers, and engineers - since the beginning of published surveys with a basic emphasis on agricultural land use and management. Others have been recognized and cultivated, while still other groups and disciplines have discovered on their own this wonderous natural resource data set. We should recognize the dominant users and their information needs now and in the future. Their level of sophistication in using technical information, and their frequency of use, will influence the future direction of the national soil survey program.

A. Soil Survey Users

Six broad categories of soil survey users are identified in general relationship to informational needs in Figure 1. Three levels of informational needs are portrayed within the pyramid. The kinds of information and categories of users are not necessarily distinct. Interpreted information is most often part of management information needs as modified by social and economic constraints. A researcher may also be an educator and so forth. The groupings do, however, provide a basis for further discussion.

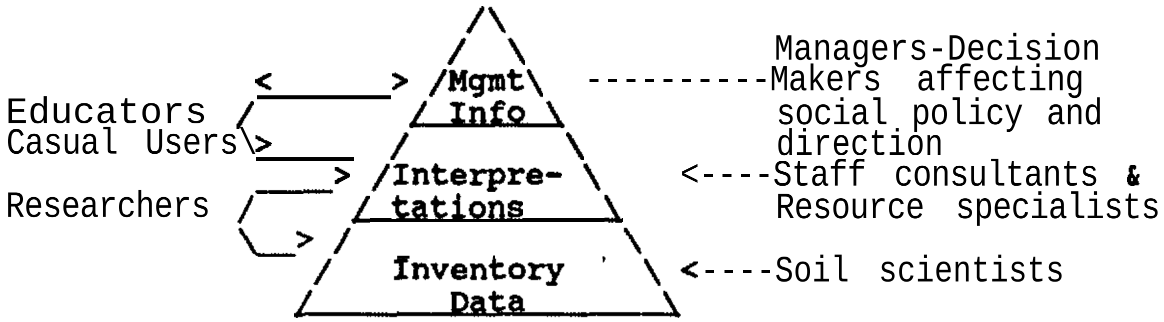

Figure 1. Schematic representation of soil survey user groups and their general information needs.

The categories or levels of data aggregation in Figure 1 start with the basic data collected during inventory work. As is generally recognized, basic data alone does little to explain observed phenomena. For this reason basic data are interpreted to provide estimates of potential erosion or productivity, for example. Management information is yet another aggregation of interpretations, usually from more than one resource, to address managers' needs.

Following is a characterization of each user group.

MANAGERS:

Managerial users of soil information are decision-makers who implement or approve land use activities or assessments and/or affect policy and direction. Managerial users include:

Land owners/users (Farmers, Ranchers, Industry)
Elected Officials
Agency Line Officers (Local, State, Federal)
Banks/Lending Institutions

All managers of environmental resources should have the goals (not always practiced) of providing goods and services from the land without impairing productivity or degrading water quality. They meet these goals using the traditional tools of planning, organizing, directing, and controlling. The key to planning resource management practices is knowing what can be controlled. Management elements are those controllable variables that a manager can manipulate through a decision, to achieve the desired goals and objectives. For natural resource management, the controllabia elements are (Warrington 1989):

1. Quantity of outputs produced (for example board feet, AUM's) or inputs used (such as tree planting, range improvements, etc.).

2. Quality is the goal toward which the methods used to implement the management practices are aimed (Pirsig 1974). It is expressed through the effects of the chosen management practices on the functioning and productivity of affected watersheds. This includes the aerial extent of disturbances, the magnitude of disturbance, and the duration of the effects of the disturbance.

3. Location of the practices on the ground.

4. Timing of practices through the sequencing of entries into a watershed and/or the season of operation.

5. Mix of outputs can be changed through crop rotations. This element is more important in agriculture than in forestry or range management because crops can be changed in shorter time periods than are practical for forests or rangelands.

Managers most often use interpreted information supplied by staff consultants (and private consultants or service agencies such as SCS) in a format that displays controllable environmental elements and can be quickly and easily analyzed in relation to economic, social, and legal constraints. Interpretations may be needed from the level of the map unit or the soil interpretation record (Form 5) to support decision rationale. Attribute maps that combine map units to address the issues and their relationships to other concerns are probably most valuable 'at this level. Because of sometimes sudden changes in values (Leonard and Staid1 1989), environmental concerns, technology, etc., rapid generation of new attribute maps is often required to meet managerial needs for information.

Reliability requirements for managers vary with values at risk. At the very least, managerial information must be consistent across the area under consideration and not contain biases based on personal preferences of a specialist. Where landscapes have a large amount of variability in one or more components, the information must adequately reflect this variability. Therefore, interpretive tables must be accurate and up-to-date in order to complement the attributes presented on individual maps.

STAFF CONSULTANTS / RESOURCE SPECIALISTS:

Staff consultants are resource specialists who are employed by an organization to provide in-house management support services. They, along with private consultants or service agencies such as SCS as users of soil survey data and interpretations, must supply managers with recommendations and alternatives on land use. These interpretations of soils data may be used for setting policy, planning land uses, designing management strategies, and planning and implementing projects. Consultants are often specialized in one discipline or interest area such as:

*Forestry
*Range Management
Wildlife Biology and Management
Ecology/Environmental Consultants
Geology
Realty
*Appraisal/Assessment
*Agronomy
*Soils
*Conservation
*Land Use Planning (Industry, Government)
Mineral Exploration/Reclamation
*Landscape Architects/Managers
Waste Management (Toxic Waste and Sanitarian)
Chemical Companies
Water Quality
Entomology
Archeology
Public Health
*Engineering
Pest Management
Urban Development

* Most likely to be current users of soil survey report information in its present format.

Because of their specializations, individual consultants should work with other resource specialists as an interdisciplinary team. Through a negotiating process the team provides viable alternatives to managers where multiple resource values are involved. The success of a consultant depends on the reliability of the information used to support a recommendation as well as an ability to present supporting documentation in a clear, understandable, and persuasive format. Reformating soil survey information is often necessary to provide effective presentation of recommendations and supporting rationale.

The consultant needs reliable basic soils data and interpretations in order to produce accurate information for managers. They may use either specific soil attributes such as texture or depth for interpretations of soil properties or interpreted information like productivity or suitability for certain practices. In addition to more detailed maps and reliable site information, a consultant may need additional data than can be found in a soil survey report about specific conditions that are important to a recommendation. For example, greater detail about soil surface texture variability may be needed in order to determine the quantity of herbicide to apply. The current surveys do not always quantitatively address, map unit variability.

SOIL SCIENTISTS:

The soil survey and additional soil inventory data are provided by soil scientists, hopefully with coordination among other technical specialists (USDA 1983) and managers, to insure the information meets user needs. The survey soil scientist is not only responsible for documenting soil attributes, classifying and mapping soils, but may also be the consultant involved with interpretation and analysis of soil information for management alternatives.

A soil scientist doing inventory will be one of the most intense users of soil survey data. When doing a survey, the soil scientist uses existing soil surveys for established precedence in mapping, classification and correlation while considering current standards, policies and information needs. Fast, easy access to existing inventory data can enhance on-going survey efforts.

Reliability of survey information is the responsibility of the survey soil scientist. However, there are few statistical criteria to guide and monitor accuracy and reliability of different soil survey levels. Usually, reliability is maintained through empirical guidelines (USDA 1983) based on a scale of mapping and correlation quality control procedures. Although empirical reliability is defensible, the responsibility for the resulting products rests more on individuals than would any kind of quantitative analysis procedure. Empirical reliability can put individuals in rather awkward positions where legal mandates are concerned.

A soil scientist in a management support role is in charge of interpreting soil data and transforming it into something that another staff consultant or manager can utilize immediately. Support services specialists usually use the survey report as a starting point in a decision making process. The specialist will glean as much information out of the report as possible, then evaluate the contents of the survey to determine how much additional information needs to be gathered to make sound interpretive decisions.

RESEARCHERS:

Researchers may use soil survey information in investigations of environmental resources and to help in developing technology of interest to any of the aforementioned users. Research may be intensive (plot specific) or ssessment). Reliability in quantitative terms is usually a necessity for research applications. Intensive applications are usually verified by on-site investigations; however, for extensive applications researchers are more likely to rely on existing soil survey reports.

One thing that separates soil scientists and researchers from most people in other groups is their ability to question the product and recognize mistakes. The other groups are more likely to accept a survey as 100% correct simply because their knowledge of soils is not as extensive. For this reason the basic background data for soil survey needs to be made available to all researchers for their use in making interpretations.

EDUCATORS:

Educators in private and public schools and universities use soil surveys in their present format as "textbooks" to assist in teaching soils and applications of soil information. They need to be assured that the information in a survey report is reliable.

Perhaps more emphasis needs to be placed on teaching the teachers about soil surveys and how this information can be used to improve the quality of life. These teachers of our children must be adequately prepared to pass on the essence of a basic body of environmental knowledge. At all levels of our educational system, from civics to law and including natural resources, soils should be introduced in the way that is pertinent to the subject being presented.

CASUAL USERS:

The "casual" user may belong to a non-technical group that uses soil survey information in conjunction with some personal interest. Their needs will likely be taken care of if the needs of other groups can be satisfied. However, a casual user is a self-motivated person who may become a professional user as his knowledge and awareness of soils increases. This person should be sought out and encouraged to learn.

GENERAL USER CHARACTERISTICS:

Potential users of soil surveys have many reasons for wanting the information and very diverse levels of knowledge about soil science and soil surveys. In order to present appropriate background discussions in soil survey reports to target audiences, general levels of knowledge about soil science and soil survey and the expectations about reliability must be assessed. These are diagrammed in Figure 2.

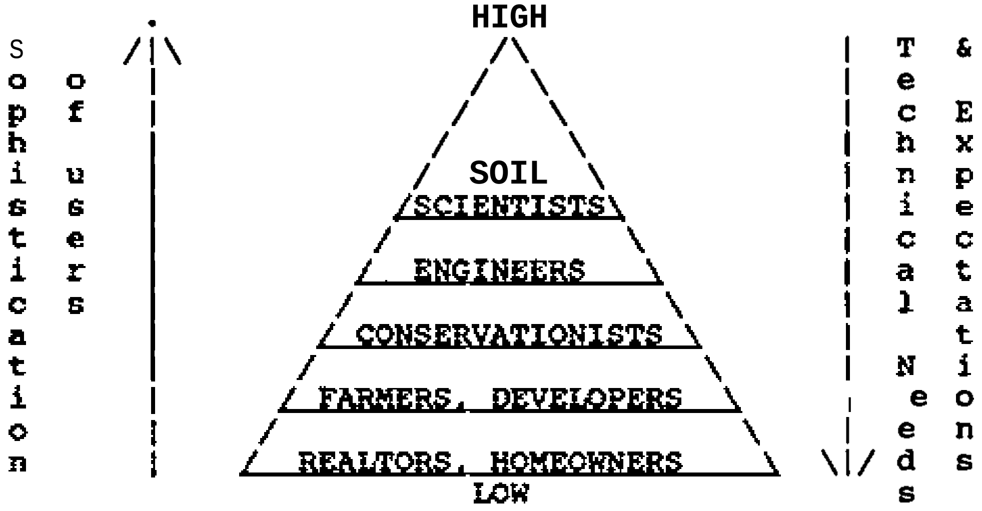

Figure 2. Relative relationships between user knowledge about soil science and technical needs for soil survey information.

B. Soil Survey Uses

Soil survey data and interpretations are used in both the public and private sectors. The public sector function of setting policy and providing direction might occur in private land holding corporations but probably does not play a role in the rest of the private sector. Using soil surveys for evaluating land areas to implement policy and direction, to do project planning and project implementation is common to both sectors and involves similar analytical processes wherever they are applied.

Making land management plans and implementing them is a process of trying to move from a present condition to some desired future condition (DFC). On commercial lands the DFC may be to maximize some commodity output through intensive management or the development of building sites. A greater public awareness about ecology is leading to DFC's on public lands that make commodity outputs a result of management to maintain a healthy ecology.

Identifying a direct link between individual user groups and potential uses seems to be almost impossible because most uses or applications of soil surveys can be associated with each user group. Tables provide a neat way of organizing things, but they do not explain emerging philosophies such as a desired future condition where ecosystem needs are a first priority. However, the following tables will be used to display relationships in several different ways.

Users and potential users of soil survey information can be categorized into three broad groups based on their level of use of this information:

Group 1: Users of low to medium intensity soil survey (order 4 to 3) information for land use planning and management.

Group 2: Users of medium to high intensity soil survey (order 3 to 2) information for planning land use changes and locating building sites.

Group 3: Users of high intensity soil survey information that is small parcel/site specific. The information on soil behavior characteristics and limitations must be highly detailed. Follow-up on-site investigation is most always required.

Current soil survey data are most reliable for user group 1, less reliable for user group 2, and somewhat reliable to not adequate for user group 3 (Table 1).

Table 1. User needs far soil survey information by level of need.

SOIL SURVEY USERS	SOIL SURVEY LEVEL NEEDED		
	LOW/MED GROUP 1	MED/HIGH GROUP 2	HIGH GROUP3
Agronomists		x	x
Archeologists		x	x
Conservationists/Fed.,St., Local	x	x	x
Educators/Teachers	x		
Engineers/Agricultural		x	x
Engineers/Urban		x	x
Environmental Consultants		x	x
Farmers		x	x
Foresters		x	x
Geologists	x	x	
Home Owners/Buyers			x
Landscape Architects	x	x	x
Landscape Managers		x	x
Mineral/Energy Industry			
Exploration/Reclamation	x	x	x
Planners/Urban Land Use			
Federal, State, Local		x	x
Public Health Managers		x	x
Ranchers	x		
Range Managers	x	x	
Recreation Planning - Management		x	x
Researchers/Industry			x
Researchers/University		x	x
Soil Scientists	x	x	x
Urban Developers			
Residential/Commercial		x	x
Waste **Managers/Sanitarians**		x	x
Watershed/Floodplain Management	x	x	
Water Supply/Quality Managers	x	x	
Wildlife Biologists/Habitat Managers	x	x	

We must anticipate the needs of future generations of soil survey users if the Task Force recommendations will impact long-term planning and goals. An assessment of future soil survey applications are presented in table 2.

Table 2. Projected applications of soil surveys and examples of needs by use.

MAJOR USES	NEW/INCREASED PROJECTED APPLICATIONS	SPECIAL NEEDS EXAMPLES
Crop Management	Irrigation management Low input agriculture Nutrient management Pesticide use and management Speciality crop production Biomass production Waste utilization for crop production	Soil erosion models Soil yield potentials Soil fertility models Soil pesticide models Crop yield data Soil moisture data Additional lab data New field test kits Digitized maps and attribute data
Natural Resource Management and Ecological Assessment	Range and pasture management systems Biomass production Ecosystem management and mitigation Watershed and floodplain management Ground water protection Tentatively suited lands identification	Digitized maps and attribute data Special soil and landscape units New soil phases Mass wasting inventories Integrate remote sensing data for interpretation
Waste Management	Agricultural waste management Domestic waste treatment Hazardous waste and residue treatment Support of organisims for bio-treatment Landfill, stockpile siting Federal, State, Local Additional lab data	Digitized maps and attribute data Soil potentials Water table depth studies Deeper profile descriptions New soil phases New field test kits New interpretations regulations Permeability models

MAJOR USES	NEW/INCREASED PROJECTED APPLICATIONS	SPECIAL NEEDS EXAMPLES
Forest Management	Site preparation Stand establishment Stand maintenance Harvest practices	Productivity potential Herbicide rates Water quality Site degeneration potential
Special Uses	Crop forecasting Trafficability	Remote sensing Modeling
Land Use Planning and Development	Water quality and quantity planning Ground water protection Watersheds and floodplain management Farmland preservation Open space planning Subdivision and commercial development Federal, State, and Local regulations Radon hazard assessment Land appraisals/Tax assessment	Digitized maps and attribute data Water table depth studies Soil potentials New interpretations
Recreation	Facility planning and management Development vs preservation planning	Special soil and landscape units

MAJOR USES	NEW/INCREASED PROJECTED APPLICATIONS	SPECIAL NEEDS EXAMPLES
Energy Production Management and Reclamation	Facility planning and siting Biomass production Tank hazards Pipeline planning Site reclamation	Digitized maps and attribute data Additional lab data Soil data below 5 feet Soil/yield relationships Productivity assessments of reclaimed lands Relationships to other environmental factors
Environmental Research	Biological potentials and limits Soil physical potentials and limits Soil chemical potentials and limits	New interpretations
Engineering	Facilities siting	
Soil Survey	Integrated ecological inventories Correlation with other systems (FAO, etc.) Classification/ Taxonomy revisions	Integrate remote, sensing global positioning, geographic information, and expert system technologies
Range Management	Site conversion Carrying capacity Riparian management Forage production potential Pesticide use and management	

III. SOIL SURVEY DESIGN AND OPERATIONS

Task Force members generally agree that current soil surveys adequately serve many land use planning needs, but some modifications are needed to support new products now and in the future (Grossman, et. al. 1989). **However, there** was not complete agreement among the members about some of the perceived shortcomings discussed in this section.

A. Map Unit Design

If soil surveys are to be multi-use tools, then the survey must give unbiased support for all kinds of land uses. Many surveys show a short term bias in the perceived value of information about lands adjacent to agricultural lands, by creating large map units of vague composition. Even if the adjacent land is not managed as intensively as the lands with more detailed mapping, chances are that sometime during the life of a survey report, land use pressures will require an equivalent amount of soils information.

The majority of Task Force members felt that soil map unit design should be tied to the landscape characteristics where particular soils are found. Map units need to be based more on physiographic criteria than on soil taxonomy. Aspect, hydrology, geology, climate, vegetation, and geomorphology are a few of the factors needed in map unit composition.

In some situations, elliptical map units are often used to represent a ridge and associated side slopes. These map units are given a wide range of slope classes and soil characteristics. These large ranges *in* characteristics do not permit meaningful management interpretations to be made. For example, the delineation does not reflect whether the map unit is a ridqetop and sideslope or a **ridgetop** and toeslope. These combinations may have drastically different management implications, but because they look taxonomicaly similar they are mapped the same.

Most Task Force members are concerned that soil map units are probably not as pure in composition as we would like to have users believe. Map units almost always have small areas of similar or contrasting inclusions in addition to the described dominant soils. With a physioqraphic approach to map units, the location of soils and associated inclusions can be described in terms of a landscape position. Computerized data bases provide a way to record characteristics of inclusions so that the data will be available for evaluating over-all map unit management potentials.

Statistical characterization of map unit composition is possible and should become a part of mapping quality control. With the aid of small computers and summary programs, map unit composition could be evaluated in the field within minutes. A standardized field note procedure should be implemented to ensure that the best data is captured for characterizing map unit reliability.

Soil map units do not always reflect important'management differences even when the differences are obvious. Often subtleties in landscape characteristics may affect management. For example, spacing of aspen stands and their associated soils may not be important in a taxonomic approach to map unit design, but, this spacing may have a profound effect on the way wildlife will use an area.

Designing map units to meet the needs of all land or soil survey users may not be possible: however, map units that are designed to accurately reflect landscapes should meet the needs of the dominant users and many other uses can be accommodated without compromising accuracy and usefulness of the survey.

B. Correlation

The relationship between soil taxa and map units has often been a stormy one. Soil taxa are used as reference terms in naming map units, but the limits of taxonomic classes rarely coincide precisely with mapable areas. But, taxa and a taxonomic system are vital to a consistent, defensible soil survey program.

Some Task Force members feel that the series concept, and an emphasis on the correlation process - on taxonomic class consistency and purity - detracts from the interpretative utility of many map units. Because of this concern, the Task Force wishes to emphasize that the correlated series and map unit should reflect important interpretative differences. The use of phase criteria should be encouraged and expanded to recognize landscape, geologic, profile, climate, aspect, or ecosystem features. Using these features as part of a map unit name will help non-soils users see the occurrence of these soil groups in the field.

Documenting taxonomic placement of soils at the series or other taxa levels through correlation is needed for at least two user groups, soil scientists and researchers. However, problems occur when soil scientists doing the correlation focus on taxonomy, because of their interest, to the exclusion of other needs. Rationalizations and technical explanations are given to users in an attempt to justify that the taxonomic approach will cover other interests as well. Because this approach to correlation is not described in **"user friendly"** terms, these rationalizations generally lower the credibility of the final product.

Correlation should be driven by use and management in addition to soil taxonomy. Correlation needs to be broadened to focus on integrated, multi-factor landscape units (which is what mapping units are), rather than just soil pedons. Emphasis should be shifted from soil taxonomy toward soil, landscape, climate, vegetation relationships (Leonard, Miles, and Tueller 1988). In addition, more emphasis should be placed on describing conditions below and above the presently defined control sections of soil pedons in accordance with their effects on use and management.

ANALYTICAL TOOLS

Producing interpretive maps and reports, improving a user's access to the information needed, or gathering field data can be enhanced through the use ofvarious analytical tools.

Analytical tools for resource management are used to create interpretations and information about the ways processes can be expected to respond to natural forces and/or management practices (Warrington 1983). With the currently available computer technology, analytical tools are often thought of as computer programs. However, any techniques that can be used to sort through a data set to find relevant information are analytical tools. The computer has provided a way to capture some analysis processes for use by a large number of people.

Two relatively new computerized technologies are coming of age for resource management. Geographic Information Systems (GIS) are used to store and manipulate spatial data (maps) sets. Expert Systems (a subpart of artificial intelligence) are used to capture knowledge and offer **"advice"** on problems that are difficult enough to require significant human expertise, somewhat in the manner of a human expert (Naylor 1987, Rauscher 1987).

Geographic Information Systems

The analytical power of a GIS is contained in its capability to use attributes of identified map units along with data derived from models to create new representations of land capabilities. On the Bridger-Teton National Forest a GIS was used to compile management information about the location and nature of lands that were tentatively suited for management (Warrington 1988).

For managers, the resultant GIS displays can show the location of resources, and depending on the data used for an analysis, the potential quantity of outputs from the resources, and items that pertain to job quality and timing. Surface net diagrams of large areas can bring into focus the kinds of variability that occurs in the resource that is plotted on the net.

Other potential uses for a GIS include supervision of the classification of remotely sensed data used in vegetation mapping. It can be speculated that a GIS containing coverage8 about factors that affect soil development (geology, elevations, vegetation, isothermal, and isohyetal data) might be used to upgrade existing soil surveys or even provide premappinq for new surveys.

Expert Systems

Expert systems have at least two components. They contain various kinds of data representing knowledge within a domain of interest and they have an inference engine to control the logic used to find a solution to a problem within the domain of knowledge. These systems will help solve soil management problems that exceed the ability of the people who are working on the problem (Rauscher 1987).

An expert system could be used to capture knowledge about soils. This would include subtle insights a soil scientist gains from the field work as well as research knowledge about soils.

Data Bases

Computer data bases provide a way to capture and organize large amounts of measured and inferred data about the soil and other resources. In turn this data is used to support geographic information systems, expert systems, analytical models, and other yet to be recognized uses.

Geographic information systems, expert systems, and associated models or analysis methods become analytical tools for interpreting data and preparing management information. Spatial data used for interpretations would come from a number of sources. Because this data represents the views of different knowledge areas, the resulting information would be an interdisciplinary product. This information would be used to plan and implement an appropriate sequence of management practices to achieve a desired future condition.

V. DELIVERY OF SOIL SURVEY INFORMATION

currently, the dominant form of modern soil survey information is the soil survey report published on an area, county, or multi-county basis. It is touted as a multi-purpose document to be used by a wide variety of users. Although efforts have been made to narrow the focus to individual survey area needs (by mapping intensity, map unit and legend design, interpretations), the emphasis has been to provide some information for all users in as standardized a format as possible. This formula has been successful in satisfying most, but not all users needs. The Task Force has considered current methods of presentation, future user needs, and the need to keep information current and adaptable to computer applications.

A. Quality Assurance and Reliability

Quality is based on how well the soil survey products actually meet the stated and implied goals and standards that have been set. A user will evaluate the actual quality of soil survey products by comparing them to some set of expectations and objectives.

Reliability	The quality or state of being reliable. The extent to which an experiment, test, or measuring procedure yields the same result on repeated trials. (Synonym - dependable . . . describes what can be counted on or trusted to do as expected or to be truthful.) (Merriam-Webster 1986).

Data which is perceived as very reliable for broad area planning may not be dependable enough for an operational use like septic system design. Therefore, reliability (as in dependable) is a relative term based on a user's needs and expectations. Some things that affect perceptions of reliability are:

- knowledge (level of sophistication) about soil science and soil survey techniques.

- Skill or knowledge in cartography, geography, and natural resources.

- Intensity and complexity of decisions that are based on soils.

- Level of intended use such as broad planning as compared to site specific planning.

- Expectations about the ease of using a soil survey.
- Costs and benefits of conducting or using an on-site investigation.
- How often soil survey products have been used in the past.

Task Force members agree that soil scientists have an obligation to inform users of the accuracy and precision of our products. The level of detail and statistical analysis should be presented so that it is commensurate with the user's expertise. A non-technical user may only need to know that standards and procedures were followed and what limits the intended use. Researchers constructing a model may want specific probability data. However, data collected during a survey may be woefully deficient for many kinds of statistical analyses.

Out of date or inaccurate tables are a source of reliability problems in a report. This information is either used incorrectly by the unknowing or is dismissed by those who do know. Neither of these alternatives should be acceptable. If information is published it should be backed up by documented data. If data are not available, then the published information should have a statement that describes the basis for an interpretation.

For current soil surveys, reliability has been a relative term that is often confused with the amount of map unit variability. All users want reliable data at a level of detail that meets their needs. However, greater mapping detail does not automatically lead to more reliable data. In fact the reverse may occur more often than not unless great care is taken to check the accuracy and precision of delineated map unit composition throughout a survey area.

Accuracy The degree of conformity to some standard value (Merriam-Webster 1986).

This is the correctness of the population or composition estimate of soils in a map unit. It is based on the ability of a soil scientist to recognize, identify, and consistently delineate the same kinds of soils and to name them correctly in a legend. It is like hitting the bull's-eye of a target (Arnold 1979).

Precision The degree of agreement amoung repeated measurements of a quantity (Merriam-Webster 1986).

This indicates whether the sampled values are clustered together or are scattered out in a shotgun pattern. If an estimate is very precise, it means that there is a tight cluster around some central value with only a small range of variation. A precise estimate can be inaccurate. Many shots at a **bull's-eye** may all be in a small area but miss the **bull's-eye.** When this happens in a soil survey it constitutes a biased estimate of what actually occurs (Arnold 1979).

B. Soil Survey Reports

The soil survey report tries to be an all-encompassing document. It tries to satisfy everyone's needs at the same time, but, by so doing it may have actually detracted from its perceived reliability.

When we consider the varied audience of present and potential soil surveys and the different user needs, it is apparent that the present format cannot possibly satisfy all requirements. Table 3 provides a brief cross reference between user groups and the kinds of products they might use.

Table 3. User groups cross referenced with currently available sources of soil survey materials.

	USER GROUPS					
DOCUMENT	MANAGER	STAFF CONSULTANT	SOIL SCIENTIST	RESEARCHER	EDUCTOR	CASUAL USER
MAPS						
SOIL		X	X	X	X	
ATTRIBUTE	X	X	X	X	X	X
DESCRIPTIVE		X	X	X	X	X
LAB DATA		X	X	X		
FORM-5		X	X	X		

With today's technological advancements it should be feasible to present soil survey results in formats that will fit individual user needs. Accommodating different users and their needs will require a considerable deviation from traditional methods of information distribution.

We believe that soil survey reports should be available in both paper and electronic formats. In addition, soil survey data reports should be separate from interpretations. It should be possible to provide interpretive reports for each need. Whether paper or electronic, soil survey content should include sections on:

- Data Compilation Reports
  - Pedon descriptions and locations of those descriptions
  - Lab data
  - Field note summaries
  - Form 5 information for each soil and soil phase
- Interpretive reports keyed to users and kinds of uses
- Maps
- Associate data bases and resource report references

Paper (hard copy) reports should probably be in a fixed format for general reference. Additional graphics such as cross-sectional diagrams for multi-taxa map units, etc. would enhance the utility and understanding of reports. Presentation of hard copy interpretive reports in loose-leaf form would allow easy updates of individual sections of reports based on new information or technology. A way is needed to periodically, or continually update the basic reports as more data is accumulated. We need "dynamic" reports rather than "static" reports.

Computer data bases have numerous advantages and maybe a few disadvantages, We can use data sets from many sources and these data are easily updated. But, computer data bases may not be available to all users and probably will not replace all portions of a hard copy soil survey. Unfortunately, existing computer programs tend to see data as black and white while interpretations of soil properties and landscapes are often gray. Expert systems offer a way to capture logic, thus, providing a means of automating professional judgement.

Electronic distribution of report information should allow for tailored formats to fit individual users. With computers, community data can be easily shared and survey updates made as new data is acquired. Electronic formats for soil attribute data will allow specific/detailed interpretations to be developed or added as the need arises or at least interpretational algorithms can be shared with other data base users.

Electronic format presentations need to take into account the capabilities of developing technology (Johnston 1989) in addition to traditional data base development. For example, IBM and Intel are co-developing Digital Video Interactive products that could have potential applications in both training soil survey users as well as enhancing interpretational capabilities.

As with any presentation of information, workshops, training sessions and guides need to be developed for various levels of expertise in soil survey use. These activities can minimize possible misinterpretation of information as well as "sell" the utility of soil surveys to prospective users.

C. Soil Survey Maps

Many management decisions are based on the soils that are said to occur in a map unit. Land planners, farmers, and others need to know about the characteristics of individual soils that occur in each map unit and their spatial distribution. This type of information, for example, may influence how much and what type of chemical to apply to each soil for a management practice. Research work is being conducted at Montana State University at ways to "Farm Soils Not Fields" (Nielsen 1989, personal communication). To accomplish this, detailed soil data are used with other technology to respond to environmental and economic management decisions as the farm equipment moves from soil to soil.

Map unit descriptions should focus on landscape features including landforms, landscape positions and shapes, drainage features, typical shapes and sizes of mapping units, homogenity or heterogenity, native vegetation, etc. Mapping standards that are used should be communicated in the soil survey report. For example, the relationship between mapping scale and the minimum size map delineation should be explained i.e., 1:15,840 map scale may have a minimum size delineation of 3 acres as compared to a 1:63,360 scale with a 40 acre delineation.

D. Soil Survey Interpretations

In the future, more interpretive information will be needed for uses related to environmental concerns, including waste management, pesticide use, erosion and sedimentation control, harmful naturally occurring substances, vulnerability to affects of acid deposition, etc. To fill these and perhaps other needs, there will be a need to develop interpretations with more input from users and other resource disciplines.

There is an increasing need to go beyond the traditional "slight", "moderate", and "severe" ratings, perhaps encouraging more use of soil potentials concepts, especially for dominant uses. Probably more use of special and/or supplemental publications will be required to meet specific needs.

The pedon is the fundamental unit for learning about the soils of an area and it provides much of the data that is used in interpretations. But pedons are not what managers usually deal with when working with the land. Therefore interpretations must focus more on interpreting the multifactor site and mapping unit characteristics and less on just the soil pedon. Expected individual, cumulative, on-site, and off-site effects of inputs on outputs and soil properties need to be documented.

VI. SUMMARY

Task Force members believe that the time is quickly approaching when major changes will take place in the Soil Survey Program. Updating and perhaps consolidating older surveys and assisting users of our products should take precedence. Before we enter this new era, however, we must have a clear picture of who our dominant users are and what are their needs. Past and present soil survey products are used, but future needs are changing and we must adapt.

With new and improving information management technology, NCSS cooperators should be able to prepare information with stated levels of reliability that is commensurate with user needs and comprehension. Developing new ways of communicating our knowledge to meet individual user needs is a major challenge for the future. A more limited approach does not set our goals high enough to meet tomorrows needs.

The creation of a basic product supplemented with special reports appears to be one method of keeping technical information current for the users. Information on reliability of soil survey products needs to be gathered and presented in useable formats. User groups appear to want specifics about accuracy, precision, and probability of finding the.described conditions. The use of special methods and analytical tools will not only help meet the users needs, but will help create a more precise and accurate product. More detailed recommendations have been incorporated in the Task Force Report.

The survey was originally designed to serve agricultural purposes. Little attention was given to alternate users. The information presented in the surveys has been generic in nature and often outdated because completed reports were not revised in a timely manner. Times have now changed and we have identified a multitude of users both intense and casual. Many more people will be relying on the expertise of soil scientists. The soil survey needs to expand its reliability in making interpretations for non-agricultural uses.

If the survey continues to publish soil interpretation tables that are dated or map units that are too vague, many users will cease to use it. If their need is great enough a user may try to get technical help, but, to expedite a job they employ their own people to do the mapping and make interpretations. At the same time they will be asking their Congressman why they have to pay for information they can't use and help they can't get in a timely manner.

Soil survey is at a crossroads, the federal budget is getting tighter and tighter, the survey will be getting more and more pressure to "justify its existence." The justification can be made by listening to the users of today who will be the backers of tomorrow. Let's continually evaluate the survey and ask the question; what can we do to improve this product for our consumers, the taxpayers of this country?

VII. RECOMMENDATIONS

ACTION ITEM	SECTION	RECOMMENDATION
EDUCATION		
Soil Scientist	II	Teach soil scientists the techniques of providing support services. This is in recognition of the multiple roles many soil scientists have in providing management support services, soil interpretations, and soil inventory. Support services require a special set of skills from a soil scientist.
	II	Require soil scientists to have several college credit hours or their equivalent in business management to foster an understanding of how managers operate. Most soil scientists will work for managers or they may have their own business.

ACTION ITEM	SECTION	RECOMMENDATION
	II	Require soil scientists to have several college credit hours or their equivalent in allied natural resource areas to foster an understanding of how other disciplines operate. Soil scientists must be able to work within an interdisciplinary environment.
	III	Need more emphasis on enhancing soil scientist skills in mapping landscape attributes.
	II, III	Have soil scientists receive training in other disciplines, e.g., botany, forest management, agronomy, land use planning, hydrology, etc.
EDUCATION Users	II, v	Develop techniques to keep the misuse of soils data to a minimum. Some users seem to be more prone to misapply soil survey data than others. These groups should be targeted for assistance.
	II, v	Provide a way for users to become better informed about soils by designing courses that could be incorporated into evening class offerings by colleges and universities. Emphasize how data is gathered and how this data can be used including knowing when to call on qualified personnel for on-site investigations or more detailed soil maps.
	II, v	Communicate to the users how the survey was made and how it is to be used.
	II, v	Develop and desseminate displays to libraries and other public places that will help casual users become aware of soils and obtain more information.

ACTION ITEM	SECTION	RECOMMENDATION
	V	Provide user services groups and telephone **"hot lines"** to provide user support.
EDUCATION		
Educators	II, v	Develop a set of short educational packages on soils that are tailored for interdisciplinary use with existing course materials. Target classes that should consider the role soils play within the subject field.
SURVEY DESIGN		
	IV	**Define user** needs before a soil survey is started, along with anticipated relationships between soil properties and interpretations or management information for the user.
	III	Expand the use of soil phasing concepts and criteria to include the more subtle physiographic features which affect interpretations and use in specific areas.
	III	Put more emphasis on interdisciplinary and user involvement to promote the integration of pedology with other sciences such as geomorphology, stratigraphy, physical geography, ecology, biology, hydrology, climatology.
	II, III, V	Map scale should be one that is suited to user needs, but not a scale that implies greater accuracy than actually exists. With advent of GIS, published scale is becoming less important. However, the scale used for mapping must be commensurate with the amount of detail being mapped, which in turn must be in accordance with identified user needs.

ACTION ITEM	SECTION	RECOMMENDATION
DATA Acquisition	III	Need to place more emphasis on acquiring data about conditions below the presently defined control sections of soil pedons. For example, depth to **water-table**, soil water characteristics, bedrock, and contrasting materials in accordance with their effects on use and management.
	III	Provide more data about temporal surface soil properties such as crusting, rupture resistance, permeability, and bulk density.
	III	Acquire more information about landscape attributes which include, but are not limited to, **landform,** landscape position and shape, surface stratigraphy (geologic formation), vegetation (especially in forested and grassland areas), and water/hydrologic features.
MAPS Making	III, v	Use the best available imagery and reference points to locating positions on base maps.
	III	Use new technologies (automated cartography and GIS) to improve the map compilation process.
	V	Evaluate old maps for quality and accuracy, upgrade where needed before digitizing for GIS input. GIS is coming fast to all levels of government and industry. Soil maps need to be high quality, and compiled on stable base materials at a suitable scale so the data can be digitized for GIS input.

ACTION ITEM	SECTION	RECOMMENDATION
MAPS		
Display	II	Implement the technology and procedures for rapid generation of custom made soil attribute and interpretive maps to meet managerial needs for information.
	V	Show the date of the imagery that was used to make the soil map in order to provide the user with a reference.
	V	Improve quality of reproduced orthophotoquads used in soil survey reports.
CORRELATION		
	III	Insist that soil correlation carefully includes use and management in addition to Soil Taxonomy in the decision making process.
	III	Expand soil phasing criteria to include physiographic (landscape) features (including vegetation in areas yith natural vegetative communities).
	III	Create a better balance in quality assurance/quality control between meeting user needs and documenting taxonomic placement of soils. If needed, revise soil taxonomy to change soil differentia limits that are important to ecology and management.
	III	Require participation from other related disciplines and users for field reviews. This might be accomplished by holding two kinds of reviews (task force is not in agreement on this); one oriented toward users, and the other orientedtoward those interested in more technical aspects of soil survey.

ACTION ITEM	SECTION	RECOMMENDATION
ANALYTICAL TOOLS		
	IV	Become more automated to strengthen our capability to manage and update resource information.
	IV	Use Geographic Information Systemsfor spatial data storage, display, and manipulation.
	II, III, IV	Interface soil survey data with models, GIS, and other high tech applications to digitize maps and create outputs.
	IV	Develop and use expert systems to create an organizational memory for soil management interpretations.
	IV	Develop GIS user groups for the purposes of establishing standards and sharing digitized information.

In support of these analytical tools, it is recommended to:

ACTION ITEM	SECTION	RECOMMENDATION
	IV	Increase the use of remote sensing to support the collection of field data and mapping.
	IV	Purchase appropriate high tech equipment such as ground penetrating radar, seismographs, resistivity meters, etc.
	IV	Use portable global positioning systems (GPS) to accurately and automatically locate geographic features. Data can be electronically transferred to GIS data bases.
	IV	Use portable electronic data recorders and analyzers.
	IV	Develop and use field test kits for permeability, pesticide sensitivity, radon, nutrients, etc.

ACTION ITEM	SECTION	RECOMMENDATION
REPORTS Interpretations	III	Use a narrow range of properties for making management interpretations.
	III	Create special interpretations for specific uses and users. More interpretations should be geared toward the map unit and the landscape.
	III	The soil survey report should address management concerns through phases of soil taxa.
	III,V	Do a better job of describing and using the map unit concept with less emphasis on individual soil pedons and more on the polypedon and soil landscape. Document map unit design criteria in soil survey reports. Clearly communicate that landforms are being mapped.
	III, IV, V	Increase the use of soil scientists in non-traditional roles. A professional soil scientist trained in extension techniques can best present up-to-date soil survey information to the user. A local soil scientist performing technical soil services can provide site specific data, make special studies, and hold workshops on ways to use soils information. The most efficient method of presenting current information in areas with older surveys may also be through a professional soil scientist.

ACTION ITEM	SECTION	RECOMMENDATION
	V	Expand the use of technical supplements and technical reports specific to the survey area. This could include woodland site index information, soil potentials, crop yield studies, etc. This can be a very effective method of providing up-to-date interpretations in survey areas with out-of-date technical sections in reports.
	V	Develop the capability to update and expand'interpretive data quickly and accurately in older survey areas; soil survey reports should be dynamic rather than static.
	V	Separate portions of the soil survey report. This will make it easier to serve major user groups, and to update information cost effectively. Perhaps a basic report of maps, map unit descriptions, and basic interpretations or features, then a technical document of taxonomic descriptions, laboratory data, detailed interpretations, reliability statistics, etc. Or perhaps a basic report with a separate document for interpretations which can be updated on a periodic basis.
	V	Create special soil survey interpretation documents that will serve the projected "special" and/or "minor" users. Minor users could receive information from special supplements or directly from the soil scientist. A major complaint of many users "...there is too much information."

ACTION ITEM	SECTION	RECOMMENDATION
	V	Initiate a fee schedule for specially prepared data and supplemental reports.
	V	Communicate the accuracy and precision to others. Me need to do a better job of communicating to users how to use our maps, and on the limitations of extrapolation beyond the original prepared map scale.
	V	The usable scales and the scale at which the map was made should be explained to the user.
REPORTS Data	II	Make data available to users in ways that will allow easy reformating to meet new needs.
	II	Develop ways to ensure fast access to existing inventory data.
	II	Basic soil survey data needs to be available for soil scientists and researchers to use in making their own interpretations.
	III	Integrate data bases, for soil, climate, vegetation, and landscapes as needed.
RESEARCH	III	Through research and special studies, provide better documentation about soil behavior.
	IV	Develop ways to use GIS and remote sensing technologies to improve existing soil surveys.
	IV	Develop expert systems that will capture the best thinking and knowledge about soil processes and their effects on ecosystems and human activities.

ACTION ITEM	SECTION	RECOMMENDATION
	IV	Pursue the human side of using soils knowledge to gain insight into reasons why people do or do not use soils information.
	II, IV	Study the logic structure about soils to find ways of efficiently building data bases and producing needed user products.

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MODEL COOPERATIVE SOIL SURVEY(S) FOR AREAS WITH FOREST SERVICE, BUREAU OF LAND MANAGEMENT, AND PRIVATE LANDS

Executive Summary

The task force assignment was to select a soil survey with important acreage of private land and lands controlled by the Bureau of Land Management and by the Forest Service. This survey would receive assistance from national fund sources to provide a management structure to make the survey as applicable as possible to the needs of the Bureau of Land Management and the Forest Service as well as meeting the needs of the Soil Conservation Service for private lands. Additionally, assistance would be provided for technical innovations designed to improve the rate and/or quality of mapping or the utility and range of interpretations.

Eight western states submitted proposals. They range from strongly management oriented to technically innovative; all seem well developed. A selection was not made because it seemed better done by senior management.

Three issues arose: (1) whether assistance to the states should be managed through the West Technical Center or the National Soil Survey Center; (2) whether support for mainly technical innovations should be separated from management aspects; and (3) whether to broaden the approach to include surveys primarily directed to private land.

The recommendations propose execution of the charge through establishment of a temporary inter-organization committee to select the survey(s) and establish the management structure for providing assistance. Additionally, it is recommended that the regional committees of the National Cooperative Soil Survey be asked to consider on a national basis a strategy for model surveys in areas of private ownership as well as mixed public and private ownership.

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W. P. Volk, BLM, Billings, MT

Charge

“The long-range objective of this committee will be to locate an SCS state office with a soil survey area that includes United States Forest Services lands, Bureau of Land Management lands, and private agricultural lands, which is in need of an update. They would then work with the SCS state office to get an agreement from the agencies involved to cooperate in the survey and to assist the SCS state office in developing a memorandum of understanding for the survey which will detail the work needed to produce a model soil survey where we can do some of the innovative things we have been discussing for the last several years. This survey is to serve as a model for other soil surveys of the future. Things to be considered include **:** developing the soil survey legend on an **MLRA** or natural landscape basis; developing soil-landscape units (mapping unit concepts); gathering transect data sufficient **to document** the composition of the mapping units; provide statements on the reliability of the interpretations; incorporate new methods of soil investigations that are more cost effective and provide better data; include any additional investigations needed to supply the information needed in a new generation of soil survey; have the maps developed in a digitized format; and produce a modem published **soil survey** under the management concepts **of** a soil survey project."

Proposals Submitted

States with appreciable Forest Service **(FS) and** Bureau of Land Management **(BLM)** lands were asked to submit proposals. Eight states responded. The proposals were very well prepared. No attempt was made to limit the proposals to the charge which stipulated updated surveys. The proposals contain managerial and technical innovations in different mixes. Some are strongly managerial and others strongly technological.

Summaries follow prepared by the chairman. These **summaries** do not do complete justice to the proposals.

Arizona.--Graham County. **MLRA's** D39, D40, and D41. Start in 1992. The area encompasses state lands and the agricultural experiment station would be a cooperator. Includes a large range in parent materials and in moisture and temperature regimes. Lend use includes irrigated intensive crops, range, timber, and recreation. A wilderness area is encompassed. The survey is **considered** an excellent opportunity to **re-establish** FS-SCS cooperative activities. The survey would be applicable to surrounding areas.

California.--Humboldt-Del Norte survey area. **MLRA's** 4 and 5. Complex area geologically and geomorphically. Mining, grazing, irrigated crops, recreation, wood products, and urban. The National Park Service and the California Department of Parks and Recreation would be involved. Timber companies are interested in environmental aspects of the soil survey inventory. The soil survey office is at Humboldt State University with good computer and natural sciences support. Technological innovation would center on image processing in premapping and use **of** geomorphology and stratigraphy to assist in making predictions about control of soil erosion and sediment movement related to timber harvest.

Colorado.--Red Feather Area. Mostly within **MLRA** 48A with some 48B and 49. Initiate in 1990. 85 percent mountains. Interpretations for recreation activities **are** very important. **BLM** is concerned with a landscape analysis approach and Forest Service wants a special study of soil landscapes and plant associations by **photogramitry.** Urban development in a checkerboard pattern. **Rawah** wilderness area occurs in the survey.

W.--Separate proposals are made for the Clearwater area and for Boise County. The **Clearwater** area includes MLRA B9 and E43. Very varied parent material and temperature and moisture regimes. Uses include dryland cropping through range and timber production plus recreation and urban uses. The information would be applicable to the Kooskai soil survey which needs an update shortly. The University of Idaho would cooperate. The Potlatch Timber Company is a major private owner and may provide digitizing support. The survey is of interest to the Nez Perce Indian tribe and to the Bureau of Indian Affairs.

MLRA's B10 and E43 are represented in Boise County. Parent material and moisture and temperature regimes are complex . Very diverse uses as with more emphasis than in the Clearwater area on urban interpretations. Adjacent counties have completed soil surveys, some of which need updating shortly. Land users for both the Clearwater and Boise areas have expressed interest in the R1/R4 sediment prediction model developed by the Forest Service in Boise. The Forest Service would like to have the information collected for the'model as part of the soil surveys.

Montana.--Beaverhead County. MLRA's 43 and 44 are represented. Elevations 4,000-9,000 feet. Diverse parent materials with a wide range of temperature and moisture regimes. Landuse includes forest, range, dryland, irrigation farming, mining, and urban uses. BLM and the Forest Service have soil scientists in the area. SCS plans to staff in 1992. The area would provide an opportunity to evaluate the soil landscape analysis project (SLAP), and provide ground truth for the BLM digitizing effort. The Montana Reparian Association is collecting information in Beaverhead County as part of a statewide description of reparian vegetation. The Remote Automated Weather Stations (RAWS) would be incorporated in the survey program. The mapping would be on Ortho black and white, enhanced with CIR to eliminate the compilation process.

New M&.---eddy County. MLRA's 27, 39, 42. and 70. Large range of sedimentary rocks and unconsolidated materials. Expected cooperators besides the FS and BLM include the Department of Energy, the National Park Service, and the New Mexico State Agricultural Experiment Station. The Department of Energy has a nuclear waste pilot program in the county and Carlsbad Caverns occur in the county. The Forest Service would like to use the survey to re-establish cooperative relationships with the SCS. Land use includes irrigated crops, range, mining, recreation, and urban applications.
The survey is applicable to Lea end Otereo Counties which is scheduled for updating and possibly to counties in Texas.

Oregon.--Curry County. (Note that this county is adjacent to the proposal from California.) MLRA's Al, A4, and A5. The diverse parent materials including serpentine; a wide range of temperature and moisture regimes occur. Mass wasting is common. Geomorphic surfaces are complex. Parson's work has been carried on by Reckendorf. There is a question of terrace correlation with California. Mapping would range from Order 2 through 4. The survey has been started with 150.000 acres completed. It will be completed in 1995. BLM soil scientists are participants. The Forest Service provides specialist assistance for interpretations. Recreation versus forestry is a major land use question. Water quality is a concern because of fragile estuaries and anadromous fisheries.

Utah.--Duchesne and Emery Counties. The Bureau of Indian Affairs is involved in addition to the FS. BLM, and Utah State University. The proposal emphasizes remote sensing to improve the quality and speed of mapping. A SPOT satellite transparency would be obtained for a portion of the survey area. Parts of the SPOT transparency would be digitized and adjusted to scale electronically. Video imagery would be flow" at low elevations for the digitized parts of the SPOT imagery. Utah State has the equipment which is compatible with major geographic information systems. The imagery would be obtained three times through the growing season. This video imagery can be converted into computer compatible formats for use with personal computers. The relationship between the video imagery and ground surface conditions would be evaluated for the selected areas of the SPOT satellite transparency. The field evaluation at least in part probably would be in the Price River Experimental Watershed.

Discussion

point 1:
The proposals need to be acted upon in a reasonable length of time or they become moot. The surveys will be completed whether part of a model soil survey effort or not. Further, we should not cut the issue too fine. We need to change what we are doing; and in order to learn and to have such change, we need concentration of funds and an effort in a few soil surveys. This of necessity means less funds for other surveys. It complicates management because technological and managerial promise become larger considerations. Finally, the need of first priority given the charge is to apply increased management inputs to present technology.

Point:
T. L. Parham (New Mexico) with additions by D. L. Richmond (Arizona) has addressed the structure for execution. The statement in slightly altered form follows:

1. "Establish the commitment between the major agencies (SCS, BLM, USFS, etc.) at the National level ...."

2. "Establish a joint task force of agency leaders at the national level . . . [to] establish the working guidelines, review the MOU [Memorandum of Understanding] and resolve any differences in revisions and/or changes the state task force cannot resolve."

3. "Establish a joint task force of agency leaders at the state level. Their responsibility would be to recommend working guidelines to the National task force, review the HOU, and to assure that the guidelines are carried out. At the start of the survey, the state task force should meet with the field soil scientists to review the task at hand, the responsibilities, and the guidelines . . . . Among the activities monitored are the following:

   - Identify who and what agency would provide the interdisciplinary assistance (range, woodland, crops, recreation, engineering, etc.).

   - Establish the procedure for requesting/obtaining assistance between agencies.

- Establish a procedure for maintaining quality control. This would parallel current NCSS standards but is needed to specify responsibilities.

- Establish commitments to participate in reviews, soil series development, SCS-SOI-5 preparation, interpretation development, and manuscript preparation and review. All these activities should be addressed in the MOU.

- Review and evaluate the imagery status and other essentials needed to conduct the work. This would include arrangements to have everything "on hand" when the soil survey crew arrives and is ready to start.

- Involve the National soil/range team at the beginning of the survey in order to get the soil survey project members off on a consistent basis."

4. "Provide training to field staff related to any new or unique measurements needed to gather data for new generation soil surveys."

5. "The National Soil Survey Laboratory (NSSL) should be involved in the initial planning stages. Obtain a commitment from NSSL to assist in soil moisture/temperature study by providing recording instruments to the extent possible. A soil sampling plan would be needed in the early stages so the data would be available at publication time."

Point 3:
The activities covered by the charge are of two types: One kind of activity concerns the management of soil surveys for land areas of mixed ownership. This management is complicated because federal agencies have legitimate differences in what they need from soil surveys. The other kind of activity is concerned with technological innovation in soil mapping and/or the delivery of information.

The technological innovation portions of the proposals could be grouped together and a selection made of a set of activities in different soil surveys to be funded by the National Soil Survey Office. The selection could be made on the basis of perceived needs for technological innovation in the National Cooperative Soil Survey as a whole, whether pertaining to areas of mixed ownership or private ownership. The management of soil surveys where technical innovations were introduced might or might not be structured to meet the requirements sketched in Point 2.

In other words, one could either couple or decouple the management innovation and the technical innovation. An advantage of decoupling is that strong management programs could be utilized to explore management innovations. This could be combined with the selection regionally of potential worthwhile technical explorations. A committee member expressed the strong conviction that support for management and technical innovations should be for the same soil survey.

If technological innovation and management development were separated, then perhaps the pool of proposals for technological innovations would be increased. Finally, the question may be raised whether proposals for technological innovation should be considered on a national basis and not restricted to surveys of mixed ownership.

point 4:
It would seem advisable to have assistance for model soil surveys from regional and national units in the SCS managed by a single office. The matter is complicated by the recent changes in organization in the Federal Soil Survey and lack of precedences. The Soil Staff of the West National Technical Center has broad interraction with the states concerned and with the cooperating federal agencies. On the other hand, most operational aspects of technical management are assigned to the Quality Assurance Staff of the National Soil Survey Center. The division might be that the West Soil Staff would be responsible overall for the interractions with the states and, if the proposal in Point 2 were accepted, furnish a member to the joint task force of agency leaders at the national level. On the other hand, the West Soil Staff would delegate the' responsibility for the technical aspects of management that pertain to the quality assurance program to the National Soil Survey Center. Alternatively, the overall management responsibility could be by the National Soil Survey Center with delegation of the responsibilities not handled ordinarily by the Center-to the Soils Staff of the West National Technical Service Center.

Recommendations

1. Change the name of the task force from “A Model Cooperative Soil, Survey” to ‘Model Cooperative Soil Survey(s) for Areas with Forest Service, Bureau of Land Management, and Private Lands.” This has been done.

2. The National Soil Survey Office should establish the money to be allotted for execution. If no money is available for FY 90, then recommendation 3 would be moot but recommendations 4 and 5 could be carried forward. It would be advisable to sponsor at least two soil surveys in order to increase the change of a successful completion and also to have some competition. The allocation should defray the expenses of the national and state advisory committees as these are outlined under Point 2 of the Discussion section. Considerable extra travel by regional and national offices would need to be budgeted.

3. Soil Conservation Service, Forest Service, and Bureau of Land Management national staff should establish a temporary committee to (1) select the proposals to fund , and (2) establish the management structure to provide assistance to the states as requested. The structure given under Point 2 of the Discussion section should be considered. The national staff committee then would be disbanded. The temporary committee should include representatives of the three agencies and persons from the National Soil Survey Center, the West Interpretations Staff, and a” experiment station. The last should be selected by the West Regional Conference.

4. The proposal under Point 2 of the Discussion section on the structure of the management of soil surveys of areas of mixed ownership should be considered for adoption independent of whether national funds are committed for model soil surveys.

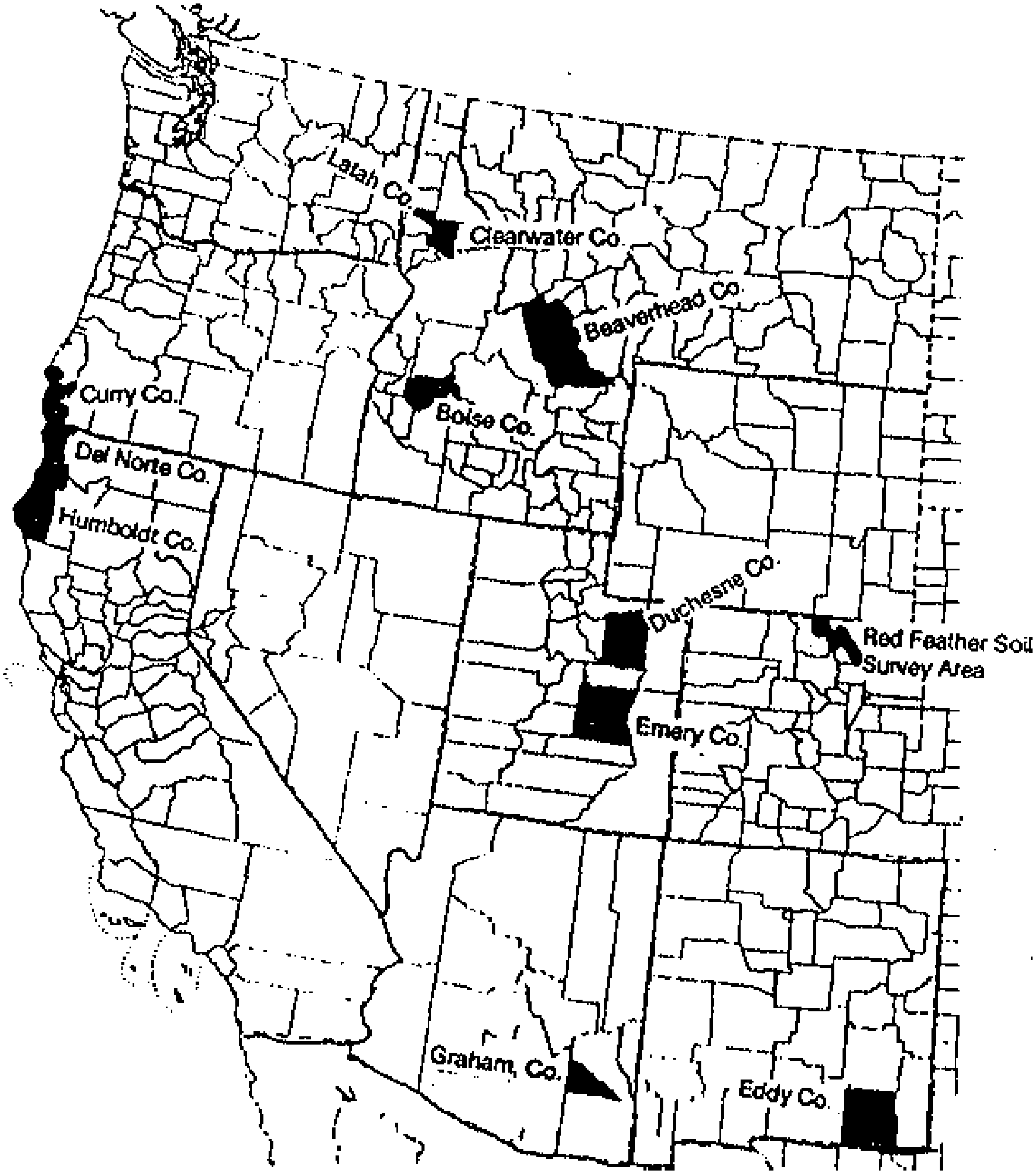

FIGURE 1. PROPOSED MODEL SURVEYS

5. The task force recognizes that the charge is part of a larger issue of using the strategy of concentration of effort to promote and support managerial-technological change. Further, it is accepted that the subject has national application, is not limited to areas of mixed public and private ownership. and should pertain to intra-state fund sources as well as to national fund sources. Lastly, with the hypothetical once over for cropland at hand, it would seem that the time is appropriate to explore variable input soil survey.

With this in mind, the steering committee is requested to ask the regional committees to explore the development of a national program that would encompass the charge of the present task force but be conceived more broadly as has been sketched and would, if implemented, lead continuously to a few soil surveys for which the expenditure of money per acre would exceed the median markedly.

6. The present task force should be disbanded upon acceptance of the completed report.

ADEQUACY OF SOIL SURVEY DELIVERY SYSTEMS

Task Force Report Prepared for the
National Cooperative Soil Survey Conference
Lincoln, Nebraska
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by

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EXECUTIVE SUMMARY

In order for soil survey to be ***effective it must*** be broad in scope, dynamic, and above all responsive to the needs of users. An effective soil survey delivery system must focus on three components: human interaction (field soil scientist); print media ***or*** text focused at the intended user; and electronic/interactive technology. Greater emphasis on the human component, modification of the existing text format, and greater accessibility to up-to-date computer databases will increase utilization of soil survey information. This report, a collaborative effort of task force committee members and conference participants proposes the following recommendations to improve soil survey delivery systems:

1) The National Cooperative Soil Survey (NCSS) should actively promote the establishment of resource soil scientists at the local or regional level and should improve communication, interaction, and cooperation with these professional soil scientists.

2) The soil survey report format should be modified to a two volume document. Technical data and maps should be published in one volume and interpretations published in a second volume. This format would facilitate periodic revision and updating of soil survey interpretations. More technical data should be published in soil survey reports and use of more graphic elements such as photographs, illustrations, and graphs is recommended. The NCSS should assist state and local agencies in the development of supplementary soil survey publications for non-technically trained users.

3) The NCSS should take the lead in promoting use and development of electronic-interactive technology. Existing and potential users, databases, and software must be identified. The NCSS should encourage the development and use of new software, and provide leadership in quality control/assurance and field validation.

Adequacy of Soil Survey Delivery Systems

The key feature of soil survey in the United States is the resource inventory conducted by cooperative agencies of the National Cooperative Soil Survey (NCSS)(Brown and Miller, 1989). Soil surveys contribute to our knowledge about soils and provide us with the basis for applying to specific tracts of land, what has been learned about those soils through research and experience (Kellogg, 1966). The ultimate objective of soil survey is the improvement of citizens knowledge of the soil landscape, so that land use decisions will be based as much as possible on factual information (Brown, 1988). How effectively citizens make use of soil survey information depends, in part, on how we communicate or deliver the wealth of information contained in a soil survey. The NCSS has a responsibility not only to develop, update, and improve the soil survey resource database but must also utilize delivery systems that facilitate widespread use of soil survey information. To be effective, soil survey delivery systems must focus on several important interrelated components: human interaction; printed media or text; and electronic/interactive (computer) technology.

Human Interaction

For soil genesis, soil geography, soil classification, and soil interpretations to be relevant to the needs of users, soil survey must be broad in scope, dynamic, and above all, responsive to users needs (Brown and Miller, 1989). What is needed, in part, to meet the needs of land users for soils information is human interaction with an information delivery system (Brown , 1988). Even after a soil survey is completed, there continues to be a need for trained, experienced, field soil scientists to reexamine, update, and interpret soils in the field. Providing soil survey information to users will be carried out best when and where such people are available to interact directly with users. Experienced field soil scientists, especially those directly involved in producing the soil survey report, offer clients what few others can. They can provide an understanding of the three-dimensional soil landscape in a region, including the variability of that landscape, knowledge of the value and limitations of the published soil survey, knowledge picked up incidently as the survey progressed but not included in the published report, and skills and experience to carry out specialized on-site activities (Brown, 1988). To a limited extent, Extension specialists, with responsibilities related to soil survey and land use, contribute to this effort. However, extension specialists typically have statewide responsibilities and rarely have the funding or personnel necessary to operate ‘at the local level. At the local level, the professional soil scientist who fills such a role may be in either the public or private *sector.* The NCSS should encourage establishment of county- or regionally-based resource soil scientist positions and work cooperatively with state agencies and legislators to fund state programs to maintain and expand soil databases and interpretations. In Illinois, for example, several metropolitan counties currently employ field soil scientists who conduct on-site investigations and high intensity soil mapping and assist ‘other county and community agencies with soil interpretations. In addition, consulting firms in engineering and planning currently employ field soil scientists, who aided by soil surveys, conduct on-site investigations for a number of land uses. Examples like this can be found in many states. The key will be how the NCSS can make the “case” for a continuing maintenance and update phase which provides feedback between these professionals and the database. The NCSS should also maintain contact and interaction with soil scientists that employed by agencies that are not traditionally NCSS cooperators.

Printed Media (Text) - Soil Survey Reports

The published soil survey in its present format is a useful document and will continue as an important means of distributing soils information to technically competent users. A reevaluation of soil survey publications (Stout, 1981; Holland, 1981; Arnold, 1982a, 1982b) however has suggested possible changes in both content and format. Well-prepared maps and soil descriptions should be useful for many years. The soil interpretations, however, depend on the current state of the art and are subject to change or modification. Some users have suggested that two separate volumes be published, one of technical material including maps, and one of interpretations. This would allow the interpretations to be updated periodically. Stout (1981) noted several respondents to a questionnaire in the midwest region supported separate publications for technical data and interpretations. Arnold (1982) noted that the feasibility of publishing the soil survey in two volumes, one bound (technical material and soil maps) and on unbound as a loose-leaf type (soil interpretations) warranted further study.

Technically competent users have suggested that more data and technical information be included in soil survey reports.

Modern soil surveys include detailed soil maps, soil descriptions, soil properties, and various soil interpretations prepared for specific uses. This information can be used for a variety of applications, including soil management for agricultural and forest production, wildlife management, land assessment, planning and zoning, engineering, urban development, and soil erosion and water pollution control. The soil survey report, utilizing a standardized format is commonly a large technical document with much information. As a consequence of this rigid format, an soil survey report for an urban county contains the same content and audience orientation as a report for a rural county. It may not be appropriate, cost effective, and useful to provide soil interpretations for crops, pasture, and woodland management and productivity in a soil survey of a county that is predominately urban. Oschwald (1975) noted that audience identification and preparation of reports for specific rather than general audiences could improve survey utilization. Part of a long term maintenance and update program should be to package the information in a manner targeted for specific users.

In its current format, parts of the document are too technical for users who do not speak or understand the language of soil science. Graphic elements such as illustrations, graphs, and tables can be used to supplement text. Oschwald (1975) has suggested that due to its technical format, soil scientists may represent the predominant users of soil survey information. Nontechnical terms should be used whenever possible if soil surveys are to be effective communication channels for nonsoil science audiences. Soil survey reports by their very nature are technical publications and it is neither desirable or possible to express all soils survey information in nontechnical language. Communication of technical soil survey information to target audiences can be aided through resource soil scientist and soil survey extension activities, i.e., the human interaction component. Interpersonal communication with target audiences provides extension specialists and/or field soil scientists with an opportunity to evaluate needs and suggest communication channels that are complimentary to the soil survey.

The manner in which information is presented in a soil survey may play a big part in its utilization. Presenting data in tabular form is appropriate for technically competent users but simple interpretive maps might be more appropriate and useful for general audiences. However, manually prepared interpretive maps can be costly. They require users to locate parcels of land, draw the parcel boundary, find some soil property or interpretation corresponding to the map units included in the parcel, transfer these properties or interpretations in each map unit, and shade or color them according to predefined attribute classes (Rdbert and Anderson, 1987).

An excellent example of a document incorporating innovative format and content for soil survey information was prepared by the Soil Conservation Service (SCS) for the Hennepin, Minnesota Conservation District (Kennedy and Lueth, 1976). The document, sporting a colored cover, contains numerous colored landscape photos with captions that identify appropriate urban land use. Colored block diagrams with overlays illustrate soil landscape relationships and soil profile illustrations identify dominant soil morphological ‘characteristics. Colored interpretive maps are utilized to identify parent materials and slope classes.

McCollum (1986) has suggested that changing the title from Soil Survey of . . . to Soil Resource Inventory of... and using colored photos on the covers of soil surveys, as has been done with a few reports in several states, might stimulate more use of the survey. We live in an age when style is perceived to be as important as substance. The soil surveys major strength is its substance; perhaps the style can be improved to make it more appealing. Respondents to a questionnaire sent to the northeast region (Holland, 1981) overwhelmingly supported use of multicolored graphics. Stout (1981) noted that every soil survey should have a picture cover and respondents from the northeast region supported colored photographs on the cover and possibly inside the report (Holland, 1981).

Electronic/Interactive (Computer) Technology Transfer

The current advances and developments in electronic transfer of information will make it easier for soil survey to remain current. The existing hard-copy format of soil surveys makes them difficult to update or to expand, as with addition of soil interpretations. Soil survey has joined the technology transfer age of the computer, however, public knowledge of computer databases, their capabilities, and use is limited. Making soil survey information more accessible by computer may dramatically increase its utilization and application by non-technical users. We must make a concerted effort to identify to users existing databases, both public and private, and to promote both the development of new software and use of existing software. A number of computer-based systems are available. Space does not permit a thorough listing of existing soil survey related software, but several examples are described below to illustrate the range of computer-based soil survey information systems.

The State Soil Survey Database (SSSD) is an in-house SCS computer ‘program that allows all data in a state to be checked, corrected, and distributed to SCS field offices for use in the Computer Assisted Management and Planning System (CAMPS) program. Soils information in SSSD is the most current in any database, and in many states it includes data that is not in the National SCS database. A system is needed for supplying SSSD data to users other than SCS. This could be done by the State Soil Scientist providing data to a public or private vendor specializing in the duplication and sale of electronic data. Arrangement could be made to provide data at no cost to cooperating agencies, universities, libraries, and schools.

SCS soils information is stored, at the national level, on the Iowa State University Computer at Ames, Iowa. The data is stored in 4 databases consisting of the Official Soil Series Description, Soil Interpretation Records (SCS-SOI-5), Map Unit Use Files (SCS-SOI-6), and Soil Classification Files. The data contains information on approximately 18,000 soil series and 210,000 map units. The Iowa State Computer is accessible to SCS personnel directly. Other users can obtain the data on tape.

The U.S. Army Construction Engineering Research Laboratory (CERL) under a cooperative agreement with SCS, has developed the Interactive Soils Information System (ISIS), a public accessible database. The database is stored on computer operated by the University of Illinois, Department of Urban and Regional Planning (Thompson et al., 1987). The ISIS includes the following: Soils Information Retrieval System (SIRS); Line Printer Soils Information Retrieval System (LPSIRS); Multiple Parameter Series Search (MPSS); Map Unit Use File System (MUUFS) and; Computer-Aided Land Evaluation System (CALES). The database at Ames, and the State Soil Survey Databases are updated daily, while the CERL database is only updated every six months.

The University of Minnesota has developed the Soil Survey Information System (SSIS) (Robert and Anderson, 1987) a user-friendly and menu-driven soil geographic information system that runs on IBM* PC and compatibles, The software, available through the

Minnesota Cooperative Extension Service, is capable generating soil maps, acreage, descriptions, properties, interpretations, and interpretive maps. Soil survey base map sheets on mylar without aerial photo base are digitized using a high resolution scanner. The number of Minnesota counties using SSIS grew from 2 to 30 from 1985 to 1989. Principal uses of the system, based on a survey of Kandiyohi County, Minnesota, were in decreasing order, land appraisal, farm management, government and local programs, and education. Main uses of the software by county departments were for land assessments; federal and state conservation programs; and land use planning and zoning.

The U.S. Geological Survey's EROS Data Center, in cooperation with the Bureau of Land Management, Forest Service, and SCS (Horvath et al., 1987), has developed a procedure that uses spatial and tabular databases to generate elevation, slope, aspect, and spectral map and tabular products . These data can be used to evaluate and describe mapping units and provide valuable information to users of soil survey in resource planning and management.

The electronic/interactive format lends itself to a discipline that is broad in scope, dynamic, and responsive to the needs of users. Over time, more software will be developed by both the public and private sectors that meet the specific needs of individual soil survey users. With the availability and increasing abundance of these databases, it has become increasingly apparent that a long-term coordinated program should be initiated, between SCS, NCSS, 'and the states, to maintain and update the soil survey databases on a state by state basis.

Summary and Conclusions

The ultimate objective of soil survey is the improvement of citizens knowledge of the soil landscape, so that land use decisions will be based as much as possible on factual information. In order for it to be effective it must be broad in scope, dynamic and above all responsive to the needs of users. An effective soil survey program must focus on three components: human interaction; print media or text focused at the intended user; and electronic/interactive technology. The NCSS should encourage the establishment of resource soil scientists and work cooperatively with state agencies and legislators to fund state programs to maintain and expand soil databases and interpretations. The published soil survey in its present format is a useful document, however, publication of soil survey reports in two volumes, a technical volume containing additional data and maps, and a volume containing interpretations, which could be periodically updated, would be more useful. Part of a long-term maintenance and update program should be to package the information in a manner targeted for specific users. Current advances and developments in electronic technology transfer of information is making it easier for soil survey to remain current and up-to-date. As databases become more accessible, maintaining and updating databases on a state by state basis will require that a coordinated program be initiated between, SCS, NCSS, and states. The NCSS should take the lead in identifying users of electronic/interactive technology, existing databases, both public and private, promote the development and use of existing software and provide some leadership in quality control/assurance and field validation.

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* Names of equipment are for information only and do not imply endorsement.

MAJOR SOIL SURVEY ACCOMPLISHMENTS FOR FISCAL YEAR 1989

Dr. Richard W. Arnold, Director
Soil Survey Division
USDA-Soil Conservation Service

Project Soil Surveys

Item	1989 Acres	1988 Acres	% Inc.
Soil Survey Acres Mapped	**45,200,000**	**44,578,000**	2
Cropland Acreage Mapped	**26,300,000**	**21,100,000**	20
Soil Survey Manuscripts sent to GPO	85	57	49
Soil Surveys Published	70	72	-3
Project Soil Surveys Digitized	20		

Assembled information on the strengths, weakness, and additional needs in the soil information delivery system.

Coordinated erosion-related interpretations amoung states and regions.

Assisted in assuring the correct use of soils information *in* the Universal Soil Loss Equation (USLE), Water Erosion Prediction Project (WEPP), and Computer Aided Management and Planning System (CAMPS).

Provided staff specialists with soils expertise in croplands, rangelands, woodlands, engineering, and urban interpretations to assist states.

Provided the following software to states:
- Automated Pedon Description Program
- Soil Survey Schedule
- Soil Transect Module
- Soils-6 Module
- Soil Communication Network
- Modifications to the State Soil Survey Database for use in CAMPS

Increased analysis from the National Soil Survey Laboratory by.20 percent.

Completed the revision of the Soil Survey Manual (Agriculture Handbook No. 18).

Updated the Keys to Soil Taxonomy.

Instituted a desk top publishing process for formatting soil survey manuscripts which saves approximately $3,000 per manuscript in publication costs.

Published the first color-cover soil survey report on upgraded paper.

Continued efforts on the State Soil Geographic Data Base (STATSGO). A total of 39 states heve completed map compilation and 22 of these states have been or are in the process of being digitized.

Participated in the World Soils and Terrain Digital Database (SOTER) initiative to assist in the development of an automated data base of soils information for the world. A general soil map with attribute data is being developed for a 2-degree lattitude area spanning the U. S.-Canadian border between Montana, Alberta, and Saskatchewan.

Incorporated the staff of Soil Management Support Services (SMSS) as.part of the NHQ Soils Staff.

SOIL SURVEYS

The top priority for use of soil survey funds for FY-90 will be to complete the mapping of croplands for the 1985 Food Security Act. FSA funding for states has been adjusted to reflect the anticipated needs to complete this mapping. Base funding for some states has also been adjusted to reflect, changes in program and staffing needs. Selected states have been allocated funds to be used to cost share digitizing of soil surveys. We urge all states to develop a soils digitizing initiative in cooperation with a local govemnent agency or university. Some states are well underway with this effort. We stress the need to continue efforts to increase mapping production, especially in those states where FSA mapping has been completed and the primary emphasis once again is project soil surveys and updates. Continued efforts should be made at all levels to improve efficiency in map finishing, manuscript development, and soil investigations.

Soil Survey in Canada

w. Wayne **Pettapiece***
Agriculture Canada, Ottawa

We always appreciate the invitation and opportunity to attend the NCSS conference. It offers five days of in-depth discussions about soil survey, present and future. As well it is a chance to renew acquaintences and to make new contacts in areas of joint concern. We have a few cooperative studies in the taxonomy but I would also like to explore some possibilities of further cooperation in applications, particularly degradation models.

Today I would like to briefly describe our core program, take a look at current impacting issues and suggest what our future emphasis might be.

The soil survey program can be discussed in terms of 6 programs.

Mapping: in a period of general reduction with federal emphasizing small scale national coverage and provinces farm level mapping.

Correlation:, still some effort in taxonomy but more in standard methodology and particularly in the area of electronic data management and exchange.

Applications: increased emphasis in the area of interpretations with concerns on linking with other kinds of data and other agencies - land evaluation.

Monitoring: a” emerging issue for us supported by the present political stances on conservation and sustainability. We are developing a National Soil Conservation Program which includes predictive modelling of soil degradation processes and methods for tracking land use.

Can SIS/GIS: our soil information system is moving into applications. Data management, standard products and degitizing take the time but the GIS ability to link with and support other agencies and programs is the payoff part.

Cartography: has been strongly reoriented to support electronic data input and management.

I would like to share with you some of the issues which are presently impacting on our soil survey program.

Client responsiveness: this is a” accountability problem. It is apparent that we have done a less than adequate job of involving our users. We must be more proactive and this will mea” some reorientation of approach.

.../2

Privatization: there is close scrutiny of all aspects of the public service as to private sector opportunity. Also involved is discussion of the level of public funded responsibility to support various sectors of the country.

Federal-provincial realignment: this involves an evaluation of roles and responsibilities in the documentation and management of our natural resources. This could result in the definition of complementary rather than sharing roles and resulting reorientation on an agency basis.

More with less: this definitely puts pressure on agencies and individuals. But it challenges the imagination and forces us to critically evaluate our programs. It also gives us an opportunity to get rid of historical baggage which is no longer required.

The future will bring some changes in emphasis with two areas in particular being stressed.

Applications: the need for responsiveness means that we must be able to access and evaluate our soils data base in a versatile and timely fashion. We must work in a pluralistic world with other disciplines and agencies and in a variety of media. Geographic Information Systems will be absolutely necessary in this task which will support planning and management at many different levels.

Monitoring: this is basic to responsible resource management. Sustainable development, which is a plank in every political platform requires an audit function of the environmental as well as fiscal resources and we see a major shift in that direction. It will likely involve development of predictive modelling systems and we look forward to collaborating more closely with US people.

We are in apocalyptic times - a lot of change. It may be unsettling but it is rife with possibilities as well. It is only when there is change that we can influence the future. We appreciate the initiatives (such as the Minnesota meetings) taken by the Americans, and I look forward with real interest to the discussions this week.

Thank you.

*A/Head, Soil Inventory Section, Land Resource Research Centre, Ottawa, Ontario. K1A 0C6

John E. Witty
NCSSConference
7/24-28/89
Lincoln, NE

CONVENTIONS USED IN SOIL TAXONOMY

INTRODUCTION

Soon after Soil Taxonomy was published there was talk of preparing a set of **"Rules** of Application". At that time I was not in favor of developing a set of **"rules";** I believed the time could be better spent in clarifying the criteria already in Soil Taxonomy in order for the criteria to be more uniformly understood and applied. No one ever followed up on the original suggestion of writing a set of **"Rules** of Application".

During the last few years I have received several suggestions that I write an article on "Conventions Used in Soil Taxonomy**. So far I have not written an article but this session is a response to those suggestions.

The major concern is interpreting what the numbers (or criteria) really mean in Soil Taxonomv. For example, how do we interpret the phrases **"have** a color value less than **3.5",** **"have** a duripan that has its upper boundary within 1 m of the **surface", "have** dominant **chroma** of 2 or **less",** and **"the** major part 'of the horizon"?

IS THERE A NEED FOR SPECIAL RULES OR CONVENTIONS?

I like to think that I am relatively flexible but it seems that I have not really changed my mind from nearly 15 years ago. In other words I do not believe we should have a separate set of conventions for use in Soil Taxonomy. If we have a set of 'conventions" it should be the same throughout the National Cooperative Soil Survey (NCSS) program. We should be able to interpret a number or value using the same conventions whether the number or value is given on a lab data sheet, on an interpretation record, in the Soil Survev Manual, or in **Soil Taxonomy**.

If the way a value is used does not follow the convention then it seems the value should be adjusted so it follows the convention rather than setting up special rules on how to interpret the value. I searched through Soil Taxonomy and I believe that all criteria can be adjusted so they would conform to a simple set of conventions. In places where a word or words, such as **"dominant"** or **"the** major **part",** are used rather than a value, these words can be changed to a value. For example, if I **prepared a "rule"** for interpreting the meaning of "dominant" I would indicate that it meant more than 50 percent. If that is what it means we might as well use the phrase **"more** than 50 percent" rather than the word **"dominant"** which is not always interpreted consistently.

WHAT ARE NCSS CONVENTIONS?

I doubt if we need to develop any new conventions but only accept already established ones. Probably the most important convention is to use values that imply a precision that can be measured or reproduced repeatedly: or is significant for the purpose in which the value is used. In most cases, however, these can only be approximations. An individual's lab technic or the quality of equipment affects precision. The limits or yalues we use in Soil Taxonomy or on interpretation records are subject to change as we learn more about soils or improve our precision.

Another convention is that if we are comparing a value against a standard value, they should be equal in terms of units and significant digits. Zeros to the right of all non-zero digits in standard values are considered to be exact-and, therefore, are also considered to be significant digits. If the value has more significant digits than the standard, it should be rounded off before making the comparison. The standard value may be a limit in Soil Taxonomy, a class limit defined in the Soil Survev Manual, or a class limit in one of the interpretation guides.

What other conventions should we have? Undoubtedly there are many other conventions that could be listed but maybe most of these could be covered under the statement "read the instructions." If the instructions are not clear, rewrite the instructions rather than preparing a set of rules explaining the instructions.

PLANS FOR SOIL TAXONOMY

During the past two years we have been revising the keys to subgroups to put them in a similar format as the keys to orders, suborders, and great groups. The forth edition of the "Keys to Soil Taxonomy", which should be ready for distribution in October or November, will be in the new format.

Converting to the new format required numerous changes in wording: mainly changing negatively worded statements to positively worded statements. We also attempted to use uniformity in wording of phrases where ever phrases meant the same thing but were previously worded different. Certain values were adjusted to provide uniformity and also reflect the precision that we are able to accomplish. For example, depth and thickness limits were given in terms of either meters or centimeters; those given in terms of meters were changed to centimeters. Also, since we do not report color value in terms of tenths of units, where ever tenths of units occurred, the class limits were reworded to reflect limits in terms of whole numbers.

There are still a lot of ambiguous statements in <u>Soil Taxonomy</u>' including faulty punctuation etc. I plan to work with an editor, hopefully one of the editors at the NSSC, and thoroughly edit the "Keys to Soil Taxonomy" during the next two years. If we accomplish this the 1991 printing (fifth edition) of the "Keys to Soil Taxonomy" will be properly edited. I do not see a need to edit all of <u>Soil Taxonomy</u> until we are ready to republish it.

CONCLUSIONS

There does not appear to be a need for a separate set of conventions that apply only to <u>Soil Taxonomy</u> and that are separate from <u>Soil Taxonomy</u>. Most of the problems that I am aware of are the result of ambiguous statements and interpreting what "less than" and "more than" means. Some ambiguous statements can be corrected by an editor; others, if we could write a convention for applying what we think the statementmeans, we would have enough knowledge that we could rewrite the statement so it would make sense. I believe some words or phrases such as "dominant" or "the major part of" were meant to be ambiguous because the significance of an exact limit was unknown or difficult to measure. If standard conventions for rounding are used then there would not be a problem in interpreting the meaning of "less than" and "more than."

NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
LINCOLN, NEBRASKA
JULY 24-28, 1989

BUREAU OF LAND MANAGEMENT REPORT

Colin W. Voigt

I. NUMBER OF ACRES SURVEYED FY 89

ALASKA:	0	
ARIZONA:	514,000	ORDER 3
CALIFORNIA:	137,500	ORDER 3
COLORADO:	100,000	ORDER 3
IDAHO:	381,000	ORDER 3
MONTANA:	50,000	ORDER 3
NEVADA:	1,596,000	ORDER 3
NEW MEXICO:	257,000	ORDER 3
OREGON:	235,000	ORDER 3
UTAH:	230,000	ORDER 3
WYOMING:	195,000	ORDER 3
EASTERN STATES:	0	

II. NUMBER OF ACRES TO BE SURVEYED FY 90

ALASKA:	0	
ARIZONA:	657,700	ORDER 3
CALIFORNIA:	185,000	ORDER 3
COLORADO:	115,000	ORDER 3
IDAHO:	381,000	ORDER 3
MONTANA:	35,000	ORDER 3
NEVADA:	1,800,000	ORDER 3
NEW MEXICO:	350,000	ORDER 3
OREGON:	300,000	ORDER 3
UTAH:	200,000	ORDER 3
WYOMING:	195,000	ORDER 3
EASTERN STATES:	0	

III. SPECIFICS FOR THE FUTURE:

1. WYOMING, MONTANA, IDAHO, AND UTAH FIELD OFFICES HAVE ALL BEEN COORDINATING WITH SCS STATE OFFICES TO INSURE THE SUCCESS OF THE ISCOM VI TOUR THIS AUGUST.

2. NEW MEXICO, NEVADA, COLORADO, AND WYOMING HAVE AND WILL CONTINUE TO SUPPORT MAJOR DATA AUTOMATION INITITAVES FOCUSING ON DIGITIZING SOIL MAPS, INTERPRETATION DISPLAY AND DATA MANIPULATION.

3. A MAJOR EFFORT WILL BE MADE IN ALL BLM OFFICES TO ENHANCE OUR COOPERATIVE EFFORTS WITH REGARD TO NCSS ACTIVITIES AND RESPONSIBILITIES.

SOIL SURVEY ACTIVITIES IN MEXICO

Lewis A. Daniels, SCS Soil Scientist, Cuernavaca, Mexico

Agencies and institutions that conduct soil survevs

Soil surveys in Mexico are conducted by the following agencies and institutions: Secretariat of Programming and Budget (SPP), National Institute of Statistics and Geography (INEGI); Secretariat of Agriculture and Water Resources (SARH); universities and private companies.

Soil surveys in INEGI

INEGI has the responsibility for a nationwide geographic inventory; a small scale soil survey is part of this inventory. All of Mexico has been mapped at a scale of 1:250,000 using the FAO-UNESCO Legend and portions of the country have been mapped at a scale of 1:50,000 using the same legend. The published soil surveys include colored maps with interpretations for potential use for agriculture, grazing and forestry.

Soil survevs in SARH

The SARH soil surveys are mainly project oriented. Most of these surveys have been in the realm of feasibility studies for irrigation projects. The scale is mainly 1:20,000 although the detail and map unit design is generally insufficient for on-farm conservation planning. The soils are classified according to the FAO-UNESCO Legend.

Mexico has no functional system of soil correlation, however, a computer program has been developed for pedon input and automatic classification in Soil Thxonomy. This program is not operational at this time.

The soil survey program in SARH is housed in the newly created National Water Commission (CNA). The soil survey organization is as follows:

National Office

- Establishes policy and procedures
- Provides quality control

Regional Offices

- Perform soil surveys

-Provide technical support to the states
-Provide quality control

State Offices
-Perform soil surveys

There are no area or field offices.

SCS participation

The Soil Conservation Service participation in Mexico is through the World Bank financed Program for Integrated Rural Development in the Humid Tropics (PRODERITH). This program is housed in the Mexican Institute of Water Technology (IMTA) and operates in 8 project areas.

The SCS soil scientist provides leadership for a soils program in IMTA, trains soil scientists in the CNA and develops technical guidelines. A Soil Survey Manual and the soils section of a Technical Guide have been developed, both in Spanish.

A DECADE OF INTERNATIONAL TECHNICAL ASSISTANCE
WHERE DO WE GO FROM HERR

Hari Eswaran

(Program Leader, Soil Management Support Services
Soil Conservation Service, USDA)

Paper presented at the National Work Planning Conference
of the Soil Conservation Service, USDA,
July 24 to 28, 1989, Lincoln, NE

SUMMARY

The paper deals essentially with SMSS's thrust in the areas of land resource inventorying, monitoring and evaluation. After a brief historical background, information on past activities is given and this is followed by aspects of future activities as proposed to AID. The rationale for the future thrust is as follows.

Assumotions:

1. Countries are at different stages of development and hence have different needs and aspirations.

2. AID has a major interest in areas of resource conservation, sustainable agriculture and biological diversity.

3. SCS is a world leader in subject area and SCS standards, methodology and quality control mechanisms are de facto international standards.

4. SMSS 'has established reputation and confidence in developing countries and services are in demand, both by LDC institutions and USAID Missions.

Past:

1. Provide on request, services to Missions and LDC institutions.

2. Catalyze activities in LDCs or regions in collaboration with other donors or institutions, thereby developing linkages and ensuring continuity of activities.

3. Provide a mechanism for LDC scientists to interact with US counterparts: provide an opportunity for LDC scientists to contribute to developments in subject area.

4. Train trainers and junior staff in LDCs in methodology and interpretation of data.

5. Create awareness among decision makers and assist in problem identification or solving.

6. Collaborate with IARCs in the areas of optimizing utilization of resources.

Future activities:

1. The services provided hitherto are still needed by many countries and institutions, though in some, the approach and contents may be more refined.

2. Countries such as India, Pakistan, Thailand, Philippines, Zimbabwe, Costa Rica, have experience and expertise in subject area. Their current needs are essentially to establish contact with their peers in the US and the application of advanced technology, such as:

- development of data bases
- development of data base management systems
- development of Geographic Information Systems
- application of remote sensing techniques in monitoring and evaluation of land resources

In each of the above, information flow and training are important components.

3. band evaluation and methodology for discriminatory use of land. Needs include training in many countries and technical workshops for exchange of information, and to improve current systems particularly methods of presentation.

4. Items 2 and 3, require quality data. As major limitation in **LDCs** is equipment to generate data, new cost-effective and reliable methods. need to be developed and personnel trained to apply them.

5. Soils data base is the basic driver for all the crop-weather simulation models and with countries moving into this technology, two approaches are necessary:

- a short term approach requires salvaging current information, developing statistical approaches to derive missing data and applying this data to drive the models:
- a longer term approach is to assist countries through training and other means to begin to generate quality data of land resources.

6. Recent international efforts on Global Climate Change require long term monitoring of natural resources; methodology needs to be developed and countries assisted in applying the techniques.

7. Item 6 is also related to the subject of soil degradation. Though a degraded soil can be identified, rates of degradation and potentials for restoration

cannot be estimated and require long term and systematic monitoring. Methodology must be developed and personnel trained. Degradation is one component of sustainability but currently, its relation to productivity is not well defined for many ecosystems.

8. The soil component in sustainable agriculture has not received the attention it deserves. The concept of Major Land Resource Areas (MLRAs) is tied to sustainable agriculture and MLRA maps of countries are needed to target sustainable agriculture development programs. LDCs need training to apply these concepts.

A DECADE OF INTERNATIONAL TECHNICAL ASSISTANCE

WHERE DO WE GO FROM HERE[1]

Hari Eswaran

(Program leader, Soil Management Support Services
Soil Conservation Service, USDA)

BISTORICAL

The international community of soil scientists has always looked to the Soil Conservation Service (SCS) **of** USDA for concepts, definitions, standards and quality control methods. The Soil Survey Manual (Soil Survey Staff, 1952) has been and is the standard for soil surveys despite the fact that there are many other manuals, guidelines and handbooks available. Soil Taxonomy is used by more than 45 countries even though there are vehement critics around the world. The methods of soil analysis of SCS are still adopted around the world even though new methods are continuously published. The basic reason for this confidence in SCS methods and approaches, apart from the quality, ***is*** the institutional backstopping that is guaranteed by the system. SCS has been dynamic and has made changes in its standards and approaches and has made it evident that though ·**it** is a national program, it is receptive and invites international inputs in its efforts to improve the quality of soil surveys and the utilization of soil survey information.

A basic constraint of SCS has been its inability to maintain a dialogue with the international community and to interact on a more systematic basis. This became very evident when Soil Taxonomy was published in 1975 and gathered international acceptance and the international community looked for a mechanism for assistance in using the system and also to contribute to enhance the system. Dr. Guy D. Smith had obtained some funding from the Agency for International Development (AID) to travel and interact with international soil scientists during the development phases of Soil Taxonomy and appreciating the value of this collaboration and his desire to internationalize Soil Taxonomy, worked very hard to formalize this. Mr. William Johnson, then Deputy Chief of SCS, supported the idea and initiated discussions with AID. The concept of an

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[1] Paper presented at the National Work Planning ***Conference*** of the Soil Conservation Service at Lincoln, NE, July 24 to 28, 1989.

international project to assist developing countries in the areas of soil survey and classification was welcomed by Dr. Tej Gill of the Office of Agriculture of AID as it matched with their strategy of technical assistance and was a logical follow up to their then existing projects on 'Soil Resource Evaluation' with Cornell University and the 'Benchmark Soils Project' of the Universities of Hawaii and Puerto Rico. At the International Congress of Soil Science at Edmonton in 1976, Bill Johnson, organized a meeting to solicit opinions from the international community for such a project. In the same year, Dr. Jack McClleland, National Leader of Soil Taxonomy, created the first international committee on Alfisols and Ultisols of the tropics. This committee was led by Dr. Frank Moormann, then at the International Institute of Tropical Agriculture, Nigeria: the committee was later called the International Committee on Soils with Low Activity Clays (ICOMLAC) and was the forerunner of ten other ICOMs. Dr. Fred Beinroth of the University of Puerto Rico approached AID for funds to organize a workshop on soil classification and the First International Soil Classification Workshop was held in Brazil in June 1977 for ICOMLAC. Although Guy Smith was retired during this time, he was still very active and was invited to Trinidad and later to New Zealand to assist them in the areas of soil survey and classification.

In the seventies, a momentum had already begun to create some kind of international institution for soils. The earliest proposal was by Dr. Brady in 1972[2] and later at an AID sponsored meeting on 'Soil related constraints to food production in the tropics' at IRRI in 1979, 'Dr. Swindale[3] of ICRISAT (who was the originator of the Benchmark Soils Project) made a strong plea. Dr. Swindale elaborated on an earlier proposal[4] made at ICRISAT in 1978 for an International Benchmark Soils Network. He also called for activities to internationalize Soil Taxonomy and establish a system for international soil correlation. These events were to lead to the formation of the International Board for Soil

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[2] Brady, N. 'C. 1972. International cooperation for tropical soils research. Paper presented at the Seminar on Tropical Soils, IITA, Ibadan, Nigeria. (mimeo).

[3] Swindale, L. D. 1980. Toward an internationally coordinated program for research on soil factors constraining food production in the tropics. Publ. in 'Priorities for alleviating soil-related constraints to food production in the tropics'. Irri, Philippines, 5-22.

[4] Swindale, L. D. 1978. A soil research network through tropical soil families. Pages 201-218, in. L. D. Swindale, ed. Soil-resources data for agricultural development. Hawaii Agric. Experiment Station, Honolulu, Hawaii.

Research and Management (IBSRAM) now headquartered at Bangkok, Thailand, but also established the need for an international project here in the U. S. The Soil Management Support Services (SMSS) was created on October 1979 by AID and SCS was charged with implementing it, with OICD managing it.

Dr. Richard Guthrie, now Director of International Affairs at Auburn University, Alabama, was the interim Director until I came on board in November 1980 (from April to November, I was a consultant).

A DECADE OF SMSS

The achievements and some unaccomplished aspirations are summarized in the latest Progress Report of SMSS. Some of the accomplishments are tabulated in Appendix I. One of the criticisms we have received is our overemphasis on Soil Taxonomy. Our response has been:

1. SMSS was created to assist countries in using Soil Taxonomy;
2. We believe that Soil Taxonomy is the rallying point and the unifying factor in all our activities;
3. Though we have highlighted Soil Taxonomy, we have also emphasized all aspects of soil survey including the use of soil survey information for soil management and agrotechnology transfer.

Basically we see SMSS as:

1. a vehicle for providing assistance in the areas of soil survey and classification -- today this is more important than before as there are few other entities involved in this task;
2. a part of the international section of SCS whereby LDCs are informed of SCS's qualities and standards;
3. a mechanism for bringing foreign technology and information to SCS;
4. enhancing the spirit of the National Cooperative Soil Survey (NCSS) and contributing to its international role.

A STRATEGY FOR ASSISTANCE IN THE NEXT DECADE

During the decade of SMSS, many countries have undergone changes. Soil survey organizations have strengthened and soil survey information is increasingly being used and as a result, the needs of these countries have also changed. Some of these countries have acquired computer technology and are moving into the uses of data bases and geographic information systems (GIS). However, there are still many countries that do not have the institutional framework for soil surveys or still need the kinds of assistance we have provided in the past. Consequently, though I will be focusing on some new areas of assistance, it must be *remembered* that our past activities are **still** relevant to some *countries and* must **be continued.**

We also have to consider another facet of international technical assistance which is dictated by donor requirements. This includes the areas of sustainable agriculture, resource conservation, and biological diversity. Unfortunately, some donors adopt a blanket policy for all countries even though the pressing needs of some of the countries are more immediate *concerns* dealing with food and fiber production.

The following are areas for emphasis or renewed thrust in the next decade of SMSS:

1. Systems approach to research and development

As indicated earlier, there are many countries such as India, Pakistan, Thailand, Zimbabwe, Jordan, which have not only made considerable progress in soil surveys and utilization of soil survey information but have or are developing the capability to move into the area of applying modern technology to natural resource productivity problems. Their needs are now in the areas of data bases, more accurate monitoring of properties atgeo-referenced sites, systems approach to problem solving, and better and more refined methods of analysis of data. SCS and USDA in general has this expertise and the role of SMSS would be to help transfer some of these to countries who desire them.

2. Soil Taxonomy

Currently Soil Taxonomy is being used by about 45 countries as the national system or as an adjunct system. Most articles on soils carry the Soil Taxonomy classification and the **International** Soil Classification Workshops, Training and Soil correlation meetings have all contributed to this enhanced use, as a result of which, Soil Taxonomy has become the *de facto* international soil classification system. The work of the International Committees are finishing or have finished and many changes have been made to Soil Taxonomy.

In terms of less developed countries (LDC) needs, the following strategy will be adopted:

- training in Soil Taxonomy in some countries;
- informing others of the major changes that has taken place in ST and this to be done through International Soil Correlation Meetings:

- training in the use of ST for soil survey interpretations.

3. Soil survey and soil characterization

The scientists in LDCs who collaborated with us during the last decade now occupy senior positions or will soon occupy such positions and this effectively takes them out of field operations. The new generation of scientists are frequently trained within the country and have had little or no exposure or opportunity to interact with his foreign peers. As many universities in LDCs are poorly staffed and equipped, the quality of this new generation is not very impressive. Due to foreign exchange problems, soil survey laboratories are still in a poor shape and back-stopping services for soil surveys are poor or non-existent.

Training and assistance in the whole field of soil survey remains necessary in many countries. As indicated earlier, some countries have graduated and these countries could use assistance in more advanced approaches or technologies such as GIS, Soil Information Systems and data bases in general.

Now that SMSS has a better appreciation of the country situation and needs, and has good contact in each of the countries, it will attempt to develop country specific programs for a few countries interested in collaborating in such assistance.

4. Soil management

The basic focus will be on the use of soil survey information for soil management. There are many institutions, particularly the International Agricultural Research_ Centers (IARCs) who are involved in developing technology in the areas of farming systems. The mechanism for the transfer is still a problem and there are instances where good technologies have failed in a new area because of lack of appreciation of the resources. We believe we have a role to play by maintaining contact with the IARCs and other national and regional institutions and collaborating with them in the task of matching farming systems to soils. The International Soil Management Workshops are designed for this purpose and will be continued.

Simulation models for crops is now in vogue and a soils data base is one of the drivers of such models. Simulation models are point specific and the desire of users is to be able to extrapolate the information to an area. This of course requires detailed soil surveys and is going to require soil survey information dictated by the models. Although IBSNAT and others have touched on the problem, we still have to address it seriously, both within SCS and also in SMSS. This will be a new era in utilization of soil survey information and we have an opportunity and a duty to play a lead role.

5. Sustainable agriculture

The concept is one of increasing or maintaining productivity of the land while conserving it by reducing degradation. The current approaches relate largely to designing farming systems appropriate for sustainable agriculture. We have a role to play here and some of the areas include:

1. matching farming systems to soil qualities;
2. elaborating on soil degradation in terms of Soil Taxonomy units:
3. getting the message across that targeting sustainable agriculture activities requires reliable soil surveys.

We need SCS assistance in refining the concept of Major **Land** Resource Areas **(MLRAs)** so that we can **extend** the **MLRA** concept to district or province level.

6. Training

Training is an integral part of **SMSS**. Our current training has been in the use and application of Soil Taxonomy. We have had a few training courses on soil survey methodology. There is still a need for such training.

The scope of the training courses will be increased to include soil management. We have conducted a few of these in 'collaboration with **IBSRAM** but we need to increase these and specifically in collaboration with the **IARCs** or other S&T projects. A project like **TROPSOILS** does not have the mandate .to conduct training courses and **SMSS** could join forces to conduct them on their behalf.

7. International Linkages

We have linkages with practically all the international organizations dealing with soils.' This is mutually beneficial and we have benefitted considerably.

Two activities, not directly of SMSS but in which SCS is involved, are the World Soils and Terrain **(SOTER)** Digital Database at a scale of 1: 1 million, and the Global Assessment of Soil Degradation **(GLASOD)**. Both the projects are coordinated by the International Soil Reference and Information Center (ISCRIC) with funding from the United Nations Environmental Program. Under the **GLASOD** effort, Mr. B. Smallwood is using the **MLRA** map of the US to develop a soil degradation map. For the SOTER activity, a pilot area was selected in Montana in the US and Alberta/Sasketchewan in Canada. Mr. D. Yost is handling the Montana evaluation using a manual developed by ISRIC and its collaborators. The immediate purpose is to test the manual and based on the experience gained, improve the manual for international use.

We have also collaborated with FAO in developing their legend for the Soil Map of the World, with ISRIC on its Inter-laboratory cross-checks, and with ISSS in developing an international reference base. Whenever feasable, we get SCS scientists to participate in these activities.

We have not succeeded in getting as many of SCS scientists to international meetings as we would like to. I have requested SCS for a special fund so that we can have a coordinated program. My personal goal is to get some of the field personnel to attend the international meetings and give them the exposure which would be very beneficial.

8. Information dissemination

This is our link with the outside world. LDC scientists do not have access to recent publications, specifically journals and they also do not have the facilities of publishing their work. SMSS has attempted to provide this in a small way, through the proceedings of all the meetings we conduct, through the'newsletter published in collaboration with IBSNAT and through the Technical Monographs.

I would like to recommend the publication of a NCSS newsletter which could go to all the'collaborators in the US and abroad. SMSS could be responsible for the international section of the newsletter and for the distribution to international collaborators.

CONCLUDINO REMARKS

SMSS is in a transition phase now and is awaiting an extension which is to be in place for FY 91. Currently and for the last two years .we are operating at 50% of our original budget. In the mean time, OICD which handles our finances, has increased its overheads to 33%. We have been obtaining annual extensions which makes it impossible to plan for more than a year at a time. As a result, we have to curtail most of our activities.

As a result of this temporary setback, we have lost some of our momentum. However, we are hoping that AID will restore our funding level and that in the near future we will back on track again.

Appendix I

Activity	1980	1981	1982	1983	1984	1985	1986	1987	1988	1889
1. Tech. Assistance										
Persons	20	29	35	42	33	37	41	46	25	16
Person/days	280	444	538	507	396	394	725	443	187	224
2. Training Forums										
Number of Forums	1	1	1	3	3	4	2	3	2	
No. Participants	40	56	55	170	152	271	114	184	160	
No. Countries	11	11	8	36	40	35	22	15	4	
3. Soil Class. Workshops										
Number Workshops		1	1	2			1	1		
No. Participants		41	40	122			65	75		
No. Countries		22	22	40			11	18		
4. Int. Correlation Meetings										
Number meetings						1		3	1	1
No. Participants						45		150	75	80
No. countries						4		46	18	20
5. Int. Management Workshops										
Number workshops						1	1	1	1	4
No. Participants						55	60	45	35	255
No. Countries						20	5	18	12	34

6. Publications										
Technical Monographs	-	1	4	12		2	4	2	2	1
Benchmark soils						1		1		
Newsletter		1	3	3	3	3	3	3	3	2
Brochure	1			1	1	1				1
Bibliography				1				1		
Forum Proceeding		1		1	1	3	1	1	1	1
Class. W'kshop Proc.		1			1	1	2	1	1	2
ISCOM Proceedings								1	1	1
CLAMATROPS Proc.								1	1	1
Annual Reports		1	1	1	1	1		1		
7. World Benchmark Soils Project										
No. Countries	1	6	16	18	7	5	8	6	2	
No. Pedons	3	42	135	123	120	55	101	23	37	
No. Samples	15	221	816	651	731	429	629	167	94	
8. Audio Visual products			2					1		
9. Computer software								1		
10. Countries visited	12	16	22	24	28	21	20	18	9	21

SOIL RESOURCE INVENTORY PROGRAM
USDA FOREST SERVICE
July 24,1989

PETER E. AVERS

It's good to be here at the Work Planning Conference again. The Forest Service has been an active partner in the National Cooperative Soil Survey (NCSS) for over 3 decades. This report is intended to provide you with a generalized update on our current program activities.

Forest Service soil inventory operations make up about one fourth of the soils program. Soil quality monitoring, developing soil and water conservation practices, management services, soil resource improvement, resource coordination, and planning make up the remainder.

Over the last several years, National Forests have completed soil resource inventories at a rate of 5 to 6 million acres annually. Over half of this acreage is order 3 and 4 inventories needed for general capability determinations and land management planning. The remainder is detailed order 2 that not only serves land management planning efforts but also provides data for project planning to implement forest plans. This work is mostly done at scales of 1:12000 to 1:15840, but 1:24000 is also used. About 80 percent of this annual acreage of soil inventory work is accomplished as part of the NCSS under individual soil survey area Memoranda of Understanding (MOU).

Areas where we are not involved in NCSS fall into two categories:

1. large survey areas where managers view cooperation as nonbeneficial. This is troublesome and takes on many forms, but is primarily caused by a lack of meaningful communication.

2. The other acreage is scattered tracts of order 2, not in a progressive survey, usually done in areas previously published at a more generalized level. We need to workout ways to include this work in the national soils database. I think in both cases part of the answer is drawing up appropriately developed MOU's and work plans.

About 8 USDA soil survey reports were published last year that included National Forest land. More are in the pipeline. Double that amount of in-service soil management reports ware printed.

Nationally, we have well over 100 USDA series soil survey reports published that were completed over the past 3 decades. That number may sound impressive, but we have dozens of survey areas with mapping complete on over 50 million acres that are in the "process" of being published. For a variety of reasons most of these will be printed internally, even though they are NCSS soil surveys with final correlation of the soils by Soil Conservation Service (SCS).

Last December, Forest Service (FS) and Soil Conservation Service (SCS) held a 1 day coordination meeting here in Lincoln, Nebraska, and we discussed mutual concerns in the soil survey program. A major area of concern had been Forest service decision not to publish some national forest soil inventories but still achieve final soil correlation through SCS.

Forest Service views soil correlation as essential to gain consistency and include national forest soil data into the national soils database. At the Meeting we agreed that a NCSS manuscript for USDA publication is not a requirement for final soil correlation. Soils data, like other resource data in Forest Service, is more and more being handled electronically for a broad spectrum of applications. Printed reports of technical data have limited use. This is not to say they have no value. They do, but the cost is being critically evaluated in relation to their usefulness to management.

Consequently, publication of National Forest soil resource inventories as standard USDA soil surveys will be a regional option worked out with concerned State SCS offices and evaluated for each survey area. The maps, descriptions, correlations, interpretations, etc.. will meet national standards regardless of publication plans and be available to the public and all State, local, and Federal agencies. In some cases there will be an in-service soil management report with or without standard USDA publication.

I think most of us feel comfortable with this direction considering the fast changing climate of information management.

A question that often comes up about soil inventories is. "vi.11 we ever get this job done?"

At one time, I thought that we would complete the soil inventory and it would be done. Currently, I do not see an end. We see it as a continuous process of updating, refining, or conducting more detailed inventories to meet management needs. Cur long-term plans reflect this view. Plans well into the next Century continue soil inventory at the 4 to 5 million acre rate. Incidently. about 70 percent of soil resource inventory is being done by contract or interagency agreement.

Like you, Forest Service has learned a lot about making and using soil inventories over the last 3 decades. We need to find better ways to share this collective understanding to improve our effectiveness and prevent duplication of past errors. This conference aids that process with a free exchange of ideas.

If there is one major thing Forest Service has learned, but that still gives us trouble implementing, is that the people who are going to use the inventory <u>must</u> have a say in how the inventory is to be designed. Without this, use and acceptance is an uphill battle, regardless of product quality. This is a serious problem since the use of soils information in management planning and environmental analysis is critical to Forest Service programs.

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The reason I mention this is that it is not just a Forest Service problem. our surveys are cooperative surveys in the NCSS and we (collectively that is SCS, BLM, experiment stations, and Forest Service) must develop useful products. We can not do it talking amongst ourselves. The users must be involved in design or the survey should be postponed until meaningful input can be gained.

Two weeks ago, I was on a national forest that recently completed their cooperative standard soil survey at a cost of well over $1 million and they indicated it is a good soil survey but that it has limited value to Forest Service management. I think the reason they feel that way, after discussing it with them, is that the managers were not involved in map unit design and setting objectives and they have not had adequate orientation on use. We can do better than this and we must. Just getting the users and managers to sign the MOU is not enough.

As most of you know. map unit design in some regions is oriented toward the ecosystem by using properties of vegetation, geology, climate, and landform as well as soil, as criteria to establish map units. I would like to discuss this concept somewhat in depth today and try to relate to you our goals and where we are in developing the concept and in preparing national direction.

Where appropriate, we are attempting to integrate soil inventory with vegetation classification and inventory. Our early integrated inventories were called Land System Inventories and related names, but now a name we are tentatively using nationally is Ecological Unit Inventories. The current approach places more emphasis on vegetation than land systems. The conduct of the inventory and design of the map units is somewhat similar to the soil survey process, but depending on objectives, equal weight may be given to potential natural vegetation (PNV), landform, climate. geology, and soil properties. Central to this concept is the Ecological Type which is a category of land having a unique combination of PNV. soil, geology, landform, and climate.

These Ecological Types are the taxonomic units, if you will, that can be used to name and characterize the map units. The classification of Ecological Types and design of ecological map units requires an interdisciplinary team of plant ecologists, soil scientists, and geologists. Some regions are conducting ecosystem oriented inventories, but they use different terminology than I'm using today. However, the basic concepts are similar. The reason we are moving towards these inventories is to not only reduce dual efforts on the same piece of ground, but to delineate map units that can be better interpreted for a wide range of uses to meet management needs. We believe that site index ratings, capability determinations, and other vegetation oriented interpretations are more useful on ecological map units than on standard soil map units. Also, other new interpretations, like for biological diversity, can be made. This has great appeal to our managers.

Ecologialinventories ce" meet the standards of soil inventory as long as the soil taxonomic units and their spatial distribution are identified for the map units. However, problems arise during soil correlation in naming units and in map unit descriptions. We find that, with a little effort, these problems can be resolved. Both inventories are similar in that we actually map landscapes and then characterize the map units for the soil components. For comparison, it could be said that soil is the major component used in designing units in a soil survey. whereas soil is only one of four landscape components evaluated in designing ecological units. I hasten to add that the two inventories, in some cases, may not be all that different. Since good soil surveys use some of these other components, particularly land form. in map unit design. However. descriptions and interpretations may be lacking for the other components in the soil survey even though they were used in map unit design.

These inventories are interchangeably referred to as soil inventories by soil scientists since they meet FS and NCSS soil inventory requirements. In addition, however, they can meet requirements for other component inventories and also serve as ecosystem inventories. What the inventory accomplishes depends largely on the objectives astablished by users and managers at the outset.

Ecological unit inventories have baen most successful where FS research stations and universities are closely associated with classification systems for Ecological Types and where they are involved in the conduct of the inventory. We currently have a national task force working on procedures and developing handbook direction.

I vould lika to mention a few examples of other Forest Service activities related to soil inventory:

1. We have a few regions working on quality control guidelines for conducting soil resource inventories. Most noteworthy is the Southern Region and many of you are familiar with the development and testing of those guidelines over the last 5 years. They are planning a presentation or two on these guidelines at the annual Soil Science Society of America meeting this October.

2. Several regions are in the advanced stages of implementing soil quality standards. Thase are directly related to the soil inventory and soil map units. We recently initiated, in cooperation with our research stations, a national study on long-term soil productivity to establish and validate soil quality standards.

3. Concerning the water quality issue, our soil inventory interpretations are considered very important for developing soil and water conservation practices. These practices generally far exceed State requirements for best management practices.

4. We recently had a national task force to identify and define the most commonly shared soil data elements to be used in the information system for our Geographical Information System (GIS). We recently purchased ORACLE, a software package that provides a framework for handling all kinds of data. including databases for GIS. This is being implemented nationwide and will allow us to exchange data more freely than if we were tied to just Data General software. We are working on sending out our request for proposal for GIS by January. We are getting industry comments now on the specifications.

5. An interagency committee (BLM, FS, SCS, and State agencies) in California developed an excellent erosion hazard rating system. It is in trial now. I think committees like this are effective for getting work done. We need to have more of these task oriented groups as ad hoc committees of regional and national soil survey work planning conferences.

This concludes my remarks and I look forward to working with you on the major issues the remainder of the week.

Report on a Canadian Interagency Soil Intepretations Committee

W. Wayne Pertapiece
Agriculture Canada, Ottawa

In the early 60's Canada embarked on the Canada Land Inventory program. This was a multi-sector evaluation of our natural resource base for national and regional planning. Included was a soil capability for Agriculture which was carried out by our cooperative Soil survey. This was well accepted by the planning community but was small scale (1:250,000) and the need to address both local issues and larger scale concerns soon resulted in many modifications. In addition, there were any number of local "suitability" ratings and many of the local agencies preferred to use Storie-type index ratings. The result was a somewhat duplicative, cumbersome and inefficient system. While each worked well for individual objectives it was recognized that some rationalization was necessary.

A committee with representatives from Agriculture, Forestry, Public Lands, Assessment Services and the private sector, was struck in 1981 to evaluate the situation in Alberta. The conclusion was that, while the systems in use might look different, they used similar criteria and resulted in similar relative ratings. It was recommended that a single system be developed.

The committee set some guidelines:

- it should use a 7 class capability framework
- it should be specific and explicit
- it should be flexible
- the committee also agreed that it was more important to accept a standard than to be absolutely correct

As part of the ground rules, definitions of capability, suitability, productivity, land evaluation and soil potential were accepted.

A primary decision was to rate each of climate, soils and landform separately **because each, on its own, could limit agriculture.** Also this greatly increased flexibility in terms of future modifications and uses. The final class would be based on the most limiting.

Within each category criteria were selected and rating scales established. In a rather simplistic approach, climate can be thought of as a measure of flexibility, soils as a measure of productivity and landscape as sustainability.

An important feature of the system is the provision for documentation of both the field assessment of the characteristics and the ratings. This contributes to the explicitness of the system, facilitates auditing and has proven useful in court. It also contributes to standard application of the system and facilitates use by non-pedologists with a minimum of training. The method of rating individual characteristics is well adapted to computer calculation.

.../2

The multi-agency process, while at times slow, had some very positive spin-offs. First, it was able to identify and accommodate user concerns during the developmental stage. The involvement of all parties in the development of the system facilitated trade-offs, encouraged imaginative solutions and provided a broad base for testing. The process took nearly 5 years but implementation was accomplished in 2 months.

We are presently in the process of converting the system to a national scheme. The main additions will be the development of a national climatic framework.

Concluding remarks.

1. I have shared with you one experience with rationalizing our agricultural capability system.

2. The main objective was to provide a guiding framework for more detailed work.

3. A secondary objective was to develop a flexible structure and format adaptable to computer manipulation.

4. The “new” system was mainly an exercise in reorganization. The main features were:
    - retention of a seven class capability approach
    - added explicitness in all areas
    - separation of climate, soils and landscape components
    - addition of a rating for organic soils

5. ‘Multi-agency processes take time and patience but result in superior and more acceptable products.

Report on Soil Characterization Standards
Ellis G. **Knox,** 26 July 1989
National Cooperative Soil Survey Conference
Lincoln, Nebraska

This report gives a **summary** of the results of the 1987 task force and describes work of the National Soil Characterization Data Base Committee.

I. Soil Characterization Standards Task Force

The Soil Characterization Standards Task Force began its work in May 1987. Results of a questionnaire were not available for the 1987 NCSS Conference. Results are now presented in the Report on Responses to the 1987 Questionnaire, dated 26 July 1989, and are summarized below.

Responses to **the** questionnaire show strong support for a set of standard laboratory procedures for soil characterization, based on some combination of SSIR 1 and Monograph 9, to be followed rigorously by cooperating laboratories, with a **protocol** for validating equivalency among laboratories.

They also show broad support for seeking **ASTM** acceptance of procedures without binding **the** NCSS to **ASTM** methods.

The responses strongly support NCSS action to test and adopt new procedures and changes in procedures as well as publication of this work.

There was strong support for detailed documentation of methods; including tests of equivalency among methods, by the NCSS, in a NCSS manual with periodic supplements.

II. National Soil Characterization Data Base Committee

The National Soil Characterization Data Base (NSCDB) Committee, established by action of the four Agricultural Experiment Station regional soil survey committees **and the** SCS Soil Survey Division **met 25-29** July 1988. **AES members were** William Allardice, Edward Ciolkosz, Thomas Fenton, and Wayne Hudnall. SCS members were David Anderson, Benny Brasher, Ellis Knox, and Billy Wagner. The committee undertook to guide and oversee the creation and management of a NSCDB, to make arrangements with source laboratories, to work with the SCS National Soil Survey Data Bases Staff in the formation and operation of **the** NSCDB. Specific charges are:

1. Establish the standards and procedures for the NSCDB.
2. Provide expertise, information, technical support, and coordination for development, testing, implementation, management, and maintenance.

3. Establish operating procedures for the use and' management of the NSCDB.
4. Establish and maintain the list of data elements.
5. For all data elements, establish standard definitions, length and type of data entry, data validation criteria, and naming conventions.
6. Establish and maintain the list of acceptable and standard analytical methods and quality-control procedures. Promote development and testing of new methods and quality control procedures. Investigate the issue of ASTM recognition.
7. Disseminate information about the NSCDB to the NCSS.
8. Establish mechanisms for marketing and distribution of the data to the NCSS and the public.

Subcommittees on Inventory of AES Data, Methods and Procedures, System Development, ASTM or Alternative Recognition, Information, and Prototype Data were named.

More detailed information about the July 1988 meeting of the NSCDB Committee is available.

The analysis and design work of the committee has been used by the NSSL and Data Bases staffs and a contractor for further development using the STRADIS method for analysis and design of data-base systems. Draft materials, subject to NSCDB Committee approval, include data flow diagram, entity-relationship model, objectives and constraints, and logical models of the current and proposed systems. All data elements currently used by the NSSL have been defined. A complete list of methods used by the various SCS laboratories has been compiled. Methods currently used by the NSSL have been described in detail. Examples of these methods descriptions are available. Benny Brasher and Dave Anderson have been working with the contractor to design an exchange format. Another contractor will be used to complete development of the exchange format.

Pedon descriptions will be part of the NSCDB. When the Pedon Description Program (PDP) software becomes fully operational, we expect that a laboratory version will be incorporated into the NSCDB.

EXAMPLES OF HIERARCHICAL CLASSIFICATIONS OF LANDFORMS USING GENERAL AND MORPHOGENETIC TERMS[1]

F.F. Peterson, University of **Nevada-Reno**

Draft Version, July, 1989
National **Cooperative** Soil **Survey Conference**
Lincoln, Nebraska

EXAMPLE OF A MORPHOGENETIC LANDFORM-HIERARCHY FOR THE BASIN & RANGE PROVINCE'

I Grand Landform	II Great Landform	III Major Landform	IV component Landform	V Landform Element
		(LANDFORM ELEMENTS:		Flat[2] Channel[3]
				Crest/Summit[4] Shoulder Backslope[5] (or Noseslope, or Sideslope, or Headslope) spur[6] Footslope Toeslope)
BOLSON & SEMI-BOLSON	...	...	...	...
	Piedmont Slope	...	...	...
		Mountain-Valley Fan	...	Flat
			Mtn.-Valley-Fan Remnant	C-S/S/B/F
		Rock Pediment	...	Flat
			Rock-Pediment Remnant	C-S/S/B/F
		Pediment[7]	...	Flat
			Pediment Remnant	C-S/S/B/F
		Ballena	...	C/S/B/F
		Alluvial Fan	...	Flat
			Fan Collar	Flat
			Erosional Fan-Remnant[8]	C-S/S/E/F
			Inset Fan	Flat Channel

Intermontane-Basin Landforms--Continued.

I Grand Landform	II Great Landform	III Major Landform	IV Component Landform	V Landform Element
		Fen **Piedmont**[9]	...	Flat
			Erosional **Fan-Remnant**[8]	C-S/S/B/F
			Inset Fan	Flat
				Channel
			Nonburied Fan-Remnant	Flat
			Fan Apron	Flat
				Channel
		Fan Skirt	...	Flat
				Channel
	Bolson & Semi-Bolson Floor	...	...	...
		Alluvial Flat	...	Flat
			Basin-Floor Remnant	C-S/S/B/F
		Alluvial Plain	...	Flat
		Lake Plain	...	Flat
			Lake-Plain Terrace	**Flat/B**
		Sand **Sheet**	...	Flat
		Dune Field	...	...
			Dune	...
			Parna Dune	...
		Axial-Stream Floodplain[10]	...	**Flat**
		Axial-Stream Terrace[10]	...	Flat
		Beach	...	Flat
		Beach Plain	...	...
			Offshore ear	c-s/a
			Lagoon	Flat
		Floodplain **Playa**	...	**Flat**
		Playa	...	Flat

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[1] After: **Peterson,** F.F. **1981 Landforms** of the **Basin & Range** Province Defined **for Soil Survey. Nev.** Agr. Exp. **Sta.** Tech. **Bul. 28.**

[2] **"Flat"** provides **a Landform-Element-level** term for those **level** to sloping, Smooth **surfaces** of constructional **landforms** such as **lake** plains, undissected **fans,** and **floodplains to** which the **"summit"** term of the erosional-landform slope **sequence** of **summit-shoulder-backslope-footslope-toeslope does** not apply.

[3] Slightly-incised **channels** or **splayed** distributary-channels **can be** significant **elements** Of landforms such as inset fans, fan skirts, **and** alluvial **fans.**

[4] A crest is narrow and fully rounded whereas a summit is broad and may be flattish or rounded.

[5] Noseslopes, sideslopes, and headslopes are all "backslopes." By providing choice between these terms, the need for a Separate, sixth category of Slope Components is removed.

[6] Spurs were called "partial ballenas"--an esoteric term-in Peterson (1981). They are a small "noseslope" attached to a longer backslope. Such landforms as erosional fan-piedmont remnants can themselves be strongly dissected, creating numerous spurs and a high proportion of sideslope area to crest or summit area.

[7] Geomorphologists now recognize that pediments, which originally were recognized as erosion surfaces cut across bedrock, are cut across both alluvium and bedrock; some now apply the term "pediment" to the more common erosion surfaces cut across alluvium and distinguish like erosion surfaces cut in rock as "bedrock pediments". This new convention is followed here.

[8] A commonly-used synonym for "fan remnant" is "fan terrace."

[9] More-or-less synonyms for "fan piedmont" are coalescent-fan-piedmont, bajada, and, very loosely, alluvial tan.

[10] Only on semi-bolson floors. Alternative term for stream terrace is alluvial terrace.

EXAMPLE OF A LANDFORM HIERARCHY FOR ALASKA

Adapted from U.S.F.S. Landform I.D. Legend, 5/85, Alaska
Categorical ranking added; some units deleted, or
only their listed components shorn here.

I Grand Landform	II Great Landform	III Major Landform	IV Component Landform	V Landform Element
[MOUNTAINS]	...	...	...	...
	[Glaciated Mountains1	...	...	...
		rugged alpine topography	...	...
			jagged mountain summits	...
				cols
			cirques	...
				cirque headwalls
			horns/arrets/nunataks	...
			alpine sideslopes	...
			(snow-avalanche slopes inclusions1	...
		rounded alpine summits	...	...
			rounded mountain-peaks	...
				summit
				shoulder slope
			ice-scoured ridgetops	...
			rounded mountain-ridgetops	...
				summit
				shoulder slope
				broad saddles
		snow & ice fields	...	...
			nunataks	...
			moraines	...
			talus cones	...
		subalpine muntsin-slopes	...	...
		snow-avalanche slopes	...	...
			snow-avalanche tracks	...
		mass-wasting slopes	...	...
		closely-dissected, deeply-incised mountain slopes	...	...
			["backslope-interfluves"]	...
			V-notches (fluves)	...
			knobs	...
			benches	...

Alaskan Mountainous-Landforms--Continued, 2.

I Grand Landform	II Great Landform	III Major Landform	IV Component Landform	V Landform Element
		closely-dissected, shallowly-incised mountain slopes	...	...
			["backslope-interfluves"]	•••
			V-notches (fluves)	...
			knobs	...
			benches	...
		widely-dissected, smooth mountain slopes	...	...
			["backslope-interfluves"]	•••
			V-notches (fluves)	...
			knobs	...
			benches	...
		broken mountain-slopes	...	•••
				summits
			knobs	...
			benches	...
		mountain-slope ravines	...	•••
				backslopes
		widely-dissected footslopes	...	•••
			colluvial footslopes	•••
			colluvial toeslopes	• .*
			landslide-debris slopes	•••
			talus slopes	...
			lateral moraine	•••
		closely (and shallowly-) dissected footslopes & alluvial tans	...	•••
			alluvial footslopes	•••
			alluvial fan	...
			coalescent alluvial-fans	...
			alluvial-colluvial footslope	•••
[HILLS]	•••	•••	•••	•••
		rolling-hill country	...	•••
				summits
				sideslopes
				footslopes
			knobs	...
			benches	...
		[large hills]	...	...
			closely-dissected hillslopes	...
			widely-dissected, smooth hillslopes	...

Alaskan Mountainous-Landforms--Continued, 3.

I Grand Landform	II Great Landform	III Major Landform	IV Component Landform	V Landform Element
[VALLEYS]	...	...	•••	•••
	[valley bottom (floor)]		•••	••• •••
		valley gorges/canyons	•••	•••
		floodplains	•••	•••
			wander scars	•••
			oxbow lakes	•••
			river [natural] levees	•••
			braided channels	•••
			low stream-terraces	•••
[PLAINS]	•••	•••	...	•••
	till plain	•••	...	•••
		lake bed	...	•••
		kettle & kame topography	•••	•••
			[kettle]	•••
			[kame]	•••
		glacial *[ground?]* moraine	•••	•••
		terminal moraine	•••	•••
	outwash plain	...	•••	•••
	(i.e., "outburst floodplains" of I.D. Legend--youthful outwash plains)			
	coastal plains		•••	••• •••
		marine terraces	•••	•••
[SHORELINE]	• • •	•••	•••	•••
		river deltas	•••	•••
		estuaries	•••	•••
			intertidal mudflats	•••
			saltwater marshes	•••
		beaches & dunes		
			sand beaches	•••
			sand dunes	•••
		uplifted (inland) beaches	•••	•••
			stabilized dunes	•••
		spits	...	•••
		tars	...	•••
		barrier islands	...	•••

NOTE: These "major landform" units seem too heterogeneous, too dependent on diagnostic peat-forming vegetation. Their otherwise traditional component landforms are listed above. Gently Sloping Lowlands: cirque-basin bottoms, valley bottoms, till plains. and coastal plains. Flat Lowlands: outwash plains, till plains, stabilized upper alluvial terraces, lacustrine basins, marine terraces.

A SPECULATIVE CLASSIFICATION OF GLACIO-FLUVIAL LANDFORMS

I Grand Landform	II Great Landforn	III Major Landform	IV Component Land torn	V Landforn Element
GLACIO-FLUVIAL LANDFORMS				
	(erosional)	Roche Moutonee	...	Crest
				Backslope
		Wave-Worked Boulder-Field		
		Cirque	Cirque Headwall	...
			Cirque Floor	Flat
	Till Plain	...	...	...
		Ground Moraine	...	Flat
				Pothole
			Hill/Hillock	Crest/Summit
				Backslope
				Footslope
			Swale	Flat
			Drumlin	Summit
				Backslope
			Kame	crest
				Backslope
			Kame Terrace	Flat
				Backslope
				Kettle
			Esker	Crest/Summit
				Backslope
		Terminal Moraine	...	Crest
				Backslope
		Recessional Moraine	...	crest
				Backslope
		Lateral Moraine	...	crest
				Backslope
	Outwash Plain	...	...	Flat
				Kettle
		Outwash Terrace	...	Flat
				Kettle
				Backslope (scarp)
		Valley Train	...	Flat
				Kettle
		Delta Plain	...	Flat
	Lake Plain	...	...	Flat
			Lake Plain Terrace	Flat
				Backslope (scarp)
	Loess Plain	...	...	Flat
		Loess Hill	...	C-S/S/G/F/T

A SPECULATIVE CLASSIFICATION OF SOME GENERAL LANDFORMS

I Grand Landform	II Great Landform	III Major Landform	IV Component Landform	V Landform Element
MOUNTAINS (variously > 300 m or > 1,000 ft. high)				
	Mountains			
		Mountain Summits	•••	•••
		Mountain Ridgetops	•••	•••
		Mountain Sideslopes	•••	•••
		Mountain Valleys	•••	•••
		Mountain Foothills	•••	•••
		Mountain Footslopes	•••	•••
	Calderas	...	•••	•••
	Volcanic Cones	...	•••	•••
		Craters	•••	•••
		Volcanic Flows	•••	•••
	Block Mountains	...	•••	•••
	Folded Mountains		•••	••• •••
	Dome Mountains	...	•••	•••
HILLS (variously < 300 m or < 1,000 ft. high)				
	Hills (a group, or large area of similar hills & valleys)			
		Hills/Ridges		
			Hill Crests/Summits	Crest/Summit
				Shoulder
				Saddle
			Hill Sideslopes	spur
				Backslope
				Footslope
				Landslide
		Foothills	•••	...
		Buttes	•••	...
		Cinder Cones	•••	•••
		Cuestas	•••	•••
		Hogbacks	•••	•••
		Mesas	•••	•••
		Knobs/Knolls	•••	•••
		Nunataks	•••	•••
PLATEAUS				
	Plateaus	...	•••	•••
	Mesas	...	•••	•••
	Tablelands	...	•••	•••
	Dissected Plateaus		•••	•••
		High/Low Hills	•••	•••
		Valleys/Canyons	•••	•••
	Scabland	...		•••

Speculative Classification of Some General Landforms--Continued, 2.

I Grand Landform	II Great Landform	III Major Landform	IV Component Landform	V Landform Element
PLAINS				
	Plains	...	...	...
		Hills/Ridges/Valleys	...	...
		Pediments	...	...
		Rock-Pediments	...	...
	Coastal Plains	...	...	...
		Hills/Ridges/Valleys	...	...
		Pediments	...	...
		Rock-Pediments	...	...
		Pocosin	...	...
	Till Plains	...	...	...
	Lake Plains	...	...	...
	Lava Plains	...	...	...
	Karst Plains	...	...	...
			Sinkhole	...
RIVER VALLEY	...	...	...	...
	Valley Floor	...	...	Flat
		Floodplain	...	Flat
			Channel	Channel
				Point Bar
				Knickpoint
			Meander	Channel
				Slough
			Braided Channel	Channel
			Natural Levee	...
			Backswamp	Flat
			Oxbow Lake	...
	Valley-Border Surfaces			
		stream Terrace	...	Flat
				Backslope (scarp)
		Strath Terrace	...	Flat
				Backslope (scarp)
		Structural Bench	...	Flat
				Backslope (scarp)
		Pediment	...	Flat
				Backslope (scarp)
		Valley Sideslope	...	Backslope
	Bluff	...	...	C-S/S/B/F

Speculative Classification of Some General Landforms--Continued, 3.

I Grand Landform	II Great Landform	III Major Landform	IV Component Landform	V Landform Element
SHORELINE				
		Reef	...	...
	Beach	Beach	Beach	...
				Wave-cut Platform
				Wave-built Terrace
				Swash zone
				Berm
			Beach Ridge	...
			Barrier Flat	...
			Spit	
		Beach Terrace	...	...
		Barrier Beach	...	...
		Bar	...	...
		Lagoon	...	...
		Mud Flat/Tidal Flat	...	...
		Foredune	...	...
		Marina Terrace	...	...
		Delta	...	...
		Headland	...	...

National Cooperative Soil Survey Converence

July 24-28, 1989

Lincoln, Nebraska

Northeast Agricultural Experiment Station Report

by

John C. Sencindiver

West Virginia Agricultural and Forestry Experiment Station

Morgantown, W

This report will summarize activities in the following areas:

A. 1988 regional conference committees and task forces.

B. Activities of NEC-50, the northeast experiment station coordination committee on soil survey, and

C. Research programs.

For further details of each of these topics I suggest that you refer to the 1988 Proceedings of the Northeast Cooperative Soil Survey Conference which was held at the University of Maine at Orono.

A. Committees and Task Forces of the 1988 Regional Conference.

Committee 1: The Impact of the Food Security Act on the Soil Survey Program in the Northeast; Chairman, William Hatfield, SCS State Soil Scientist, West Virginia.

Charges:

1. To identify NCSS responsibilities for FSA and how they affect the soil survey program in the northeast.

2. To identify NCSS activities to be carried on in the northeast after 1990 when mapping is completed for FSA.

Responses:

Charge 1 - FSA has affected the soil survey program both positively and negatively, but most of the affects have been positive. Positive effects are the following:

a. Has given that portion of soil science that deals with field identification, characterization, and interpretation a "shot" of enthusiasm.
b. Although there is added pressure, soil scientists have a feeling of being needed.
c. Increased awareness of the need for soil survey.

d. Forced soil scientists to set priorities and to become more efficient.
e. Broadening of experience for soil scientists on details.
f. Accelerated the mapping of cropland.
g. Increased funds.

On the negative side, some previously started surveys have been delayed because soil scientists have been detailed to other areas. Also, some reviews have been delayed, and others have been shortened to accomodate reviews in counties with extensive mapping for FSA. The pattern of mapping has been altered from block mapping to the less efficient farm or tract mapping.

Charge 2: The following activities should receive the highest priority after 1990.

a. After completion of FSA work the backlog of surveys will need to be correlated and published.
b. Basic soil services.
   (1) Interpretations.
   (2) User training-(within SCS and outside SCS).
   (3) Remapping at a larger scale.
   (4) Interdisciplinary input.
   (5) Maintaining technical guides, etc.
c. Updating and recorrelating previously published surveys.
d. Developing potential or similar methods of presenting soil survey data.
e. GIS development.

<u>Committee 2</u>: Soil-Water Contamination; Chairman, Peter Veneman, University of Massachusetts.

Charges:

1. What are the soil properties that are important to the soil-water relationship, especially involving the addition of wastewater or the movement of organics through the soil?
2. Evaluate interpretations in the NSH relating to the addition of wastewater to the soil? Are the guidelines in the NSH sufficient for rating the interpretations?
3. Identify new interpretations that may be needed.
   a. Are-there interpretations that should be developed for wastewater disposal that are not in the NSH?
   b. If so which ones?
   c. What soil properties and ranges are needed for the interpretations?
   d. What are the restrictive features?
4. IS more research needed to better understand the soil-water relationship, especially relating to wastewater disposal and to the movement of organic compounds in the soil environment? If so, in what areas and for what soil properties?

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Recommendations:

Based on the items included in this report and the deliberations during the meeting, the committee recommends the following:

1. To change the restrictive feature designation of "poor filter" to "rapid percolation".
2. To use the "frozen soil" designation as the appropriate soil property in the interpretation guide tables for waste management, to indicate a permafrost condition.
3. To reevaluate the use of the limitation terms "slight, moderate, and severe".
4. To more accurately define the limiting features in the interpretation tables.
5. To evaluate the potential of using soil-water state information in simple prediction models assessing the potential leachability of pollutants.
6. To develop a computer assisted procedure calculating the temporal variability in the soil-water state of major soil series in several MLRAs in the northeastern region.
7. To continue this committee to accomplish items 5 and 6 of these recommendations.

Committee 3: T Factor; Chairman, Fred Gilbert, SCS State Soil Scientist, New York.

Charges:

1. Evaluate the guidelines for assigning the T factor to a soil series in the National Soils Handbook (NSH).
2. Is the definition of renewable and nonrenewable soil in the NSH sufficient? If not how can it be improved?
3. Can observable soil properties be used as criteria to assign T values to a series? If so, what properties?

Recommendations:

1. The Guidelines are general and clear. It is apparent, however, that the application of these guidelines has not been carried out in good fashion.

   It is the committee's recommendation that a computer program be developed that would query data to locate inconsistencies.

2. The definition is insufficient and is subject to varied interpretations. He suggest that criteria be developed for renewable and nonrenewable surface layers followed by specific applications to subsurface layers; i.e., till with bulk densities of 1.8 or greater, saprolite, etc.

3. Observable properties can be used as criteria to assign T values. Some of these properties are:

   a. Depth to rock, saprolite, coarse layer, fragipans, dense till, clay pans, micaceous layers, free carbonates, extremely acid or alkaline layers, and other root limiting layers.
   b. Texture (available moisture).
   c. 'Organic matter distribution.
   d. Soil structure.
   e. Soil tilth.
   f. Rock fragments.
4. Terminate this committee.
5. Continue study of the subject of soil tolerance to erosion but with a new committee. Focus the committee as follows:

   Explore a new system in addition to the present that would indicate soil fragility. The system would use existing data. It was recommended that the conference structure a committee to explore a fragility index based upon readily available records. It was further recommended that the committee consider all available research in devising a fragility index. Several proposals have been published. The fragility index should consider various planning horizons, the years that the soil would be used for production. The new quantities should be presented in such a way that they would not be confused with the current "T" values.

Task Force 1: Soils of the Northeastern States; Chairman, Edward Ciolkosz, The Pennsylvania State University.

Background

Bulletin 848 of the Pennsylvania Agricultural Experiment Station, Soils of the Northeastern United States, was published in 1984. Committee 4 of the 1984 Northeast Cooperative Soil Survey Conference suggested that an additional report be prepared that would provide interpretations for the map units on the General Soil Nap in Bulletin 848. This has not been done. The supply of Bulletin 848 has diminished to the extent that if an interpretative report were prepared, there would be no publication to go with it. Additionally, SCS is requiring all states to prepare a state general soil map (STATSCO) at a scale of 1:250,000. This map will be available with some interpretive material.

Task Force Considerations: (Charges)

1. Does the proposed interpretative report (to supplement Bulletin 848). overlap, conflict, or duplicate information that will be prepared by the STATSCO map?

2. Should Bulletin 848 be reprinted?

3. Should Bulletin 848 be reprinted with revisions?

4. Should Bulletin 848 be reprinted with interpretations?

5. If revisions and additions of interpretations are suggested, who will develop the interpretations and revise the Bulletin?

Recommendations

1. The bulletin should be revised and a standard format be established for the chapters to make the bulletin more consistent and complete.

2. The map should be compared to the STATSCO map and revised only if there are major discrepancies between the two maps.

3. Only general interpretations should be included in the bulletin at about the great group leve.

4. The conference steering committee should establish a map and bulletin committee and an overall committee chairman to get the job done.

Task Force 2: State Soil Survey Database; Chairman, Greg Schellentrager, SCS Assistant State Soil Scientist, Vermont.

Charge 1: Are there soils data that should be in the State Soil Survey Data Base but currently cannot be stored?

It was recommended that Soil Conservation Service offices work closely with Agriculture Experiment Stations in determining the need for additional the State Soil Survey Data Base data tables. These data tables should be designed to meet the demand for both University and Soil Conservation Service needs.

Charge 2: Are there data needed by Universities or consultants that are not currently in the State Soil Survey Data Base?

Categories of data which could be useful to Universities and consultants were identified. These data generally do not conform to the current structure of the State Soil Survey Data Base. It was recommended that the Soil Conservation Service and Universities continue to investigate a means for linking site specific (point) data to soil map units and automating these data.

Charge 3: How can individuals, other than Soil Conservation Service, use the data in the State Soil Survey Data Base?

The lack of responses of many of the non-Soil Conservation Service committee members to the questionnaire, as well as discussion during committee meetings and the general sessions, indicated to the task force that there is little awareness of the availability of automated soil survey information outside of the Soil Conservation Service. It was the consensus of this task force that the State Soil Survey Data Base software and data should be available to those who ask for it. State wide data could be distributed through the University/Extension systems. County based data could be distributed through the Soil and Water Conservation Districts.

Soil Conservation Service National Headquarters should provide policy pertaining to the potential reimbursement of costs associated with the distribution and subsequent maintenance of data and software.

Charge 4: Should individuals, other than Soil Conservation Service, access a 3B2? If so, what security factors need to be considered?

It is recommended by this task force that telecommunication access to the 3B2 in which the Official State Soil Survey Database resides should be limited. When access is provided via telecommunications or any other method, read only permissions should be assigned to the login.

B. Activities of NEC-50.

The major activities of NEC-50 have been the following:

1. A computerized listing of available pedon data. The list includes soil names, location of data and types of data, but no data are given. Only experiment station data are included.
2. Soils of the Northeastern United States, Bulletin 848, was published in 1984 by the Pennsylvania Agricultural Experiment Station in cooperation with the other northeast stations. Revision and reproduction of this bulletin are being planned.
3. A one-week long regional soil genesis field course (trip) has been conducted for several years for graduate students and faculty. Visits are made to different parts of the region each summer. The 1989 field trip will be held in New Hampshire.
4. A regional soil mapping course has been discussed. It will be further discussed at the 1989 NEC-50 meeting.

C. Research Activities.

Environmental research continues to be emphasized in the northeast. The following list of research projects was extracted from reports submitted by each of the northeastern experiment stations and published in the 1988 proceedings of the northeast conference.

Connecticut

1. Movement of toxic organics from on-site septic systems.
2. Effects of pesticides on groundwater quality.
3. Gains, losses and management of soil nitrogen.

Delaware

1. Characterization and genesis of loess - derived soils.
2. Morphological indicators of soil moisture regimes.
3. Affect of selective dissolution on particle density.

Maine

1. Effect of woodash on soil nutrient composition.
2. Evaluation of deep soil incorporation and annual maintenance dressings of fertilizer on apple nutrient deficiency disorders.
3. Examination of the contribution of aggregate bound N and K to plant nutrition.
4. Distribution of N in soils which have received various organic amendments.
5. Nutrient cycling in northern New England forests, particularly as that cycle is affected by disturbance.
6. Soil characterization studies in active soil survey areas.

Massachusetts

1. Soil moisture regimes.
2. Fragipans.
3. On-site sewage disposal.
4. Phosphorus sorption.
5. Soil water movement.
6. Landfill leachate treatment utilizing artificial wetlands.
7. Spatial distribution organic matter.

Maryland

1. Morphology, characterization, classification and reclamation of highly man-influenced and acid sulfate soils.
2. Pedogenesis, iron sulfide formation, and iron and trace metals in tidal marsh soils of the Chesapeake Bay.
3. Aquods on the eastern shore.
4. Micromorphology and trace metals of glauconitic parent materials.
5. Physical modeling of soil reflectance.
6. Oyster shell middens effects on soil chemical properties.

New York

1. Soil temperature regimes in the Catskills, Salamanca Re-entrant, Glaciated Allegheny Plateau and Champlain Valley.
2. Dye tracer analysis for evaluating nonpoint source pollution.
3. Development of a soils database for Central America.
4. Preferential reduction of hematite over goethite in some oxisols in Brazil.
5. Pedogenesis and landscape evolution in the Salamanca Re-entrant, Southwestern New York.
6. Strength analysis and micromorphology of fragipans in loess-derived soils of northeastern Louisiana.
7. Comparative, iron mineralogy in brown and redbed till-derived soils of the Catskills.

8. Radon flux in New York soils.

Pennsylvania

1. The potential of information systems for soil survey information.
2. Amorphous materials in soils from various parent materials and drainage classes.
3. Radon in soils.
4. Pedogenesis of well-drained soils developed from limestone materials.
5. Soils developed from tall grass prairie in northwestern Pennsylvania.
6. Remote sensing projects related to soil resources.

Rhode Island

1. Distribution of heavy metals from urban runoff in a vegetated detention basin.
2. Nitrogen removal from on-site sewage disposal systems: a field evaluation of alternative and conventional designs.
3. Use of soil survey and GIS processing for groundwater protection.
4. Management implications of a state-wide GIS.
5. Soil properties in the transition zone forested wetlands.

Virginia

1. Soil erosion and productivity of the Piedmont region.
2. Minesoil genesis.
3. Statistical description of map unit composition.
4. Studies of high elevation Haplumbrepts.
5. Floodplain and terrace systems in the great valley and lower Coastal Plain.
6. Saprolite weathering in soil landscapes formed from schistic and gneissic parent material.
7. Genesis and characterization of residual soils influenced by colluvium in the Piedmont.
8. Characterization methods for quantifying mica.
9. The extent and nature of capping on major interfluves along an east to west transect in the southern Piedmont.
10. Characterization studies in support of active soil surveys.

West Virginia

1. Reclamation of abandoned minelands.
2. Minesoil mineralogy.
3. Characterization, classification and genesis of minesoils.
4. Use of volunteer and man-made wetlands to treat acid mine drainage.
5. Land application of sewage sludge.
6. Utilization of fly ash and wood residues in mineland reclamation.
7. Evaluation of different methods of determining lime requirement of minesoils.
8. Characterization of soils for wastewater disposal potential.

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West Agricultural Experiment Station Report to the National Cooperative Soil Survey Conference in Lincoln, Nebraska, July 24-28, 1989

by Chien-Lu Ping, Associate Professor of Agronomy

This report is based on the WRCC-30 report in WRWPC in Maui, Hawaii, June 1988, informal discussion with members of the WRCC-30 during the ASA meeting in Anaheim, California, Nov. 1988, and some subsequent exchange of ideas after the meeting.

A. Activities of West Agricultural Experiment Station related to NCSS:

1. Soil mapping

Several stations have been actively involved in soil mapping either through contract or research projects. Oregon and Washington are ready to publish a general soils map. Montana cooperated with SCS to map saline seeps using color-IR photography. Alaska has a contract to map 12000 acres as part of a soil baseline study for Usibelli Coal Mine. Wyoming has reported 25000 acres of rangeland mapped.

2. NCSS reviews and correlation

and manuscript **review**

Most stations participate in field reviews and correlationshin support of NCSS. However, the degree of participation varies among stations. The primary concern for the University representatives is the requirement of publication. Some states have been successful in making use of NCSS reviews to identify research needs or topics, and obtain logistical support from cooperators, mainly SCS, to do transect and sampling.

3. Teaching and research

Nearly all representatives of the West Agricultural Experiment Station are involved in teaching rlasses in soil genesis and classification and soil management and field trip classes.

Research projects on soil genesis and classification contribute. and knowledge of the soils to the revision of Soil Taxonomy. Alaska, Arizona, California, Idaho. Oregon, and Washington have research projects contributing to the Andisol proposal and Spodosol revision, whereas Arizona, California, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming are contributing to the Aridisol revision. Nearly all stations have on-going soil climate research programs contributing to the redefinition of soil moisture and soil temperature regime.

Coordination committee WRCC-50, Soil Climate and Vegetation Indicator, will be discontinued after 1989. Propose to combine with WRCC-30.

4. Laboratory analysis procedures

   After 4 years of comparative study, the laboratory analysis **committee** of WRCC-30 found high variability in several of the routine analyses, e.g. extractable cations, exchangeable acidity, and particle size distribution. This study raises a flag on the value of the information to be stored in the national pedon data base.

B. Concerns to the West Agricultural Station and NCSS

1. **Most stations** reported decreasing enrollment in agriculture **science, including** soils, in recent years. This raised the concern'in the universities that such trends would hurt the continuity of programs. Also, it would hurt the NCSS in the future if there were not enough soil scientists to fill the positions.

2. Most stations also reported decreasing support in soils research. On the national level, the emphasis of agriculture research has been placed on biotechnology and molecular biology, and most recently on water quality. It is more difficult for soil scientists to get support to do basic research in soil genesis and classification that would benefit NCSS. In many cases, soil genesis and classification research projects are embedded in other programs. California and Montana have been successful in winning contracts applying soil classification to management practices.

   Faculty in the universities are required to produce refereed journal articles from their activities. Activities related to NCSS generally do not fit this category. This sometimes discouraged the faculty members from participating in NCSS related activities. Mechanisms should be considered at the higher levels in both USDA-SCS and the agricultural stations to facilitate such cooperation and benefit the academic requirement.

3. The 1990 Work Planning Conference is scheduled to be held at the campus of University of Alaska Fairbanks from June 22-28, 1990. It is ideal to bring this regional group to focus on the soil classification and mapping and land management in the subarctic zone, not only because many of the western states share the cryic and even pergelic soil temperature regime in the alpine zone, but also because of the recent interest of US-Soviet cooperation. The site of this conference is unique because **UAF** is the only institution in the US involved in land resource research and management in the circumpolar region, and SCS in Alaska is the primary NCSS unit that deals with soil survey in the permafrost zone. I would like to take this opportunity to welcome you all to come to this conference.

The Use Of Geographic Information System (GIS) In the Soil Conservation Service (SCS)

by

George Rohaley
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Washington, D.C.

BACKGROUND

In 1985 the SCS got seriously involved with GIS when the Department of Agriculture awarded a contract to automate SCS state and field offices with AT&T computers using the UNIX operating system. The advent of the Field Office Communications and Automation System (FOCAS) gave SCS the opportunity to purchase hardware to support GIS.

At that time, very few GIS's operated in UNIX. An investigation and evaluation of the Geographic Resources Analysis Support System (GRASS) software found that GRASS was UNIX based, written in the "C" programming language, well designed, relatively easy-to-use, and public domain. GRASS was originally developed by the U.S. Army Construction Engineering Research Laboratory (CERL). The public domain software being free makes GIS affordable to our many state and county field offices. Commercial GIS software comparable to GRASS runs in the $15,000 to $20.000 range per licensed site.

Through a cooperative-agreement with CERL, the GRASS software was ported from the CERL SUN computers to SCS AT&T 3B2 and 386 computers. The "C" language and UNIX both help to simplify the porting of software to different hardware platforms. For example, GRASS currently runs on 10 different computer vendor hardware systems.

A careful an extensive pilot test was held in seven state locations, National Headquarters, and our National Cartographic Center (NCC). During this test period, SCS wrote computer programs or drivers which interfaced GRASS to digitizers, plotters, graphic cards. terminals and other GIS computer peripherals. SCS also wrote programs to allow certain types of available digital data (MIADS, SCS-GEF soil data, and ERDAS) to be imported to GRASS. GRASS imports most digital data through the federal defacto standard called DLG-3 Optional format developed by the USGS.

GRASS was selected as the agency supported GIS software in October 1988. The selection of a UNIX based GIS complies with the Agency policy which states SCS support for the UNIX operating system as the system of choice. We believe UNIX is an excellent choice since it is multi-user, portable, and a more powerful operating system than DOS.

IMPLEMENTATION STATUS

The SCS strategy for CIS technology at all levels of the agency is to make it available as a routine tool for the natural resource manager. Fifteen states presently have full-time GIS Specialists. User support such as training, technical assistance, and database development, reformatting, and maintenance will come from the NCC and the State Offices. Coordination of software and hardware development is managed by the Cartography and GIS Division, National Headquarters. An interagency GRASS Steering Committee made up by the many organizations using GRASS participate in the coordination and sharing of development.

Today, approximately 70 SCS sites have installed the GRASS software and are in the early stages of Implementing GIS. Approximately 35 pew sites are planned to receive GRASS in FY-90. Software installation in most states depends on the availability of financial resources for hardware, staffing and training. There is no national effort to equip all offices with a GIS. Most new sites are installing GRASS on the 386 machine as it runs 4 to 10 times faster than the 3B2 depending on the type of processing being done.

Guidelines have been established to help States implement GRASS in a logical and effective manner. Some of the guidelines are listed in sequential order:

- Obtain management support for GIS.
- Appoint a GIS Coordinator.
- Hire a GIS Specialist.
- Develop a State GIS Plan.
- Identify required databases.
- Check for existing databases.
- Select an accurate base map for digitizing.
- Allocate time and funds to acquire digital data.
- Secure funding for hardware.
- Take the Introduction to GIS training at NCC.
- Take the GRASS Users training at NCC.
- Allocate time for on-the-job training.
- Coordinate GIS activities with others.
- Establish agreements with others to share in the development and exchange of databases.

SCS GIS APPLICATIONS

Analyzing and managing natural resources is one of the major challenges facing the SCS in the future. Because SCS is a major land management agency, using GIS is a logical and natural outgrowth of that role. SCS conservation specialists frequently use geographic information from maps and aerial photography in helping land owners, State, and local government to manage land and water resources.

GIS is a very important technology which will be used in SCS to support the increasingly complex solutions required in wind and water erosion prediction, to analyze water quality and quantity and to develop effective conservation planning alternatives.

GRASS is very fast at analysis, it has proven to do very well in supporting township, county, and regional resource analysis and making soil interpretative maps. GRASS is used for soil map digitizing at the map compilation and or map finishing stage as it meets the national soil survey map digitizing specifications in vector format. Comparisons of digitizing soil surveys with GRASS to manually drafting or scribing have tested to take about the same time. The digital survey gives the user the added benefit of using the data in a GIS for analysis.

GRASS is presently being interfaced with the Computer Assisted Management and Planning System (CAMPS), which will require a field office user to have only minimal knowledge of GRASS or GIS to be able to generate a conservation plan map or a soil interpretative map. The scheduled release for this interface for state testing is April 1990, and is designed to be used on a 386 computer.

Digital soil surveys and other geographic databases for farm and field houndaries, hydrologic units and land cover are the primary natural resource map layers SCS plans to acquire for GIS analysis. Digitizing is said to take 70-80 percent of the cost to implement a full working GIS. SCS will be working with others to share in the development of these databases, we cannot do it alone. Many county governments are seeing the value of digital soil survey data and are supporting the digitizing effort while SCS provides the quality control in order to maintain the integrity of the original soil survey.

The SCS and the Bureau of Census signed a Memorandum of Understanding to exchange and update digital data. In brief, the Census Bureau will give SCS the TIGER (digital files of roads, political boundaries, and drainage at 1:100,000 scale) data and SCS in return will provide updated files as the data is used. TIGER will be used in SCS to form the base map for overlaying natural resource data at the county and local level.

SOFTWARE AND HARDWARE DEVELOPMENT

Some of the development efforts currently being worked on in SCS are summarized:

- Funding and cooperating in the development of interface programs which will allow users to import ARC-INFO, TIGER, and Integraph SIF files directly into GRASS without having to convert the data to DLG-3 before importing. This work will greatly increase the SCS ability to share and exchange spatial data files.

- Developing a SSURGO-GRASS and STATSGO-GRASS interface. This allows SCS-GRASS GIS users to more easily develop soil interpretive maps without having no special knowledge of GRASS or GIS concepts. This is being done in coordination with the National Soil Survey Center.

- The SCS and Forest Service have been cooperating for the past year in the porting of the LT Plus digitizing software to both agencies UNIX machines. The software has been dramatically enhanced as well. Preliminary tests show LT Plus to be 2 to 3 times faster in digitizing soil data compared to other public end commercial software. Release of this software for the AT&T hardware is set for April 1990. The NCC will provide training to SCS users of LT Plus.

- The SCS has improved the the plotting subsystem of GRASS. The new system called Map Gen enables GRASS to plot maps having high cartographic quality. Use of color fills, symbols. and different style and sizes of typefaces make GRASS output products equivalent to leading commercial systems. Map Gen is already being used but official release is set for June 1990.

STATUS OF FOREST SERVICE GIS PLAN
National Cooperative Soil Survey Conference
Lincoln, Nebraska
July 26, 1989
Don Eagelston

What Are We ...

The U.S. Department of Agriculture (USDA) Forest Service is responsible for managing nearly 200 million acres of land nationwide. The Agency employs over 30,000 employees in approximately 800 offices located in 45 states, Puerto Rico, and the Virgin Islands. We manage 156 national forests, 83 experimental forests and ranges, 19 national grasslands, and 16 land utilization projects. The Forest Service cooperates with the States in helping private landowners apply good forest practices on their lands, and we do research to find better ways to manage and wisely use our natural resources.

The Forest Service is a geographically dispersed organization, which is composed of five program areas:

- National Forest Systems
- Research
- State and Private Forestry
- Programs and Legislation
- Administration

Timberlands in the National Forest System account for 18 percent of all timberlands in the United States and rangelands account for 5 percent of the U.S. total. The Forest Service managed lands contain 128,000 miles of streams and two million acres of lakes and reservoirs. The National Forest System hosts more than 40 percent of all outdoor recreation in the United States.

The Forest Service mission is best expressed in the phrase, "Caring for the land and serving people". To successfully accomplish this mission, the Forest Service needs to be responsive to a wide variety of public uses of this land and its many natural resources and constructed features.

Managing information is also critical to the Agency's success. Forest Service managers need quality management information about "what" resources are available, and "where" they are located. This information must be relevant to the Agency's mission. It must be accurate, consistent, and timely. It must be easily accessible, commonly understood, and shareable.

Where We Have Come From ...

Like many other large organizations, the Forest Service started using computers in the **1960's.** These "decentralized" computers were located and used in several regional offices. Remote data communications were non-existent. The computers were used primarily for routine number crunching applications such as accounting and engineering. The systems were very **"unfriendly",** and only a few "computer **types"** knew how to operate them.

In 1973, large **"mainframe"** computers and "remote processing" came on the scene when the Department of Agriculture established the Fort Collins Computer Center (FCCC). The Forest Service used this **"centralized"** computer system over the next ten years to support a number of **"national"** business, engineering, and resource management applications. Remote access to FCCC was through **"dumb terminals"** and a low-speed data communication network. The applications were run mostly by trained specialists. While word processing technology began to appear late in this period, typewriters, calculators and telephones were still the predominant office tools.

In the **1980's,** we have witnessed another significant stage in the evolution of the Forest Service computing environment. We began the transition from the "computing **era" characterized** by management's attempts to contain and control the proliferation of diverse functional computer systems: to the **"information era"** characterized by **management's** initial efforts to bring essential information together in an integrated and managed information environment.

In 1983, the Forest Service made a **giant step** forward by beginning to implement a "distributed processing" system that was designed to be accessible and used by all employees. With investments totalling S125 million to-date, we now have about 865 **"mini-computers"** and about 18,000 terminals located in all of our offices and serving all of our employees Service-wide.

During this round of office automation, we have revolutionized the way we communicate and share information through the introduction of electronic mail, word processing, and a filing system. We have also successfully begun to automate our **"administrative"** class of information and streamline a number of processes in the areas of finance, procurement, and personnel.

The returns from these investments have been significant. Over the past five years, we estimate that the benefits have exceeded the costs by five times. The payoffs have been in the areas of increased accessibility by all employees to timely and consistent information, streamlined management tracking and reporting systems, increased data accuracy, and overall more efficient processes.

Where Are We Headed . . .

We are now preparing to enter a new phase in the evolution of our information environment. The planned GIS procurement provides the Forest Service with an opportunity to begin to automate another class of information -- spatially related information about the natural resources and constructed features we manage. More importantly, it provides 'an opportunity to take another big step toward integrating all of our management information into one seamless "one-stop-shopping" automated information environment.

Currently, the technology used to store, access, analyze, and display resource information, and the terminology used to describe this information, varies widely throughout the Forest Service.. It is clear that shareable, quality resource information, available through a common, easy-to-use information delivery system will help the Agency more effectively accomplish its mission.

Consequently, in January, 1988, the Chief of the Forest Service approved a plan for implementing geographic information system (GIS) technology Service-wide beginning in 1991. The focal point of this plan is the vision of resource managers being able to easily use GIS technology, and the information it supports, to get closer to the ground and better serve our publics.

The largest uses of GIS will be in developing and maintaining resource inventories, manipulating these inventories for resource management decisions, and in program and project design. Basic data (such as stream networks, transportation, land ownership, elevation, culture, soils, vegetation, geology, and cultural resources, etc.,) will be utilized in analysis. Other uses of the GIS include, but are not limited to, resource monitoring, forest plan implementation, inventory maintenance and update, etc. Currently, our resource inventory data resides on maps, map overlays, photos (both geodetically controlled and uncontrolled photography), books, various hardcopy and digital files, microfiche, etc.

Geographic information system technology will be used for the collection, input, storage, retrieval and analysis of data and presentation of geographically referenced, or spatially located information. It will help the Forest Service achieve its mission through better resource data analysis and display. It will also facilitate the sharing of data and information needed to support resource management decisions. It will automate the data that has traditionally resided on maps and various hardcopy data records. Hardware and software technology will allow the user to perform work in an automated electronic environment that is currently done by manual processes.

What Are Our bong-Range Plans...

Data and information are vital resources, Everyone, and every job, in the Forest Service depends upon having timely and accurate data and information. It is important that an environment be created within which all employees can use these resources easily to carry out their work. This data and information environment will provide decision-support tools needed to manage the land and its resources: it will facilitate the sharing of data and information, both internally as well as with the publics we serve: and it will enable the agency to be administered efficiently.

It is the combination of GIS technology and data base technology that will enable Forest Service managers to share data or information about resources within the organization, as well as externally with our cooperators and publics the agency serves.

The following principles provide a focus and some guidelines for accomplishing the GIS objective:

0 The national GIS technology and information structure will support the management information needed by the Agency to accomplish its mission, which includes addressing issues and making decisions on all lands within the National Forest System, as well as facilitating activities within Research and State & Private Forestry.

0 GIS data shall be organized and described to facilitate understanding and sharing of management information both horizontally and vertically within the organization, and with other land management agencies and organizations where possible.

- Forest Service managers must be able to easily access the technology and the information is supports via a "non-technical, user-friendly' human interface;

- Technology shall be flexible enough to expand and incorporate new related technologies as they become available.

Our strategy for implementing the new technology is based on building from the bottom-up, implementing on the Ranger District first. The Ranger District is where we do most of our resource management work, and it is where we have most of our direct contacts with the publics we serve. The Ranger District is the primary source and user of most of the resource data and information. This implementation strategy will be supported by a family of general purpose servers and workstations, supporting GIS functions and the full range of administrative, scientific, and technical applications which will become the information platform of the 1990's for the agency.

NCSS Conference, Lincoln Nebraska, July 27,1989

Land Information Systems in the Bureau of Land Manaaement

Danny L. Tippy, BLM, Phoenix Training Center

OUTLINE:

1. LIS in general (SEE ATTACHED LIS PAMPHLET)

   A. ALMRS

   B. GCDB

   C. ARD/GIS

   D. Why BLM is doing all this?

      High priority from all management

      Major investments are committed to this, 100's of millions

      25 million per year now

      System design is going ahead

   E. Where are we at today?

      BLM focus: data administration is the challenge

      - Data managers- will help us avoid islands of separate automation, people are not trained, and need to be.

      - Data standards- bureau-wide we have to have set standards for each data theme, and we are currently working on this.

      - Quality control- garbage in garbage out

      - Data sharing- why duplicate what other agencies have already done

      - This system will be used in all BLM offices at 225 separate locations, currently less than half have access. There will be 65 Prime main frame computers in the interim system.

      - Target system will be in place, from 1993 to 2000

2. How does soils fit into this? Where are we now? What will happen in the future?

A. Data standards - We have an established committee that is working on soil standards. We are using and intend to use NCSS standards for all soil data.

B. Digitizing - Digitizing is going on at various levels. Some are cooperative efforts, others are not. Some problems we've had are people digitizing soil information that isn't correlated or joined between orthophotos. People are anxious, but we must keep to standards. An interagency approach is essential to making sure we keep up to standards.

C. Supplemental mapping - The BLM would like to use GIS to upgrade order III 'and IV surveys. Using digital elevation models (DEM's), for slope class maps, and aspect maps, and other remote sensing data we can increase the quality of our soil information dramatically.

D. Displaying information - ELM is a multiple use agency. We intend to use soil information in.our land use planning. GIS is making it easier to display soil information to our users and decision makers. Combining soil information with other resource data, other information such as DEM's, can increase our effectiveness and usefulness to resource management.

E. Interfacing models to soil surveys - Another aspect of using soil data in GIS is to interface that soil data with predictive models such as RUSLE or WEPP for large scale applications. Certainly the ongoing research in these models will take this into account.'

F. Joint efforts, Sharing information - there are ongoing joint efforts in use of soil information through GIS now in several states. Sharing knowledge and experiences is the key.

REVIEW OF GEOGRAPHIC-INFORMATION-SYSTEM TECHNOLOGY IN THE U.S. GEOLOGICAL SURVEY

by Kelly L. Warner

ABSTRACT

The Water Resources and Geologic Divisions of the U.S. Geological Survey use geographic information system (GIS) extensively in studies of water resources and earth sciences. A GIS combines two computer software technologies: data-base management and digital mapping. The computer hardware currently used for GIS processing is mostly minicomputers. Three Survey GIS research laboratories provide state-of-the-art equipment and expert personnel for answering technical and application questions. The multitude of features that can be shown on maps complicates the application of standards for GIS coverages.

The Survey has produced many national coverages that were generated to show spatial distribution of geologic end hydrologic characteristics. The Survey maintains several quality-controlled national data bases that can be used to create digital coverages. Local coverages, which are created for specific projects, are used for planning and analysis. The Survey maintains a computerized data-management system--the Earth Science Data Directory--that references Federal, State, and local digital data.

The Water Resources and Geologic Divisions of the Survey are continually considering new research topics and applying GIS to study these concerns. The GIS will continue to be a major pert of the computer technology of Survey because it has proven to be a valuable and effective way to manage and display data.

INTRODUCTION

Purpose and Scope

This overview describes the use of geographic information systems (GIS) technology in the U.S. Geological Survey. The Survey consists of three program Divisions (Geologic, Water Resources, and National Mapping) and two support Divisions (Information Systems and Administrative). The three program Divisions represent the Nation's primary producers of cartographic, geographic, hydrologic, and geologic data. All three program Divisions are using GIS for their traditional mission of data collection, research, and information retrieval. Although it is not surprising that the National Mapping Division uses GIS in its cartographic and geographic missions, the Water Resources and Geologic Divisions also have extensive GIS activities related to their studies of water resources and earth sciences. This paper is concerned primarily with GIS activities in the Water Resources and Geologic Divisions of the Survey.

Organization of U.S. Geological Survey

The Geologic Division is organized largely along programmatic lines. It consists of six line offices--Regional Geology; Mineral Resources; Earthquakes, Volcanoes, and Engineering; International Geology; and Scientific Publications--and 29 subordinate branches through which Division programs are implemented. The line offices are all headquartered in Reston, Va., and the branches are variously headquartered in Reston, Va., Denver, Colo., Menlo Park, Calif., Flagstaff, Ariz., Anchorage, Alaska, and Woods Hole, Mass.

The Water Resources Division is structured by geographic area. It is organizationally divided into four geographic regions--Northeastern Region (Reston, Va.), Southeastern Region (Atlanta, Ga.), Central Region (Lakewood, Colo.), and Western Region (Menlo Park, Calif.). Each Region is subdivided into District offices. Each District office has the responsibility for water-resources data collection and publication for one to five States.

Definition of a Geographic Information System

A GIS combines two computer software technologies: data-base management and digital mapping. Data-base management is a systematic way of organizing and accessing tabular data. Digital mapping represents map elements as points, lines, polygons, or gridcells (Lanfear, 1989). For example, the outline of a hydrologic basin is a polygonal map element, and the tabular data associated with that hydrologic basin may be area and basin name.

STATUS OF GIS

Computer Systems

The Survey maintains GIS data bases and software for a variety of operational equipment. The hardware currently used for GIS processing is mostly minicomputers (88 percent), but some processing is done on a mainframe (2 percent) and microcomputers (10 percent) (Federal Interagency Coordinating Committee on Digital Cartography, 1988, p. 23). Ninety percent of the GIS software used by Survey is commercial, primarily ARC/INFO 1/, and 10 percent is public-domain software such as Geographic Resources Analysis Support System (GRASS). In 1984, following an extensive evaluation, the Survey began using an ARC/INFO based GIS developed by Environmental System Research Institute, Redlands, Calif., to organize, manipulate, analyze, and graphically display natural-resources information. There are 42 installations in the Water Resources Division and an estimated 200 to 300 active GIS users. Nearly all new projects use GIS in some way.

The Survey offers six GIS training classes. The topics of these courses include data-base planning, custom commands, ground-water modeling, GIS principles, GIS for managers, and GIS publications. Personnel from the Survey and outside agencies participate in these classes, which are usually taught in Denver. The course instructors are generally Survey personnel with expertise in the course topic.

Research Laboratories

The Survey operates GIS research laboratories in Reston, Va.; Denver, Colo.; and Menlo Park, Calif. (table 1). These interdisciplinary regional-research laboratories are operated by the National Mapping Division but support activities in all Divisions. They are equipped with a wide variety of hardware and software packages not usually found in the Survey District or Branch offices. For example, the Reston GIS laboratory has an artificial-intelligence center, image analysis system, vectorizing drum scanner, and compact-disk read only memory (CD-ROM) premastering system. The GIS research laboratory personnel test a variety of new computer cartographic technologies and hardware and software packages for applications to the study of natural resources.

Table 1. U.S. Geological Survey GIS research laboratories.

The laboratory staff works with personnel from all Divisions of the Survey to develop new methods and applications for GIS. Many programs for increasing the efficiency of GIS are done at the research laboratories. An example of these new methods and applications includes a procedure to perform a binary search on a key file, giving the GIS the capability to access massive data files quickly (Lanfear, 1987, p. 13; Parks, 1988, p. 1).

1/ Use of brand or trade names in this paper is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Table 1. U.S. Geological Survey GIS research laboratories.

Reston, Virginia	U.S. Geological Survey GIS Research Laboratory 586 National Canter **Reston,** VA 22092	(703) 648-4175
Denver, Colorado	U.S. Geological Survey GIS Research Laboratory Mail Stop 516 P.O. Box 25046 Denver, CO 80225	(303) 236-5838
Menlo Park, California	U.S. Geological Survey GIS Research Laboratory Mail Stop 531 345 Middlefield Road Menlo Park. CA 94025	(415) 459-4256

Data Transfer and Data Standards

Development and distribution of GIS coverages is not standardized. The National Committee for Digital Cartographic Data Standards (NCDCDS) and the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC) developed the proposed standards for digital cartographic data (Digital Cartographic Data Standards Task Force, 1988). These standards are still undergoing extensive empirical testing by the Survey. The policy of the National Mapping Division has been to release coverages officially only if they are in digital line graph (DLG) format.

Standardizing GIS coverages is complex because of attributes associated with each map feature. Not only do the topological features in the base map need to conform to a set of standards, but the quality of the attribute data associated with each map feature must be controlled and assured.

Funding

The funding for GIS operations and research in the Survey is from several sources. In 1988, 60 percent was appropriated agency funds, 10 percent was cost-shared funds with other agencies, and 30 percent was line item appropriation (Federal Interagency Coordinating Committee on Digital Cartography, 1988, p. 29). The Survey estimates that in 1988-89 more than $5 million will be spent on GIS. Sixty-five percent of the total expenditure will be for operational use, 30 percent for research and development, and 5 percent for testing and evaluation.

DATA BASES

National Coverages and Data Bases

The Survey has produced many national coverages to show spatial distribution of characteristics. Many of the national coverages generated by GIS are digitized from 1:2,000,000-scale maps and projected into Albers equal-area coordinates. National coverages include hydrologic basins. streams, county boundaries, State boundaries, and water bodies. These coverages may be displayed for the entire Nation, region, State. or county.

The maps in the 1986 National Water Summary (U.S. Geological Survey, 1988) were developed on a GIS and have added substantially to the national coverages. The maps include point population for the United States, contours of annual average precipitation and runoff, location of hazardous-waste sites, location of major dams, water-use information, and ground-water-quality data. Recently, the Geographic Names Information System (GNIS) has been used to generate a digital map (coverage) for the Nation which includes names of reservoirs, valleys, lakes, and other physical features. Other digital maps include those showing application rates of 184 pesticides by crop in each county (Gianessi and others, 1985). This coverage stimulated enough concern about aquifer susceptibility to contamination that en effort to develop a coverage of principal aquifers, based on aquifer maps from the 1984 National Water Summary (U.S. Geological Survey, 1985: Moody and Lanfear, 1988), has been started.

The development of GIS coverages is most limited by available data. If a data base contains locations, then a GIS coverage may be created. The GIS coverages are only as good as the data used to develop the coverage.

The Survey maintains several quality-controlled national data bases that can be used to create digital coverages. Latitude and longitude are required for all new data input. The Survey national data bases include, but are not limited to, the following: National Water Information System. (NWIS), National Water Data Exchange (NAWDEX), New State Water Use Data System (NEWSWUDS), Aggregated Water Use Data System (AWUDS), Ground-Water Site Inventory (GWSI), National Coal Resources Data Base System (NCRDS), Geographic Names Information System (GNIS), and Rock Analysis Storage System (RASS). A new data base, the National Geochemical Data Base, will include RASS and the Department of Energy's Uranium Resource Evaluation (NURE) information. This new data base is being developed by the Geologic Division. It will contain approximately 1.7 million analyses of the chemistry of rocks, soils, sediments., plants, and surface waters.

Local Data Bases and Cove-rages

Some GIS coverages are not derived from national data bases. The coverages are used for local projects and may have distribution restrictions. For example, the Illinois District is digitizing drainage basins for all gaging stations or sampling sites in Illinois. This coverage will be stored on the District computer and used for project planning and basin analysis. This coverage is not designed to be included in a national data base.

Some local GIS coverages may develop into national coverages. For example, the Oregon District, in cooperation with Bonneville Power Authority and other State and Federal agencies, is preparing a 1:100,000 basin-by-basin stream coverage for the Columbia River basin. This coverage includes attributes from the 1:250,000 U.S. Environmental Protection Agency River Reach coverage and the geographic features of the 1:100,000 Survey DLG hydrography coverage. This coverage is a common resource base for the northwestern United States; it is the prototype for a national stream coverage.

Local Survey offices can be contacted for information on local coverages. In the Geologic Division, the Branch Chief (table 2) may refer requests for information to the appropriate GIS project person. The project personnel using a GIS are the primary sources of information about specific coverages.

Table 2. U.S. Geological Survey, Geologic Division, Branch Chiefs.

The Water Resources Division has a GIS contact person in each District Office (table 3). These people are the local experts on the applications of GIS for the States in each District. Both the Geologic Division and Water Resources Division rely on the GIS research laboratories for help in solving technical problems.

Table 3. U.S. Geological Survey, Water Resources Division, GIS managers.

Table 2.--U.S. Geological Survey, Geologic Division, Branch Chiefs
[Anchorage is in Alaska; Menlo Park is in California; Lakewood is in Colorado; Reston is in Virginia; Woods Hole is in Massachusetts; Flagstaff is in Arizona.]

Branch Office	Location	Branch Chief	Telephone
Office of Mineral Resources			
Alaskan Geology	Anchorage	Donald Grybeck	(907) 78[illegible]-7403
Western Mineral Resources	Menlo Park	Edwin McKee	(415) 329-5477
Geochemistry	Lakewood	Lorraine Filipek	(303) 236-1800
Resource Analysis	Reston	William Menzie	(703) 648-6125
Central Mineral Resources	Lakewood	David Lindsey	(303) 236-5568
Eastern Mineral Resources	Reston	Bruce Lipin	(703) 648-6327
Geophysics	Lakewood	Thomas Hildenbrand	(303) 236-1212
Office of Energy and Marine Geology			
Petroleum Geology	Lakewood	Donald Gautier	(303) 236-5711
Coal Geolgy	Reston	Harold Gluskoter	(703) 648-6401
Sedimentary Processes	Lakewood	Walter Dean	(303) 236-1644
Pacific Marine Geology	Menlo Park	David Cacchione	(415) 329-3184
Atlantic Marine Geology	Woods Hole	Bradford Butman	(508) 548-4155
Office of Regional Geology			
Eastern Regional Geology	Reston	Wayne Newell	(703) 648-6900
Central Regional Geology	Lakewood	Glen Izett	(303) 236-1258
Western Regional Geology	Menlo Park	Rowland Tabor	(415) 329.4909
Isotope Geology	Lakewood	Carl Hedge	(303) 236-7880
Astrogeology	Flagstaff	Hugh Kieffer	(602) 527-7015
Paleontology and Stratigraphy	Reston	Richard Poore	(703) 648-5288
Office of Earthquakes, Volcanoes, and Engineering			
Engineering Seismology and Geology	Menlo Park'.	Thomas Holzer	(415) 329.5613
Global Seismology and Geomagnetism	Lakewood	Robert Masse	(303) 236.1510
Seismology	Menlo Park	William Bakun	(415) 329-4793
Geologic Risk Assessment	Lakewood	Kaye Shedlock	(303) 236-1510
Tectonophysics	Menlo Park	Wayne Thatcher	(415) 329-4810
Igneous and Geothermal Processes	Menlo Park	Robert Christiansen	(415) 329-5228

Table 3. U.S. Geological Survey, Water Resources Division. GIS managers

Location	Contact person	Commercial telephone
Anchorage, Alaska	Leslie Patrick	(907) 271-4138
Tucson, Arizona	Colleen Babcock	(602) 629-6629
Little Rock, Arkansas	John Terry	(501) 378-6391
Menlo Park, California	Richard Smith	(415) 329-4438
Sacramento, California	Ann Elliott	(916) 978-4633
Lakewood. Colorado	John Crisci	(303) 236-4895
	Debbie Spahr	(303) 236-4083
	Charles Washington	(303) 236-0896
Miami, Florida	Roy Sonenshein	(305) 594-0655
Orlando. Florida	Roger Belles	(305) 648-6191
Tallahassee, Florida	Miguel Orona	(904) 681-7658
Tampa, Florida	James Kiesler	(813) 228-2124
Doraville, Georgia	Jack Alahdeff	(404) 331-4858
Honolulu, Hawaii	Patricia Shade	(808) 541-2653
Boise; Idaho	Randall Fields	(208) 334-1847
Urbana, Illinois	Art Schmidt	(217) 398-5376
Iowa City, Iowa	Jim Majure	(319) 337-4191
Lawrence, Kansas	Claud Baker	(913) 864-4321
Louisville, Kentucky	Tim Liebermann	(502) 582-5241
Towson, Maryland	Gary Fisher	(301) 828-1535
Boston, Massachusetts	Saiping Tso	(617) 565-6892
St. Paul, Minnesota	Dave Lorenz	(612) 229-2617
Jackson, Mississippi	Mike Mallory	(601) 965-5587
Rolla, Missouri	Jim Morris	(314) 341-0832
Helens, Montana	Gary Rogers	(406) 449-5263
Lincoln, Nebraska	Donald Schild	(402) 437-5113
Carson City, Nevada	Elizabeth Frick	(702) 882-1388
Trenton, New Jersey	Curtis Price	(609) 771-3978
Albuquerque, New Mexico	Gary Levings	(505) 262-6653
Albany, New York	Patrick Simmons	(518) 472-2875
Syosset, New York	George Hawkins	(718) 895-0243
Raleigh, North Carolina	Thomas Frazier	(919) 856-4789
Bismark, North Dakota	John Atwood	(701) 250-4604
Columbus, Ohio	George Casey	(614) 469-5553
	Vance Nichols	(614) 469-5553
Oklahoma City, Oklahoma	Jonathan Scott	(405) 231-4256
Portland, Oregon	Tim McGrath	(503) 687-6446
San Juan, Puerto Rico	Agustin Sepulveda	(809) 783-4660
Columbia, South Carolina	Susan Lambert	(803) 253-3685
Huron, South Dakota	Debra Matthews	(605) 353-7176
Nashville, Tennessee	William Barron	(615) 736-5424
Austin, Texas	Randy Ulery	(512) 832-5791
Salt Lake City, Utah	Scott Bartholoma	(801) 524-5663
Reston, Virginia	David Stewart	(703) 648-6847
Richmond, Virginia	Todd Augenstein	(804) 771-2427
Tacoma, Washington	David Wilson	(206) 593-6510
	Scott McKillop	(206) 593-6510
Madison, Wisconsin	Greg Allord	(608) 274-3810
Cheyenne, Wyoming	Jim Wilson	(307) 772-2729

Additional Data Bases and Coverages

There are many references for available digital data. One reference, "Scientific and Technical, Spatial, and Bibliographic Data Bases and Systems of the Survey, 1983" (U.S. Geological Survey, 1983), is a comprehensive inventory of automated and nonautomated data bases that belong to many different entities. The Earth Science Data Directory (ESDD) is the computer data-management system for references to digital data. It is updated quarterly and is designed for automated retrievals. The ESDD has approximately 150 on-line users and 1,900 references. New users, from many different agencies, are continually being added to the list of references.

APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS

The primary applications of GIS in the Survey cover a variety of regional and local research topics, These topics include the national mineral resources assessment, regional earthquake-hazard assessment, the national mapping program, national earthquake-hazard reduction program, national water-quality assessment, strategic and critical minerals, offshore geologic framework, landslide hazards. and volcano hazards.

Water Resources Division

The Water Resources Division has applied CIS technology to study and map our Nation's water resources. The studies are too numerous to describe here, but a few examples will be presented. The Mid-Continent Initiative is an example of a regional project involving GIS. The study is to investigate the effects of agriculture on the occurrence of herbicides in ground water and surface water in the Midwest (Burkart and others, 1989). Hydrology, land use, soils, and other factors will be compiled in a GIS. These data will include site locations and county data at the largest scale and LANDSAT data at the smallest scale. Verification (ground truth) of estimates and variance will be determined. A Spatial Data Integration Coordinating Committee has bean established to organize this regional GIS effort.

An example of a statewide GIS project is the Illinois ground-water-quality study. The scope of this project includes 3,000 municipal wells and associated water-quality data from 1984-88 for Illinois. Spatial correlations and trends will be determined using a GIS. The coverages will be housed in the Illinois District office, Water Resources Division.

Geologic Division

The Geologic Division has applied GIS technology to study and map our Nation's geology and mineral resources. The mapping of surface materials is an example of a regional CIS project. A map showing Quaternary deposits in the glaciated States east of the Rocky Mountains has been recently completed and is being input into a GIS. Attributes of thickness and texture are associated with the map. This map is being used in studies for developing contamination-potential maps.

The study of hazardous areas in San Mateo County, Calif., is an example of a local project. The purpose of using a GIS is to develop maps that show liquefaction susceptibility, slope, aspect, predicted seismic intensities, potential for debris flows, potential for earthquake-generated landslides, and cumulative earthquake damage potential for buildings (Brabb, 1987). The digital maps are used for a variety of county land-use planning, emergency response, and decision making needs,

The aforementioned examples of regional, statewide, and local studies using GIS are just a few of the many ongoing research projects in the survey. The Water Resources and Geologic Divisions of the Survey are continually looking into new research concerns and applying GIS to study these concerns.

LONG-RANGE PLANS

The usefulness of GIS in the Water Resources and Geologic Divisions' program activities has been well established. New data bases will continue to be developed and put in GIS formats. The Divisions are now addressing the problems of distributing and maintaining GIS data bases.

The Water Resources Division is revamping its computer network. This means that the Survey will be making the transition from a microcomputer environment to a network of powerful work stations. Software used with the current computer system will continue to be used as this transition is being made. GIS will be a major factor in this future environment because it has become a valuable and effective way to manage and display data.

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NATIONAL COOPERATIVE SOIL SURVEY

National Soil Survey Conference Proceedings

St. Paul, Minnesota
July 13-17, 1987

United States
Department of
Agriculture

Soil
Conservation
Service

Proceedings National Cooperative Soil Survey Work-Planning Conference

St. Paul, Minnesota
July 13-17, 1987
(Reports from 1985 Conference included)

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NATIONAL COOPERATIVE SOIL SURVEY WORK PLANNING CONFERENCE
JULY 13-17 1987
ST. PAUL MINNESOTA.

NCSS - A 5 YEAR OVERVIEW

Monday - July 13

10:00 AM - 12:00 PM	Registration
12:00 PM - 1:00 PM	Lunch
1:00 PM - 1:15 PM	Welcome - Gary R. Nordstrom State Conservationist, USDA-SCS St. Paul, Minnesota
1:15 PM - 1:45 PM	Introductory Remarks Richard W. Arnold - Director Soil Survey Division - USDA - SCS
1:45 PM - 2:00 PM	County Soil Information System Dr. Pierre Robert & Dr. Richard Rust Dept. of Soil Science University of Minnesota
2:00 PM - 2:30 PM	Report on Soil Survey Activities of Mexico
2:30 PM - 3:00 PM	Break
3:00 PM - 3:30 PM	Report on Soil Survey Activities of Canada
3:30 PM - 5:00 PM	Soil Management Support Services
3:30 - 3:45	SMSS: an overview Dr. Hari Eswaran - Project Leader USAID: Washington, D.C.
3:45 - 4:00	Classification of Oxisols (ICOMOX) Dr. John Witty National Leader for Soil Classification - USDA - SCS Washington, D.C.
4:00 - 4:15	Classification of Andisols (ICOMAND) Dr. John Kimble Research Soil Scientist USDA - SCS National Soil Survey Laboratory: Lincoln, Nebraska
4:15 - 4:30	Classification of Vertisols

	(ICOMERT) Terry Cook - Soil Management Specialist - USDA Washington, D.C.
4:30 - 4:45	Discussion
Tuesday - July 14	Committee and Task Force Deliberation
8:00 AM - 9:45 AH	Group A - Soil Survey Data Bases
	Group B - Landscape Analysis and Design of Map Units
	Group C - New Packaging of Our Information
9:45 AM - 10:15 AM	Break
10:15 AM - 12:00 PM	Group A - Landscape Analysis and Design of Map Units
	Group B - New Packaging of Our Information
	Group C - Soil Survey Data Bases
12:00 PM - 1:00 PM	Lunch
1:00 PM - 2:45 PM	Group A - New Packaging of Our Information
	Group B - Soil Survey Data Bases
	Group C - Landscape Analysis and Design of Map Units
2:45 PM - 3:15 PM	Break
3:15 PM - 5:00 PM*	Task Force 1 - Food Security Act
	Task Force 2 - Soil Characterization Standards
	Task Force 3 - Soil Family Categories

*Experiment Station Representatives may want to use this time to discuss their report.

Wednesday - July 15 Field Trip

Thursday - July 16

8:00 AM - 8:45	Task Force 1 Food Security Act of 1985 - Kenneth Hinkley - Assistant Director - Soil Survey Division - USDA - SCS - Washington, D.C.
8:45 AM - 9:30 AM	Task Force 2 - Soil Characterization Standards Report - Dr. Steve Hnlzhey - Head - National Soil Survey Laboratory - USDA - SCS - Lincoln, Nebraska
9:30 AM - 10:00 AM	Break
10:00 AM - 10:45 AM	Task Force 3 - Soil Family Categories Report Dr. Ellis Knox National Leader for Soil Research USDA - SCS Washington, D.C.
10:45 AM - 11:30 AM	USDA - SCS Soil Survey Productivity Improvement Study Report - Richard W. Arnold
11:30 AM - 12:00 PM	U.S. Bureau of Land Management Report Jim Stone - Soil Scientist Washington, D.C.
12:00 PM - 1:00 PM	Lunch
1:00 PM - 1:30 PM	U.S. Forest Service Report Pete Avers, Soil Resource Program Manager Washington, D.C.
1:30 PM - 2:00 PM	Agricultural Experiment Station Report
2:00 PM - 3:00 PM	Impact of the Food Security Act of 1985 on SCS Programs Dennie G. Burns Associate Deputy Chief for Programs USDA - SCS Washington, D.C.
3:00 PM - 3:30 PM	Break
3:30 PM - 4:00 PM	Water Erosion Prediction Projects - Dr. George Foster USDA - ARS National Erosion Laboratory Purdue University
4:00 PM - 4:30 PM	Technical Developments in Soil Survey - Dr. Robert B. Grossman Pedologist - USDA - SCS National Soil Survey Laboratory Lincoln, Nebraska

Friday - July 17

8:00 AM - 8:30 AM	Committee 1 Report - Soil Survey Data Bases
8:30 AM - 9:00 AM	Committee 2 Report - Landscape Analysis and Design of Map units
9:00 AM - 9:30 AM	Committee 3 Report - New Packaging of our Information
9:30 AM - 10:00 AM	Break
10:00 AM - 10:30 AM	Open Discussion
10:30 AM - 11:00 AM	Closing Dr. Richard Arnold

NATIONAL SOIL SURVEY
WORK PLANNING CONFERENCE
BUS TOUR, JULY 15, 1987

8:00 - 9:00	Computer demonstration-Orientation on Soil Tech-Thunderbird Motel by Pierre Robert-Roger Knutson
9:00 - 9:45	Bus to Soil Tech Site
9:45 - 11:30	Field demonstration of equipment and technology (coffee and rolls served)
11:30 - 12:00	Bus to Minnesota Landscape Arboretum/Welcome
12:00 - 1:00	Lunch served-grilled pork chops
1:00 - 2:00	Unstructured tour of Arboretum grounds
2:00 - 3:15	Review of soil pits-Classification of profiles and discussion of updating in Carver County.
3:15 - 4:30	Tour of Metro landscapes/lend use in western Hennepin county
4:30	Arrive back at Thunderbird Motel

A convenient Soil Survey Information System (SSIS)

Pierre C. Robert and James L. Anderson

Abstract

A user-friendly and menu-driven soil information system (SSIS) is presented. SSIS can retrieve, sort, display, highlight, and print soil survey information (soil descriptions, soil characteristics, and soil interpretations), one section at a time (1 square mile, 259 hectares). It can also display and overlay other digitized maps such as land use, vegetation cover, and ownership parcel. Prompted screens make interaction with the system very simple and rapid. Interpretive maps are displayed on a standard graphics color monitor. Menus, text, and tabular data are shown simultaneously on a monochrome monitor or, alternatively, with a map on a graphics monitor. An electronic tablet can be used to delineate individual parcels. The software requires an IBM PC or compatible system with 512 K RAM memory, two disk drives, graphics and digitized soil maps.

INTRODUCTION

Modern soil surveys include detailed soil maps, soil descriptions, soil properties, and various soil interpretations prepared for specific uses. This information can be used for a variety of applications, including soil management for agricultural and forest production, land assessment, planning and zoning, engineering, urban development, soil and water pollution control and education. However, the county soil survey report is commonly a large technical document, with much information. The report is difficult to use by non-technical users, limiting utilization of the information.

One common way to display soil survey information is to create a series of simple interpretive maps. Manually prepared interpretive maps require a significant amount of time. The user has to locate a parcel of land using a map index, draw the parcel boundary, find some soil properties or interpretations corresponding to the map units included in the parcel, transfer these properties or interpretations in each map unit, and shade or color them according to predefined attribute classes. This can be done very easily, in a few minutes, using the county Soil Survey Information System (SSIS).

Soil Survey Information System is not a complete geographic information system (GIS), although it has most GIS characteristics. SSIS was developed for the inexperienced microcomputer user with software operating on a standard system so that “anyone can use it anywhere”. It is a stand-alone system. It can be installed on many computer systems within a completed survey area and does not require an off-site facility. Users have “hands-on” access to the system for day-to-day decisions.

Principal objectives of SSIS are: (1) to provide easy, fast access to soil geographic information (map, description, properties, interpretations), related to any tract of land; (2) to display interpretive maps; (3) to assist in production of simple printouts; (4) to develop “user-friendly” and menu-driven software; (5) to develop application software based on the SSIS database for specific tasks such as individual parcel assessment, establishing field eligibility for federal, state programs (e.g., Conservation Reserve Program), soil sampling recommendations [1], and field soil and crop management; (6) to create a dynamic system so that maps and data can be updated quickly and new soil properties or interpretations for rural and urban uses can be easily added.

SOFTWARE DEVELOPMENT AND ASSEMBLY

The Soil Survey Information System can access, sort, display, highlight, and print any soil survey data for one section (one square mile, 640 acres, 259 hectares1 at a time or a similar gridded area (e.g., 5000 square foot grid or 500 square meter grid) (Figure 1).

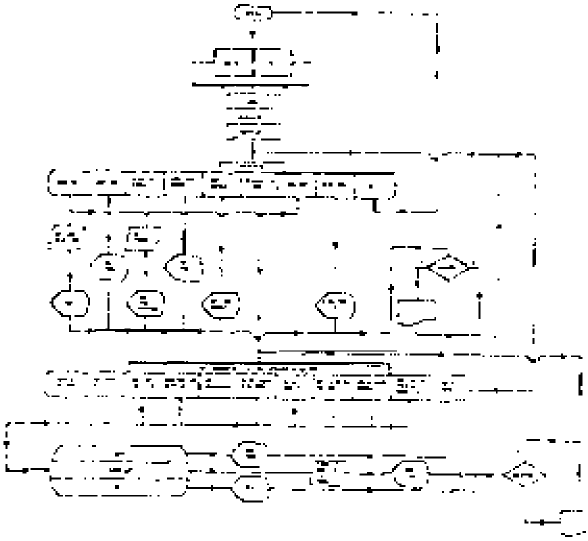


Figure 1: Flow diagram of the Soil Survey Information System

SSIS can also display and overlay other digitized maps such as land use, ownership, vegetation cover types, roads, and drainage. The software is “user-friendly” and menu-driven. Options are clearly presented. Menus have pop-up HELP screens to assist in making selections. The computer program has routines to check menu selections and data entries. When an error is detected, a message indicates the correct procedure or expected input, INFORMATION screens are provided upon request to define soil terms and procedures, to explain how data were collected and analyzed and to specify data limitations for specific applications. The software can be used without consulting a manual but a user guide is provided.

Two different versions of the software are available: a single graphics monitor system and a double-monitor system, with one graphics and one monochrome. The two-monitor system is recommended because map and data can be seen at the same time. To use the one screen system, one has to press a key to flip back and forth from monochrome display (menus, text, and tables) to graphics display (maps).

Data input

The Soil Survey Information System requires detailed county soil survey reports. The soil survey base map sheets on mylar without aerial photo base are digitized using a high resolution scanner. The image processing software filters the digitized images, thins the polygon lines, windows the sheets into sections (or other gridded areas), and saves the bit maps in a condensed file format. During the development phase it was found that, because of microcomputer limitations, a raster image was more efficient for speed of display and storage size than the vector image mode. This is due to the numerous polygons (mapping units) and complex shapes of the mapping units. Map polygons are labelled using interactive software. Label locations and label names are entered sequentially. Each map is reviewed twice to avoid label overlaps and incorrect symbols. Input of soil descriptions, soil properties, and soil interpretations is also executed with an interactive program. INFORMATION or HELP text screens are entered using a word processor. These data files are standard ASCII files.

Data output

Maps and summary tables are displayed on monitors and printed using a standard dot matrix printer. Maps are displayed on the graphics monitor. On a two-monitor system, menus, texts and tables are displayed on the monochrome monitor. Printing options are available to print a map, or a table and text, or both map and summary table.

The map printout is a copy of the screen map at a scale of about 1:11,000. This cannot be changed. However, the MAIN MENU has an option to use a plotter to draw maps at a specific scale. The PLOTTER MENU has two predefined scales of 1:20,000 and 1:15,840. To plot a map at another scale" requires the plot coefficients for x and y axes. Program prompts request this information. Making a hard copy with a plotter is much slower than using a printer. Map files must be converted from raster to vector. Also, plotters are slower than printers. Interpretive maps consisting of entire sections or individual fields outlined with the digitizer can be saved.

SOFTWARE DESCRIPTION AND APPLICATIONS

The Soil Survey Information System is menu-driven. The menu-driven design makes the package very easy to use by presenting the user with only the feasible options at each step of the analysis. After booting the system by turning on the computer and entering the program name (SSIS), prompts indicate the procedures to follow. For example, the first screens display the prompt "Press <space bar> to proceed" and the MAIN MENU displays the prompt "PLEASE MAKE YOUR SELECTION" (Figure 2).

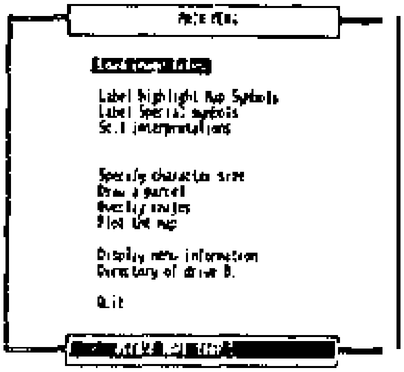


Figure 2: MAIN MENU

*larger scale printouts facilitate reading but cannot imply additional accuracy to map delineations.

All the program features are accessed through menu selections by overlaying a menu option with a moving cursor and pressing the <ENTER> key (Figures 2,3,5).

The cursor can be moved up and down by pressing the /up/ and /down/ arrow keys. It can also be moved down by pressing the <SPACE> bar key. In this case, the cursor wraps around the options. After selecting an option, a window overlaps the previous menu to show new options (Figure 3). A new option is chosen the same way, i.e., by moving the cursor over a menu feature and pressing the <ENTER> key. Additional menus may be displayed until all options are selected.

The type of standard soil features that the software can retrieve are listed in the "SOIL INTERPRETATIONS" menu (Figure 5). They are crops and pasture, building site development, construction materials, water management, sanitary facilities, recreational development, wildlife habitat potentials, engineering properties, soil and water features, and physical and chemical properties of the soils. Each soil feature type offers several options. Options may slightly vary from one county to another. For example, the submenu "Construction materials" has the options : source of roadfill, sand gravel, and topsoil. Sources are rated as good, fair, poor (roadfill and topsoil) or probable, improbable (sand and gravel). Each soil is evaluated to a depth of five or six feet. The submenu "Physical and chemical properties" offers the options: clay percentage, moist bulk density, permeability, available water capacity, soil reaction, salinity, shrink-swell potential, erosion factor (K and T), wind erodibility groups, and organic matter level. These are estimates of characteristics and features that affect soil behavior. They are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data. Another type of feature is given in the Wildlife habitat potential submenu: habitat environment potential for grain and seed crops, grass and legumes, wild herbaceous plants, hardwood trees, coniferous plants, shallow water areas and habitat wildlife potential for openland wildlife, woodland wildlife, and wetland wildlife. Soils are rated good, fair, poor or very poor according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning wildlife areas, parks, nature study areas and other developments for wildlife; in selecting soil that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management need for each element of the habitat [6].

The following example helps illustrate the process that would be used to highlight the area of expected corn yield greater than 110 bushels per acre (6.9 Mg/ha) in Redwood County, Brookville township, section 01.

1. Display the MAIN MENU (Figure 2);
2. MAIN MENU: move the cursor over "load image files" and press <ENTER>. The LOAD IMAGE FILES MENU window overlaps the MAIN MENU (Figure 3);
3. LOAD IMAGE FILES MENU: move the cursor over "load from Directory" and press <ENTER>. A file directory of the drive B: is displayed. Move the cursor over the map file name (e.g., 6401011 and press <ENTER>. The six digit code number stands for county 64 (Redwood), township 01 (Brookville), and section 01. The soil map corresponding to section 640101 is displayed on the graphics monitor (Figure 4);

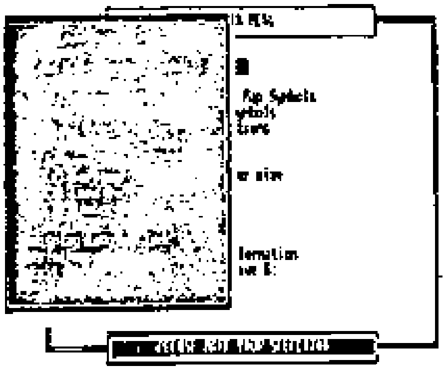


Figure 3: LOAD IMAGE FILES SUBMENU window

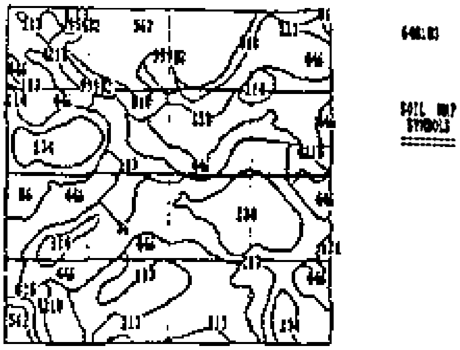


Figure 4: Soil map

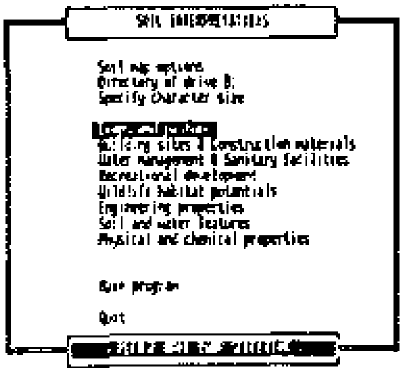


Figure 5: SOIL INTERPRETATIONS MENU

4. MAIN MENU: move the cursor over “Soil interpretations” and press <ENTER>. The SOIL INTERPRETATIONS MENU is displayed (Figure 5);
5. SOIL INTERPRETATIONS MENU: move the cursor to the option “Crops and pasture” and press <ENTER>. The CROPS AND PASTURE MENU is displayed;
6. CROPS AND PASTURE: move the cursor over "corn" and press <ENTER>. The CORN MENU window overlays the previous menu
7. CORN MENU: move the cursor over the option “Highlight .. Greater than val" and press <ENTER>. A new window overlays the previous window and prompts the lower limit of expected corn yield to be ‘highlighted.
a. Threshold window: type 110 and press <ENTER>. The highlighted map is displayed on the graphics monitor (Figure 6) and a summary table is displayed on the monochrome monitor. A printout of the table can be made by pressing <P> and a printout of the map from the LOAD IMAGE FILE MENU;

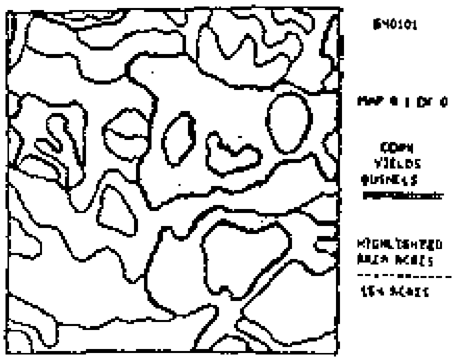


Figure 6: Interpretive map showing map units with corn yields greater than 110 bu./ac.(6.9 Mg/ha)

9. Press <ESC> to return to the CROPS AND PASTURE MENU. Select the “Previous menu" option to return to the SOIL INTERPRETATIONS MENU. Another interpretive map can be displayed or one can leave SSIS by selecting the "Quit" option. The MAIN MENU (Figure 2) has other options, selected in a similar manner, to display the soil survey “special symbols”; the “overlay symbols”, that is, the labels of other digitized resource maps such as land use and vegetation cover; an overlay map, in a different color, over a soil map: and to draw a subset of a full section (ownership parcel) over the screen map, mask the map outside the parcel,and display selected features inside the parcel.

Most SOIL INTERPRETATIONS screens have an option INFORMATION which provides various kinds of help,

To input or "cut" a field boundary within the section displayed on the screen and erase area outside the outlined parcel, a digitizing tablet can be used. The map or aerial photograph used to draw the parcel(s) is scale independent. SSIS rescales the parcel map to the map displayed on the monitor after the four corners of the section are entered using the digitizing tablet cursor. Previously saved maps on diskettes or firm disks can be retrieved, displayed, and printed from a MAIN MENU option.

Figure 7 shows a parcel in Redwood county, Brookville township, section 01 (code number 640101) displaying crop equivalent ratings (CER). Crop equivalent ratings reflect relative differences in productivity between soils. They are used by farmers, planners, assessors, realtors, bankers to help determine how a specific tract of land should be managed, what a fair rental or purchase price is, and to assist in defining prime agricultural land. Figure 8 shows the CER summary table which lists the CER for all map units included in the same parcel.

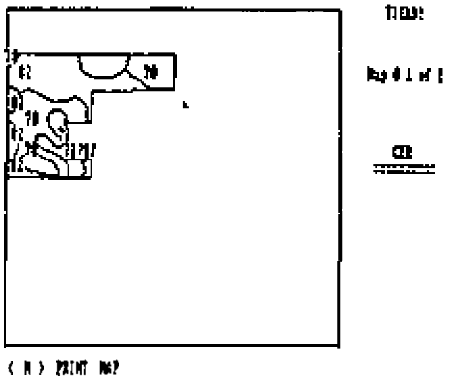


Figure 7: Crop equivalent ratings (CER) for an individual field drawn over the soil map using a digitizing tablet

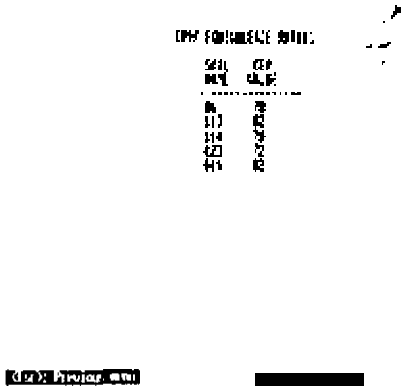


Figure 8: CER summary table for the Figure 7 field

Presently, twenty Minnesota counties are using the Soil Survey Information System. According to a recent survey in Kandiyohi county [2], principal uses of the system were, in decreasing order, land appraisal, farm management, government and local programs and education. Main uses of the software by county departments were for land assessment, federal and state conservation programs, and land use, planning and zoning. The Olmsted County Planning Department routinely uses SSIS for planning and

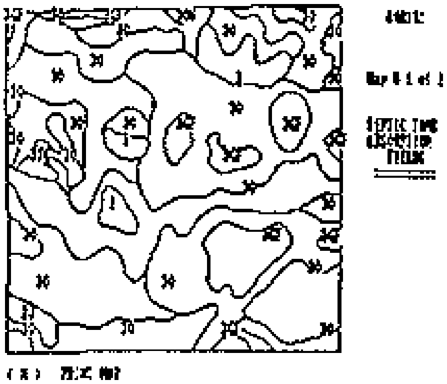
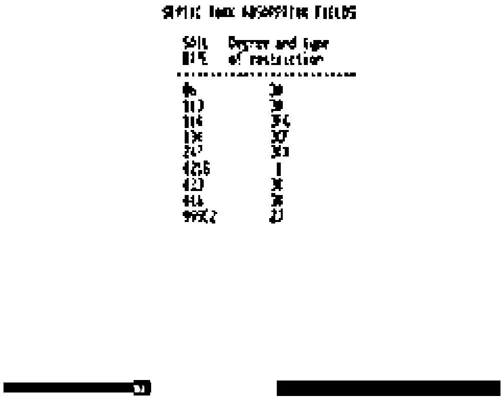


Figure 9: Limitation for septic tank absorption field map



SEPTIC TANK ABSORPTION FIELDS

Soil MUS — Degree and type of restriction

Figure 10: Summary table for the Figure 9 map

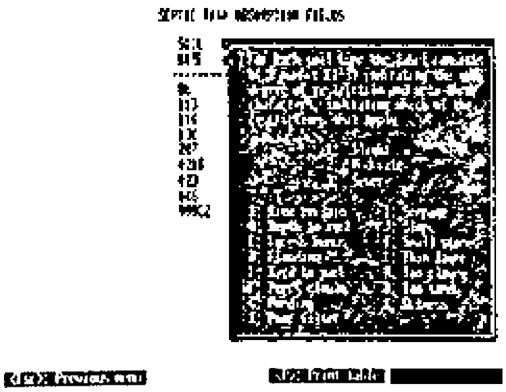


Figure 11: Overlay window explaining labels used to indicate degree and type of restrictions for septic tank absorption field interpretations

zoning purposes. SSIS is used to make printouts of the soil map to evaluate a zone change request from agricultural to non-farm residential. CER map and limitation for septic tank absorption field map (Figures 9, 10 and 11) are produced. The Soil and Water Conservation District and the Soil Conservation Service personnel use SSIS to prepare farm conservation plans. For each field, the system displays very quickly soil types, slope gradients and lengths, land capability classes, soil erosion factor K (soil susceptibility to erosion by water) and factor T (estimate of' the maximum average annual rate of soil erosion by wind or water that can occur without effecting crop productivity over a sustained period) and expected crop yields. SSIS is also used to calculate acreages of soil types. On farms, the system is principally used to improve fertilizer and herbicide management, select sites for soil sampling, design conservation plans, prepare cropping plans, and evaluate land for rental or purchase. Ray Olson is farming in Pennington county. He has been using a computer for the past several years. He uses SSIS to better organize records and to help him make better judgments on application rates of fertilizers and herbicides [3]. Maps of organic matter percentage, pH levels and soil surface texture are useful when selecting herbicide rates (Figure 12).

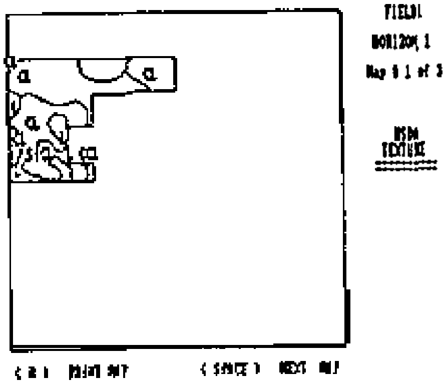


Figure 12: Soil surface texture (USDA) interpretive map (C: clay; CL: clay loam; L: loam; SICL: silty clay loam)

Extension agents are using SSIS to help farmers locate the most productive soils, to improve soil management (tillage and drainage1 and crop management (agrichemicals)[4]. When SSIS became available in Kandiyohi county, Marv Olson, county extension agent, had hundreds of requests from farmers, realtors and bankers to make printouts of crop expected yields and CER maps to estimate soil productivity (Figure 7).

Several counties are using a land use overlay for land assessment, planning and zoning and conservation programs. Four northern Minnesota counties will soon have a vegetation cover overlay for timber management.

The soil map database is utilized in several application software packages developed for specific uses. The PRODEX software, also named FIELD CER CALCULATION, computes average weighted CER (productivity rating) by ownership parcels[5]. The CONSERV software helps define eligibility of individual fields to conservation programs such as the Conservation Reserve Program (CRP), Conservation Compliance, Swampbuster, and the Minnesota RIM program (Reinvest in Minnesota). The program highlights in units can be redefined as eligible or non-eligible after field check.

SSIS is used at the Department of Soil Science, University of Minnesota in several graduate and undergraduate level classes. Problem-solving modules were developed for soil and crop management, land use management, and soil conservation. It is also used to train students in geographic information systems.

The Iowa Cooperative Soil Survey acquired SSIS and the data entry software Spring 1987 to computerize Iowa county soil survey reports. The software requires very limited modifications when a similar microcomputer and digitizing system are used. The software is written in a modular way. Changes are easy to make. The graphics software allows transformations to match different graphics resolutions. However, using a different digitizing system would require more substantial programming.

SOFTWARE AND HARDWARE REQUIREMENTS

The software requires four flexible diskettes (51/4, DS, DD). The first disk contains an INSTALLATION program to help copy the software (program and data disks) onto a firm disk if this is desired, Disks two and three contain the SSIS programs. Disk four has the county data files. Soil map data files are packed, using a special routine so that a township (36 sections or about 9324 hectares) can be stored. An average county of twenty townships requires twenty map data diskettes.

The program is written in BASIC with some assembly routines. It is compiled with QUICKBASIC (Microsoft).

The Soil Survey Information System runs on IBM PC' and compatibles with 512 K RAM memory, two flexible disk drives or a combination of flexible drive(s) and firm disk drive(s), one standard monochrome adapter and monitor, and one standard color graphics adapter (CGA) or enhanced graphics adapter (EGA) and monitors. Another version of the software is available for a system with one graphics adapter and monitor only. A dot matrix printer compatible with the IBM graphics.com printer driver, a plotter (Houston Instrument or Hewlett Packard), and a digitizing tablet (Houston Instrument, True Grid Series) are optional. The software runs on portable computers, including briefcase size micros such as the IBM PC convertible, When used on a firm disk based system, the program and all the data require, for an average county of twenty townships or about 470,000 acres (about 116,000 ha), approximately seven megabytes of firm disk storage. On a hard disk system, another option is to store the program on the hard disk and read the soil map data files from a flexible drive. In this case, the hard disk requirement is less than one megabyte.

CONCLUSION

The number of Minnesota counties using the Soil Survey Information System grew from two to twenty from 1985 to 1987. At the same time, the SSIS range of applications has expanded. Diversification of users has

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*Names of equipment are for information only and do not necessarily imply endorsement.

developed: extension agents, farmers, assessors, planners, conservationists, agri-business, realtors, bankers, natural resources managers, engineers, health sanitarians, foresters, and educators. The principal reasons for this growing interest seem clearly to be the large amount of information available in a soil survey, easy-to-use and menu-driven software running on standard microcomputers, and application software exploiting the information system. In the future, additional application software will be developed for soil and crop management, soil and timber management, and soil and road management. The SSIS database manager and portability will be Improved while maintaining its user-friendly and menu-driven characteristics. The new version will be less graphics hardware dependent, will take advantage of higher resolution adapters and monitors, and will display areas larger than one section.

The software is available from the Hinnesota Extension Service, Distribution, Room 3 Coffey Hall, 1420 Eckles Avenue, St. Paul, MN. 55108.

SOIL SURVEY ACTIVITIES OF CANADA

Keith Valentine

I appreciate the opportunity to join you in your conference this year, and bring you sincere greetings from your colleagues in Canada. Unfortunately, limited budgets are restricting our travel more and more, so we meet you on fewer field trips and correlation tours, but we remain very interested in what you are doing.

I will try in a few minutes this afternoon to tell you of some of the things we are doing in Canada. I will tackle the whole picture without details of exactly which sectors, federal, provincial or private, agriculture, or forestry, are doing what. For, as many of you know, our whole program is distributed in a very complicated way among various levels of government, various departments, and numerous private consulting companies- large and small. Indeed, perhaps the first thing to mention is the continuing pressure from senior government levels to privatize aspects of our work, including detailed surveys and cartographic services.

Our inventory continues to be the fundamental aspect of our program, but it is here that private companies are playing a larger part, especially in order 1 and 2 surveys. We are working at all orders of intensity. For example, in Nova Scotia order 1, single farm, surveys are being carried out with maps published at 1:5,000. Many provinces are doing order 2 surveys (usually with maps at 1:20,000) for agricultural, forestry and municipal planning purposes. Order 3 surveys are becoming less common after their preeminence during our Canada Land Inventory program of 1965-75. However, Saskatchewan has recently started a large remapping program at this level of lands originally surveyed in the 1940's and 1950's. This is their Rural Municipality series with 1:1000,000 maps bound into a report which also contains many interpretive sections such as capability for agriculture, forages, susceptibility to water and wind erosion, and the incidence of salinity. Order 4 and 5 surveys are done mainly in north for broad multi-use

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*Head, Soil Inventory Section, Land Resource Research Centre, Agriculture Canada, Ottawa, K1A 0C6.

purposes. However, with limited funds and more emphasis on directly applied surveys they too are getting rarer.

One Inventory project I would particularly like to mention is our 1:1 million soil landscapes work. We are attempting to cover the whole country in about five years with twenty-three maps. This is being done partly through the compilation and generalization of more detailed surveys, and partly by extremely broad exploratory inventory. The structure of the information is different from that of standard soil surveys. Each polygon, or delineation, is unique and is described by a standard set of thirty-two attributes. Some of these attributes are fundamental, such as variations on a theme of texture, slope and drainage. Others are a little newer, such as complexity, reliability, peat landforms and the nature of water bodies. We are almost ready to publish our first map, for Alberta, but it will really be all the soil and land attributes attached to the map, as on electronic data base, which will be the power behind the project. After initial skepticism about the usefulness of data at 1:1 million, we are now finding considerable interest in the potential of a land inventory covering the whole country with an absolutely standard set of information. We have used some of the initial data already for an assessment of our tobacco lands of the east and marginal cereal lands in the Prairies that might be retired from cultivation. The Canadian Forestry Service are also interested in connecting our soil and land information with their 1985 National Forest Inventory. We are also cooperating closely with the compilation of the International 1:1 million data base (SOTER) being organized by Dr. Wim Sombroek from Wageningen.

In talking about the 1:1 million map.1 have wondered into the realm of interpretations. As we insist that all our inventories are done for particular purposes a distinction between inventory work and the application of that work via interpretations is artificial. However, some of our interpretive work, such as the development of the systems themselves, can be considered separately. At the moment we have individuals and working groups engaged in developing refinements to our agronomic interpretations, including specialty crops such as small fruits for particular areas like the Niagara Peninsula of southern Ontario. Similar work on forestry interpretations and the suitability of organic soils is also going on. Closely associated with all this is our cooperative work on soil conservation and degradation with various other agencies such as the Prairie

Farm Rehabilitation Agency (PFRA). Soil survey is supplying much of the basic information for various assessments (usually regional, but sometimes national) of soil degradation, including water and wind erosion, acidification, salinity and susceptibility to compaction. We are also working with a national working group concerned with the Long Range Transport of Airborne Pollutants (LRTAP). This is primarily a forestry program, and contains elements of monitoring work: that is periodic reassessments at permanent sites. so far, in this program, the periodic reassessments concern the trees not the soils. However, we have an initial one year project which is to recommend what sort of monitoring program could be started for soils. Our main constraint, as you can imagine is one of money, but there are other significant problems to be sorted out as well, such as the permanancy of sites, methods of repetitive, but representative soil sampling (which is essentially a destructive procedure), and the distinction between spatial variation and. temporal variation at a site. This monitoring work is connected with our cooperative work on Soil Quality. You must have some purpose behind a monitoring program. The purpose foi us, in conjunction primarily with research scientists in the Land Resource Research Centre, Agriculture Canada, Ottawa, is to establish the characteristics (and their threshold limits) that constitute a quality soil for a number of major crops. The survey's job at a later date will be to discover whether those characteristics of our major soils are above or- below the threshold limits, and whether the whole picture is getting worse or better. This has, in fact, introduced a new dimension into inventory. Soil survey deals fundamentally with soil variablity. Such variability can be spatial or temporal. In the past we have concentrated almost exclusively on the former. NOW, at least some of our work is concerned with the latter.

A major change now underway related to all this inventory and assessment work is the conversion of the Canadian Soil Information System (CanSIS) from its own inhouse custom software to commercial software. The Land Resource Research Institute of Agriculture Canada has bought the ESRI ARC/INFO system and a VAX computer on which to run it. Now we at-e at the beginning of an eighteen month conversion project. There are 900 maps to transfer from the old system to the new, and a new set of soil attribute files to be created and linked to the maps. We had to face this major purchase and conversion because our software was not compatible with many other soil or geographic information systems that have been established recently based on commercial software.

Therefore we could not exchange information easily. We have not completely decided what the new CanSIS system will look like, but so far we have plans for the straightforward conversion of our map files to ARC, and four attribute files attached to them in INFO (polygon, map unit, named soil, and layer, or horizon). The information stored will be related to biological productivity and soil degradation assessments, and the major characteristics of soils. There will be national data (maps and attributes) that are required and standard, and regional data that are optional and may be non-standard. We are also developing a distributed, or network, system where some of our large regional offices will have significant capabilities of their own, quite separate from the Ottawa central office. Indeed not all the data may reside in Ottawa, but it must be easily acquired from regional offices, and we must know that a core of it is compatible and standard. One rather contentious item at the moment is the omission of pedon data from the standard national attributes files. These data have proved to be exceedingly time consuming to compile, verify and store, and are difficult to associate with maps. We envisage their place being taken by the named soil and layer files, although I must acknowledge that some land evaluation modellers are unhappy.

Two final aspects of our work that must be mentioned are the establishment of survey procedures, in the boradest sense, and our cooperative research. Correlation is intimately connected with procedures, and an important part of the Agriculture Canada federal soil survey work continues to be correlation. Above all the conversion of CanSIS to ARC/INFO with all its demands for standard files will require correlation to control the flow of information within the system, checking its quality and completeness, and approving it for storage, publication and future assessments. Another aspect of procedures work is a current project on survey reliability. This work borders on research in that we want to determine appropriate techniques for various order surveys. Work to date on some order 2 surveys indicates that we are claiming appropriate levels of reliability for major assessments based on the survey, but undue levels for the mapping and description of some soils in the survey itself, and certainly undue levels for all the phases of soils that are included on some maps. This may mean a broadening of soil class definitions in order 2 surveys. Among our purer research projects are work in unglaciated and deeply weathered soils of the Yukon Territory, the refinement of the Universal Soil Loss Equation incorporating a snow melt factor so important in Canada, the refinement of the Spodosol order, in cooperation with yourselves, and the nature of Grumic or swelling soils in the Great Plains.

The description has necessarily been brief and cursory, but I hope it has given you some idea of the breadth of our present activities. Once again I would like to thank you for the opportunity to tell you about our work this afternoon and assure you that we look forward to continuing cooperation.

SOIL MANAGEMENT SUPPORT SERVICES (SMSS) AN OVERVIEW

The Soil Manayement Support Services (SMSS) is a program of the U.S. Agency for International Development, implemented by the Soil Conservation Service. It was established in October 1979 and Attachment I gives a summary of the activities to-date. In addressing you today, I would like to give you and idea of the role SMSS has played and wishes to play in the efforts of, the United States in general and the Soil Conservation Service, in particular, to help developing countries in attaining the goal of sustainable agriculture.

Saturday July 11, as some of you may know, was a historical day in the history of mankind.-- we reached a world population of five billion -- and by the end of this century we may surpass 6.5 billion. In the recent past, U.S. food sales have declined which prompted a debate and questioned our assistance program to developing countries. But the fact remains that many countries will be unable to feed themselves in the near future: some like Ethiopia already have a population beyond the capacity of the land: in others, particularly in many countries in Africa, food production is showing a gradual decline.

As a result of these stresses, many countries are faced with several immediate problems, some of which include:

1. Most of the people in the developing countries live in rural areas and this segment of the population is expected to grow by the end of the century. I" their efforts to satisfy needs for food and fuel, the rural poor strip the land of trees and shrubs for firewood, cultivate the fragile lands, particularly steep lands, and overgraze the already poor pastures. The consequence is that, in order to survive, they impair ecological processes and destroy genetic and other renewable resources.

2. Tropical forests and savannah are important renewable resources, acting as reservoirs of genetic diversity. Apart from yielding a

continuous supply of forest products, they help to generate soils and protect them from erosion. They also protect downstream areas from floods and siltation. Tropical forest areas are continually disappearing and there is little or no effort toward regeneration. The situation is more alarming because many of the forests occupy two ecosystems -- steeplands and coastal (lake) swamps -- and agriculture is encroaching on both these areas.

3. Semi-arid lands cover extensive areas in many developing countries. Unless used with care and skill, they are extremely prone to desertification. Pressures of population and livestock, extension of rainfed agriculture into unsuitable areas, and poor management of irrigated agriculture, are al ready. degrading vast areas.

4. An institutional framework for conserving and managing soil resources in man; developing countries is poor or non-existent. Knowledge of the soil resources of a nation should be the basis for agricultural development and technology transfer. It is also the basis for determining research priorities and development alternatives. In the developing countries, this information is usually meager or absent.

SMSS is the only project in the portfolio of the U.S. Agency for International Development (AID) committed to address the question of soil resources and assisting countries to evaluate and use these resources in a judicious way. However, the magnitude of the problem is very great and our assistance is just a drop in the ocean. Despite that every assessment of the project indicates that it has made an impact.

Is there a need for more SMSS?

In the last few decades, the focus of technical assistance has been on commodity oriented research: the International Agricultural Research Centers (IARCs) were created and without any doubt, they have made an enormous contribution. The fact that some countries have reached an export capability in grains is partly due to the work of IARCs and other donor assisted activities such as those of AID. Much of the increased production comes from opening new land: new technology is yet to be practiced by farmers and the extension of the technology to the farmers is the challenge of the future. This extension cannot be successful unless there is information on the soil resources of the farmer and the response of these soils to the different technologies. Agrotechnology transfer is an interesting and useful concept, but the transfer is not successful if:

a. T-here is no institutional framework to effectuate the transfer, and

b. if the technology is not transferred as a package.

The package includes, not only information on germ plasm and management, but also knowledge about the soil resources of the country, region or farmer.

The situation in many developing countries is that there is little or no information about the soil resources. Soil survey and conservation organizations are non-existent or if present, they are poorly staffed and lack facilities. Although agronomic research has been conducted and is being conducted in many countries by national and/or donor assisted programs, it is shocking to note that as a rule there is no soil or site characterization at most of these stations. The catch phrase today in donor assisted projects is to conduct experiments on farmers' fields. The purpose of conducting an experiment is to be able to extrapolate the results to other sites in the country. When the soil and site information at experimental sites or in other parts of the country is not available, such research is always less useful.

SMSS is not a research project as are other projects of AID. It is a service project designed to assist countries in soil resource evaluation and management and as such it is a long term effort. It is also uniquely qualified to provide this service as it is back-stopped by the Soil Conservation Service and the National Cooperative Soil Survey.

SMSS is a world wide program and as each country is at a different stage of development, its activities are geared to country needs. In some countries, we initiate activities while in others we only catalyze. Having had the opportunity to visit more than 65 countries in the last seven year*, I am convinced that if we do not provide greater assistance in the area of soil resource evaluation, conservation and management, the world as a whole will be poorer in the near future. Regretfully, due to the current budgetary crunch, AID is unable to support such activities.

Why Soil Taxonomy?

SMSS has several activities and more than half its budget is allocated to direct technical assistance to countries. Many of you have participated in short-term TDYs for us. However, the more visible activities are related to use and application of Soil Taxonomy. By visible, I mean the publications, training and other workshops, audio-visual materials etc. As a result, we have been criticized that we focus too much on Soil Taxonomy and that this is not the purpose-of an AID funded project.

We consider Soil Taxonomy as a rallying point, apart from the merits and usefulness of the system. We are convinced that a resource inventory becomes meaningless without a classification system to bind it together and stratify the population so that each component of the population can be interpreted for use and management. We have shown that Soil Taxonomy can be used as an effective tool for agrotechnology transfer and in some instances, the basis for transfer. Because of this conviction, we work toward improving the system for its use and application in the developing countries. Developing country scientists have participated in this activity enthusiastically as they believe that they are helping to develop a system which they will be using. Partly as a result of our work, international and regional organizations, such as World Bank, Asian Development Bank and others now require that SCS methodology and soil Taxonomy be used in their soil resource evaluation projects. To facilitate its use, Soil Taxonomy has been translated into Spanish, French, Italian, Arabic, Indonesian, Japanese, Chinese, Thai, and a Greek translation is in the process. As a result, even the patriotic French are using Soil Taxonomy. Soil Taxonomy has now emerged as the de facto international soil classification system and any attempts to curb our activities in this area will be short sighted.

The Future of SMSS

The project comes to an end on September 30, 1987. We have been given a two year extension with 50% of our original budget to continue (or exist). In this interim period, AID will determine the nature of the new project and the funding level.

In a project proposal for an extension, we have indicated that in the next phase, emphasis will be on:

a. Utilization of soil survey information

b. Land evaluation

c. Geographic information systems and national resource inventories

These will be in addition to the current activities, particularly training on how to make soil surveys and the interpretation of the data for planning and management at all levels -- national to farmers' fields.

The irony of the situation is that in its seven years of existence, SMSS has established itself and become a 'household' word. Developing country institutions and scientists now know SMSS and its staff and have come to appreciate and even rely on its services. We have established credibility and reputation not only for the project, but also for SCS and all our U.S. collaborators. With our reduced budget, I fear we cannot live up to the expectation*.

Because the future is somewhat bleak, I'd like to conclude by mentioning the glory of the past. The project achieved its objectives because of the support we received from all of you. I'd like to take this opportunity to thank every one who has participated in our TDYs and others, particularly the staff of the NSSL, who have assisted us in many ways. I particularly like to thank the Chief of the SCS and all the former Chiefs who have given full support to the program. The commitment, support, and hard work of my two colleagues -- John Kimble and Terry Cook -- ensured the operational success of the project. Final ly, a word of thanks to Dick Arnold for giving us a relatively free rein to run this project.

Attachment

PROJECT ACTIVITIES SUMMARY

JULY 21, 1987

1. Name of Project:

   Soil Management Support Services (SMSS)

2. Implementing Agencies:

   Soil Conservation Service, USDA
   Office of International Cooperation and Development,
   (OICD), USDA

3. Project Staff:

   3.1 Principal Investigator

   Dr. Richard Arnold
   Director, Soil Survey Division
   Soil Conservation Service, USDA
   P.O. Box 2890, Washington, D.C. 20013
   Telephone: (202) 382-1819

   3.2 Program Leader

   Dr. Hari Eswaran
   Soil Management Support Services
   P.O. Box 2890, Washington, D.C. 20013
   Telephone: (202) 475-5333
   Telex. 8423 UHBSP HR

   3.3 Project Monitor

   Dr. Ray Meyer
   Agency for International Development
   (S&T/AGR/RNR)
   State Dspartmont
   Washington, D.C. 20523
   Telephone: (202) 325-8993

   3.4 Full-time Staff Members

   Dr. Hari Eswaran, Washington, D.C.
   Deborah Minor (Secretary, Washington, D.C.)
   Dr. John Kimble, Lincoln, NE

3.5 Part-time Staff Members

Terry D. Cook (50%), SMSS/SCS
William Reybold (10%), SMSS/SCS

4. Information On The Project:

4.1 Date commenced: October 1, 1979
4.2 Date of extension: October 1, 1982
4.3 Date project ends: September 30, 1987
4.4 Funding (FY-1987): $1,250,000

5. Project Objectives:

5.1 To provide technical assistance to AID and LCD's in problem identification, evaluation of opportunities and planning and utilization of land resources, especially in the subject areas of soil survey, soil conservation and soil fertility and management;

5.2 to develop worldwide linkages for the more efficient utilization of agricultural information for crop production;

5.3 to refine soil taxonomy for the intertropical areas and assist LCD scientists in its use and application in transferring agrotechnology from one region to another similar region.

6. Project Activities:

In fulfillment of the first objective, TDYs were provided for:

6.1 Helping countries establish policies and programs for solving problems in land use and food and fiber production;

6.2 helping plan, carry cut, and evaluate soil surveys and soil conservation programs:

6.3 providing laboratory and field testing services:

6.4 Publishing soil management information that is needed in land-use planning and for food and fiber production;
6.5 Conducting seminars and other training sessions on soil management improvements and soil classification:

6.6 Interpreting soil properties to determine the potentials of the soils for agriculture and to predict their response to management: and to

6.7 disseminate new ideas for increasing soil fertility, improving plant nutrition, and controlling soil erosion and sedimentation.

With respect to the second objective, developing linkages, SMSS has established and worked with more than 30 international organizations and with countless national institutions. Many of the international and regional organizations have supported SMSS sponsored workshops and training courses. Through SMSS initiative and in collaboration with IBSNAT, en ASEAN network and a" Oceanic network are being discussed. As a result of the assistance provided by SMSS, many countries are adopting the standards of SCS in their soil survey programs.

Probably many of the achievements have centered on the third objective. Today more than 40 countries use Soil Taxonomy as the primary system of classification and an equal number use it in addition to other systems. SMSS has 8 international committees working to refine Soil Taxonomy.

It has organized 9 soil classification workshops, 17 training courses, 4 international soil correlation meetings (ISCOMS), 3 International Soil Management Workshops and produces a number of publications and a quarterly newsletter, which is published in collaboration with IBSNAT as Agrotechnology Transfer News.

7. Collaborating Institutions:

In the past 7 years SMSS has had the privilege to work with the following organizations:

1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India

2. International Rice Research Institute (IRRI), Philippines

3. International Institute of Tropical Agriculture (IITA), Nigeria

4. Food and Agriculture Organization (FAO), Rome
5. United Nation Environment Program (UNEP), Kenya
6. International Soil Science Society (ISSS), Nederland
7. International Soil Research and Information enter (ISRIC), Nederland
8. Office de Recherche Scientific et Technique OutreMer (ORSTOM), France
9. Belgian Assistance Development Cooperation (ABOS/AGCD), Belgium
10. German Technical Assistance (GTZ), West Germany
11. Norwegian Technical Assistance (NORAD), Norway
12. Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Syria
13. World Bank, USA
14. Centro Agronomico Tropical de Investigation y Ensenanza (CATIE), Costa Rica
15. South East Asian Center for Research in Agriculture (SEARCA), Philippines
16. Land Resources Division, Ministry of Overseas Development, Great Britain
17. International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), Hawaii
18. Australian Center for International Agriculture research (ACIAR), Australia
19. International Board for Soil Research and Management (IBSRAM), Thailand
20. Kagera Basin Authority (KBO), Rwanda
21. Food and Fertilizer Technology Center (FFTC), Taiwan

22. Centro Internacional de la Papa (CIP), Peru

23. Centro Internacional de Agricultura Tropical (CIAT), Colombia

24. International Fertilizer Development Center (IFDC), Alabama

25 Asean Development Bank (ADB), Philippines

26. University of the South Pacific (USP), Fiji and Western Samoa

27. European Economic Community (EEC),

28. South Pacific Council (SPC).

U.S. Universities, USAID country Missions and LDC national institutions are not included in this list.

CLASSIFICATION OF OXISOLS

John Witty

The International Committee of Oxisols has submitted their recommendations to the SCS and we are in the process of preparing the Oxisol amendment which will be issued as National Soil Taxonomy Handbook Issue No. 11. We plan to have it completed before the end of August so it will be included in the next printing of the Keys to Soil Taxonomy which is scheduled for. this fall.

The changes are extensive enough that we will replace all of Chapter 14 with the new materials on Oxisols. Since the whole order of Oxisols is revised, the amendment itself is relatively straight forward, but of course, many other parts of Soil Taxonomy are also affected. The latest draft is nearly 50 pages long so the Oxisol amendment will be about as voluminous as the Low Activity Clay amendment.

At present we are somewhat undecided as to which format to follow concerning the amendment. Three formats are under consideration and I have prepared drafts of al I three. One is the same format that is already used in Soil Taxonomy. The second is the same format that the Committee has used in the last several Circular Letters. The third is the same format that is now used in Soil Taxonomy, except for not switching formats at the subgroup level. In other words use the same straight forward key at the subgroup level as is used at the great group and higher levels. I have a handout which shows an example of this format. To tell you the truth, I like' it.

The format that is currently used in Soil Taxonomy at the subgroup level has always been somewhat confusing to use. The ICOMOX format, which is a modification of the format used in Soil Taxonomy, facilitates the keying out of pedons, but you can not derive the class definitions without making certain assumptions. The Committee also prioritized the subgroups in a way to eliminate the possiblity of implied subgroups by using more with or without" statements. New subgroups can still be established though.

Prioritizing the subgroups made it relatively easy to go from the old format to the same format used at the higher levels, When using the proposed key to subgroups one stops at the first subgroup that appears to include the soil in question, which is the same method used at the great group level. The end results are exactly the same as using either the old format or the modifiod format submitted by the Committee because no class limits were modified in setting up the proposed key. Also definitions can be derived from the key if the proposed format is used.

I would like your feedback on which way we should go with the amendment, although some of you will also have a memo requesting your recommendations when you return from this Conference.

Another consideration. Do the keys in the publication, “Keys to Soil Taxonomy”, have to be worded the same as in Soil Taxonomy or can they be changed so as to facilitate the keying out of pedons? I believe that Soil Taxonomy needs to include the definitions of the taxa, or atleast be able to derive them, but the “Keys to Soil Taxonomy” should be simplified to facilitate the keying out of pedons.

I have strayed away from the “Classification of Oxisols.” The last time I counted we had 39 series classified as Oxisols and they are in Hawaii, Puerto Rico, Pacific Trust Territory, and Guam. All will require reclassification so the impact is quite great on our Oxisols. Series limits will probably require only minor modifications, if any. Oxisols will also include soils with a kandic horizon, low weather-able mineral content, and 40 percent or more clay in the surface horizon. As a result a few eroded phases of Kandiudults or Kanhapludults may require reclassification as Oxisols. We may therefore have 1 or 2 Oxosols in the Southeast and a” additional 2 or 3 in Hawaii.

This concludes my remarks on the Oxisols. We have the amendment nearly ready for publication, but must decide which is the best format. The soils Division at the National Headquarters would like to use the same format as is used at the great group level.

CLASSIFICATION OF ANDISOLS

International Committee on Classification of Andisols
I COMAND

This is a brief report on the International Committee on the Classification of Andisols (ICOMAND). ICOMANO has been a functioning committee since 1979. In Apt-i l of that year ICOMAND Circular Letter No.1 went out. The bases for this circular was a one year visit to New Zealand by Dr. Guy Smith. While there, he produced a Preliminary Proposal for the Reclassification of Andepts and some Andic Subgroups. The New Zelanders also interview Dr. Smith and published the interviews, which provided the first glimpse of some of the rationale for Soil Taxonomy. (Later SMSS took over this task and Technical Monograph No. 11 is the product). Dr. Smith proposed to elevate the suborder of Andepts to an Order level and suggested the term ANDISOLS. This proposal gave birth to ICOMAND, and many years of hard work.

As with the other ICOM's ICOMAND communicated predominantly by correspondence. For this to be successful many dedicated people are needed. This work is usually done outside ones normal position and responsibilities. ICOMAND was very fortunate that it was backstopped by a whole institution, The Soil Bureau of New Zealand. New Zealand is one of the countries using Soil Taxonomy, and as they have large areas of volcanic ash soils in the country and have considerable involvement in the Pacific Islands where such soils are prevalent, they made an institutional commitment to improve the classification of volcanic ash soils.

In 1981, together with the Soil Science Society of New Zeal and, they organized an international conference on soils with variable charge. This meeting provide many new ideas to ICOMAND. It got the committee off and running.

To develop the classification of the Andisols, ICOMAND enlisted the help of all the Pacific rim countries where such soils were prevalent. Soil chemists and mineralogists were requested to test analytical criteria. The New Zealand soils data base was merged with the NSSL data base and the pedons collected by SMSS so that some of the new criteria could be tested.

After the meeting on Variable Chaigc there were several other relevant international meetings. These were Fourth International Soil Classification Workshop, Rwanda Africa, June -1981; VI international Soil Classification Workshop, Chile and Ecuador, January 1984 (Totally dedicated to Andisols); Congreso International de Suelos Volcanicos, Tenerif, Canary Islands, July 1984; First International Soil Correlation Meeting (ISCOM) Idaho, Washington, and Oregon, July 1986; and IX International Soil Classification Workshop (ICOMAND and ICOMAQ), July, 1987.

ICOMAND has had to interact extensively with ICOMOD to ensure that the proposed definitions produced mutually exclusive classes with respect to Andisols and Spodosols. Even today there are still problems, however they seem small now as compared to the initial task. It seems there will be Spodic Andisols and Andic Spodosols. The real challenge is to develop a system which will allow the field soil scientist to make the separation, and this is happening.

In 1986, ICOMAND produced a draft which was tested at the first International Soil Correlation Meeting (ISCOM) which was held in the Pacific Northwest of the United States. Many problems were identified and many suggestions given at this meeting. It brought together many soil scientist from outside of the United States and many more United States soil scientist that had bean able to attend the other international meeting. The cut come of this meeting was a major revision to the proposed Andisol order, and another Circular. By now they were up to Circular No.9. This Circular will be tested at the IXth Soil Classification Workshop in Japan. By the middle of 1988, the final proposal will be submitted to SCS for final testing and then hopefully approval and inclusion into Soil Taxonomy as the 11th soil order.

The work of ICOMAND has really been a internationalzation of Soil Taxonomy. The number of participants has been large, and very hard working. At times there were major disagreements but everyone worked together and major advances in the classification of Andisols have been made. In giving a report on ICOMAND it is not possible to thank everyone who contributed but Dr. Mike Leamy the committee's chairman from its birth must be thanked. He spent many extra hours outside his job as director of the Soils Bureau of New Zealand ensuring the rational and proper development of the new soil order Andisols.

INTERNATIONAL COMMITTEE ON VERTISOLS

(ICOMERT)

SUMMARY OF ACTIVITIES

TERRY D. COOK

This is a summary of the work done by ICOMERT.

Dr. Juan Comerma, Chairman of ICOMERT has studied and observed Vertisols in Texas, Alabama, California, Oregon, Philippines, Australia, and his home country of Venezuela. Extensive work and collaboration has been completed with Drs. Wilding, Texas A&M, Thompson and Isbell, CSIRO, Australia, and many others that responded to the circular letters. In addition DeWayne Williams of the South NTC has worked and contributed greatly to the revisions and changes and testing these changes in the Vertisols.

1. Definition of the Vertisol ORDER.

1.1 Gilgai - There is a proposal to eliminate gilgai as a sole criteria in addition to depth, clay, and cracks. Most respondents agreed that gilgai could be confused with patterned ground, the many different kinds of expression of gilgai, and cultivation that eliminates or subdues the expression of gilgai.

1.2 A depth requirement for the presence of slickesides within 1 meter has been proposed and supported by most members.

1.3 Thickness of vertic properties. This proposal is still under investigation that would allow soils with vertic properties to a depth of 30 cm in the Vertisols. Most of the support for this proposal is from the Australians who would like many areas' that are less than 50 cm, but greater than 30 cm to be included with other soils of the area that have vertic properties and appropriate inter- *pretations.

1.4 There is a proposal to add a criterion of the abundance of inclined slickensides between '25 and 100 cm. The minimum amount of observable slickensides on natural structural surfaces would be a weighted average of 10%. This would help differentiate pedogenetically young soils with some vertic properties and with a few random slickensidcs, with Entisols and Inceptisols and other soils with argillic horizons that also have a few slickensides.

The same requirements could also apply to wedge shaped tilted structural aggregates.

2. SUBORDEHS

2.1 In the first published edition of the 7th Approximation, 1960, Aquerts was included as a suborder. They were subsequently dropped for various reasons. Recent studies and support from committee members indicate the need for reinstating the Aquerts. The definition of the aquic conditions for Vertisols is closely associated with the work of Dr. 'J. Bouma of The Netherlands, Chairman of the International Committee on the Aquic Moisture Regime (ICOMAQ).

Some field work has been in testing dyes (reagents) that detect the presence of reduced compounds like Fe++ or Mn++. Two materials, a dipidrydil and bensidyne, show promise of simple field identification of soils that have been saturated and reduced.

2.2 There has been renewed interest and support from those in higher latitudes for a new suborder, Cryerts. There are documented soils that have frigid and cryic soil temperature regimes with vertic properties. At present most of the documentation is from high elevations in the Rocky Mountain states and Canada. Those soils with a frigid soil temperature regime could still be classified as frigid families, but those with cryic regimes as Cryerts. Interpretations between frigid and cryic are quite distinct, therefore the separation at the family and suborder level. This would be consistent with other orders as Cryods, Boralfs, or Borol ls. It could also be recognized at the great group level as in the Cryorthents, Cryaquolls, Cryumbrepts, etc. This proposal needs further study and testing for additional documentation and support.

2.3 Requirements and criteria for the Uderts, Xererts, Usterts, and Torrerts remain essentially unchanged.

3. GREAT GROUPS

3.1 Six formative great group elements have been proposed. At the present time not all suborders have used every great formative element.

Dura and Duri - Soils with a duripan between 50 and 100 cm. An example would be Durixererts.

Dystr - This is an attempt to differentiate soils that are acid and many have significant amounts of Al and/or Al phytoxicity that affects the use and management of these soils.

> Dystr has been tentatively defined as "having in the major part of tho upper 50 cm a pH of 5 or less (1:1 water) or 4.5 in 0.01 M $CaCl_2$ when the EC is less than 4 mmhos/cm." An example would be Dystruderts.

Eutr - Definition of Eutr would be the counterpart of Dystr with pH values of more than 5 or 4.5. An example would be Eutrusterts.

Epiaqu - These would be the soils that are subject to ponding for at least a few continuous days in most years. An example would be Epiaquerts.

Haplo- These would be the soils that represent the central concept and that have no other significant diagnostic features or characteristics.

Sali - There is documentation that some soils have a salic horizon within 75 cm of the surface. Some are saturated within 1 m and some are without saturation. Additional comments are pending to further refine this class. An example would be Salitorrerts.

3.2 Under consideration and testing are the following:

Sodi- Those soils that have an ESP of 15 or more in some part of the upper 1 m (Soditorrerts).

Pale - Those soils that have a petrocalcic horizon. However this has not been documented and does not necessarily indicate an expression of age. At this time the Pale great group will not be used.

Calci - The Calcitorrerts would be the soils that have a calic horizon whose upper boundary within 1 m and are calcareous in all parts above the calcic horizon. Many Vertisols are calcareous especially in ardic climates. This great group will probably be dropped and combined with the Haplotorrerts.

4. SUBGROUPS

4.1 Ten subgroups have been proposed and 8 are under consideration pending comments. These are listed below with a brief description of their definition or use:

Typic - Without any of the following criteria for other subgroups.

Aeric- Provides for the somewhat better drained soils or the for soils that are reduced less or more intermittently than the Typic.

Ardic - Used in the Xererts and Usterts to group soils that are drier than the Typic.

Chromic - Typic subgroups will be considered as having dark colors, chromas less than 1.5 (same as the current definition for Pell). Chromic subgroups will be the brighter chroma soils. It has been noted by many individuals around the world that the current criteria for the Chrom and Pell great groups do not represent the original intent of the more poorly drained soils as Pell and the better drained soils as Chrom.

Haplic - Used in the Durixererts to separate the nonmassive or lesser indurated duripans from the indurated opalized and platty Typic subgroups.

Leptic - The current proposal is to use this subgroup to express lesser vertic properties such as slickensides or wedge-shaped aggregates only to a depth of less than 1 m. It would also include lithic and paralithic contacts and a petrocalcic horizon. Some comments have been voiced to separate the harder contacts into a separate subgroup. The Leptic subgroup is provided for differences in engineering interpretations and degree of expression of vet-tic properties.

Sodic- The criteria would be the same as for the great group. These would be the soils that have a value of 15 ESP or 13 SAR or more in any subhorizon within a depth of 1 m.

Udic- Provided in the Dystraquerts and Eutraquerts that have ustic regimes as the Typic.

Udic subgroups have cracks that are open for lass than 150 cumulative days.

Ustic- Used in the Duriaquerts to indicate soils that have cracks that open and closemore than once. The Typic concept for this groat group is Xeric or the cracks open and close only once. In the Eutraquests the Typic is defined as being in the Udic regime and therefore these soils would represent slightly drier conditions.

Xeric - Used in the Epiaquerts and Eutraquerts to separate soils from the Typic that have cracks that open in the summer and close in the winter.

4.2 The following 8 subgroups have been proposed or are under consideration, but have not been thoroughly documentedor tested:

Aquic - Provisions are being considered to provide subgroups that are integrating toward the Aquerts. These soils have wetness conditions at some periods of the year, but do not meet the criteria for Aquerts.

Entic- This subgroup will probably be dropped. There is no evidence to date to support separation.

Grumic - Some comments support the return of separating strongly granular surface expression of vertic properties and "on granular or crusty surfaces as Mazic as originally proposed in the 1960 7th Approximation. There are many pros and cons to or not to separate surface features at the subgroup level. These properties are often ephemeral and are subject to rapid and repeated changes by cultivation, irrigation, kinds of crops, and management of the soils.

Lithic - Proposals have been submitted to use Lithic subgroups to separate soils with lithic, petrocalcic, petrogypsic, petroferric, etc., that occur between the depths of 50 and 100 cm. This would be contrary to the Lithic subgroups of other orders which is used at 50 cm except in the Oxisols.

Mollic- As with the Entic subgroup there is little support to keep this subgroup. There has been no documentation to show any significance in the original separation.

Paralithic – This subgroup would have a paralithic contact between the depths of 50 and 100 cm.

Sulfic – Provided for in the Dystraquerts that have jarosite mottles and usually have a pH of < 4.0.

5. FAMILIES

The family criteria using fine and very fine, mineralogy and temperature classes remains essentially unchanged.

Calcareous families would not be applied to Dystr great groups; all others could be calcareous or non-calcareous.

The use of depth classes to a meter is still under consideration and will be submitted for comments in a future Circular letter.

More detailed and complete criteria and definitions are provided in 4 Circular letters submitted by Dr. Comerma. Those who are interested in receiving these Circulars or future editions or wish to comment may contact one of the following persons:

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Dr. Richard Arnold
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FOOD SECURITY ACT OF 1985
TASK FORCE REPORT

Status of Soil Surveys on FSA Lands

When the 1985 Food Security Act (FSA) was enacted the Soil Conservation Service (SCS) determined that 94 million acres of land in the United States needed soil maps for FSA activities. As of September 30, 1987, 35 million acres of FSA land remain to be mapped by January 1, 1990.

During FY-1987 the greatest workload was concentrated in the upper Midwest and Northern Plains states. Five states: Illinois, Missouri, Minnesota, Montana, and North Dakota accounted for 45 percent of the nations remaining FSA acres to be mapped. During FY-1987 special assistance was provided to the soil survey program in those states for planning and implementing management strategies developed by the 1987 Soil Survey Task Force. Fifty-five soil scientists were detailed into these 5 states during the summer, and they alone contributed over 1.4 million acres to this mapping effort.

In 1988 emphasis is being placed on assisting the 25 states with the greatest remaining acreage of FSA priority lands. Additional funds were provided in the 1988 Appropriations Act to increase productivity of soil survey activities and to prioritize mapping of FSA lands. Management initiatives being undertaken to enhance productivity include: authorization of overtime for soil survey project members, temporary reassignment of soil scientists from areas where seasonal climate inhibits mapping activities to areas with less severe weather conditions, hiring additional soil scientists, and contracting out mapping activities where qualified private sector soil scientists are available.

There were 49 soil scientists on temporary details in the states Arizona, California, Florida, Louisiana, North Carolina, Texas, and Virginia during the FY-88 winter months and we are anticipating needing 107 soil scientists on detail during the FY-88 summer-months. In addition, efforts are being made to hire additional soil scientists in an attempt to offset the continuing loss of soil scientists from SCS.

Each state has recognized this workload as a national priority and has a plan for completing the mapping of this cropland and potential cropland by January 1, 1990 and/or for providing staff to other states needing assistance.

TASK FORCE REPORT 2

SOIL CHARACTERIZATION STANDARDS

Reasons for the Task Force

The matter of standardization was brought up at each of the regional soil survey conferences last year, and at some of the regional conferences in previous years. Major stimuli for discussion were:

1. General interest in standardization

2. Concern about the significance of OMB Circular A-119

3. Concern about status of NCSS procedures relative to procedures sanctioned by' other groups such as ASTM, EPA or OSM, and

4. Interest in considering the option of allying NCSS procedures with ASTM by proposing them for ASTM acceptance.

Agenda

This is a" interim report of Task Force perceptions and preferences about the issues. Following this conference, the attached questionnaire will be sent to selected user-s of NCSS cooperators at large who produce laboratory data. Responses are to be tabulated and task force recommendations completed by mid-November. Task Force positions will not be solidified until after reviewing the responses.

National Soil Survey Conference Action

No formal action is requested unless this report stimulates the conference to add further instructions to the four charges. The Task Force does request advice on NCSS cooperators that should be sent the attached questionnaire or the approach to the issues.

Charge 1 - Does the NCSS need a set of standard laboratory procedures?

Task force opinion is an overwhelming, “Yes”. Opinions divide when we begin to discuss the purpose of the standards, how limited and how limiting to make them.

There is diverse opinion about whether we should specify that the procedures in Soil Survey Investigations Report No. 1 (SSIR-1) are the standards, whether Agronomy Monograph NO. 9 plus SSIR-1 should be specified or whether there should be a NCSS document citing equivalent procedures from a variety of references.

There is also a diversity of opinion about the purpose of a standard set of procedures. For Soil Taxonomy there is a more or less standard set in use. For other purposes some prefer to view the standards as guides.

For a computerized data base, a modest majority favors standard procedures, but the issue quickly becomes complicated with regard to non-standard procedures that are good information for many purposes, but might not be exactly like the specified standard. Those favoring procedural standards for a data base overwhelming favor a standing NCSS committee to take responsibility for the standards. With or without standards, the very existence of data bases will force some standardization to provide continuity between new research and old data. In a grant-oriented scientific community the broader impact of research that ties into existing data bases will compel at least in format standardization regardless of what we decide.

Responses are mixed with regard to standards for interpretations. For legal applications a sanctioned set of standards would compete better with standards of other groups. For grant or contract competition there is usually a specified set of standards to be met. This might more often be the NCSS sanctioned procedures if they were more formalized. Furthermore, when NCSS cooperators have to follow non-NCSS procedures there is an erosion of a coherent NCSS effort, and that erosion it a serious matter today. Presumably, no one's standards would be binding for many kinds of research, except, perhaps to show how non-standard procedures calibrate to certain data bases. There will be some strong opinions for and against NCSS sanctioning of procedures for specific applications. The Task Force will have to screen responses from producers and users of data very carefully when making any recommendations in this area;

Charge 2 - Should NCSS attempt to have a set of procedures by ASTM?

There is a majority preference to keep ASTM and NCSS standards separate, but some see advantages to closer ties or to proposing selected NCSS procedures to ASTM for specific purposes.

Task Force respondents agree that the advantages of adoption of NCSS procedures by ASTM is legal standing and credibility relative to specific applications. Disadvantage would be in loss of flexibility. One respondent strongly suggests that such inflexibility would slow progress in soil science.

OMB Circular A-119 (1983) was one stimulus for this charge. A-119 states federal position about use of voluntary standards. It encourages Federal agencies to utilize standards such as those of ASTM, which are created by voluntary, public-private interactions. It emphasizes those standards that affect industry and those that can be used by regulatory agencies. NCSS lacks private sector input and therefore does not have voluntary standards in quite the same sense carried by A-119. We may learn more, but at this time it looks as though A-119 would encourage a Federal posture in which NCSS would utilize procedures from groups such as ASTM where there is some advantage to doing so, but not at the cost of efficiency or effectiveness of our operations or of our products. Therefore, the appropriate stance at this stage is to be aware of the circular, and chart a course that allows NCSS to best perform its various missions defined by users and providers of information.

Charge 3 — If voluntary standards or procedures arc used, how should changes in procedures or new procedures be tested and adopted?

The strong preference is for some kind of NCSS review process. Opinions vary on how and on degree of formality for creating change, but include some kind of periodic review, possibly quite broad-based in NCSS, and possibly with the new methods published in a scientific journal. These preferences are expressed across the spectrum from those who wish to view the standards as only non--binding guides, to those who want legally formal standards.

Charge 4 — If voluntary or standard procedures are used, how should they be implemented?

Respondents favor simplicity. Some point out that implementation could be in steps, beginning with NCSS formal sanctioning of all or parts of SSIR-1 and Agronomy Monograph No. 9, and probably leading to some kind of NCSS document (possibly loose leaf). Most favor a NCSS standing committee as the central action group. Some envision task forces to settle specific issues, and several see National Soil Survey Laborator-y efforts as a necessary support to committee and task force actions.

Members - Soil Characterization Standards Task Force

Chairman: Steven Holzhey

Bill Allerdice
Ray Bryant
Victor Carlisle
Maynard Fosberg
Tom Ammons
Gary Peterson
J. L. Richardson
R. V. Rourke
A. R. Southard
Benny Brasher
Warren Lynn
John Kimble

Task Force Advisor: Neil Smock

Dear Task Force on Soil Characterization Standards was recently created to evaluate NCSS positions and recommend action on charges listed in the attached questionnaire. We are soliciting comments from those who produce characterization data for the soil survey program, and from a number of those who use the data. Please fill out all or part of the questionnaire, add any comments to help us understand your perspective on these or related issues, or pen in options not in the questionnaire. Charges to this task force relate to characterization procedures and not to the whole subject of standards. Should we in NCSS more formally identify those laboratory procedures that most accurately fit our concepts of the properties and intended data users? If so, how do we do it and how do we change standard procedures as technology evolves?

If you see deficiencies in other aspects of NCSS characterization standards, please call them to our attention. We can summarize your concerns, although action may be the realm of a different group.

There are several reasons for these questions now, including the size of the combined data bases of all the laboratories; the rate these data bases are growing, tho increasing variety of uses for the data, worry that we do not know quite how well standardized we are and the slow certainty that we will have a national NCSS data base for pedon data.

Another reason is the growing number of formal sets of standard procedures in the environmental and engineering communities. Do we need more visible standards to hold our own on technical or legal grounds? If so, what should the standards be? Do we need acceptance of our flexibility and freedom to do research? Might concern about standards stampede us into complexities we should avoid?

We hope you can give these critical topics some careful thought.

A response is requested by September 20,1987.

Task Force Chairman: C. Steven Holzhey

Questionnaire to National Cooperative Soil Survey (NCSS) Participants and to Users of NCSS Laboratory Data

Those who are mainly users of the data may wish to answer all or only some of the questions, or may wish to put views in writing. We want to define your needs accurately, any problems you have with NCSS laboratory data, and whether more formal standards would be helpful. For your information some typical characterization data are appended to the questionnaire.

CIRCLE AS MANY OPTIONS UNDER-ANY HEADING AS NEEDED TO DESCRIBE YOUR PREFERENCES

Charge 1 - Doos the NCSS need a set of standard laboratory procedures (for soil characterization)?

(A) No.

(B) No, but there should be a compilation of methods used by NCSS laboratories, and method codes assigned, suitable for use in data bases to show equivalence and differences among procedures.

(C) Yes, and we should:

(1) Consider that we have adequate standards and need no further formality or NCSS documentation,

(5) Other (specify)

(D) Yes, and we should view the set of standard procedures as:

(1) General Guidelines

(2) Standards to be followed rigorously by NCSS cooperating laboratories, but without a protocol for validating equivalency among laboratories,,

(3) Standards to be followed rigorously by NCSS cooperating laboratories, and have a protocol for validating equivalency among laboratories,

(4) Standards to be followed rigorously by NCSS cooperating laboratories, and have a protocol for validating equivalency among laboratories,

(E) More formal NCSS recognition of a standard set of laboratory characterization procedures would be helpful to me (specify why).

Charge 2 - Should NCSS attempt to have a set of procedures accepted by the American Society for Testing Materials (ASTM) ?

(ASTM would probably require separate approval of each procedure.)

(ASTM lacks standard procedures for many measurements used in NCSS, but receives proposals for procedures that would compete with NCSS. Agriculture-related procedures are being added. Some engineers want more input from our direction. This, plus the question of whether NCSS procedure, helped spur discussion of this charge at regional Soil Survey Conferences last year. There was also concern that a 1983 revision of OMB Circular A-119 might force Federal NCSS participants to follow what the circular calls voluntary standards, such as those of ASTM. That now seems improbable. Discussions within NCSS evoke strong responses about ASTM linkage: positive from those worried most about legal status, and negative from those worried most about flexibility and the complexity of serving too many masters. We want your answers from standpoint. Possible ramifications are serious enough to require careful thought from as many standpoints as possible).

(A) No.

(B) No for now, but we should review the situation every few years.

(C) No, but NCSS participants should be encouraged to join ASTM committees.

(D) Yes, with the intent of binding NCSS operations to ASTM methods.

(E) Yes, with the intent of not binding our NCSS operations to the ASTM methods (i.e., recommend procedures to ASTM, but keep NCSS standards under NCSS control).

(F) Yes, and if there is no one ASTM committee to address soil characterization standards, NCSS should seek to have one established.

(G) What advantages and disadvantages do you see in going to ASTM?

Charge, 3 - If voluntary or standard procedures are used, how should changes in procedures or new procedures be tested and adopted?

(You may profit from reading options under Charge 4 before filling out those under Charge 3).

(A) Through SCS action.

(B) Through NCSS standing committee action,

(C) Through periodic NCSS task force action.

(D) Through one of the above, using a set protocol for proposing and testing changes or new procedures. The protocol to be written into NCSS policies and procedures.

(H) Through ASTM committee action (as they now operate).

(J) Data that justify changes should be published.

(K) Clther (specify).

Charge 4 - If voluntary or standard procedures are used, how should they be implemented?

(A) They are already implemented adequately.

(B) How detailed would you prefer the specifications for standard procedures?

(1) One citation of a standard procedure for each measurement, with no procedural discussion,

(2) Several citations of equivalent, published procedures from each measurement, with no procedural discussion

(3) Citations plus identifcation of critical steps required to produce equivalent results with each kind of measurement (as saturated paste for saturation extracts to measure salts), but not detailed stepwise procedures.

(4) A laboratory manual with one detailed, standard procedure for each property, and literature citations for other equivalent methods,

(5) Compile statements of rationale for the choice of procedures,

(6) State procedural limitations (for example, ranges in properties over which a procedure is known to be effective).

(7) Identify changes in procedures necessary to overcome specific limitations.

(8) Other (specify)

(C) If you prefer to specify equivalency among alternative, published procedures, how should equivalency be determined for the initial list of standard procedures?

(1) Through inter-laboratory comparisons among laboratories that use different published methods (to test equivalency of methods, not to test quality of laboratories),

(2) Through correspondence among NCSS laboratories in which each laboratory specifies the designated standard procedure to which each of its published procedures is equivalent. Unpublished procedures to be omitted from list. Compilation and publication of lists just the way they are sent in. No reference to who sent them in except a general list of participating laboratories.

(3) Same as Option (2), above, except that a task force of experienced analysists fron NCSS labs should screen the citations

(4) Other (specify) and require proof of equivalency for questionable prcedures.

(D) Who should be in charge of initial implementation?

(1) SCS

(2) Standing NCSS committee

(3) NCSS task force,

(4) Other (specify).

(E) What vehicle should be used to distribute methods and what vehicle should be used for later changes?

- (1) Supplements to Soil Survey Investigations Report No. 1
  - (a) For initial implementation
  - (b) For later changes
- (2) Notes in Soil Science Society of America Journal
  - (a) For initial implementation
  - (b) For later changes
- (3) A NCSS manual with periodic supplements,
  - (a) For initial implementation
  - (b) For later changes
- (4) A NCSS newsletter,
  - (a) For initial implementation
  - (b) For later changes
- (5) Pages for loose leaf binders,
  - (a) For initial implementation
  - (b) For later changes
- (6) Addenda to the National Soils Handbook
  - (a) For initial implementation
  - (b) For later changes
- (7) Other (specify)

TASK FORCE 3
SOIL FAMILY CATEGORIES

The chairman sent the charges and 3 discussion of the issues on 18 May to the 11 prospective Task Force members listed below. Written responses were received from the first eight listed. The last three plus Base and Edmonds and, in addition, Hari Eswaran, Gary Muckel, and John Witty participated in a Task Force meeting at the Conference.

Richard Base, USDA-SC:S, Lincoln, NE
William E. Dollarhide, USDA-SCS, Reno, NV
Joe Downs, USDA-SCS, Salt Lake City, UT
W. J. Edmonds, VPI and State University, Blacksburg, VA
Richard Fenwick, USDA-SCS, Washington, DC:
A. D. Karathanasis, University 'of Kentucky, Lexington, KY
D. L. Mokma, Michigan State University, East Lansing, MI
Ronald Paetzold, USDA-SCS, Lincoln, NE
Ben F. Hajek, Auburn University, Auburn, AL
Jerry Ragus, USDA-FS, Atlanta, GA
Wayne Robbie, USDA-FS, Albuquerque, NM

The five issues presented to the members are discussed below:

1. Definition of Family Category

Charges for the task force ask for a "meaningful definition" of the family category "consistent with Soil Taxonomy". The issue seems to be that it is not appropriate in a taxonomic system to have one category in which classes can be regarded as "technical groupings" (Cline, 1949). That is, families should not be defined simply to achieve homogeneity for interpretive purposes. The charges suggest that it may be possible to define the family category in a way that preserves most or all of the homogeneity without violating the taxonomic proprieties. The original concept of Soil Taxonomy and two recently proposed concepts of the family category are presented below.

Soil Survey Staff - 1975 - Page 80

Families

In this category, the intent has been to group the soils within a subgroup having similar physical and chemical properties that affect their responses to management and manipulation for use. The responses of comparable phases of all soils in a family are nearly enough the same to meet moot of our need5 for practical interpretations of such responses. Soil properties are used in this category without regard to their significance as marks of processes or lack of them. .. These properties are Important to the movement and retention of water and to aeration, both of which affect soil use for production of plants or fur engineering purposes.

HaJek - 1985

In higher categories (above the family) emphasis has been on marks of important sets of processes, both historical (geologic) and current. The family category emphasizes those additional soil properties that mark future potential for change and rate of change. Classes are grouped on the basis of the soil material primarily particle size, mineral and/or elemental composition (capacity factors) and soil temperature (intensity factor). Classes are defined in terms of the current state of soil material and temperature at defined depth limits. It is not necessary that past processes he known. However, both historical soil forming processes and the initial state of the material are often apparent.

Witty and Arnold - 1987

At the farnlly level, classes are differentiated on the basis of properties that reflect the potential for further change, including such properties as particle-size distribution, mineralogy, temperature, soil depth, and others. Particle izc, mineralogy, and soil depth are mainly capacity .actors, whereas soil temperature is an intensity factor.

An extension of the Witty and Arnold definition (concept) was proposed to the Task Force. Five written responses favored the proposal and two favored the Witty and Arnold version. Two of the seven responses questioned the need for a change from Handbook 436. At the Task Force meeting, there was general support of the draft Task Force proposal modified, primarily by addition of the first sentence frorn Handbook 436, as follows:

Task Force Proposal

At the family level, classes are differentiated within a' subgroup on the basis of properties that control current processes within the soil and the potential for further change in such features as mineral composition, status of organic matter, differentiation of horizons, and nutrient status. Current processes include movement and storage of water, leaching, mobilization and immobilization of components, organic matter decomposition, mineral weathering, and so on. In this category, the intent has been to group soils having similar physical and chemical properties that affect their responses to management and manipulation for use.

2. Criteria for Families

The Task Force proposal above does not require any changes in the list of properties used to differentiate families.

In his recent review of families and the family category, Hajek (1985) identified mineralogy as the most problematic diagnostic at the family level. His major recommendations were to consider clay mineralogy in loamy and loamy-skeletal as well as clayey and clayey-skeletal particle-size classes and to emphasize assemblages of minerals rather than single minerals. Extracts from his report (Attachment 1) outline many of the revised mineralogy classes. Hajek told the Task Force that he used new, provisional names to avoid conflict with current names. Only 11 or 12 classes, all phyllosilicate classes, are used for the mineralogic map of southeastern states under development by the regional committee S-152, Significance and Distribution of Mineral Components in Southern Soils.

Task Force members expressed general support of Hajek's approach to revise mineralogical criteria and suggested the need for refinement and simplifiction. The most extensive comments, forwarded by one of the members, were in a letter dated 9 April 1986 from the Midwest NTC: to John Witty. Differential application of mineralogic criteria by carders or by other classes of higher categories was recognized as a promising possibility. Need to change the key was suggested.

The Task Force expressed some interest in Dr. Van Wambeke's proposal (Attachment 2) to use both summer and winter temperatures to define soil temperature regimes where mean winter and mean summer soil temperatures differ by 5oC or more. This proposal was included in Hajek's interim report of January 1984.

3. Control Section

As defined by Soil Taxonomy, the control section for particle-size and mineralogy classes used at the family level ranges in thickness from a bit more than 0 to 75 cm.

The depth to the top of the control section ranges from 0 to almost 200 cm. The depth to the bottom of the control section ranges from a bit more than 0 to almost 250 cm. The task force was charged to consider simplification, "improved effectiveness", and inclusion of surface layers. The issues suggested to the Task Force were:

a. Surface Layers

Except for shallow and cold soils, the control section excludes the upper 25 cm of the soil at both family and series levels. This continues the longstanding practice of recognizing differences in surface texture by subdividing soil series into soil types and avoids change in classification with tillage. On the other hand, some diagnostic horizons and characteristics used in categories above the family do consider the upper 25 cm of the soil. Members of the Task Force were divided between exclusion of the 0-to-25-cm layer and starting the family control section at the surface of the soil.

b. Grossarenic Soils

The exception made for grossarenic subgroups adds 100 cm to the range in depth to both the upper and lower boundaries of the control section. Task Force members were asked: Is this a useful exception? Is it reasonable to allow the control section to go so deep? Does anything need to be fixed? Only one member supported (with strong reservations) the special treatment of grossarenic soils.

c. Argillic and Natric Horizons

Much of the complexity in specification of the control section results from emphasis on argillic and natric horizons. Task Force members were asked: Is this justified? Would it be better to consider an arbitrary section without regard to argillic and natric horizon? The Task Force was divided between support of and opposition to current treatment of argillic and natric horizons.

d. Ap horizon

Of the members of the Task Force who favored exclusion of surface horizons from the control section, only one favored a standard depth for its upper boundary (25 cm) rather than the base of an Ap horizon thicker than 25 cm.

Written responses about these four issues from Task Force members suggested that further consideration is needed, particularly with respect to argillic and natric horizons. The following definition of the control section for particle-size classes or their substitutes evoked mixed reactions from Task Force member5 at the Conference.

Particle-size modifiers or substitutes are used to describe material from the surface to a root limiting layer if any of these come within a depth of 36 cm or less, or to a depth of 36 cm if the soil temperature is 0 degrees C or lower within this depth about 2 months after the summer solstice.

In other soils, particle-size modifiers or substitutes are used to describe material from (1) the top of an argillic, natrlc, or kandic horizon shallower than 25 cm, (2) the base of an Ap horizon deeper than 25 cm, or (3) a depth of 25 cm, if neither (1) nor (2) applies; to (1) a root limiting layer at a depth less than 1 m, or to a depth 25 cm below the level at which the soil temperature is 0 degrees C about 2 months after the summer solstice, or to 1 m, whichever of these is shallower, or (2) if the depth to the upper boundary of an argillic, natric, or kandic hot-lion is between 50 cm and 1 m, to 50 cm below such boundary. If within these depth limits there is an argillic, natric, or kandic horizon or some part of such horizon and no strongly contrasting particle-size classes, then particle-size modifiers or substitutes are used to describe the upper 50 cm of the argillic, natric, or kandic horizon, or the whole of such horizon if it is less than than 50 thick, rather than the entire control section.

Task Force members at the Conference recognized that the importance of thin argillic and natric horizons varies strongly with differences in moisture regine and supported definition of the family control section for specific orders or other classes above the family level. ICOMAND (Leamy and Kinloch, 1987) already has defined a control section for Andisols different from that used for other orders.

4. Relationship of Family and Series Categories

Two Task Force members expressed mild concern about confusion or overlap of criteria between the family and series categories. One wrote that there are problems in use of less than the whole range of a family as a component of a.

map unit. One pointed out the possible use of refined mineralogical criteria in place of bedrock differences at the series level.

5. Charges For an International Committee

A group from the Steering Committee for the NCSS Work Planning Conference intended that the Task Force lay the groundwork for an international committee on the family category and suggested these questions;

What properties best meet the needs or intent for the family category?-

Do we need different properties or just expansion or refinement of existing properties?

Do we need to differentiate more clearly between the family and series categories with respect to the criteria used at each level?

What should the family control section reflect?

Do we need to change the control section? If so, what should it be?

Should we simplify the family?

Should the specifications far identification of families be presented in a separate chapter of Soil Taxonomy as is done now or should they be dlstrlbutcd within the text in the chapters far each of the orders?

The Task Force supported the following charges and issues for an international committee on the family category:

Evaluate suggestions and recommendations for changes In the family category resulting from the work of the Task Force on Soil Family Category of the 1987 NCSS Work Planning Conference.

Solicit and evaluate suggestions and recommendations from other sources.

Make studies and prepare report6 and publications as appropriate.

Develop and present proposals and recommendations for changes in the family category.

Issues to be considered include:

Definition or Concept of the Family Category

Properties to be used at the family level

Mineralogy classes

Temperature regimes

Possible soil moisture classes

Control Section

Relationship of family and series categories (low priority)

RECOMMENDATIONS TO THE CONFERENCE

Request Formation of an international committee on the family category with the charges listed above.
Ask regional conferences to review and test Hajek's proposals fur mineralogical classes and Van Wambeke's proposals fur soil temperature regimes.

Call for a study of U.S. soil series to provide information on the number, classification, extent, and location of grossarenic soils and of series with upper or lower boundaries of argillic and natric horizon shallower than 25 cm or deeper than 1 m.

Refer all these issues to the international committee.

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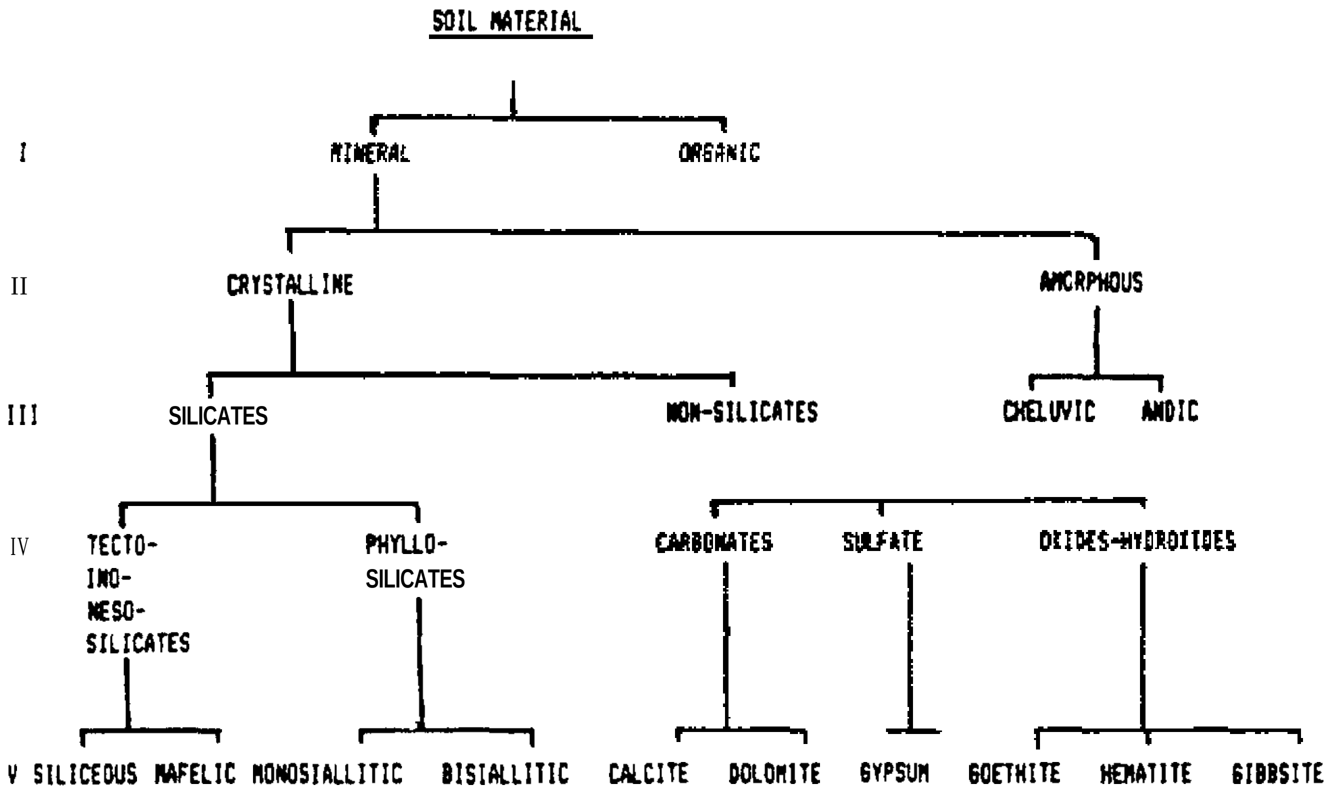
Ellis G. Knox

Task Force Chairman
23 July 1987
20 August 1987

FLOW CHART OF SOIL MATERIAL CATEGORIES FOR SOIL TAXONOMY



Definition of classes in Category v

Siliceous

Definition - More than 90 percent by weight or siliceous minerals and other minerals that are as, or more, resistant to weathering than quartz.

classes - fragmental, sandy-skeletal and sandy at the family level when not implied at a higher level such as quartzi-great groups.

family class - siliceous

Hafelic

Definition1 - More at 10 percent weatherable minerals containing significant amounts of bases such as Ca. Mg, Na and K (mafic and feldspathic minerals)

classes - same as siliceous

Family class - mafelic

Monosiallitic

Definition -

1. less than 15 percent expanding layer silicates in the < 2 μn fraction.

2. clay activity, derived from permanent charge, is less than 16 cmole(+) kg^{-1} clay (ECEC)

3. kaolinite and or halloysite dominate the clay fraction, often present but not necessary are lesser quantities of HIV illite, and oxyhydroxides of Al and Fe.

   a. less than 32% Fe_2O_3 (CBD), whole soil
   b. < 25% Gibbsite, whole soil

classes - In loamy and clayey families of Dxisols, Ultisols. Alfisols, Entisols, and Inceptsols,

Bisiallitic

Definition - soil material consists of appreciable 2:1 and 2:2 phyllosilicates.

characterized by:

a. greater than 15 percent expanding layer silicates
b. clay activity derived from permanent charge is > 16 cmole (+) kg^{-1} clay (ECEC)
c. less than 32% Fe_2O_3 whole soil
d. less than 40% calcite + dolomite + gypsum.

Family class - classes defined at lower level (VI)

classes - loamy and clayey families of Alfisols, Mollisols, Entisols, Inceptisols, Vertisols, Ultisols, Aridisols.

Definition of Monosiallitic and Bisiallitic Classes in Category VI

Monosiallitic Subclasses

monorthic
juvenic
quasibisiallitic
Ferritic
sibbsitic
sesquijuvenic
allic
quasiandic
juvenallic
sesquioxidic

Distinctions Between Monorthic Mineral Assemblages and Other Classes

Monorthic are soil materials that:

a. have less than 40 cmole (+) Kg^{-1} soil non-exchangeable (Ca + Mg + K + Na) or an equivalent amount of weatherable minerals in the 0.02-2 mm fraction.

b. have more kaolinite and/or halloysite than any other phyllosilicate and ECEC is less than 12 cmole (+) Kg^{-1} clay.

c. have less than 7.5% Fe_2O_3 (CCB total soil).

d. have less than 3.5% gibbsite (total soil).

e. have exchangeable Al <5 cmole (+) Kg^{-1} clay or <2 cmole (+) Kg^{-1} soil.

f. do not have >1% Al-oxides derived from amorphous or cryptocrystalline material.

Juvenic are like monorthic except for a.

Quasibisiallitic are like monorthic except for b.

Ferritic are like monorthic except for c with or without b.

Gibbsitic are like monorthic except for d with or with c and b.

Sesquijuventic are like monorthic except a, c, or d, with or without b.

Allic are like monorthic except for e.

Quasiandic are like monorthic except for f.

Juvenallic are like monorthic except for a and e.

Sesquioxidic are like monorthic except for c and d.

aisiallitic subclasses:

biorthic	expanic
senilic	calcaric
quasimonosiallitic	expancalic
ferrsiallic	biandic
quasisenilic	micaic

Distinctions Between Biorthic Mineral Assemblages and Other Classes

Biorthic are soil materials that:

a. have more than 40 cmole (+) Kg^{-1} soil non-exchangeable (ΣCa + Mg + K + Na) or an equivalent amount of weatherable minerals in the 0.02-2 mm fraction.

b. have more 2:1, 2:2 phylosilicates (as discrete phases or interstratified) than 1:1 species and the ECEC ranges from about 25-40 cmole (+) Kg^{-1} clay.

c. have less than 7.5% Fe_2O_3 (CBD total soil).

d. have less than 50% smectite plus vermiculite in the clay fraction (<2 μm).

e. are non- to slightly calcareous, less than 2% $CaCO_3$ or $CaSO_4$.

f. have less than 25% mica (0.02 to 20 mm) on a whole soil basis and percent mica in the .002-2 mm is <40.

g. do not have >1% Al-oxides derived from amorphous or cryptocrystalline material.

Senilic are like biorthic except for a.

Quasimonosiallitic are like biorthic except for b.

Quasisenilic are like biorthic except for a and b.

Ferrsiallic are like biorthic except for c with or without a and b.

Expanic are like biorthic except for d.

Calcaric are like biorthic except for e, with or without a or b.

Expancalic are like biorthic except for d and e.

Biandic are like biorthic except for.9 with or without a, b, c, and d.

Micaic are like biorthic except for f with or without a, b, c, and d.

Attachment 2

Temperature Regime Computing Program

The new temperature computer program is a program which classifies temperature regimes taking into account seasonal differences in temperature. It has been developed in response to claims that the mean annual soil temperature is not an adequate criterion to characterize temperature regimes and that extremes in temperature reached both in winter and summer are more significant to plant growth and pedogenesis than the annual mean.

The program follows a computation model which allows testing of critical limits to identify seasonal extremes in temperature. It accepts monthly air temperature data as input. It partly follows the terminology of Soil Taxonomy; it recognizes for example the &o-temperature concept. The lso-temperature regimes are subdivided according to the present definitions of Soil Taxonomy.

The non-iso temperature regimes are classified according to two major considerations.

1. A critical maximum temperature level above which the temperature of 3 consecutive months fall. This maximum level defines the suffix of the name of the temperature regime.

2. A minimum critical temperature below which the temperature of two consecutive months drop. The minimum critical level determines the prefix of the name of the temperature regime.

In case both the prefix end the suffix have the same name. the name of the temperature regime is only determined by the name of the suffix.

The program allows to select five critical temperature levels which can be used and tested when processing data. A" example of such critical limits would be 0, 8, 15, 22. 28°C. Different sets of critical levels can be used for subdividing the "iso" or "non-iso" temperature regimes. In the non-iso temperature regimes the five critical limits generate the prefixes gelo, cryo, meso, thermo, and hyper which designate the lowest critical level below which the winter temperature drops. The same critical levels generate the suffixes as follows: gelic, crylc, mesic, thermic, hyperic, superic. A gelomesic temperature regime for example would be a temperature regime in which the winter temperature would drop during at. least two consecutive months below 0°C and reach during 3 consecutive months temperatures above 15°C but lower than 22°C.

The program also lists a set of parameters which give numerical information on the mea" winter (WT) and summer (ST) temperature calculated according to the methods proposed In Soil Taxonomy, taking Into account a constant increase conversion from air to soil temperature and a" attenuation of the differences between winter and summer. The program also gives the lowest average of air temperatures of three consecutive months In one year (CST) and the highest average of three consecutive months in one year (WST). It finally calculates the difference between WT and ST. designated as DIF, and the difference between the average coolest and warmest months (TIF).

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Professor of Soil Science

USDA - SCS SOIL SURVEY
PRODUCTIVITY IMPROVEMENT STUDY
EXECUTIVE SUMMARY

A Soil Survey Productivity Improvement task force was assembled by the Soil Conservation Service to study it's soil survey program. The task force consisted of Buell M. Ferguson, Coordinator, Verne M. Bathurst, Chairman, Arthur B. Holland, Member, James R. Talbot, Member, Carl B. Fountain, Member, Thomas H. Wetmore, Jr. Member, Kenneth C. Hinkley, Technical Advisor. The purpose of the study was to find the most effective and efficient organization for accomplishing the agency objectives for the soil survey program and to identify those activities those activities in this program which are inherently governmental and activities that can be considered commercial in nature.

The task force concluded that the soil survey program In SCS has, in general, been well managed. Both quality and efficiency have been steadily improving over the years. The changes suggested in this report should not be interpreted as an indication of past inadequacies. However, changes are needed at this time to more efficiently and effectively complete the task of mapping and documenting the soils of the nation and of providing the technical soil services to CS programs and other users.

The recommendations will improve both the overall quality of soil survey and the efficiency and effectiveness in which mapping is accomplished and the information reported and published. Classification, correlation and interpretation functions of soil survey should be done at the state and field level, where personnel have the greatest knowledge about the specific soils. When responsibilities are made clear and proper training given, employees in the state and project offices will take the initiative to see that the work is complete and correct. Quality control at the state level and quality assurance procedures by the National Soil Survey Center will indicate where deficiencies are so that training or other corrective measures can be taken.

The task force spent considerable time studying the operating procedures for soil survey, interviewing personnel, collecting and analyzing data, discussing ways to make a more efficient operation and preparing the report. The data collection Included an extensive listing of tasks and the time spent for each level or working group. The information was obtained by interviews and questionnaires. The five areas addressed include the mission of soil survey, operating procedures, workload, equipment and technology, and organization and staffing.

The task force found that some changes are needed in thr organization and staffing presently used. Where coordination is critical, the work could be more effectively accomplished with some centralization of certain functions. There is a need to assign Soil Survey technical staff responsibilities according to major land resource areas rather than political boundaries such as states or NTC areas. A reorganization of NHQ and NTC soils staffs is recommended in the report. There Is a need to have a National Soil Survey Center (NSSC) of soils technical expertise to which scientists of the world can look for the most authoritative information on soils rather than the dispersed or segmented **organization** presently used.

The task force found that soil survey production In terms of acres mapped per staff year has been increasing over the years as efficiency has improved. The analysis shows that production can be further increased by implementing the recommended management initiatives regarding adjustment In the number of on-going surveys, use of less intensive surveys, better scheduling, moving staffs to priority areas, reorganizing some staffs, and other management improvements. The task force also found equipment and technology to be generally adequate, but improvements can be realized with more attention to these areas. Resource Soil Scientist should be located at appropriate locations such as area offices, to provide technical soil services for SCS programs and other users. The data shows that separation of project soil mapping and technical soil services improves the efficiency of both activities.

The task force found that the overall soil survey mission is documented and clear but more definitative responsibility statements are needed for each organizational level. Mission statements were prepared for the recommended organization levels. Overall operating procedures were found to be good, however, there is duplication of effort, some tasks are being performed at levels higher than necessary, time is spent inappropriately, there are scheduling difficulties, and in some cases surveys are overdesigned. The presentation of soilsurvey information was looked at and the task force feels that it needs to be studied further for improvement In efficiency and effectiveness. Some shifting of functions and tasks are recommended to make the program efficient and effective and to make programs more responsive to state and cooperator needs.

Sir: major functions were found to he inherently governmental and should remain under SCS leadership. These are: (1) development and interpretation of policy, (2) National Cooperative Survey (NCSS) procedure development and management, (3) quality assurance, (4) quality control, (5) project management, and (6) soils technology transfer. The three major functions considered not Inherently governmental arer (1) manuscript editing, (2) map finishing, (3) and laboratory testing work done by technicians. These functions need to be studied to determine if contracting 16 appropriate. Additionally, tasks such as: (1) field mapping, (2) digitizing of data, (3) software development, (4) training materials development, and (5) word processing and data input are tasks that might be contracted when cost effective and adequate quality control can be maintained.

EROSION-RELATED COMMONPLACE SOIL PROPERTIES IN THE NATIONAL COOPERATIVE SOIL SURVEY[1]

R. B. GROSSMAN[2]

The program of the National Cooperative Soil Survey (NCSS) can be divided into mapping and the direct description of the mapping concepts employed, and the prediction bf the behavior of these mapping concepts for various uses. Soil behavior prediction in turn involves evaluation of a number of interpretive soil properties (erosional K and near surface permeability, for example). These interpretive soil properties are employed in predictive schemes to make interpretive placements for naming concepts of map units.

My purpose is to discuss several interpretive soil properties that pertain to erosion prediction. The presentation is limited to erneion-related interpretive soil properties on which I have worked. All. of the properties are commonplace within the soil survey data base. The statement concludes with a few general suggestions.

INDIVIDUAL INTERPRETIVE SOIL PROPERTIES

Runoff

Issues: Overland flow is central to water erosion prediction. Runoff class placement is the only information that we provide about overland flaw for map units which integrates both internal soil characteristics and the configuration of the ground surface. It should be noted that runoff involves slope whereas the hydrologic group concept does not.

We assign runoff classes to naming concepts of all map units. The classes come from the 1951 Sol I Survey Manual. The classes are not defined in our published sol I surveys. The 1951 class definitions are suspect. The rapid class implies 3 50 percent of the precipitation runs off. this is too high for many if not most map units that are placed in the rapid class. In the first place, if the prOportion 0f precipitation that ran off was > 50 percent, taxonomic moisture regime changes with slope class would be the rule rather than the exception in much of the United States. Furthermore, yield differences across slope classes would be

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[1] Prepared for the 1987 National Soil Conference, St. Paul, Minnesata

[2] Soil Scientist, NSSL, MNTC:, SCS, Lincoln, Nebraska

much larger than is commonly the case. In addition, there is experimental evidence that the definitions are suspect. For the highly dissected loess landscapes of southwest Iowa represented at the AHS Hydrology Station, Treynor, Iowa, 10 percent of the rainfall runs off under conventional tillage if no terraces are present. Probably the majority of the subarea of these watersheds from which appreciable runoff occurs would be placed in a rapid runoff class.

Suggestions: The runoff classes should be dropped or we should adopt a more quantitative but relative class set. We should provide definitions of runoff classes in the glossary of published soil surveys.

A proposal has been made fur inclusion in the new Soil Survey Manual (attachment 1) that would modify the runoff class concept to make it relative without stipulation of the precipitation 'that runs off. The placement would pertain to a deeply wetted bar-e soil. Characteristics of the storm to which the relative runoff pertains would be specified; the proposal calls fnr a 2-inch storm in 24 hours with no more than 1 inch in any single hour. The class definitions involve quantities that are elsewhere in the draft of the new Soil Survey Manual. The proposal is an Integral part of the revisions in the manual taken as a whole.

Roots

Issues: Apart from the importance fur soil productivity evaluation, root distribution information provides a direct approach to erosionalTevaluation. As evidence, recently the EPIC group asked for assistance with root depth prediction for purposes related to erosional T. Many soil surveys have been published with no root information including the absence of roots from the descriptions of the type locations of the soil series. Our soil surveys commonly lack generalized root information for different crops and the terms used to describe rooting are incompletely defined. It seems extremely wasteful to lose observations on root distribution that are collected incident to the completion of soil surveys. This information can only be captured through a program that require5 generalizations on a local basis by plant species.

Suggestions: In 1979 a committee of this conference proposed a scheme for documentation of roots for inclusion in soil surveys (attachment 2). We Should consider this proposal. The scheme involves making generalizations for a few important crops of the depth to the base of common and few routs at physiological maturity. We probably now should substitute very few roots (class for the new manual) for dicots. It may be better to prepare compendia at a major land resource area level instead of including such information in individual soil surveys.

Tillage Zone Bulk density and Permeability

Issues: Tillage zone bulk densities change with use and for intertilled crops commonly change through the year. Furthermore, the bulk densities commonly differ markedly within the tillage zone depending on whether mechanically bulked or mechanically compacted. Therefore, it is important that we closely define the bulk densities that are published for surface horizons of soil series that are used commonly for intertilled crops. In fact, we provide no explanation of the bulk densities of the tillage zone for intertilled crops.

For tens of millions of acres of cropland, the assigned bulk densities for the tillage zone markedly exceed the mechanically bulked portion of the soil when most subject to erosion. Additionally, the assigned bulk densities are considerably below the values for the mechanically compacted subzone. Permeability of the tillage zone is strongly controlled by the bulk density of the mechanically compacted subzone. As a consequence, the permeability values assigned to the tillage zone are probably systematically too high. For many soils, permeability of the tillage zone controls the steady ponded infiltration rate. In this regard, bulk density is employed by ARS hydrologists to predict permeability, and hence, steady ponded infiltration rate in various major models that are in process of development and application, including the Water Erosion Prediction Project (WEPP).

A comparison follows between the tillage zone bulk density in the soil series record and measured data during the period of maximum susceptibility to water erosion for three soil series with an aggregate extent of 4.5 million acres. The soil series occur in southeastern Nebraska and central and southwestern Iowa.

Soil Series	Bulk Density		
	S-5 Form	Measured Mech. Bulked	Measured Mech. Compacted
Clarion	1.40-1.45	1.00-1.20	1.60-1.70
Monona	1.25-1.30	0.80-0.90	1.40-1.50
Sharpsburg	1.30-1.35	0.80-0.90	1.40-1.50

Suggestions: Attachment 3 is a statement under consideration by a committee of the Midwest National Technical Center. It contains a range of options. As minimum, we should explain in our soil surveys just what the bulk density of the tillage zone is meant to describe. We could go further and give the user to a limited extent, use-specific, temporal bulk density and related permeability information. We could, of course, delete bulk density and permeability for the surface horizon if most of the map unit is used for intertilled crops. The problem with this alternative is that the tillage zone, and in particular, the tillage zone for intertilled crops, is central to the mission of the Soil Conservation Service,

Erosional K

Issues: For the evaluation of map units for the Food Security Act, erosional K should be and is adjusted for the horizon volume fraction of rock fragments based on the map unit record. This is in accord with the concept of K in an operational sense. If K were actually measured, the idealized surface horizon would be tilled and a surface presented to the simulated rainfall that would be free of vegetation and with at the initiation of the experiment a rock fragment mulch percentage equal to the volume percent of rock fragments in the tilled horizon.

For determination of whether a particular agricultural management area (tilled field, pasture or range) meets the requirements stipulated by the erosion legislation, the rock fragments on the ground surface for the soil use involved should be incorporated in the C factor of USLE. The product then is employed of C and K for the fine earth. It is necessary to use K for the fine earth to avoid a double reduction for rock fragments, both in K and in C.

There are persuasive reasons to incorporate the rock fragments on the ground surface in C for evaluation of the actual erosion potential. One reason is that the actual rock fragment mulch on relatively undisturbed ground surfaces commonly markedly exceeds the volume fraction of rock fragments in the surface horizon in the map unit record. Relatedly, there is no way in general for relatively undisturbed ground surfaces to estimate the rock fragment mulch from the map unit record. Another reason is that the rock fragment percent on the ground surface is highly use dependent. Concentrated grazing, physical disruption by man, or removal of rock fragments can reduce the rock fragment mulch percentage markedly. The most important reason, however, to incorporate rock fragments in C is that Food Security Act implementation procedures stipulates a two stage soil documentation. First, the potential erosiveness of the naming concepts of map units is evaluated. Then a particular use of management of these naming concepts is evaluated. The approach previously sketched fits how the Food Security Act is being implemented.

Attachment 4 is a proposed modification of the current description of erosional K for our soil survey reports. Presently we make a correction downward of erosional K for rock fragments in our soil survey reports. The reports do not necessarily indicated that a correction has been made. We do not tell how to obtain K for the fine earth and we do not explain that C, as adjusted for rock fragments, would be multiplied by K for the fine earth. We have set up a situation where double adjustment of rock fragments, both in K and in C, if not encouraged, at least is certainly facilitated.

The situation is however, even more disturbing. A few years ago it was common to publish erosional K for the fine earth. We never told our users then, as we may not now, to what composition base the K values pertained. As a consequence, in parts of the country, we have both values published, for the fine earth as corrected for rock fragments, and the difference is not identified.

Additionally, there are questions about the adjustments that are made in K for rock fragments. Attachment 5 describes how to compute a K for the fine earth consistent with the > 2 mm. If the K for the fine earth is unreasonable, either the > 2 mm, the K adjusted for rock fragments, or both is wrong. A significant portion of the erosional K values that have been adjusted for appreciable rock fragments may be in question. Usually the adjustment of K for rock fragments appears to be too small.

Suggestions: Modify the explanation of erosional K in our published soil surveys. Suggestions are made in attachment 4. Additionally, adopt a national edit routine for erosional K values that have been adjusted for rock fragments as is sketched in attachment 5.

Erosional T

Issues: C.H. Berdanier and I published a paper on erosional T that is pertinent (in Determinants of Soil Loss Tolerance, ASA sp. pub. 45). Attachment 6 presents portions of the paper. Two proposals were made. One was to make T the product of a maximum T for a hypothetical deep soil without root restrictions and of a T adjustment factor which would be determined by how the actual soil properties departed from these for the conceptual deep, unrestricted soil. Tho maximum T would be determined by the conservation movement as a whale at a particular time and would be susceptible to social, political and economic considerations. The 1 adjustment factor, which could range from unity down to perhaps 0.1 would be controlled by technical people. It would be subject to change as our understanding and knowledge increased, and in this sense, would parallel our soil taxonomy system.

The T adjustment factor would depend on two groups of soil properties: potential rooting depth and a depth change factor. The potential rooting depth would be determined by both taxonomic and nontaxonomic soil properties. The depth change factor would be determined by changes from the ground surface to the potential rooting depth in a set of characteristics, including organic carbon, extractable bases, available water, permeability. The depth change factor would provide an adjustment Index for the significance to productivity of truncation.

It would seem feasible to define two T adjustment factors. One would be as sketched. The other- would address the relative rate of parent material alteration to soil. Soil moisture regime, consistence, and depth to the top of the parent material would be considerations.

Current assignments of erosional T are not always consistent and the approach over-all, given the importance of the subject, seems to lack the requlsite sophistication and technical substance. The written record of the bases for the guidelines is sparse. Emphasis within NCSS on the T adjustment factor and therefore separation from social, political and economic considerations would make It more feasible to structure an internally consistent, correctable approach based on soil morphology.

Suggestions: Separate the social, political and economic considerations from the morphological for T formulation. Explore the construction of guidelines for the morphological component of T to include both the effective potential rooting depth and the change in soil properties from the ground surface to this potential rooting depth.

Erosional I

Issues: My concern is with the lack of a provision to handle conditions where the very near surface is continually consolidated or crusted.

We assign potential wind erodibility of mineral soils map for the Food Security Act program based on texture and carbonate content of the near surface. The quantities determine the wind erodibility group, which in turn, establishes the erodibility. Formally, the erodibility is the tons per acre of wind erosion that would occur if the soil were subject to the weather at Garder City, Kansas, and in a wide, unsheltered field that was kept hare and relatively freshly cultivated through the wind erosion season. The placement is not influenced at all by the organization of the near surface. Farmers employ strategies to reduce the erodibility by increasing the amount of aggregates in the near surface. They change the organization. Recently it was decided to permit adjustments in erosional I for the percent > 0.84 mm as related to different soil uses, including tillage practices. The determination involved sieving of the soil. Under many conditions, however, the near surface fabric is continuous. There is a crust of sorts present, Sieving the soil would seem inappropriate because the operation destroys the fabric continuity, which i5 the feature of Interest.

Suggestions: Attachment 7 is a proposal to incorporate the effect of crust or a continuous near surface consolidated zone on the adjustment of erosional I. The proposal employs consistence descriptors that have been developed for the new soil survey manual, particularly the new crust dry rupture resistance class set. In a broader sense, the proposal applies field morphology-our stuff in trade-to erosional I. Consideration of near surface consolidation should make wind erosion evaluation more applicable to range and pasturelands.

Wind Erosion C

Issues: For wind erosion prediction connected with the Food Security Act, an adjustment is made for the water state of the immediate near surface during the critical wind erosion period relative to that at Garden City, Kansas. This is called the C factor (not to be confused with the C of USLE). Attachment 8 shows that at low rainfalls the SCS C values in use when the paper was published were as much as tenfold more than the FAO C values published in 1979 and also tenfold more than would be predicted by the formulation in the paper from which the figure was taken. The paper was written by E. L. Skidmore, ARS, Manhattan, Kansas, the senior ARS scientist working on the physics of wind erosion. The paper was presented in 1984 at the ASA meetings. The information in the figure, if not the figure itself, would have been at hand at the time that the decision was made to use CI/T in the Food Security Act. The uncertainty in C demonstrated by this paper for parts of the county where wind erosion is common raises the question as to why CI/T was employed in the Food Security Act. Recently, the C value has been reduced for drier conditions. The question posed here, though, is not what we are now doing or which formulation of C is more correct, but rather the uncertainty in C at the time CI/T was adopted as a criterion for determination of potentially highly erodible soils.

Suggestions: Proposal 4 in the next section pertains.

Commentary

I would like now to make a few proposals on organization and emphasis in the NCSS. The proposals together are rooted in the belief that we need to place far greater relative emphasis on soil behavior prediction. My examples are erosion related for tactical reasons--you might listen! Our needs, however, in soil productivity prediction are also large.

1. Provide administrative guidelines to test and implement the proposals of our regional and technical meetings and to integrate among the national and regional cooperative soil survey meetings and the meetings of the state soil scientists. We need a greater sense of continuity and of the possibility of implementation of proposals. The 1979 proposal to this conference on roots is illustrative of a need that was explored technically, but not carried forward.

2. Take the development, application, and review of the revised Soil Survey Manual more seriously. We need a year with the project on the front burner. There is a need for

more sophisticated field soil descriptors. The emphasis on erosion and the several process hydrologic models now at hand require a more sophisticated description of ground surface configuration and of near surface morphology. The new manual contains several descriptors that are relevant, but they need to be tested. Of the subjects in the previous section, the new manual contains currently untested material that pertains to runoff classes, roots, tillage zone bulk density, permeability, erosional T, and USLE C.

3. Work towards a formal degree of responsibility by NCSS for use-dependent temporal quantities that are to be employed in current and future erosion and hydrology models. Currently, the responsibility within SCS is outside of NCSS. My proposal on erosional and near surface consolidation is illustrative. The proposal has no place to receive consideration leading possibly to adoption.

4. Provide a formal technical review procedure for changes in the standard interpretation program that would parallel the procedure for soil taxonomic changes. This review mechanism should include explicitly formalized ties by the NCSS to soil and water conservation scientists in ARS. Such a review procedure, if it had been in operation, might have led to an alter-native to the adoption of CI/T for estimation of potential wind erosion at a time when C was so uncertain.

5. Make the investigative people in the federal soil survey mostly at the National Soil survey Laboratory explicitly part of an interpretive development group. Include the investigative people in the group responsible for the content and execution of the soil series property records. The soil property record Is a numerical data sheet. It i5 wasteful nut to give the people who work on numerical data continuously some formalized responsibility far the major body of numerical information in the NCSS.

6. Examine whether the balance in the Federal National Soil Survey Center between people charged to work on execution of the soil mapping program and people Involved In interpretations should he changed to increase the proportion of people working on interpretations. Is the balance now contemplated appropriate, given the objective that in 3 years the soil mapping is to be completed for all cropland?

Attachment 1

This is a June 6, 1986, draft for the new Soil Survey Manual written by the writer.

Surface Runoff

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff differs from subsurface flow or interflow that results when infiltrated water encounters a zone with lower perviousness than the soil above. The water accumulates above this less pervious zone and may move laterally if conditions are favorable for the occurrence of free water.

Index Surface Runoff Classes. Historically, a set of runoff classes have been employed "as 'determined by the characteristics of soil slope, climate, and cover" (Soil Survey staff, 1951). Table A contains a set of classes that parallel the sense of how the earlier runoff classes are currently applied but with some differences. These classes are referred to as index surface runoff classes. They are indicative of the relative amount of runoff.

Class placement depends on slope and on saturated hydraulic conductivity. The table is based on the minimum saturated hydraulic conductivity for the soil at or above 1/2 m. If the minimum for the soil occurs between 1/2 and 1 m, the runoff should be reduced by one class (from medium to slow, for example). If the lowest saturated hydraulic conductivity occurs at 1 m or deeper, the lowest value to 1 m depth should be employed rather than the lowest value for the soil. Steady ponded infiltration rate would be the applicable infiltration stage.

The class placement is for a conceptual standard storm or amount of water addition from snowmelt of 50 mm in a 24-hour period with no more than 25 mm added in any single l-hour period. Additionally, a standardized antecedent water state condition prior to the water addition is assumed! the soil is conceived to be very moist or wet to the base of the soil, to 1/2 m, or through the horizon or layer with minimum downward saturated hydraulic conductivity within 1 m, whichever is the greatest depth. If the minimum saturated hydraulic conductivity of the soil occurs below 1 m, it is disregarded and the minimum to and including 1 m is employed. Ice is assumed to be absent unless other-wise indicated. For soils with seasonal shallow or very shallow free water (table ___), the minimum annual steady ponded infiltration rate may be applicable. In such a case it should be indicated that the runoff class pertains to when the soil has the assumed free water occurrence. Strong control on runoff may be exercised by very local configuration of the land surface and by characteristics of the near surface. -These features commonly are influence by soil use and may change through the year. They are not considered.

Table A. Index surface runoff classes based on slope gradient and saturated hydraulic conductivity. a/

Runoff Classes b/

Saturated Hydraulic Conductivity Class c/

Slope Gradient	Very High	High	Moderately High	Moderately Low	Low	Very Low
Pct						
Concave d/	Zero	Zero	Zero	Zero	Zero	Zero
<1 and not Concave	Negli.	Negli.	Negli.	Slow	Med.	Rapid
1 to 5	Negli.	Very Slow	Slow	Med.	Rapid	Very Rapid
5 to 10	Very Slow	Slow	Med.	Rapid	Very Rapid	Very Rapid
10 to 20	Very Slow	Slow	Med.	Rapid	Very Rapid	Very Rapid
≥ 20	Slow	Med.	Rapid	Very Rapid	Very Rapid	Very Rapid

a/ Class names largely follow Soil Survey Staff, 1951

b/ Abbreviations: Zero-Z; Negligible-N; Very Slow-SV; Slow-S; Medium-M; Rapid-R; Very Rapid-RV

c/ Consult Table ____, section ________ for definitions. Assumes lowest value for layers or horizons of the soil occurs 0 to 1/2 m. If it occurs 1/2 to 1 m, then reduce runoff by one class (medium to rapid, for example). If it occurs ≥ 1 m, then use the lowest value ≤ 1 m.

d/ Areas from which no water escapes by flow over the ground surface.

Attachment 2

This is taken from the report of the committee, Water Supplying Capacity of Soils for Different Plants of the 1979 National Technical Work-Planning Conference.

Recommendation No. 2 (Roots)

Document 2 a/ reviews the documentation of routs in recent standard soil survey reports. The information generally is scanty and commonly is wanting in quantitative exactness. It would seem a low apple to improve the situation greatly. There would seem to be no real technical impediments. Guidelines (to be suggested) should be established shortly and applied in the ongoing soil survey quality control program. There is, though, a further matter. The soil survey is largely completed in 'many Major Land Resource Areas. For these MLRA's, we should collect root information by phone and correspondence from experienced soil scientists independent of the quality control program of ongoing soil surveys. An administrative procedure might be for the Soils Staffs, NTC's, to assign MLRA's to states, and to request the states to give best estimates for the soil series named in the mapping units of the general soil maps of the completed soil surveys of the MLRA. We need, in any event, to get the job done soon to capture the experience of people who have mapped in these MLRA's. The guidelines suggested are as follows:

For two index crop plants (trees Included) in the Major Land Resource Area where the survey is located provide estimates for each soil phase of the depths (to the nearest 10 centimeters) to the base of the deepest horizon with common or many roots and to whet-e roots essentially stop. Provide depth limits for both irrigated and nonirrigated soils if different. Select index crops on the basis of extensiveness, ubiquity, and economic importance. Publish these depths in standard soil surveys. Provide in the soil survey report in tabular form the descriptors indicative of strong root restriction and explain why. Indicate in the generalized discussion (tabular, hopefully) of the mapping unit that no roots would be expected because of these root restricting features.

a/ This is an examination of over 100 published soil surveys to determine what is written about roots. It was not published in the report, but is available from the writer.

Attachment 3

MNTC
Bulk Density and Permeability of Surface Horizons for the Soil Property Records of Cropland Soils

Bulk densities in the soil interpretation records for surface horizons of cropland soils need consideration. The listed values commonly considerably exceed bulk density to be expected for the upper portion of the tillage zone during the early post plant period, unless under no-till. Further, the listed bulk densities commonly are below those far the mechanically compacted subzone.

As a consequence, the listed bulk densities would imply much lower potential for erosion during the early poet plant period than is the case under conventional or even conservation tillage. Relatedly, the permeability, which is dependant on the bulk density, commonly should be considerably lower than the listed values. In reference to permeability, it is important to note that efforts are underway to employ bulk density as a permeability predictar by ARS and by NSSL, and the permeability is used to predict steady ponded infiltration rate.

No attempt is made in the National Soils Handbook to define the bulk density and the permeability values in the soil interpretation records of cropland soils. Shortly, ARS will have collected a body of bulk density infiltration data for cropland soils in connection with the water erosion model project (WEPP). It is expected that the bulk density values collected in WEPP project will differ markedly from the the soil interpretation records for the soil series concerned. Our present record entries will be open to criticism.

What could be done’?

1. Do nothing.

2. Provide an explanation of the present bulk density and permeability values in the National Soils Handbook and in published soil surveys but make no other changes. An example would follow of a technical explanation the substance of which might be in the National Soils Handbook.

"Bulk densities and. permeabilities for surface horizons of cropland soils may differ appreciably from the listed valuer. In many instances the lower limit of the listed bulk density values would accord with the upper limit of the subzone that has undergone mechanical bulking in tillage operations followed by several wet-dry cycles. The upper listed limit would be about the lower limit of the subzone that has undergone mechanical compaction while slightly moist or moderately moist. The mechanically bulked subzone for extended periods after tillage would have a considerably lower bulk density than the range given. The mechanically compacted subzone may be expected usually to have values that exceed the range given.

"Permeability may be considerably below the given range because the mechanically compacted subzone has a higher bulk density that the upper limit of the listed bulk density range."

3. Delete the bulk density and permeability values for surface horizons of soils, the majority of the area of which is in cropland. This alternative, however, would not remove the need to have an explanation in the National Soils Handbook and in our published soil surveys about the bulk densities that are published.

4. Provide bulk density and permeability estimates on a limited use specific and temporal basis. An example is appended. The following are considerations.

a. Continue the current estimates but define an discussed under (2).

b. Place at the bottom of the horizon sequence, bulk density and permeability estimates for the single most important soil use on an areal basis. The estimates probably should be for the periods when the soil-use combination is most at risk to water or wind erosion and for when the potential runoff, excluding the period while frozen, is the highest. Bulk density would he given for each period for the upper most 5 to 10 cm and for the 5 cm subzone having the highest bulk density within the uppermost 25 cm. Permeability would be given for each period separately.

Tillage zone pertains to soybeans, conventional tillage. Bulk densities and permeability for May-June immediate pre-plant and post-plant period. Erosion and runoff periods are the same.

Attachment 4

MNTC 1987 APO Item 8.3

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water on being subjected to a standard increment of a rainfall erosion index quantity that relates to rainfall energy. The soil is considered to be bare and to have been recently tilled for the purpose of the experiment. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water. The estimates are based primarily on percentage of slit, sand and organic matter (up to 4 percent) and soil structure and permeability. The K factors in table are adjusted downward for rock fragments from what they would be if no rock fragments were present. The adjustment downward is for gravelly, for very gravelly and for extremely gravelly (include other modifiers if relevant). For on-site use in the Universal Soil Loss Equation, values of K free of rock fragments are used and the rock fragments on the ground surface are included in the cover and management factor (the C factor).

Note - Added material underlined.

Attachment 5

Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
In	Pct	G/cm³	In/hr	In/in	pH	Mmhos/cm					Pct
0-4	12-22	1.50-1.60	0.6-2.0	0.08-0.10	6.6-8.4	<2	Low----------	0.24	1	8	1-2
4-15	12-20	1.45-1.55	0.6-2.0	0.07-0.09	7.4-9.0	<2	Low----------	0.28			

Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
In				Pct					Pct	
0-4	Very cobbly loam	GM-GC	A-2, A-4	35-50	45-65	40-60	35-50	25-40	20-30	

Step 1 - Determine weight percent >2 mm.

Pass No. 10 - Pct

> 3 inch - Pct	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
0	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
5	5	10	15	20	25	30	35	40	45	50	55	60	60	65	70	75	80	85	90	95	100
10	10	15	20	25	30	35	35	40	45	50	55	60	65	70	75	80	80	85	90	95	100
15	15	20	25	30	30	35	40	45	50	55	60	60	65	70	75	80	85	85	90	95	100
20	20	25	30	30	35	40	45	50	50	55	60	65	65	70	75	80	85	90	90	95	100
25	25	30	35	35	40	45	50	50	55	60	65	65	70	75	80	80	85	90	95	95	100
30	30	35	35	40	45	50	50	55	60	60	65	70	70	75	80	85	85	90	95	95	100
35	35	40	40	45	50	50	55	60	60	65	70	70	75	75	80	85	85	90	95	95	100
40	40	45	45	50	50	55	60	60	65	65	70	75	75	80	80	85	90	90	95	95	100
45	45	50	50	55	55	60	60	65	65	70	75	75	80	85	85	85	90	90	95	95	100
50	50	55	60	60	60	65	65	70	70	75	75	80	80	85	85	90	90	95	95	95	100
55	55	55	60	60	65	65	70	70	75	75	80	80	80	85	85	90	90	95	95	95	100
60	60	60	60	65	70	70	70	75	75	80	80	80	85	85	90	90	90	95	95	95	100
65	65	65	70	70	70	75	75	75	80	80	85	85	85	90	90	90	95	95	95	95	100
70	70	70	75	75	75	80	80	80	80	85	85	85	90	90	90	95	95	95	95	95	100
75	75	75	80	80	80	80	85	85	85	85	90	90	90	90	95	95	95	95	95	95	100
80	80	80	80	85	85	85	85	85	90	90	90	90	90	95	95	95	95	95	95	95	100
85	85	85	85	85	90	90	90	90	90	90	95	95	95	95	95	95	95	95	95	95	100
90	90	90	90	90	90	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	100
95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	100
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Step 2 - Determine volume percent >2. Use assumed bulk density if tilled and not strongly water consolidated. Guidelines are on the next page.

Weight > 2 mm (W>2)	Volume > 2 mm (V>2) for Various Bulk Densities of < 2 mm (g/cc)a/ 0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Pct	Pct								
5	1	1	1	2		3	3	4	4
10	2	3	4	5	[illegible]	5	10	10	10
15	3	4	5	5	10	10	10	15	15
20	5	5	10	10	10	15	15	15	15
25	5	5	10	10	15	20	20	20	20
30	10	10	15	15	20	20	25	25	25
35	10	15	20	20	20	25	25	30	30
40	10	15	20	25	25	30	30	35	35
45	15	20	25	25	30	35	35	40	40
50	15	25	25	30	35	40	40	45	45
60	20	30	35	40	45	50	50	55	55
70	30	40	45	50	55	60	60	65	65
80	45	55	60	65	65	70	70	75	75
90	65	70	75	80	85	85	85	85	90

---

a/ Assumes a particle density of 2.65.

Estimated bulk density of freshly tilled soil material. a/

Particle Size Classes†	Loose Bulk Density‡ Mollic Soil Materials§ Mg/m³	Loose Bulk Density‡ Other Soil Material Mg/m³
Sandy		
Well graded	1.65	1.70
Poorly graded	1.55	1.60
Coarse-loamy		
Well graded	1.45	1.55
Poorly graded	1.35	1.45
Fine-loamy		
Well graded	1.25	1.40
Poorly graded	1.20	1.35
Coarse-silty	1.00	1.25
Fine-silty	0.95	1.30
Fine	0.90	1.20
Very fine	0.90	1.10

† Family texture classes applied to the < 2 mm only; > 2 mm is excluded. Well graded material has 1/4 to 3/4 of the 2-0.002 mm in the 2-0.25 mm range and of this 2-0.25 mm less than 2/3 in either 2-1 or 0.5-0.25 mm. Employ noncarbonate clay on a carbonate containing basis.

‡ For "Other Soil Material," reduced by 0.10 Mg/m³ for each unit percent organic carbon in excess of 5 percent of the clay. For both materials increase by 0.03 Mg/m³ for each unit of extractable iron.

§ Soil material that meets the color and physical requirements of the Mollic of the pedon. The horizon may fail a Mollic epipedon on thickness or on base saturation.

a/ Need to be modified.

Step 3 – Enter zero **canopy curve** for soil-loss ratio vs. mulch. On the assumption that the soil-loss ratio equals the ratio of K adjusted for >2 mm over K for the fine earth, solve for K for the fine earth.

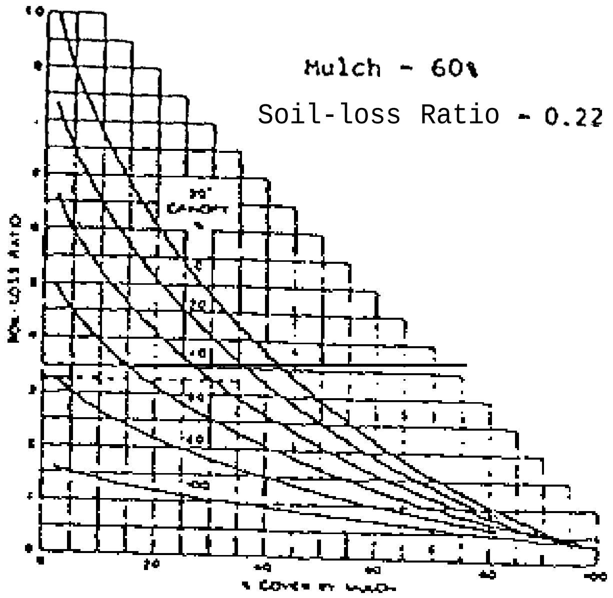
$$\text{Soil-loss Ratio} = \frac{K}{Kf}$$

where K is the value in SCS documents and Kf is for the < 2 mm

$$Kf = \frac{K}{\text{Soil-loss Ratio}}$$

$$Kf = \frac{0.24}{0.22}$$

$$Kf = 1.1$$



Mulch - 60%

Soil-loss Ratio - 0.22

FIGURE 7.—Combined mulch and canopy effects when average fall distance of drops from canopy to the ground is about 20 inches (0.5 m). From USDA Handbook No. 537

The amount of soil loss allowable can be approached systematically by separating the current T value into two quantities. the product of which is the T value. One Is (T-max)alue assigned to deep soils having uniform properties with depth. The other quantity, referred lo as the T-value Adjustment Factor (TAF), is a number from 0 to 1 that is determined by depth to a plant root limitation and certain changes with depth above that plant root limitation. In arithmetic terms then. T value $= T_{max} \times TAF$. We assume that T_{max} may change with need for food production and that determination of the values would involve a wide spectrum of interests. In contrast. TAF would be based strictly on soil properties and would be determined by technical people. If the proposal were accepted, TAF would replace the T value as the quantity of record attached to specific soils.

TAF. the T-value Adjustment Factor. is calculated as follows:

$$TAF = TAF_{50} + (1 - TAF_{50})[(PRD - 50)/150] + DCF$$

Potential Rooting Depth (PRD) is the depth of the root limiting contact or 200 cm whichever is shallower

Our objective Is to predict the root distribution In reference to the present soil surface after pronounced truncation by erosion. The zone of interest is to 2 m or a root limiting contact if above 2 m. If the base of common roots is unavailable. we begin at the soil surface and continue downward to 2 m In search of a root limiting contact as defined subsequently. We assume that as truncation procedes, common roots may occur at any depth above a root limiting contact. Potential rooting depth. therefore. is considered to be independent of distance from the present soil surface. Moreover, dry conditions at my depth are not considered to be a restriction to rooting.

Three sets of root limiting criteria are given.... These criteria pertain to most of the major feed and fiber crops of temperate regions. The first set covers taxonomic features as defined In Soil Survey Staff. 1975.

The second set of criteria are nontaxonomic physical criteria indicative of pronounced root restriction. The criteria pertain mainly to strong, dense, slowly pervious lower B and C horizons. The soil material when very moist or wet must lack moderate or strong vertical structural planes at close intervals and in addition exhibit one or more of the following: high pedological strength: high bulk density; or the combination of moderately high strength. low vertical saturated hydraulic conductivity snd low linear extensibility.'

The third set of criteria involve chemical restriction caused by high neutral-salt extractable Al. low extractable Ca. or both,, ..

. TAF_{50} Is the factor for soils with a PRD equal to or shallower than some depth, here 50 cm.

A TAF_{50} of 0.1 was assumed except when the root limiting contact was produced by high extractable Al or low Ca, In which case TAF_{50} was set at 0.2 because this root limitation is easier to ameloriate than the other kinds.

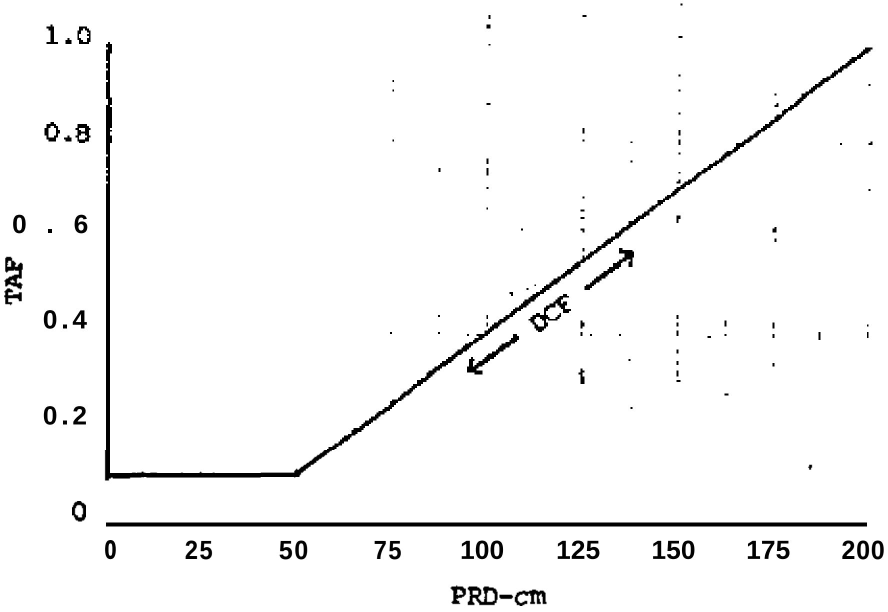
The DCF provides an adjustment for changes with depth above the root limiting contact In properties which indicate sensitivity of productivity to erosion.

It is based on depth-related changes in permeability. ah-filled porosity, organic carbon, and the sum of extractable Ca plus K. The occurrence of coarse layers is considered also.

Depth Change Factor may be zero. positive, or negative. A single negative property change dictates a negative DCF even if other properties are positive. For a positive DCF, at least one measurement must be positive and none of the others negative. The absolute value of DCF is the smaller of either 0.2 or one of the quantities:

positive adjustments: $\frac{1}{2}[1 - TAF\ (PRD\ alone)]$

negative adjustments: $\frac{1}{2}[TAF\ (PRD\ alone) - TAF_{50}]$



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Attachment 7

Adjustment of Erosional I for Near Surface Organization

I was present in Manhattan when the Texas proposal for using sieve data was discussed October 21-23, 1986. I became interested In how the Texas proposal might be applied using the revised soil consistence system. I first have a few general comments.

Erosional I is the potential long-term erodibility through the critical wind erosion period for a certain place (Garden City) and field geometry (wide, unsheltered, etc.) f soil material with a specified composition.

Classes of composition are called Wind Erodibility Groups which are the basis for the estimate. The classes depend on texture, carbonate, and organic matter. The organization of the soil as determined by the antecedent soil treatment(the management) is not a consideration. Percentages >.8 mm have been attached to the Wind Erodibility Groups. These aggregate percentages, however, are not definitive. It would seem useful to define an erosional I based on composition only (dependent only on the Wind Erosion Group). The symbol might be Ic. The value of Ic is employed in the determination of potentially highly erodible land.

We might also define an erosional I based on organization of the uppermost 3 cm (1 Inch) of soil during the critical erosion period. The symbol might be Io. The erosional I may be measured or estimated. *Invariant properties such as particle size, carbonate, and organic matter, which are employed to define the Wind Erosion Group, would not determine the value. Highly erodible land based on Ic could be reevaluated if desired based on In. The Texas proposal as I understand it concerns the collection and application of IO.

The following are suggestions for the estimation of erosional I. The criteria and class limits are arbitrary and open to change. If the framework were useful we could readily improve the class limits.

1. Sieving may be inappropriate because the near surface has a continuous fabric due to raindrop impact crust formation, water consolidation, or both. Suggestions follow

for the, definition for continuous near-surface organization. Terms and classes are expected to be defined- in the new soil survey manual. A discontinuous near-surface organization wouldbe defined by exclusion.

For the fabric of the uppermost 3 cm to be continuous one or both o the fallowing criteria must he met:

A. Rupture resistance of ≥ 80 percent of randomly obtained specimens 3 cm on edge from the uppermost 3 cm exceed soft. Cases of rupture resistance are defined in attachment 1.

B. Not "A" but a crust is present over 80 percent of the ground surface that is ≥ 3 mm thick and has weak or higher rupture resistance. Crust and classes of rupture resistance are defined in attachment 2.

2. If the soil fabric of the uppermost 3 cm is discontinuous based on exclusion by the application of section 1 > 0.8 mm aggregate percentage baaed on sieving is applicable. The management factor would be the ration Io/Ic. For example, suppose that 50 percent > 0.8 mm was measured for a *noncalcareous clay 1*oam. Io/Ic would be 38/86 or 0.44 (attachment 3). Erosion based on the wind erodibility groups would be reduced by multiplying by 0.44. Note that the ration may exceed unity.

3. If the organization of the uppermost 3 cm is continuous as previously defined and there is < 10 pet-cent 1-0 mm sand, then instead of sieving to obtain Io/Ic, the following table would be employed, where (A) and (B) refer to section 1.

Kind Continuous Organization	Io/Ic
Meets Criterion (A)	
Slightly Hard	0.5
Hard	0.2
Exceeds Hard	0.1
Meets Criterion (B) a*	
Weak	0.7
Moderate	0.4
Exceeds Moderate	0.2

a* Use next lower value of I./Ic if crust thicker than 6mm.

4. If the organization is continuous and ≥ 10 percent 1-0 mm sand is present, then a factor is assigned that would be greater than unity. The value of the factor would have to be discussed.

I recently ran the rupture resistance on several clods of several soils on which experimental work is in progress by ARS people at Manhattan and Big Spring. To follow are the median values and the class placements for these surface clods. It may help to make more concrete the rupture resistance classes for the overall uppermost 3 cm that have been used earlier In the statement.

	Rupture Resistance	
Soils	Median	Class
Amarillo	8 kg	Hard to Very Hard
Carr	6 kg	Hard
Reading	Q.6 .I	Rigid
Smolan	77 kg	Extremely Hard

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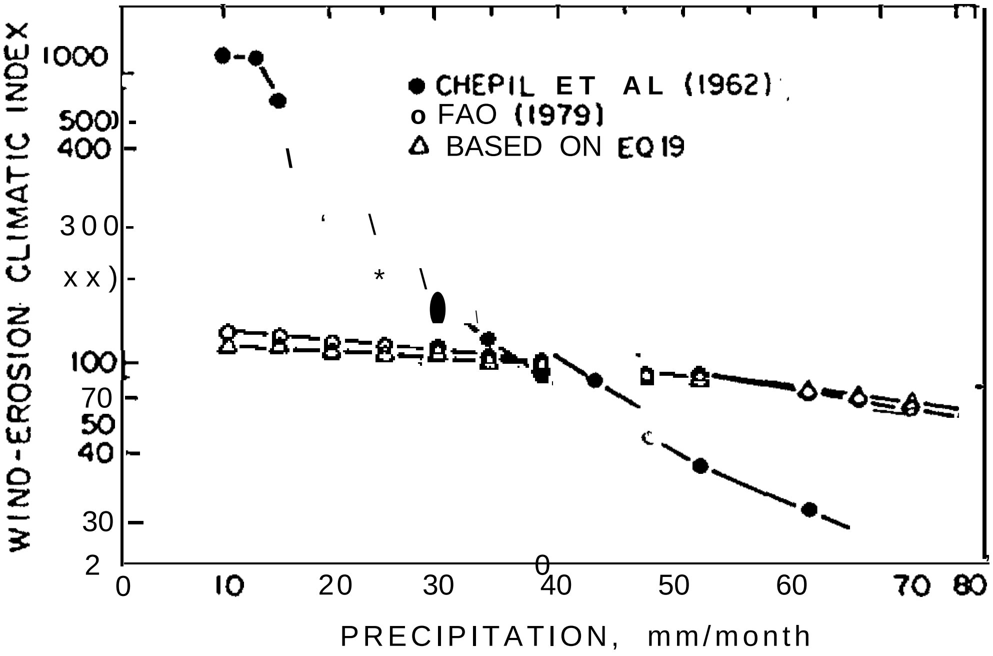
11/86

Attachment 8



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COMMITTEE I REPORT
SOIL SURVEY DATA BASES

Preamble:

As soil survey data bases issues are addressed, it is imperative that adequate attention be given user clientele, NCSS participants and others. Data bases must be designed that serve their needs. Design requirements and concrete specifications must be agreed on. Steps must be taken that initiate, strengthen and otherwise facilitate collaboration among NCSS cooperators. Mechanisms for data sharing must be provided.

Charge 1:

Determine whethrr there should be a single national pedon data haze that serves as the official NCSS respository.

Response:

Yes, there should be a national pednn data base to provide consistency and uniformity throughout the soil survey program. It should be administered by incumbents in positions dedicated to that specific task. In view of the unanimous affirmative response the following are recommended

Recommendations :

a. The kinds of data - Pedon descriptions, laboratory characterization, and engineering tests - are needed in the data base. The data should be In coded form asper Form SOI-232, or if coding is difficult, as short text strings. The range in various properties a6 well as "typical" value5 should be included.

Pertinent classifications, at least to the family level, series level preferred, must be provided for each pedon (sample as; laboratory classification, state classification). Also an index to associated lab procedures and standards procedures for calculating missing values should be incorporated in the databases.

Considerable progress has been made toward converting pedon analysis data collected at the former regional and current national soil survey laboratories In a common format. A concerted effort should now be made to enter state laboratory data into that format and system.

Careful consideration must be given as to how much pedon descriptive data are needed in the data base. But, all descriptions should have a required minimum set of soil characteristics and environmental features. No less significant is how the data, particularly the older part, will be entered. Initially, we should concentrate on entering pedon descriptions of soils sampled for characterization and/or engineering tests. This will be no small task and how it will be accomplished must be addressed. Perhaps the national data base should include only the descriptions of typical pedons from individual soil survey areas and those for which data are available. Additional pedon descriptions and notes may reside in the state soils data bases, but be 'relatively easily disseminated upon request.

b. Data Input because the SCS is perceived, at least committee members as having leadership and functional responsibilities for- this NCSS collective task it must work diligently to involve all NCSS participants in the entire development and implementation process.

Cooperating laboratories (contributing and using) would store these pedon descriptions, classifications and laboratory procedures in a format prescribed by the NCSS. the for-mat should be compatabile with a wide variety of hardware and software. Microcomputers are being touted as the way of the future and the format must accommodate their use. Pet-haps a "hard copy" data base should also be compiled.

Some inputs from laboratories could be automatic from some analytical equipment, automated analyzers for example; that capability must be captured.

For states that now have a computerized data base, the task of merging data shoJld not be too difficult. F0t-mat change6 may be necessary to merge the data with a new system.

c. Output procedures and format (s)- The output procedure(s) and format(s) should be fairly comprehensive and compatible with a wide array of hardware and software. Outputs must serve the needs of user5, otherwise any interest is soon lost. Flexibility and capability to manipulate and array the stored data to obtain "user packages" is essential, Some users, for example, and array the stored data. to obtain "user packages" is essential. Some users, for example, prefer raw compatible files (tables). Optional table and narrative descriptions are needed. A data base query language with a "smart" command interpreter will be necessary to allow the "average" user access to the data. Output must be available in both electronic and hard copy form.

d. Update procedures - These must be included in the basic design. Frequent updates may be necessary and it is essential that the procedure be fairly simple and easily performed. Electronic updating by the "originators" of the data with "checks" by others is desirable. Updates may range from changing a simple data element value to replacing a whole data set.

e. Quality assurance in preparing data. Standards for naming, defining, and determining values for the data elements should be established. Each contributing laboratory should be responsible for the technical quality of its data. Checks for compatibility and completeness should be performed at a central location. Quality assurance in updating and manipulating a quality base should be provided by the staff at the central location. A number of actions could be taken that would expedite the process including:

(1) Establish state level NCSS database steering committees which could provide a forum for working out details for Input and use.

(2) Identify individuals (contact person) In each agency, institution, etc., participating in the NCSS responsible for said data programs and activities.

(3) Provide incentives to universities, e.g., money for assistantships for specific projects which require storing data.

(4) Centralize, on one host system, existing data bases for linking and manipulating data.

(5) Establish a task force to propose and define the data base.

(6) Provide training in database system management to NCSS pat-ticipants.

(7) Seize every opportunity (conferences, workshops, meetings) to address soil data base Issues and activities.

(8) Utilize ad hoc task forces composed of members who have a keen understanding of the NCSS Program and are familiar with major kinds of hardware to provide guidance in establishing the data base.

Charge 2:

Describe how non-SCS users could/can access the State soil survey data base.

Recommendatian:

Access to the state soil survey data base should be provided through the state soil scientist. Access could be direct or by disk. The database could he rnade available to cooperators by(1) permitting them direct computer access to FOCAS equipment; (2) transfer data to compatible equipment. (Some cooperators will purchase compatible equipment so they can access to the database.) This will allow transfer of data freely between systems, and (3) provide data in the standard format and let the cooperator reformat for their equipment. In addition, or as an alternative, the data could be provided to a vendor (university computer center) that could see copies of the files. Regardless of the mechanism for accessing, a concerned effort is needed to inform NCSS and other potential users of the data base and its entries. More important is that access must not become a "hassel".

Charge 3:

Address the importance of involving and informing NCSS cooperators of data base development efforts. Identify ways that foster exchange of information.

Recommendation:

It is imperative that NCSS participants are Involved in soil data base activities. Those that "lead" must solic it: cooperator involvement. Many cooperators are willing and able to contribute significantly to the "program" if given the opportunity. A concerted effort must be made to capture all the expertise, capability and cooperation that exists among the participants.

A good beginning would be to:

1. Establish a task force composed of representatives of NCSS participants (and others) that have soil data experience, responsibilities, and needs, and charge them to:

   - o Explore interagency networking as method of exchange data and knowledge.
   - o Identify and define current data gays and database needs.
   - o Evaluate progress and' suggest direction.
   - o Review soil data definitions.

2. Set up a telemail bulletin dealing with all aspects of soils databases.

3. Maximize use of regional soil survey work planning conference as a forum for database issues.

4. Update Memorandum of Understanding to address cooperation in database development and deployment, and to assign responsibilities.

5. Communicate a cooperative spirit.

6. Demonstrate a spirit of cooperation and finally;

7. Cooperate.

COMMITTEE 2 REPORT

Landscape Analysis and Development of Map Units

Members:

Chairman - Bob Cunningham

Pete Avers
Don Franzmeier
Bob Grossman
Ron Kuehl
Dave Lewis
Darwin Newton
Gerald Post
Erling Gambel
Ellis Knox
G. D. Lemme
James Stone
Neil Stroesenreuther

INTRODUCTION

It has been suggested that new kinds of map units willbe important to improve the understanding of landscapes, the soils on the landscapes, and to enhancepredictions about soil/landscape behavior. For example, consider the movement of water from a hillcrest to a lower lying discharge area and the water budget of this landscape behaving as an integrated response unit. The combination of components and size of landscape being considered would vary from place to place and might even differ according to the behavior or response being predicted. One of the simpler cases would be crop yield estirnates of fields that are themselves landscape units or segments thereof. The units would likely be toposequences of differing configurations that would involve size, shape , and composition of constituent components and anticipated interactions among thr component parts of a designated unit. The concept is not new but widespread application in soil survey would be a new thrust in providing soil-related information to the people of the U.S.

Imagine that instead of phases of series or associations that the toposequences of a region or survey area are to be the map units. Then consider the definitions, standards, and guidelines needed to conduct soil surveys based on such units. It seems that features that affect landscape hydrology would be important in designing and interpreting such units.

Assume that the units are conceived at scales of about 1:12000 and that for many of the updates at scales about 1:24000 there would be a need to describe how to make the useful combinations to achieve satisfactory interpretations of landscape unit behavior.

The principles and precepts used in the soil survey to handle phases of series and phases of associations might also apply to these landscape units but a different set of guidelines for consistent use and data base development would be needed.

Charge 1 - Provide examples of multiple landscape component map units and discuss briefly the rationale for such a design of landscape units. For some of our members the description of detailed research plots or areas are important and we need to be able to understand how to use these units to assist in interpreting different scales of observations.

Charge 2 - Describe or discuss the hierarchy that might exist for such landscape units at scales from about 1:10000 to perhaps 1:50000. The reason is that we need to understand the problems of correlation that must be addressed to handle such units. How are the components defined so that consistent correlation is possible and a data base can be developed?

Charge 3 - Illustrate how the units might be interpreted for different purposes. This will enable others to better comprehend who the audiences might be and indicate some of the ways in which the Information can be used.

DISCUSSION

The introduction and charges were sent to each of the committee members with instructions to respond to the Committee Chairman in time to prepare this document that is being used for presentation and review of this concept and its applicability to soil survey. Despite the very limited time interval available, the response from members was excellent and I would like to thank the members for their contributions to what I believe is an extremely important concept for the consideration of the National Cooperative Soil Survey.

Examination of multiple landscape component map units as a concept in soil survey implies a need for definition. The introduction provides some descriptive information but does not define our subject. From my inspection of the responses from committee members and a careful reading and re-reading of the charges, I propose the following definition of multiple landscape component map units: A delineation composed of areas that share an interaction or a process because of proximity to each other. Further refinements to this definition are invited.

The definition assists in naming examples, and examples assisted in arriving at a definition. Newton reminds us that most map units that are an association, complex or undifferentiated unit have varying degrees of landscape components, and this is even true to a lesser degree fot consociations. Lewis points out that various landforms such as slope summit, shoulder, backslope, and footslope are placed in a single map unit and given "C" slope designation. In addition, incorporating slope component information with, for example, depth to a loess-till contact would further increase the precision of making predictions of soil behavior, Kuehl also cites examples of slope components that are mapped together in the Fayette soil formed in loess that is several feet thick. Map units based on the separation of the summit, shoulder, backslope, slide slope, head slope, nose slope, and footslope positions, although all are now mapped as Fayette, would be useful in helping to predict soil/landscape behavior. Another example given by Kuehl is the toposequence when soil materials change across the landscape as is the case in Iowa with the clayey paleosols outcropping on the side slopes in some areas where these areas are wet and seepy. Gamble cautions our use of toposequences without considering the several aspects of shape, composition, and size of geomorphic surfaces in the topoeequence that affect hydrology. His example is in the Missouri Ozarks, where a toposequence from a ridgetop to the valley floor can cross a sequence of five geomorphic surfaces, ages of these surfaces range from pre-Pleistocene to Holocene. There are suites or associations of soils related to these surfaces or combinations of them. Surficial stratigraphy should be considered in the internal composition of the toposequence and its parts. This would consider alluvium, colluvium, pedisedirnent, glacial drift, and valley side alluvium.

Avers and Strosenreuther both discuss the use by the Forest Service of multiple landscape component map units. Avers provided an article written by Richard G. Cline, Soil

Correlator and Herbert D. Holdorf, Regional Soil Scientist USDA, Forest Service, Northern Region entitled "Integrated Inventory Design and Interpretation for Northern Region National Forests." This discussion emphasizes that integrated inventories are made for utilitarian interpretive purposes. and incorporate landform, geology, vegetation and soils components in map units. All Inventories do not have the same objectives, nor are they conducted under the same environmental conditions. This is the reason that properties other than soils are used to define map units In integrated inventories.

Finally, Knox shared a copy of a manuscript prepared hy Charles M. Davis, in March 1969 under a grant from the U.S. Army entitled "A Study of the Land Type". Davis references his own and Veatch's work in Michigan with the Natural Land Types as well as the terrain classification work of Beckett and Webster of Great Britian and Australia. However, Davis was most impressed with the work of Tobler, a geographer, in the analysis of a "digitalized" surfaces. Tobler automatically classified segments of the landscapes using computer techniques.

Examples of multiple component landscape map units:

Catenas
Watersheds
Cropped Fields
Surficial Geology Classes
Gemorphologic Landforms
Topographic Units of Slope, Aspect, and/or Elevation
Present Map Unit Delineations

Associated with Charge 1 in addition to providing examples of multiple component landscape map units is the design of such units. Most contributors to the committee acknowledged that 'the design is highly use dependent. What arc the uses? Then, the design criteria can be approached. Other considerations are scale of investigation, the adequacy and/or the intensity of map unit descriptions, and the consistency of separation and definition. The design of the forestry landscape units were highly dependent upon the use and the resources available to assist in planning and management of their forests. Avers provided examples of map units used in the Northern Region.

Charge 2 alludes, to the idea that multiple landscape component map units can be arranged in a hierarchy. Avers points out that this may not be possible. The choice of the unit will determine whether such landscape units can fit into a broader class of units. An example that could fit very well. would be the watershed unit. Slope toposequences of Fayette soils may not fit either a finer or coarser map unit very well. Again, it is the use of the information that is going to control the scale, the economics, the base map, and the-understanding of the variability expected.

Definition of components requires an analysis of the units represented. In the present consociations, this analysis is usually lacking. It is not likely that in the description or the mapping of more complex map units will additional efforts be expended to obtain the necessary Information to adequately define the composition of additional complexity. The criteria for separation needs to be matched to the anticipated or stated use of the information. Two other concepts are introduced in the narrative of Charge 2. They are data base development and integrated response units. These are extremely valuable concepts that the National Cooperative Soil Survey should understand and make every effort at every opportunity to recognize their importance.

The final charge deals with interpretations for various uses. The implication is that if multiple component landscape map units are developed, they could be used for a variety of interpretations. The range of applicability would depend greatly on the coincidence of the use criteria and the criteria limits exercised to separate the map units. Interpretations, nevertheless, are only pertinent when a proper data base has been established and performance and/or behavior data can be collected, analyzed, and Interpreted. The information data base is as important as the criteria limits.

Present Inventory and Information Delivery

The National Cooperative Soil Survey has aver the past 50 years developed the guidelines and procedures for making and publishing soil survey information. These procedures have centered around the soil series concept and phase modifiers. Map unit delineations are separated according to ranges established for the series for classes traditionally recognized for slope, surface rock fragment, and a few other criteria. A soil characteristic in a series definition usually has a range of values, such as 20 to 30 inches to mottles. The slope symbolization includes a range of slope, such as 3 to 8 percent. We are very familiar with these definitions and discuss where the limits should be and what the terminology should be to make sure that Fayette is properly separated from a compilation of characteristics for any other series. Rarely is the finite characteristic defined or discussed. That is, what data have been collected from a landscape that record observed depth to mottles for a location. How many benchmarks have been established in a data set that can be manipulated to search for the relationship of a particular soil parameter and a position on the landscape representing the total environment of a soil. Series and phases are narrow classes designed to categorize the tremendous number of variables that could be associated with one spot on the landscape. Present technology offers the opportunity to store the original, to retrieve, to analyze according 'to use determining criteria. Although, Post indicates that series have been very useful and he sees them continuing to be of great value; I think the series concept does not permit the delivery of soil survey information most needed by the environmental planners and managers.

During the 1983 National Work Planning Conference, scale and quality of base maps (aerial photos) were informally discussed. The history of the 1:15840 scale photography in soil survey might lead one to wonder if soil science is really a science. In addition to scale, it is apparent to users of our information that we have been too lenient in the specifications of the map base. How can we afford to spend vehicle and person time to collect field data and scribe the results on a non-rectified (does not match recognized map standards) base map. The description of map units as phases of series in standard reports also lacks that detail necessary to understand the components of the map unit and the relationship to other map units. Several committee members stated that additional information or illustrations of map unit composition would improve the document now being published. Finally, class determining phases are used in developing interpretations. Criteria for use selected from various sources to determine the suitability or limitations expected in the use of the landscape. The criteria and the logic are exceedingly difficult to extract from the present report.

As indicated in the preceding paragraph concerning the inventory techniques, outdated methods continue to be used even though word processors, data bases, and computers are technology of the late 1960's, note Davis'* enthusiasm for computer processing of elevation data. Soil survey reports need continual updating but in their present format, the process is very costly and difficult. The fixed scale of information does not match the need for many of soil survey information users. The distorted and mosaiced base map user who is searching for the multiple component landscape map unit concept that is the subject of this committee.

FUTURE NEEDS

The list might include the following:

Better descriptions of map units
Various scales
Integrated response units
Customized interpretation capability
Consistent soil survey data bases

The future must consider the need for input to models. Grossman provided data from small scale studies that are defining the variability of the environment at the field management scale. He feels these data are heeded in order to attack multiple component landscape map units. An age of "Expert Systems" is upon us. Can we design expert systems that map soils? Can an expert system retain all the resource data that a field soil scientist uses in making his decision about the parameters Important to map delineations'? Can we also define the logic or the model that was used to reach that determination? In the comments to me form committee members, several illustrations as to landscape/soil relationships were defined. When these scientists are retired, will we have to re-discover these relationships again? The soil mapping model at whatever scale with whatever data heeds to be documented. The discovery of these relationships does not appear In any of our documents. In addition to a soil mapping model, there are and will proliferate other models that require soils information. Management models for controlling soil erosion, for estimating water quality and quantity, fot predicting performance and behavior of multiple component landscape map units.

Verification of model performance becomes extremely important in developing the probability statements soil information users are demanding. How many random site investigations have been documented so that any kind of probability statement can be made concerning the variability of a characteristic of a delineation. These are data that today's soil scientists should be collecting. Observation data at point locations reporting specific details pertinent to a unique and identified segment of the landscape. The soil related information become extremely important for that site, so that the correlation among interacting components can be addressed. Several committee members expressed their rather unsuccessful correlation of multiple landscape component map units. Additional understanding of the spatial relationships of soil characteristics to the soil related parameters also associated with that bit of the landscape must be developed before a meaningful correlation can be accomplished.

SOIL RELATED INFORMATION

Valid criticisms of soil survey include the scale, definition of units, bench mark data, and overall integration with other natural resource data. Soil related information is collected and managed by various agencies and offices. The hydrology, geomorphology, topography, vegetation, geology, climate are only a few of the soil related data sets important to soil scientists. Further, stream networks, watershed boundaries, rock unit types, land use, land form, elevation, aspect, and slope list only a few of the more specific categories of soil related data. Sources of related information are U.S.G.S. topographic maps, surficial geology maps, geology maps, land cover maps, remotely sensed imagery, tax records, and location coordinates.

Soil related information, that is information that should be compatible with soil survey data, is numerous and in various classes, scales, and forms. Obviously, in today's technology these data bases need to be managed by computer. Digitized data sets can be managed in a G.I.S. (Geographic Information System). Many States are now implementing the comprehensive GIS's to store and manage natural resource data. Specialized "ARC/INFO" or INTEGRAF" software can manage digitized topographic, census, ownership boundary, hydrology, and land use data. This software can overlay maps or representations of various other parameters of the landscape. The systems can also provide input to complex models, or use spatial statistics in the analysis of landscape information.

Where has this discussion led us? To today's needs and technology. We cannot continue to collect natural resource data such as soils and ignore the other natural resource data bases that are being compiled and used frequently in the assessment and/or management of our environment. The question or charge then does not reside in whether or not we can design and define multiple component landscape map units, (which we are already trying to do); but how do we fit our soil survey data into data sets or layers that can be utilized in Geographic Information Systems? This system then becomes an extremely useful tool in developing whatever kind of units and relationships that can be selected when data sets are available. Each segment of the landscape can be defined at selected scale and with as many parameters as exist. The classification process to reduce the quantity of data for the mind to assimilate is now unnecessary, for now we have data sets that can be defined for each of these segments, for example - elevation. There is no need to group elevation values until the use criteria has been determined, then the interpretation and map can be produced that matches the user's need. This concept and capability becomes extremely powerful in determining combinations of the environment or components of the landscape because each segment can be stored and treated as a separate entity. Its relationship to its neighbors is also defined as it has a unique location. Now the models can be defined that treat processes or interactions. Input to other related information will be consistent and the logic of interpretations and criteria can be adequately defined and described.

Examples of GIS outputs were drawn from research being conducted under the sponsorship of the Pennsylvania and Light Company who are searching for a soil data layer consistent with other natural resource data layers presently in their geographic information system. This becomes only one example of the kind of data that other users of the geographic information system technology are going to demand. If the National Cooperative Soil Survey does not recognize their needs or chooses not to change their information delivery technology, then the users of soil information will seek only the soil related information and choose to make their decisions entirely based on geology, geomorphology, topography, or other data that fit into their data base management system. The NCSS has the opportunity to adopt this new technology and assist in the development of more meaningful and valuable soils information. Such information has not been available in the past because of constraints imposed by the hard copy map and the inability to store the vast amounts of observations and data generated through the "in-field" investigations of soils by scientists.

FINDINGS AND RECOMMENDATIONS

In the limited time available for this committee's deliberations, the chairman concludes that, with the mapping procedures and product delivery system presently used, there is no possibility of adding more complexity to the map unit delineation that can be correlated and interpreted. The evidence is in the attached responses from committee members. However, using computers technology in a Geographic Information System mode would greatly improve the spatial information of land form, soil properties, and etc., in that each segment of the landscape would be inventoried and attributes assigned to it.

1. That the NCSS adopt a policy that data that are currently being collected and evaluated can be used in Geographic Information Systems.

2. That increased resources be directed to programs that use soil-related information to develop soil mapping models and field verification with the results of these programs.

3. That the cooperative aspect of the NCSS be further enhanced through a unified emphasis on Geographic Information System development that requires expertise in computer programming, information management, and the collection and use of soil-related data as well as inventories of geology, geomorphology, topography, land cover, climate, age, ownership, and soil characteristics.

APPENDIX

Peter Avers:

This is in response to charges for Committee 2, Landscape Analysis and Design of Map Units. Enclosed are some examples from our Eastern Region Ecological Classification System that respond, at least partly, to all three charges. Also enclosed Is a paper by Cline and Holdorf, Integrated Inventory Design and Interpretation fur Norther Region National Forests. Examples of map unit descriptions from the Northern Region are also enclosed.

tier-e are a few comments In relation to the charges:

1. Rationale for multiple component units. This has to be dealt with fur each survey area in terms of the purpose for which the inventory is being made. Tt : purpose and stated objective will provide the basis for selecting components and properties of components that will be used fur map unit design. The rationale for selected components and properties should be discussed in the map unit description or other appropriate place.

2. Describe a hierarchy. Depending on objectives, a hierarchy may not be important. It may even be detrimental if it drives map unit design away from the purpose of the inventory just to satisfy an artificial hierarchical structure. Conceptually, a hierarchy involving land type associations, ecological land types and ecological landtype phases (in order of increasing detail) helps in communicating the purpose design and use of the inventory. It's important to communicate to the user the link between components, properties and interpretations. Map scale should be determined by inventory objectives.

3. Correlation. Correlation for consistency, lack of duplication and efficiency, within a survey area for integrated inventories is Important. Due to the various combinations of components and properties for various purpose inventories, this may be a questionable task beyond the survey area. Caution Is needed here to prevent setting up a system that could drive map unit design. To meet objectives, taxonomic classes of components should not constrain map unit design. Map unit design needs to be driven locally based on the purpose and objectives of the inventory.

4. Interpretations. Interpretations can be made on individual components or properties or on combinations thereof. This goes back to initial objectives of the inventory and subsequent map unit design necessary to make particular interpretations.

Don Franzmier:

I wish to respond to the charges for the Soil Landscape Committee that you outlined recently.

I believe that it is important for the Cooperative Soil Survey to have a program in which it creates a product in addition to serving other programs. Stating that idea another way, we of the Soil Survey can best serve the public by working toward a goal of creating a new kind of inventory rather than by spending all of our time on service functions. Currently the emphasis seems to be on service, rather than products, as evidenced by the phrase Basic Soil Services.

To be most useful, this inventory should be fairly uniform from one area to another. I believe that one of the great advantages of the current survey is that a user of a survey in one area can quite readily use one in another area of the country. More realistically, we might need a few rather standard formats of inventories.

These are some other assumptions behind the proposal that follows:

1. The proposal applies mainly to agricultural land.

2. The new product will supplement. not replace. existing published surveys.

3. Current surveys emphasize soil profile properties; the new product should emphasize soil landscape properties.

4. The new inventory should be made on cartographically correct base maps.

5. Its major use will be for erosion control.

6. Recommendations for land management practices will be made through an erosion prediction model--the Universal Soil Loss Equation or its replacement.

7. Current surveys provide little help for providing information for the topography factor of the model (LS of the USLE).

As I visualize the new inventory, the map units will be soil landscape units (SLUs), and the base maps will be USGS topographic maps at a scale of 1:24,000. A tentative definition of a SLU is an area relatively homogeneous in landscape properties and soil properties that depend on the stratigraphy of the soil parent materials. One SLU will be separated from another, at a scale of 1:24,000, where landscape properties or soil-stratigraphic properties show a maximum rate of change.

One of the Important characteristics to be conveyed through the SLUs will be the topography factor of the erosion prediction model (e.g., slope 'length of the USLE). This could be represented as an attribute of the SLU, analogous to properties of a soil series in present surveys, or as phase of the SLU, properties of a soil series in present surveys, or as a phase of the SLU, analogous to the degree of past erosion represented in current surveys. Methods of determining and mapping this characteristic do not exist now. They could be developed in conjunction with the erosion prediction models now being developed.

Obviously, I do not have a clear picture of what the future of the Soil Survey should be. These fairly specific suggestions are being rnade in the hope that they will stimulate thought and discussion of what we should be doing after the current round of surveys is completed.

Erling Gamble:

This is in response to your letter of May 8, 1'387, requesting comments on the charges to Committee 2 - Landscape Analysis and Design of Map Units.

I have no suggestions that apply directly to the three charges. I do have some comments and perhaps cautions about. some of the items in the introductory paragraphs. The first paragraph discusses water movement across a landscape and the general water budget in terms of toposequence units. The variations of toposequences in terms of "size, shape, and composition" are seen as important. The second paragraph emphasizes the importance of "features that affect landscape hydrology.'

My impression, at the moment, is that the primary basis fur designing these landscape units is to be the configuration of the land surface. I think that there are other features that are of equal importance. In my mind they are implicit in the quoted and underlined phrases in the preceding paragraph, but their significance is not fully recognized.

There are several aspects of toposequences, in terms of shape and composition and features that affect hydrology, that must be considered along with the shape of the land surface per se. One consideration is how many geomorphic surfaces does the toposequence cross? Geomorphic surfaces are mappable parts of a landscape that differ In age. The probability is high that there are associated soil differences.. In the Missouri Ozarks, for example, a toposequence from a ridge top to the valley floor can cross a sequence of five geomorphic surfaces, ages of these surfaces range from pre-Pleistocene to Holocene. There are suites or associations of soils related to these surfaces or combinations of them.

A second consideration is the internal composition of the toposequence and its parts. By this I mean the character and geometry of the various geologic units associated with the geomorphic surfaces and the local bedrock. I refer to this as the surficial stratigraphy. Generally it includes the materials overlying the bedrock, but sometimes bedrock is included if these materials are thin. Included would be such things as alluvium, colluvium, pedisediment, glacial drift, valley side alluvium, and so forth.

The thickness, texture, bedshape, gradient, and continuity of these materials exert a strong influence on landscape hydrology. Permeable materials may allow the movement of water downslope considerable distances. Impermeable beds may restrict movement or cause discharge of water in some anomalous location. The shape of a bed may confine water movement to one particular part of a landscape. The external shape of the hill slope or toposequence may not provide clues as to these important internal features that affect the overall hydrology of a site.

I think these are important considerations that should be included in any attempt to design map units and analyze landscapes in order to make interpretations of landscape unit behavior. A proper understanding of landscape hydrology will require more field investigation than we are willing to do at the present. A hierarchy of landscape classification or map units based on external form alone will not be adequate for the interpretations that will be demanded.

Bob Grossman:

This is in reply to your letter of May 8, 1987, concerning the activities of committee 2 oh landscape analysis and design of map units.

I think that there is another kind of activity that should be considered in conjunction with the committee charges. I have sketched this approach in ah enclosure. A paper is enclosed on the EPIC model which contains some earlier thinking about the matter, arid I am also enclosing some work done that Illustrates other aspects of the statement.

The leader of the water erosion prediction project (WEPP model) effort is scheduled to speak at the conference. I think that thls underscores my comments on coordination with WEPP.

I would like to suggest a supplementary approach to the charge to the committee on landscape analysis arid design of map units for the 1987 National Cooperative Work Planning Conference. The suggestion is to characterize for model application what I would call landscape-management demonstration areas. These would be fields of pastures or portions thereof that could be construed as representing a soil management area having a repetitive ground surface configuration. Information would be collected at a spatial intensity sufficient to execute major models important to NCSS for plant growth, erosion, deep water movement, arid the like, which Involve transport of water over the landscape. Certain models would be executed at the demonstration areas and the results compiled for training of SCS arid other agency people, arid to demonstrate to the public.

As we would implement the application of models to landscape-management demonstration areas, ideas would evolve for doing mapping at lower intensity in a survey mode. The set of landscape-management demonstration areas could be a kind of experiment to sort out how to describe landscapes in the future.

The first step would be to establish sets of landscape--management demonstration areas for a very few major land resource areas (MLRA's). The demonstration areas would range approximately from 5 to 20 acres. Effort would be concentrated to obtain the necessary elevational and soil property information for execution of various process type models that involve hydrology. In parts of the United States where farming predominates, these demonstration areas would encompass fields or pastures or significant portions thereof. They would be selected to cover the important geomorphic subareas of soil associations. For an average cornbelt soil survey with eight soil associations, something like 25 to 50 landscape-management areas may encompass most of the repetitive predictable kinds of landscapes and soils that would be found in typifying parts of the associations of the soil survey. Soil surveys would be selected to be representative of the defining soil and landscapes of major land resource areas (MLRAs) and so could be extended to other soil surveys at least within a state.

Topographic control necessary to predict overland water flow would be supplied by SCS personnel through surveying if topographic maps are inadequate. We have perhaps 5,000 people in SCS who make elevational measurements as part of their regular work. According to a couple of local district conservationists, 3 or 4 people can establish a 100-foot grid on 10 acres and obtain the elevation information in 3 to 4 hours. The time necessary to make the computations presently would be about 2 hours, but I assume this would be markedly reduced with computer availability. For the average cornbelt soil survey, the field work time (not including computations) would range from 6 to 20 person weeks. The demonstration areas should be applicable to 5 to 20 soil survey areas. The time required for the 10 acres would be 0.3 to 4 person weeks per district staff to which the demonstration area would be applicable. Relatedly, the work could be done at slack time.

With the grid established, soil observations and measurements would be made as appropriate and related to the grid points. The areas once gridded could be used to obtain subsequent information through partial regridding as necessary to build a use-dependent, temporal soil property record. Our work enclosed in Cass County, Nebraska, is illustrative of such an effort. Presently, we commonly encompass a wide diversity of taxonomic concepts within the naming soils of map units. A couple of grid studies are enclosed that I did while in Missouri that illustrate the taxonomic complexity of consociation map units.

By the time the program was implemented, we would know the landscape information necessary fur the implementation of the water erosion prediction model (WEPP). A first step would be to apply WEPP and to an extent possibly evaluate it. We must link any future soil map design effort to the heeds of WEPP because the SCS will be responsible for its implementation. Certainly the current uncertainty in LS or USLE is a strong argument to avoid a similar uncertainty in WEPP. Perhaps the implementation of WEPP would be the strongest argument for the kind of demonstration areas described here.

Obviously, the program should be started where highly erodible cropland is very common and where the soils of a major research station are relevant. These landscape-management demonstration areas would be places where researchers on an interagency basis could work, remote sensing could be developed, etc. Additionally, such landscape-management units would be excellent places to train people, whether students or people who are on the job, including foreign nationals.

Finally, in my view, this suggestion is more conservative than the current charge to the committee. It would provide a way to build the future on the concrete experience of applying our major predictive models. I think, administratively, NCSS would obtain more financial support with such an organic link to major current modeling efforts. For SCS, it would put the soil survey in a posture that parallels and supplements the effort in the soil and water group of ARS to place emphasis on a few nationally applicable modeling efforts..

John Hawley:

This in response to your letter of May 8, 1987, concerning my participation on National Cooperative Soil Survey Work Planning Conference Committee 2 - LANDSCAPE ANALYSIS AND DEVELOPMENT OF MAP UNITS. I am honored to be invited to serve on this. committee (after ten years absence from the Soil Survey fold), but I am too over-committed to accept any new projects. I am very sorry because this is a very worthwhile project, and I would enjoy working with the people I listed as prospective committee members.

Ron Kuehl:

Thank you for asking me to serve on committee two - Landscape Analysis and Design of Nap Units. The following are my responses to the three charges for the committee.

Charge 1 - There are a number of examples that could be given for areas with uniform soil materials in which multiple landscape component map units would he useful. For example, soils such as Fayette formed in loess that is several feet thick. These Fayette soils are mapped on summits, shoulder, and backslope positions of side slopes, head slopes, nose slopes and foot slopes. The slopes are generally convex, but there are some areas with linear and slightly concave slopes, too. A diagram illustrating these slopes Is attached.

Certainly, map units based on these different slope positions could be very useful in helping to predict soil/landscape behavior. The water movement through a soil on a summit probably Is different than one on a backslope, even though the same soil series are mapped. We can do a better job of describing and designing landscape units by looking more at toposequences,

In summary, we can do a better job designing map units by giving more consideration to toposequences. This does not, however, make the soil series any less Important.

Gary Lemme:

Charge 1 - Many of the existing soil map complexes and associations used in our state could be converted to multiple landscape component map units. The map unit components are usually restricted to individual landscape positions. A more complete documentation of landscape position and composition would be necessary to implement the multiple landscape component map unit. I can see it5 utility at scales such a5 1:24,000 more that at scales such a5 1:10,000 because often these scale5 prevent the mapping of many landscape component consociations.

Charge 2- Scales of 1:10,000 may not lend themselves to multiple landscape component map units as well as scales such as 1:50,000. Their use at thr 1:10,000 scale may result in loss of detail. The map units should be named In a consistent manner (such a5 from summit to footslope). The order of series names in the map unit name should not be based upon extensiveness.

Charge 3 - Many interpretation table6 could be more easily comprehended by the general public if the various landscape components occurred as a single map unit instead of several consociations. The various landscape componenta could be separately interpreted, plus an overall interpretation of the landscape. This approach could be used for nonagricultural uses where an individual landuser may be interested only in a small portion of a landscape. A better understanding of agricultural interpretations such as yield or herbicide rates could be achieved by the lay public If they were expressed as they occur within the field (as a landscape unit).

Davis Lewis:

I will be happy to serve on Committee 2 of the National Cooperative Work Planning Conference. I hope I can positively contribute to the work of the Committee.

In addressing the charges of the Committee, I'm not certain whether or not what I have In mind fits with the aims of the Committee. It's not clear to me whether we're trying to incorporate small landscape differences into an overall larger unit, or if our aim is to recognize these and split them out as man units. I'm inclined to want to recognize some rather subtle differences that are presently very often incorporated into a single map unit.

We have completed studies showing that slope summit, shoulder, backslope, and footslope as well as aspects of these have a great deal to do with soil water recharge in dryland farming. Here the amount of available water in the pedon at planting time is often critical to yields. Very often these slope components are placed In a single map unit and given a "C" slope designation. I think it would be useful to break these out so that from the soil map one could get a clearer picture of the landscape. In addition, one planning to sample and establish a yield goal would have a better idea of where his water supplies are greater, hence where his higher rates of fertilizer have the greatest chance to provide a return reflective of fertilize) application. In addition, It would also show where on the landscape one has the least chance for Wet basement. Incorporating slope component information with, for example, depth to a loess - til I contact would further increase the precision of making these kinds of predictions.

Maps such as these could be made at any scale, but to be most useful, they should (I think) be at least 4"/mile or 1:12,000. I am not In favor of a shift to 1:24,000 unless its for a purpose relating to the soils In the field, rather than cartographic convenience.

Conceivably, one could combine repeating patterns of these slope components into a single unit, say at 1:50,000. A description of the unit could transfer the information important to making Judgments about larger parcels of land.

Whatever we do with this, I am philosphically strongly In favor of more use of landscape/parent material recognitions in our map units. I think we transfer experience more effectively to colleagues and to map users In this way.

Darwin Newton:

Charge 1 - In response to your question of Chat-gs 1, most map units that are an association, complex or undifferentiated unit have varying degrees of landscape components this is even true to a lesser degree for consociations. It is my opinion that we as soil scientists are the best people in the world at recognizing landscapes and the behavior of soils on these landscapes, but we are some of the worst at describing what we see and know when it is put into a written map unit form. I have tried working with party leaders in devoting a paragraph in a map unit to just landscape configuration using block diagrams, drawing cross sections, etc., with varying degrees of success.

Your- mention of detailed research plots on multi-landscape component map units Is note worthy. If a multiple landscape component map unit Is used, It should be described, but at the same time the user should be knowledgeable enough of the design of the map unit to know that for certain uses the design and scale of the map unit may not be adequate for specific use. This brings up the question of scale. One scale will never suit everyone. In Tennessee, we are mapping and publishing at a 1:24,000 scale but at the same time we are mapping the University of Tennessee's Research Stations at a 1 to 400 foot scale. The maker of the map as well as the user must recognize the limitations of the scale the mapping made. I find this to be as much of a problem as having an inadequate description of the map unit.

Iguess I have given enough on philosophy and should make a recommendation on your Charge. It is my opinion we should make a much better effort of describing landscapes in our map units. If there is more than one named component, we do provide separate interpretations in out- tables. For unnamed components, we might do a better job of identifying these included areas in the map unit and note where to go into our tables to obtain interpretations about these inclusions.

Charge 2 - The larger the scale the more precise we are going to have to be about describing various landscape components.. Correlation and data bases for Interpretations can be handled if we do a good Job of identifying and describing what is on the landscape.

Charge 3 - To illustrate how units might be interpreted for different purposes, we have to 'do a good job of identifying components.

Fred Peterson:

I hope this will get to you in time to be of some interest! unexpectedly laborious field work intervened. Rather than answering the charges directly, I will suggest concepts and policies that, in my experience, need to be decided before proceeding to such detailed, application-type question5 as the charge5 to Committee 2. Then, I cannot refrain from closing with a critique of the charges themselves.

Types of Landscape-Soil Maps

In loose terms, two types of more-or-less generalized, land resource maps that involve landscapes and soils are in use in the western U.S. One might be called a geomorphic soil-landscape map; it is exemplified by the Order 3 or 4 soil association maps being made for the BLM for range management applications. Landforms--the basic element of any landscape analysis--are used to identify the landscape position of component soils in soil-association delineations and to identify (and choose) the landscape position of the delineations themselves. To be widely useful, i.e., to be protable, in computerese-jargon, the landform concepts that thusly connect soil-locations to landscapes must be defined to be compatible with geomorphic theories of landscape evolution. This is a taxonomic task, analogous to Soil Taxonomy's development, rather than an immediately utilitarian task. Some of the very small scale soil-association maps that accompany Order 3 and 4 rangeland surveys are geomorphic soil-landscape maps since their map units have landform boundaries.

The second type might be called a geographic landscape-soil map, and appears in many varieties. Note that the "landscape" and "soil" terms are reversed in the hyphenated adjective, and that the vague term "geographic" is used. Anything goes in geography because geography is so frequently concerned with utilitarian, economic subjects. the hallmark of this type is that the map units commonly are idiosyncratic, i.e., their definition is peculiar to the individual map units (which not uncommonly are comprised of an individual, or very few delineations), their geographic location in the world, and the intended audience far the map. Slope patterns and vegetation, including cultivated crops, strongly enter into map unit definition. Examples are the Major Land Resource Areas, the soil-vegetation maps of California, and so-called soil maps and the Land Systems Inventory Maps of the Forest Service. Indeed, many of our own generalized, soil-association maps that accompany Order 2 soil surveys frequently fit this geographic type since their soil-association map units are idiosyncratic enough and break on utilitarian criteria rather than pure landforms! That's not necessarily bad.

Argument for Geographic Landscape-Soil Maps

The common argument fur geoyraphic landscape-soil maps is that they usefully organize, interpret, and generalize (simplify) a detailed soil map so that a non-soil scientist can immediately apply them. These results can be had, but one notices pitfalls along the way.

For administrators, ulterior motives are3

1. That if a new map is needed, the mapping should be cheap, because much larger areas are covered on the same size map sheet, because somehow “remote sensing” can be substituted for field study, and because entry-level personnel from any related field can be hired.

2. The product should have a good market because anybody from any discipline should be able to use its simplified, familiarly-named units. Products resulting from such misconceptions are seldom worth the paper.

For potential users (including experienced soil scientists) the common delusions are 1) that each map unit has somehow been designed so its delineations are homogeneous enough to be managed as a unit, and 2) that any and all kinds of information should be extractable from the map. The first problem will be a lasting difficulty; generalized maps, legends, and reports must be structured to frequently reaffirm the complex nature of their units. The second optimist commonly founders almost at once because the information content of most geographic landscape-soil maps (i.e., reports) is abysmally low; we need to be willing to write and print much longer, more detailed reports.

There are grounds for hope, however. If the plan is to convert existing, Order 2 and 3 soil maps to geographic landscape-soil maps, then one starts with a high information content that can be transported'. Secondly, the very idiosyncrasy of the map units means they are defined ad hoc for the particular area and use; the delineations are areas that already are familiar, or that soon can be familiar to the local user. Map unit names also should be ad hoc, familiar words. If one can hook onto the local readers interest, by starting with a familiar, large landscape unit, perhaps one could lead the reader into a progressively more detailed analysis of the individual map unit. Note, this kind of indiosyncratic unit cannot be correlated to other areas; it will be hard enough to have its delineations similar enough to form a map unit.

If one provisionally accepts these ideas, then they lead to a couple of policy suggestions:

I. We should carefully distinguish geomorphic soil-landscape maps from geographic landscape-soil maps. The latter, geographic type is the one this Committee is talking about making, I think.

The hierarchical landform concepts critical for making geomorphic type soil-association map, also are critical for making geographic type maps. We need to develop hierarchical landform classifications fur all of the U.S.--we now have only glossaries of individual geological-geomorphic-geographic terms for rnbet parts bf the U.S., with a few exceptions.

II. We should not plan to correlate the geographic landscape-soil maps. Idiosyncratic map units are by definition not amenable tb cbrrelatibn. We can war-k for quality and for content standards and familiar formats.

Charges to Committee 2

Charge 1 Examples: Unit Design - An example of a hierarchical landform classification [1] for identifying landforms of differing scale and inclusiveness for making geomorphic soil-landscape maps and an example of a geographic landscape soil map [2] and report are attached.

The landform classification has [1] has five categories, the classes of which allow identification of the landscape position of soil areas of sizes varying from very large soil-association delineations to phases of polypedons. Obviously, the more general landform units also can be used to define soil associations. I have copied only the classification table and the considerable number of illustrative diagrams--the latter, if by number alone, are meant to emphasize the need for visual-definition of landforms. We found that field soil scientists will not (cannot?) use written definitions of landforms.

The "Land Systems Inventory" for the Boise National Forest is a good example of a geographic landform-soils map. It too uses visual definitions of its geographic units, both line diagrams and oblique aerial photos. The authors note (page 3) that the classes of the first three of seven categorical levels "do not reoccur," i.e., they are completely idiosyncratic. Indeed, the Province, Section, and Subsection categories appear to have been lifted from Fenneman, or some other geographer, without reference and, more seriously, without complete enough description to be useful to the reader of this report.

The next three more specific categories, Landtype Association, Landtype, and Landtype Phase are familiar to us as differingly generalized soil associations. I think the Landtype Phase is pretty close to one of our consociation map units, but with soil identification at the Family level. The last, most detailed category, the Site, seems to be our polypedon. Delineations of classes at any of these four categorical levels "reoccur," according to the authors, but at least those map units at the Landtype Association and Landtype levels look to be quite idiosyncratic for the map area. And that is exactly what is good about this kind of landscape analysis.

What is bad about this particular Land Systems Inventory is that it was used to do the original mapping job, and the soil identifications made at the Landtype Phase and Site levels aren't very accurate (personal communications) nor are they complete. But not to worry! Here is exactly where correlation is needed, can be done, and additional soil mapping information can be added at later date; in situations where existing Order 2 soil surveys are being generalized into geographic landscape-soil maps, one can transport as much soils data as needed.

Char 3 e 2 - Correlatable landscape hierarchies. I hope 1: have made an effect, ive argument that usable landscape units should not, indeed cannot be correlated other than locally because they are by nature idiosyncratic. Landforms, which are one element of effective landscape ‘analysis, can be defines so that they are applied fairly consistently over large regions.

1/ Peterson, F.F. 1981. Landforms of the Basin & Range Province Defined for Soil Survey. Nev. Agr.Exp.Sta. Tech. Bul. 28.

2/ Wendt, G., R. A. Thompson, and K. N. Larson. 1976. Land Systems Inventory--Boise National forest, Idaho.U.S. Forest Service, Ogden, Utah.

Charge 3 - Illustrate landscape unit interpretation. The cart is before the horse. We need to identify audiences who might be interested in a geographic landscape-soils map. Most of our soil survey users want to know about a specific parcel of land, and the Order 2 survey serves them well. Possible audiences. at-e those who already have used, or tried to use our soil association maps: foresters in the Forest Service, range managers in the DLM, planners at state and county level.

Do we really have a new Job, or do we need to rethink how we have made our soil association maps and how miserably sketchy thn description of the soil association map units has been? We might make these soil association maps more attractive by using landscape units to organize them, and thus catch onto something familiar, or simple-sounding for the local audience.

Comments of the Charger;

The authors of the charge5 to Committee 2 make a statement"...the principles and precepts used in the soil...would also apply to...landscape units..." Earlier, in paragraph two of Enclosure 1, they say "Imagine that instead of phases of series or associations the toposequences.. .are to be the may units." (Emphasis added.)

Soil series are taxonomic units used to Identify soils in the delineations of map units; map units are identification5 of geographic areas (delineations) in a landscape. Did the authors mean to say soil consociations and soil associations? Indeed we need to pay attention to our principles and precepts.

Gerry Post:

This letter is in response to the Committee 2 charges of the National Cooperative Soil Survey Work Planning Conference dealing with landscape analysis and design of map units.

I believe the i: ind of mapping unite being suggested will apply to relatively small, unique areas; and, in rnost cases, not even to an entire survey area. Thus, you would likely have need for several different kinds of mapping units in a survey area with the same taxonomic units, but occurring different enough that a new unit would be needed. Thus, there will be a large proliferation of mapping units.

This appears to me to be supplemental mapping that should be done after the current standard soil survey is completed and then done only in the areas of concern. There continues to be a large ongoing need for the standard soil surveys as currently being completed. I only see confusion if at this late date a significant change is made to a whole new approach to the design of map units.

My suggestion is that this supplemental mapping be treated the same as a soil potential study and that similar guidelines be followed as published in the National Soils Handbook for soil potential ratings. This would allow very narrow, unique design of the map units from the standpoint of landscape analysis for a particular survey to satisfy an existing need.

Neil Stroensenreuther:

The U.S. Forest Service's Ecological Classification System is a prime example of a classification system using landscape units. In order to provide an effective means of determining forest land capability and to predict resource response to management activities at Forest level planning, management area and project levels, the U.S. Furest Service has developed and is applying an Ecological Classification System.

A national Ecological Land Classification (ECS) system was developed by Driscoll, et al. (1984). The Forest Service's Research and Land Use Planning section, developed the system with input and review from members of the 1978 Interagency Agreement related to Classification and Inventories of Natural Resources. Members of the review team were affiliated with the Bureau of Land Management, U.S. Forest Service, Fish and Wildlife Service and the Soil Conservation Service.

The ECS, as used by the Forest Service in Michigan, has four components: landform, soils, vegetation, and aquatic. The landform component consists of a glacial surface formation such as terminal moraine, ground moraine, esker, drumlin, bedrock controlled ground moraine, ice contact outwash, etc. The soil component is based on Soil Taxonomy as applied by tlhe National Cooperative Soil Survey. The vegetation component is adapted from a United Nation's Education, Scientific, and Cultural Organization (UNESCO) system which is recognized world-wide. The aquatic component presently uses the U.S. Fish and Wildlife Wetland and Deep Water Habitat Classification, Cowardin, et al. (1979).

The system is hierarchical in design with the top level, which is used for forest level planning, being the Landtype Association (LTA). LTAs are used to analyze large units of land for the long-term allocation of funds based on scheduled activities, costs and yields. The next level, which is used for management level planning is the Ecological Landtype Unit (ELT). ELTs provide capability information for determining road corridors, general site/species relationships, their spatial arrangement, wildlife opportunities, etc. The lowest level, used for project level planning and site specific alternative practices, is the Ecological Landtype Phase (ELTP).

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. Classification of wetlands and deep water habitats of the United States. Fish and Wildlife Service FWS/OBS-79/31, USDI, Washington, D.C.

Driscol, R. S., D. L. Merkel, D. L. Radloff, D. E. Snyder, J. S. Hagihara. 1984 An Ecological Land Classification Framework for the United States, Misc. Pub. No. 1439, USDA, Forest Service, Supt. of Doc. 56 pp.

Charge 2 - Correlation Problems. Due to the hierarchical design of the classification system, correlation problems tend to increase. Similar ELTPs exist within different LTAs. Because the major separation was made at the LTA level, the advisability of combinations at the ELTP level is questionable.

Attached are some field notes form a recent correlation, a mapping legend and classification of the Taxonomic Units;. Their attachments point out some of the correlation problems.

Report of Committee 3
New Packaging of Our Information

Members:

Chairman: Dick Rust

Ed Ciolkosz	Herb Huddleston
Jim Culver	Keith Huffman
Gordon Decker	Mickey Hansom
Rod Harner	

INTRODUCTION:

Probably no development in recent years has changed our perception of information delivery as much as the computer with its modem, word processing and graphics capabilities, available in various levels of sophistication.

Therefore it is appropriate that we consider whether our 'package' of information, which we call the soil survey report is a 'package' that should be 'repackaged' for delivery to an ever widening audience of users.

One cannot consider the 'packaging' or 'repackaging' without also considering how or whether the contents might also be revised, reduced, or expanded.

There is a perception - backed by some surveys - that the soil survey report has been generally received with confidence (since 1987) in its contents including considerable reliability in the data included. But, there is also a strong perception that we have not done a good job of 'marketing' the present product.

So if we are to 'repackage' our product, incorporate revisions, additions, etc. of what should these consist'? There were 4 charges suggested by the steering committee which directly or tangentially approach the question.

Charge 1:

Indicate major interpretation needs - and data needs - for the next 10 years.

Without a particular priority the following were suggested and generally accepted.

a. Land disposal of wastes, hazardous and non-hazardous which includes predicting the fate of wastes in various soils and identifying the relevant soil properties. Some state 5 fee I t h i li need more than others, but all have it.

b. More precision in evaluating the soil response to a variety of factors:

1. The application of agri-chemicals. Their retention. Movement in the soil. Especially movement to groundwater supply. (Many research dollars are going to this effort).

2. To tillage systems. What are the temporal changes especially in soil surface phenomena?

3. To predictions derived from the USLE, and even more, the Wind Erosion Equation. Most factors - K, L, R, - are found wanting (especially when one does a sensitive analysis on them). Defensible quantification needed.

c. Urban and engineering uses. Even though we appear to have a lot of these in the cur-rent report format, future needs seem to dictate more - with quantification. Urban erosion is a condition which many states are addressing.

d. Emphasize development of soil potentials. Soil potentials (perhaps better described as relevant, local (state) considerations- economic, physical, legal, etc. In our recent past the economic analysis hao not been emphasized. With LESA we are giving it emphasis.

e. More characterization data is needed for the above. (One correspondent said - our state is mapped and we have characterization data on less than 5 percent of our series). There is - we believe - agreement that we maintain - and update - a basic catalog of technical data (no minimum can be defined) from which the array of interpretations can be derived.

Charge 2:

Resolve the question of national vs. local guidelines for soil interpretations.

A need for national guidelines clearly exists, but we have had problems where these guidelines apparently, or in fact, do conflict with local regulations. This has been evident in a number of places in the Septic field recommendations.

The recommendation is that we encourage the development of these interpretations (soil potentials?) on the local basis. “Local questions must be answered by local people".

Our use of slight-moderate-severe limitations has been a convenient, useful means of communication. If we continue to use it, we should specify to the user the criteria by which the rating is derived. To some, when we say 'severe' limitations, there is the implication that little or no technology is available to overcome this limitation when, in fact, there is.

As alternative to national guidelines might be the use of the MLRA group as a basis.

Charge 3:

What are the training needs of the future - for new interpretations or development of new databases (and as might relate to new packaging, delivery).

a. Can we project trends - needs - for the next 10 years in ways that will better identify training needs?

b. Clearly, without training and experience, technology application, and transfer will be difficult. We must have experienced soil scientists - a trained legacy - to initiate and/or expand the effort in soil interpretations.

c. While the land-grant colleges may be equipped to provide the training, we should he aware that present trends in the educational system suggest that future graduates may be better trained in so-called basics, with less specialization. If this is true, then on-the-job training will need to be a significant part of the future. Maybe call it - continuing education. (It is now the way of many major business enterprises).

d. We need to provide training for non-soil scientists who are working in allied technical areas (county extension agents, resource conservationists, sanitarians).

e. Some of the correspondents discussed database problems in the context of this charge. In this context, if there is a training need, it is in developing the ability to recognize quality data. Additionally, perhaps, the ability to distinguish between data for planning and data for design.

f. New workers must be trained to identify user requirements, to recognize environmental concerns and problems.

g. For the present work staff we should offer the opportunity for supplemental training to work in the area of soil interpretations.

h. We need to establish working relationships with allied disciplines, with co-workers to develop many of the new interpretations we will need and to improve those we have on record. It is very probable that, in many situations, we do not fully understand the user's needs.

Charge 4:

Examine current trends in technology for adequacy in handling information needs.

(We may not have the ability to adequately evaluate current technology).

a. We should strive to get a GIS operational on a national basis.

b. We should encourage development of local GIS capabilities. At a point private concerns will test the market and probably enter.

c. As to our product, that is, our survey maps and reports, we should strive to put future mapping in a geographic computer base with ready recall capability. Consider computer entry of field documentation. At some point this may lead us to quantified landscape analysis.

d. For the next decade or so, we should plan to produce two ‘packages’ - a bound volume and an ‘unbound’ document, i.e., computer generated. The number of bound volumes can be significantly reduced - essentially for libraries, archives. (A suggestion that existing reports be copied to micro-fiche for preservation and more economical distribution). The computer generated documents, can, and should, fit specific user needs. Again, the MLRA basis may be appropriate for many special reports.

e. We should - first - develop an integrated database (of the non-geographic data) utilizing a national standard format. This data structure should be such that local (state) data, or specialized data (technical appendages) might be optionally entered as available, as needed. (Iron, copper values, e.g.). Current and quality data are paramount. Statements of reliability (levels of confidence) should be included.

f. Utilize information transfer mechanisms more energetically - especially if we are going to de-centralize control, assurance.

PROCEEDINGS OF THE NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE - 1985 - FORT COLLINS, COLORADO.

THESE PROCEEDINGS INCLUDE ONLY THOSE REPORTS SUBMITTED, AS REQUESTED, TO THE PROGRAM CHAIRMAN.

Northeast Regional Report to the
National Cooperative Soil Survey Work Planning Conference

July 8-11, 1985

by

Ray B. Bryant, Cornell University

The NECSS Conference met at the University of Massachusetts, Amherst, MA on June 11-15, 1984. General reports summarized ongoing soil survey activities at the state, regional, national, and international levels. A portion of the general program focused on the use of computer technology in soil survey, soil resource information systems and data base development, and modeling. Other general presentations addressed the topics of Sludge Application in Massachusetts, Spodic Horizon Classification, Applications of Ground Penetrating Radar, and the National Wetlands Inventory.

The major activities centered around committee activities, reports, and associated discussions. The highlights of the 1984 committee reports are as follows:

1. Spodosol Classification - follow-up report. The purpose of this committee was to initiate activity to improve the definition of spodic horizons. The problem was put forth in published form in Circular 1 of the International Committee on the Classification of Spodosols (ICOMOD). It shows pedon descriptions and data that support the current classification system. Other pedons having spodic morphology but lacking chemical spodic support and pedons lacking spodic morphologic development but meeting the spodic chemical criteria are included. The report solicits constructive comments to improve spodic identification. Work has started developing a morphologic model of soils in the Orthods, Aquods, and Humods suborders. Plans are to continue to work to construct a morphologic “typifying profile” within each suborder or, if necessary, each great group.

2. Evaluating Soil Map Quality - follow up report.

   The following three quantitative methods of evaluating soil map quality were field tested:

   Cornell-SCS Method, developed by the Cornell Agronomy Department for the Soil Management Support Services (SMSS) to aid developing countries in assessing the quality of various Soil Resource Inventories, was tested by Connecticut.

   New York Method, which estimates the number of acres deviating from the class norm, was tested by Pennsylvania and New York.

   Maine Method, which provide. an error rate per square inch of the map sheet, was tested by Connecticut and New York.

   The test results, advantages and disadvantages of the methods are reported in the 1984 Proceedings of the NECSS conference. The committee recommended that the head of the NENTC Soils Staff request that all states in the region use and test one of these methods or some other appropriate quantitative method when assessing soil map quality.

3. Regional Erosion-Productivity Studies.

   The committee summarized eight projects currently in progress of relevance to erosion and soil productivity in the Northeast. All of these activities are aimed at model development and/or data collection for calibration and testing. Soil scientists are involved in all phases of research to include: project planning, site selection, soil identification, profile description, landform description, soil characterization, yield measurements, site history evaluation, model development and prediction. The committee recommended that -

a) The types of data that are presently being used as input for model development and testing be identified.

b) The existing soils/yield/climate data bases at experimental plots that may be useful for model development and testing be identified.

c) The Soil-Crop Yield Data form (Soils Form 1) be reviewed and revised or supplemented to improve the usefulness of this data base for model development and testing.

4. Soil Survey Training Course.

The committee summarized the course offerings and field training opportunities currently being made available to students enrolled in soil science curriculum and the level of field experience obtained by students in soil science graduated with advanced degrees. The committee recommended that a regional field course of 4 to 6 weeks in duration be established to meet the training needs for graduate students at universities in the N.E. region.

5. Role of Soil Series in Soil Taxonomy.

The committee addressed the problem of the increasing use of complexes, undifferentiated groups, split series, variants, and taxadjuncts that result from the precise limits imposed by Soil Taxonomy. The committee concluded that the series plays an important role in soil classification and cannot successfully be separated from Soil Taxonomy. The committee recommends that the use of “Allowable Inclusions,” “Normal Error of Observation,” and “Laboratory Error” when fully understood and properly applied when designing map units and preparing taxanomic descriptions would eleviate many of the existing problems. The committee also recommends to national leaders of the NCSS, that definitions of the series, map unit, taxanomic unit, pedon, and polypedon be defined in one document explaining the relationships among them.

6. Interpretations of the N.E. General Soil Map.

The committee recommended that a regional soil interpretation bulletin be developed in a narrative and tabular format. It further recommended that the N. E. regional soils map be digitized for use in GIS and made available for users who wish to make their own interpretations. Specific interpretive needs and potential users were also identified.

Experiment Station Reports summarized the research efforts relative to soil survey in each state.

The Soil Survey Program in the Midwest

Don Franzmeier and Rod Harner

The once-over mapping in the Midwest is progressing rapidly. Six states (see Table) have four or fewer counties waiting to start a soil survey and have completion dates scheduled for the year 1992 or earlier. This work is being carried out by 468 field soil scientists, 154 of whom are paid by state and local funds. They work for Agricultural Experiment Stations, Department of Natural Resources or similar agencies, Department of Agriculture, SCS, and various county governmental units. Some states are concerned about the large number of soil surveys waiting to be published.

Two regional experiment station committees are functioning. NCR-3. the regional Soil Survey Coordinating Committee has completed two projects that resulted in journal article publications. They are Interlaboratory comparison of soil characterization data--North Central states, by R. H. Rust and T. E. Fenton. Soil Sci. Soc. Amer. J. 47:566-569(1983), and Organic carbon in soils of North Central United States by D. P. Franzmeier, G. D. Lemme , and R. J. Miles, Soil Sci. Soc. Amer. J. 49:702-708. The committee is also in the process of compiling a new soil map of the region at a scale of 1:2,500,000.

Relating Soil Wetness to Selected Soil and Landscape Features (NC-1091 is a regional research project authorized for 1982 to 1987. It is studying seasonal patterns of water content and the depth to water table in relation to soil morphology, geomorphology, and stratigraphy. Most states in the region are participating. Some are making additional studies of oxygen content of ground water, redox potential, and iron oxide mineralogy.

Plans for the Soil Tilth Laboratory at Iowa State University are progressing. About $11 million has been appropriated by Congress for construction, and ground breaking is planned for the spring of 1986.

Budgets for Agriculture at most of the universities are getting tight. Funds are channelled into three activities, teaching, research and extension. Teaching funds depend on numbers of students and these numbers have been declining (see Figure). The decline has been more severe in the curricula that include soil science (Plant-Soil Science and Natural Resources1 than in Animal Science or Social Science (Agricultural Economics). The national trends are from figures of the National Association of State Universities and Land Grant Colleges (NASULGC).

The soil survey program in Missouri will be bolstered by a new 5-year program. A one-tenth of 1 percent sales tax increase will provide $15 million annually for erosion abatement and the same amount for state parks. One million of the $15 million erosion abatement funds will go into the accelerated soil survey program annually. It will fund 12 to 18 new soil scientist positions and a soil characterization laboratory.

Several people associated with the soil survey program for many years have retired or changed positions recently. Those retiring include Bub Ruhe, Soil Geomorphologist at Indiana University (formerly with SCS); Clarence Scrivner, research and teaching in Pedology at the University of Missouri; R. S. Farnham, research and teaching in Organic Soils, University of Minnesota; and Bill Moldenhauer, leader, National Soil Erosion Laboratory at. Purdue. Chris Johannsen left a land use extension position at the University of Missouri to become director of the Agricultural Data Network at Purdue.

In the Midwest NTC the number of final soil correlations peaked in fiscal years 1984 and 1985 with 42 and 43 correlations respectively. Thirty final correlations are scheduled for FY 1986. The number will remain at about that level for about 4 years and then begin to decrease.

The Midwest NTC will assist with three soil correlation courses in FY 1986. One course will be held in Lincoln at the same time the course is held in Fort Worth. Another course will he in Cincinnati, Ohio, for soil scientists from Ohio and Kentucky. The third course will he in St. Paul. Minnesota, mostly for soil scientists from Minnesota with a few from surrounding states. A large part of the attendance at the Ohio and Minnesota courses will he state employed soil scientists. Jerry Post is the Midwest NTC coordinator for the three courses.

As the once-over soil survey is completed, the updating of older surveys is increasing. Currently, there are eight surveys being updated to the extent that a memorandum of understanding is required. Numerous other surveys have had or are in the process of having interpretations updated. In the Midwest States, 32 surveys are more than 25 years old; 80 surveys are more than 20 years old.

At the beginning of FY 1986. the Midwest NTC will have 36 soil survey manuscripts on hand to he edited, which is at least 1 year's work. The MNTC is examining alternatives for decreasing the time required to prepare soil survey manuscripts for publication, including author's time and editor's time.

Future thrusts:

1. Continuation of strong Project soil survey program.

2. Increased updating of soil surveys including recorrelation on multicounty. MLRA, or state basis.

3. Development of new interpretations and flexibility in presenting interpretations.

4. Change in delivery system for soil survey information with increased use of digitizing.

Status report of soil surveys in the North Central Region, July, 1985

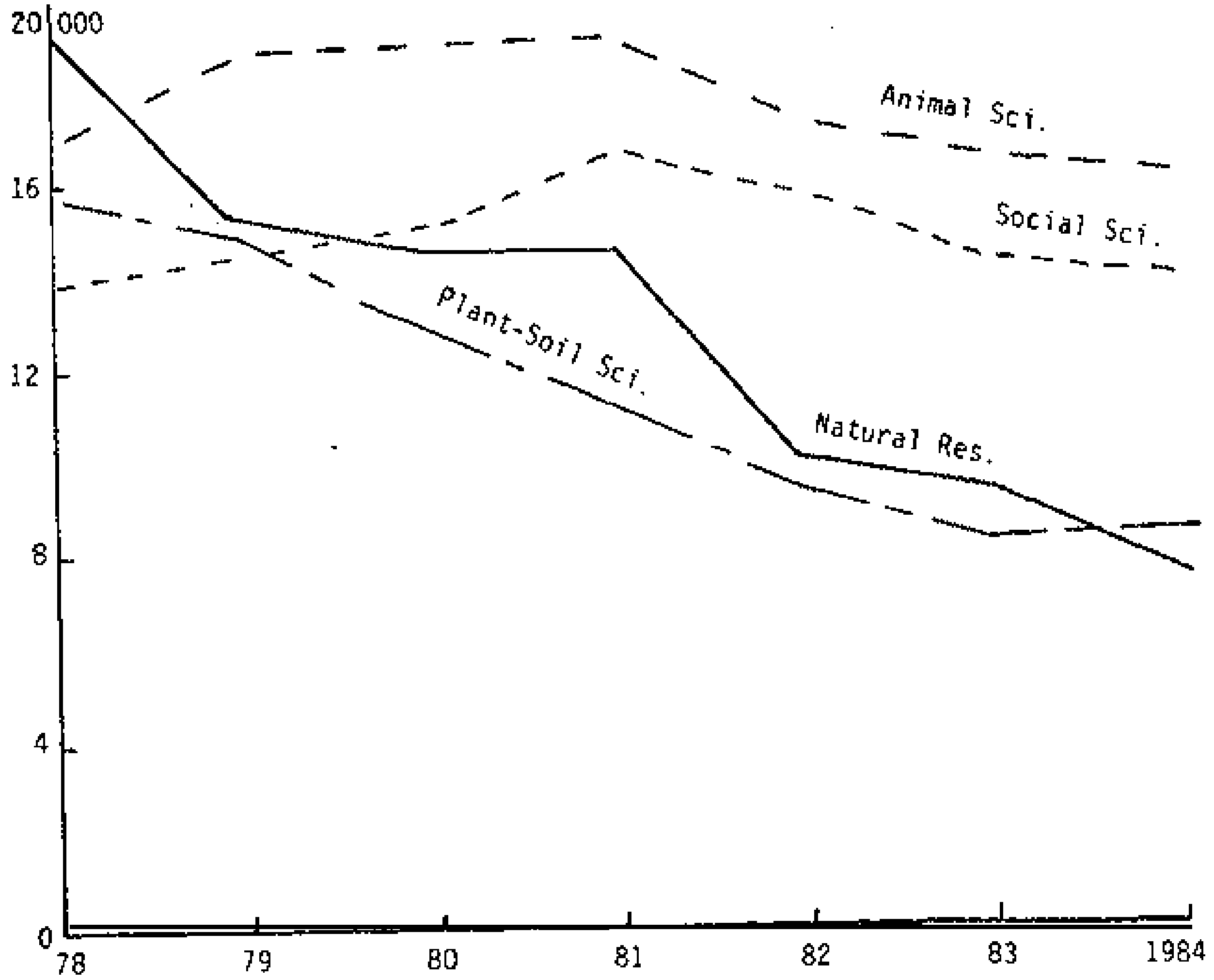
State	Counties					Field Soil Survey Scientists			Est. Compl. Date
	Total	Pub-lished	In Press	In Prog.	Waiting[1]	Federal		State & Local	
						SCS	Non-SCS		
IL	102	50	18	22	12	41	0	34	1991
IN	92	63	24	5	0	15(4)[2]	0	a	1987
IA	99	66	11	19	3	43(19)[2]	0	0	1989
KS	105	88	11	6	0	18	0	0	1987
MI	83	38	12	9	24	25	0	10	2000
MN	88	41	11	18	18	33	5	29	1992
MO	107	37	14	21	35	25	0	17	1995
NE	92	63	14	15	0	21	0	11	1987
ND	53	23	6	10	14	28	0	5	2000
OH	88	59	9	16	4	23	0	16	1992
SD	66	44	10	a	4	30	5	0	1988
WI	72	47	4	9	12	22	3	1[3]	2004
	1047	619	144	158	126	324(23)[2]	13	131	

[1] Includes planned updates of entire county.

[2] Number of SCS field soil scientists (or FTEs) whose salary is granted to SCS from state and local funds.

[3] Contract mapping for U.S. Forest Service.

Enrollment - National Association of State Universities and Land Grant Colleges



John F. Witty
NCSS-Conf.
Ft. Collins, CO
7/8-12/85

CURRENT ACTIVTIES IN SOIL TAXONOMY

Introduction

The actitivies I wish to discuss are:

1. Using computers to test and update Soil Taxonomy;
2. The status of my review of the old proposals;
3. Activities of the Soil Taxononmy Policy Committee;
4. The International Committees on Soil Classification;
5. Brief update on activities concerning the Soil Survey Manual and National Soils Handbook.

Using computers to test and update Soil Taxonomy

We currently have Soil Taxonomy on diskettes in two formats. The difference between the two formats is the number of files into which Soil Taxonomy is divided. When Cornell put Soil Taxonomy on tape they divided it up into more than 300 files and then updated those files using Soil Taxonomy Handbook Issues 1 and 2 resulting in a total of about 400 files. This was too many files for us to use for most purposes so we merged files, basically by chapter, resulting in a fraction of the number of files. We have updated both sets through National Soil Taxonomy Handbook Issue 5.

The text on the diskettes are in ASCII symbols and the diskettes were formatted using PC-DOS so the files can be accessed using any of the standard word processing programs and a" IBM compatible computer. The text, however, was originally inputted using System-6 so System-6 codes are imbedded in the text. Functionally these codes have no effect on other word processing programs but they cause some visual distraction when reading the text.

We used the computerized text for searching the location of the changes which will be published in the forthcoming National Soil Taxonomy Handbook Issue "umber 6. It corrects the horizon designation symbols so they match those in the revised Soil Survey Manual. During our first search session we used the floppy disk drives and they were disappointingly slow hut we were learning. We then checked out the hard disk drive and it was many times faster. We have the capabilities to set up a RAM drive and we found that it was significantly faster than the hard disk drive. Overall we figured using the computer was 4 to 10 times faster than making a manual search with the added benefit of somewhat improved accuracy.

I believe the computer will help us considerably in maintaining Soil Taxonomy but the benefit of the searching facility will depend on the uniformity of the search phase and number of occurences.

Our soil data bases are becoming more and more useful for testing either old or new criteria in Soil Taxonomy. We just have to learn how to access the information properly. We also have to learn how to evaluate the results.

I recently made a comparison of depth to watertable recorded on SOI-5 Records with all subgroups in aquic suborders to see what the range miqht be for each subgroup or group of subgroups. The results showed a considerable range, some ranging from ponded to greater than 6 feet. I really hadn't expected any deeper than about 3 feet for soils in aquic suborders but decided the deeper ones represented drained phases which I believe most do. After fumbling around and discussing the problem with others I finally realized all or nearly all the deep watertables were for soils from the West. It just seems the West inputted their data on drained soils different from the other three regions which affected the way I evaluated the results. The results would have been more useful if both sets of data for all the drained soils were available. That is, the drained depth to watertable, as the West reported, and the depth if undrained as reported by the other three NTC's.

One last comment on computers, our International Soils Section has a contract with Stan Buol in North Carolina to computerize the keys to Soil Taxonomy through the family level. He plans to complete the job by the end of September. He is simplifying the statements as much as possible and changing them to require yes-no answers or providing multiple choices. They will have to be reviewed thoroughly to make sure none of the meanings or limits have been changed. Stan says that there are more statements in Soil Taxonomy than he realized for which the meanings are unclear to hin.

Old proposals

I have reviewed all the old proposals that were submitted 5 to 10 years ago but never received official action. They have already been reviewed several times in the past. I believe essentially all have been approved that were submitted during that time period that should be approved without additional documentation. some, however, are being considered as part of International Committee's work and other have essentially been voided as a result of other prosposals that were submitted and subsequently approved.

I have returned some to the originators with a request that they update their proposals and resubmit them if they believe the proposals still have merit. Others I have sent to the Heads of Soils Staffs at the NTC's for general review. For most of the remaining ones, our records show that they originated in the Washington Office but I do not believe that is really true. Most probably represent proposals submitted through discussions or by phone. They really represent a combination of suggestions, recommendations, and proposals. I feel that I am starting to "spin my wheels" working on those old proposals and I would like to have your recommendations as to what I should do. Many of them are being considered by the International Committees and I believe my time would be more productively spent by keeping up better with the International Committees and working on current proposals.

I believe the only way to solve the problem of the old proposals is to revise our Soil Taxonomy Index of proposed Amendments, which lists all the proposals to amend Soil Taxonomy, by:

1. Delete all old proposals and maintain a record of only those submitted since about 1980.

2. Make both national and international distribution of the Soil Taxonomy Index making clear that it only icludes proposals submitted since 1980. In addition, any proposal submitted before 1980 that has not been approved and published in one of the National Soil Taxonomy Handbook Issues must be resubmitted to receive additional consideration.

Suggestions?

Soil Taxonomy Policy Committee

The Soil Taxonomy Policy Committee gives final approval for proposals to amend Soil Taxonomy. The Committee is active and it recently reviewed and approved 6 amendments but with the stipulation that additional documentation be submitted hy the originator for one of the amendments before it is published. At least 5 and maybe all 6 will be published in the forthcoming National Soil Taxonomy Handbook Issue number 7. We hope that we can keep the policy committee active and not let it stagnate.

International Committees on Soil Classification

The International Committee on Low Activity Clays has completed their charge. The final proposal is out for review and all review comments should have been returned by no". In general the review comments are quite favorable. We plan to begin, after the first of August, to prepare the amendment in final form.

ICOMOX is beginning to wind down and that committee plans to submit their final proposal to SCS soon after the workshop on Oxisols in Brazil next March.

A workshop on Andisols is being planned for Japan and ICOMAND should be ready to submit their final proposal shortly after that.

ICOMAQ, the International Committee on Aquic Soils, is being revitalized under the new chairmanship of Johan Bouma of the Netherlands. I highly recommend that any of you who want to have input on any reclassification of wet soils become members of that committee. Johan is a go-getter and I do not think he will sit around waiting for somebody to make up their mind as to whether or not they want to make input to the committee. Those people will be left behind..

ICOMID has become somewhat stagnated. I have not taken the time to follow up on the work of that committee.

ICOMOD is probably still having some starting plans. That is a tough problem but I have confidence that they will come up with a proper solution to the classification of Spodosols.

I am trying to revitalize TCOMMORT. Ron Paetzold is wrapping up his current soil moisture project and it looks like his next project will be developing a new soil moisture-temperature model for use in soil survey. If he does this, then I believe he will be able to work in close harmony with the International Committee on Soil Moisture.

ICOMERT distributed their 4th Circular Letter which contains a proposed classification of Vertisols through the subgroup level. It has been out for testing for approximately 1 year. I expect the final proposal will be quite similar to the current proposal.

Soil Survey Manual

All chapters have been distributed for review except Chapter 11 which is now being printed and will be ready for distribution shortly. We will be requesting that reviewers comments be back by the end of September.

Essentially all remaining chapters have been revised including comments from reviewers. Two new parts, however, are being written for Chapter 4. These are discussions on surface features and a new or revised discussion on soil moisture. The lead in discussion for Chapter 2 also is being rewritten and will include a discussion on statistical methods for determining composition of map units.

The illustrations are in pretty good shape but probably some substitutes need to he selected. It has been several years since anyone has reviewed the appendices and I think they need major revision. The revision will mainly consist of deleting all or parts of the original appendices and combining others.

National Soils Handbook

Typing is essentially completed on this year's revisions. Yost of the corrections will be in the form of page replacements with a few instructions for making pen and ink changes.

RELEVANT PEDOLOGICAL ACTIVITIES--
TOMORROW'S AGENDA FOR THE NATIONAL COOPERATIVE SOIL SURVEY

Report of the Working Committee On
Relevant Pedological Activities
for the
National Cooperative Soil Survey Conference
July 8-12, 1985, Fort Collins, CO

Committee Members:

F. P. Miller, University of Arkansas, Chairman
N. E. Smeck, Ohio State University
M. J. Singer, University of California - Davis
R. B. Brown, University of Florida
G. A. Nielsen, Montana State University
E. J. Ciolkosz, Penn State University
B. J. Miller, Louisiana State University
T. E. Fenton. Iowa State University

OBJECTIVES

The Working Committee on Relevant Pedological Activities is charged with examining ways in which the National Cooperative Soil Survey (NCSS) should adjust its direction and activities as times change and as the once-over soil survey nears completion in many areas. Specifically, the Committee was asked to determine the "universities' thinking" on three subjects:

A. What are relevant tasks for us? User groups vary in their interest, goals, and needs for information. We should list the roles and the skills that permit us to do our best.

B. Do our training opportunities adequately prepare individuals to perform the numerous tasks suggested above? How should we change, what are appropriate training strategies, and how might we make progress?

C. What constitutes relevant pedological research, and how might such research be promoted and supported? In the future we will be involved more in updating information rather than producing initial information. What should we do in investigations to be on top of these?

Toward these ends, a drait questionnaire was developed by the chairman and sent to committee members for comment and refinement. The chairman revised the questionnaire based on the Committee's input and sent it to one or more NCSS-affiliated faculty members in each of the states plus Puerto Rico.

Numbers of responses to the questionnaire to dete have been as follows:

Region	Number of Questionnaires Returned	Number of States Represented
South	18	12 (including Puerto Rico)
North Central	15	10
West	10	7
Northeast	10	8
Totals	53	37

While there were wide variations in response among the states, there were no regional trends in concerns and recommended tasks. Therefore the results reported in the following section are combined to reflect the response nationally.

RESULTS OF THE QUESTIONNAIRE

Following is a listing of the questions, the responses to each, and comments by conference participants:

1. What form does your current university involvement or support of the National Cooperative Soil Survey (NCSS) program take?

   Response of university cooperators:

   Nearly all of the universities contacted participate routinely in soil survey field reviews and. to at least a limited degree, in soil characterization work that supports soil survey. Almost all of the universities responding indicated significant ongoing involvement in soil genesis, soil taxonomic work, and soil-geomorphic activities in support of soil survey.

   Several of the states carry on research activities in the areas of (in decreasing frequency of responses) geology-hydrology, spatial variability, modelling, remote sensing, soil mapping, soil interpretations, and soil mineralogy.

   One or two states also are involved in each of several other types of research in support of NCSS, including land use, soil potential, productivity, crop yield indices, erosion-productivity, soil chemistry/physics, data base development, geographic information systems (GISs), soil climate, and patter" analysis.

   Comments of conference participants: None

2. Soil survey and soil information user groups vary in their interests, goals, and needs for information. What are the relevant tasks for universities in addressing these needs for soil survey interpretation and soil information?

   Response of university cooperators:

   The most-mentioned tasks were (in decreasing frequency of mention):

   Test, conduct research on, and modiiy soil interpretations as appropriate;
   Be flexible in addressing needs of user groups, even where those needs fall outside the traditional scope of soil investigations and soil survey reports;
   Train non-soil scientist users (DCs, professional engineers, general public, etc.) in use of soil information.

Study and interpret soil mapping units (as opposed to pedons or taxa); and
Address agronomic, range, soil management, plant-root-environment concerns;

Mentioned less often but by several different respondents each were (no order intended):

Train soil scientists in proper soil interpretation as well as in soil survey techniques;
Ensure that SCS and the Extension service cooperate in promoting the proper use of soil surveys and other soil information;
Modify soil survey reports to improve delivery of soils information;
Conduct soil genesis research;
Engage in interdisciplinary research and dialogue; and
Develop GISs, data bases, and related educational software.

Individual respondents also mentioned:

Support the Soil survey; and
Be more quantitative in soil interpretations.

Comments of conference participants:

Promote the use of soil surveys within the university in such departments as Geology, Soil Engineering, Land Use Planning, and Plant Science;
Item 3, Section 2 might better read expand (rather than modify) soil survey reports to improve delivery of soils information.

3. Assuming that the future will result in less emphasis on soil mapping and more emphasis on other areas, such as existing data interpretation, pedological investigations, landscape evaluations, soil-geomorphic relations, and geologic/hydrologic studies, what types of pedological research do you think your institution should be addressing in the iuture?

Response of university cooperators:

Mentioned most were (in decreasing frequency):

Soil interpretations and land use, on-site evaluations, large scale mapping, mapping unit interpretations, evaluation of measures now taken to overcome limitations;
Soil management and productivity, erosion-productivity, the plant root and its environment;

Hydrology, geology-hydrology, flow through porous media, influence of soil structure on flow; and
Soil spatial variability.

Mentioned less often but by several respondents were (in decreasing frequency):

- Soil-geomorphology;
- Mapping unit composition;
- Soil genesis;
- Soil moisture regimes;
- Soil mineralogy;
- Data bases;
- Problem soils; and
- Waste disposal.

Individual respondents also mentioned:

- Quantitative characterization;
- Soil micromorphology;
- Educational programs for soil scientists;
- Soil biology, soil chemistry;
- Modelling;
- Soil taxonomy;
- Remote sensing;
- Farmland losses, economics;
- Integration with other disciplines; and
- Updating soil surveys.

Comments of conference participants:

Soil temperature regimes;
Systems modeling of natural and managed ecosystems, e.g, nutrient transport models in relation to pedology;
Soil geography, mapping unit interactions, and implications of patterns of soils in landscapes. With updating soil information becoming more important, good strategies are needed for sampling and obtaining representative data that can be expanded with confidence; for example, with a population of 400+ delineations of a given map unit what strategy is appropriate to obtain a "good" sample? Are size and shape relevant? Are patterns such as clusters or uniform scatter important to any major interpretations?
Research, development, and testing of equipment needed to support NCSS missions, e.g., equipment for determination of soil moisture regimes; and
The National Science Foundation will likely become a more important source of funds for systems-oriented research on basic soil processes and on pedological aspects of landscape ecology.

4. Do you see continued reliance on state/federal funding for such research (refer to question No. 3)? If not, what other funding areas might be tapped?

Response of university cooperators	Number of Respondents
Yes	33
Yes, but decreasing	15
Yes, if we can convince sources that we do more than mapping.	2

Several respondents foresee a shift to new public sources, including state agencies, counties, cities, and environmental agencies at all levels.

Several respondents see a shift to private sources, including environmental interest groups, commodity organizations, consultants, finance institutions, and private foundations with local, regional, or global perspectives.

Comments of conference participants:

Research grant funds will not be available from SCS. However, cooperative agreements to conduct investigations are authorized by law. Investigations needed to support basic soil services might use 02 fund sources in SCS;

Funds for pedology research will decrease in some universities as the "once-over" soil survey is completed because that research is seen as supporting soil survey operations; and

Some agencies have helped support advanced degree work and thereby the research of individual staff members.

5. With respect to the demands for soil data/soil survey interpretations by various user groups, what changes, if any, do you see in our (university) programs to train soil scientists to address these demands?

Response of university cooperators:

Soil interpretations; and soil management; integration with other disciplines (engineering, geology, economics, etc.); a view beyond the look-it-up type of interpretation;

Basic sciences, including chemistry, physics, soil physics, math, and statistics; and

Field experience, mapping, 1st order surveys, on-site investigations.

Several respondents mentioned (in decreasing order of frequency):

Computer science, data bases, GISs;
Broad training, humanities, etc.;
Communication skills;
Workshops, short courses. in-service training;
No change; and
Geology-geomorphology.

Individual respondents also mentioned:

Laboratory, characterization training;
International agriculture;
Logic, scientific reasoning;
Soil taxonomy;
Hydrology; and
Crop production.

Comments of conference particpants: None

6. Since many, if not most, land use problems often transcend the discipline of soil science, should we broaden our training (e.g., hydrology, soil mechanics, political science, economics, etc.) of soil scientists, or strengthen the depth of our soil science programs (e.g., more chemistry, physics, advanced courses in soil science, statistics, etc.) or both? What do you see as areas of deficiency in soil science training today?

Response of university cooperators	Number of Respondents
Broaden	5
Strengthen depth	7
Both	18

Most-frequently mentioned areas of deficiency were (in decreasing order):

Economics, political science, land use planning, etc.
Statistics, mathematics;
Chemistry, physics, other basics;
Field training, soil-landscapes;
Computer science, data base management, GISs;
Soil mechanics, engineering; and
Hydrology, pollutant movement.

Mentioned by several respondents were (in decreasing frequency):

Communications;
Ecology, biology, microbiology; and
Geology.

One or two respondents also mentioned:

- Agronomy, crops;
- Involve field soil scientists in research;
- Mineralogy;
- International perspective;
- Soil physics;
- In-service training for soil scientists;
- Training for civil engineers working with soils;
- Soil properties and land use; and
- Basic soils.

<u>Comments of conference participants</u>:

straw votes indicated an even split between broaden and strengthen depth;

Several spoke for stronger math;

Strengthen communication skills, especially in written vs. oral presentations. Need training in "writing bullets";

Provide more field experience, many interpretation skills are learned in the field. The best interpreters are often the best mappers. Therefore:

1) reactivate the student trainee program;
2) provide field oriented work opportunities for volunteers;
3) offer more field trips;
4) encourage students to attend those training courses periodically organized for agency soil scientists;
5) provide university credit for these and other field experiences;

The Forest Service (Portland office), BLM (Denver office), the joint Southern and Western SCSS Conferences (C. Montagne, Montana State University), and the SCS Evaluation and Analysis Division (Liu Chuang, SCS, Washington, DC) have all summarized related questionnaires. They will forward these summaries for comparison with responses in this report;

"Generally, the present training is pretty good. We're impressed with the few students we've been able to hire"; and

Encourage students to pursue different courses according to their aptitudes and career objectives.

7. Do you think it is necessary to retrain (retread) experienced field soil scientists in any specific areas? If so, which areas should be emphasized?

Response of university cooperators:

Almost all respondents either stated or implied that they think retraining of experienced field soil scientists is necessary.

The most-mentioned areas of emphasis were (decreasing frequency):

Soil interpretations, data interpretation, on-site investigations;
Chemistry, physics, other basics;
Statistics, math;
Data manipulation, computers;
Hydrology, geology-hydrology.
Economics, political science, land "se planning; and
Soil physics.

Mentioned less often but by several respondents were (no ranking):

Communications;
Soil mechanics, engineering;
Soil-geomorphology;
Stratigraphy, geology; and
Fundamentals of soil science.

One or two mentions were made of:

- Logic, scientific reasoning;
- Mineralogy;
- Crop, soil, or land mangement;
- Soil variability;
- Lab data generation and use;
- Microbiology;
- Mapping unit design;
- Soil chemistry; and
- Soil acidity, salinity.

Comments of conference participants:

Conference participants agreed that continuing education is important (many older students are returning to college);
Some states have supported advanced degree programs of experienced soil scientists;
Exchanges between soil scientists in agencies and universities should be promoted;

The Agricultural Research Service (ARS) could be an excellent source of needed training, particularly as related to the development and use of models that use soil survey information; and Participants recommended that ARS be included in the NCSS, and that, in cooperation with the universities, ARS help provide training for which university credit could be obtained.

8. Does your institution offer any type of in-service training (workshops, short courses, field courses, etc.) for experienced soil scientists? What do we need to consider in addressing the needs of private, self-employed, and other soil scientists outside the NCSS program?

Response of University cooperators	Number of Respondents
Yes (ranging from a little to a lot)	23
NO	16

Most respondents mentioned audiences, rather than subject areas, in their lists of what we need to consider. Most-mentioned were (no order of frequency implied):

Consultants;
Professional soil scientist organizations; and
Soil scientists outside NCSS.

Also mentioned by a few respondents were:

Need for interpretations training;
Need for certification;
Off-campus courses in soil science; and
Need for maintenance of strong ties with soil scientists.

Comments of conference participant: None

9. SCS has made a significant investment in soil-geomorphology studies (e.g., the Desert Project, two Iowa projects, North Carolina Coastal Plains project, Hawaii and Oregon), Do you foresee any possibility of utilizing these as training grounds for soil scientists?

Response of University Cooperators	Number of Respondents
Yes	33
NO	7
Limited *	6

* Reasons given for limited possibilities:

- cost;
- Getting instructors/students to the sites; and
- Some concerns about technical aspects of particular soil-geomorphology projects.

Other comments:

Foreign soil scientists should be included;
Summer field camps for students might be combined with such training sessions;
Appropriate for regional audiences only;
New soil-geomorphology projects are needed; and
More graduate research projects in soil-geomorphology would be desirable.

Comments of conference participants:

There was strong support for cooperative training programs at these locations, especially for combining these training sessions with summer field camps for students.

10. What role do you feel SCS ought to be emphasizing in the future regarding their involvement with the NCSS program as compared to the university role?

Response

Most-mentioned roles were (in decreasing order of frequency):

Conducting and refining interpretations, on-site evaluations, mapping unit composition studies, close work with organizations and individuals using soil surveys;
Research planning and support, cooperative research efforts with universities and other agencies; and
Field mapping, including updates and evaluations of adequacy of older surveys.

Also mentioned by several respondents were (no order intended):

Soil and water conservation, service to farmers;
Control of Soil Taxonomy, consistent correlation, soil survey control, and national leadership;
Variability studies, mapping unit composition;
Cooperative (with universities) soil, geomorphic, and land use training for undergraduates, graduate students, and soil scientists; and
Provide financial support for the most pressing research.

One or two respondents also mentioned each of the following:

- Assist in obtaining federal funding;
- Soil-geomorphology projects;
- Soil characterization;
- Overseas development work;
- Computer-based data management;
- Recognized existence of regional needs and problems that cannot be addressed nationally;
  Emphasize role of soil scientists over role of conservationists; and
- No change called for.

Comments of conference participants:

More exchange between agency and university personnel.

11. If you feel these questions still leave you short of expressing your opinions, please use the reverse side of the attached letter to let us know your thoughts, concerns, and recommendations regarding the NGSS and its research needs and/or the future relationship of the SCS with universities in soil survey research.

Response

Three respondents raised additional points. One respondent notes that many field soil scientists lack a good theoretical and philosophical approach to the discipline, especially those who may have come out of regional or community colleges. This deficiency should be corrected by some form of additional training. The same respondent also bemoans the fact that fewer and fewer soil science graduates have done soil survey or fully appreciate it.

The second respondent to this question pointed out the need for researchers and soil survey users to be able to capture the vast experience of field soil scientists, especially those facets of their experience that do not currently get into soil survey reports. NCSS soil scientists need to change their attitude and philosophy. The future will call for more individual innovation. less reliance on technical guides and closely prescribed work, more contact with people, more decision-making from knowledge and experience, less naming of a soil as an end in itself, and more emphasis on understanding of principles.

The third respondent said that we need more opportunities (such as this questionnaire) to have input.

CONCLUSIONS

The imaginative use of soils information is coming to be one of the highest priorities in pedological research, teaching, and extension activities. In the eyes of many respondents, researchers need to be developing and testing soil interpretations, including monitoring the effectiveness of corrective measures employed to correct limitations. Soil scientists engaged in interpretive work need to see beyond the standardized interpretive tables and statements made in soil survey reports and technical guides in order to cope with the needs of users in an increasingly complex technical, political, economic, and social environment. To produce soil mappers, resource soil scientists, and research/teaching/extension faculty who can function effectively in such an environment, universities need to have curricula that stress both the basic sciences (physics, soil physics, statistics, chemistry, hydrology, field techniques, etc.) and broader subjects (soil mechanics, political science, economics, land use planning, computer skills, communication skills, etc.).

Interpretive needs of users will continue to range from agricultural to urban in scope. Design, study, and interpretation of soil mapping units will have great importance, as will the need to apply both scientific skills and field experience in making on-site interpretations. Information delivery must be innovative, timely, and tailored to users' needs, whether the delivery mode be a one-on-one discussion, a field workshop, or a full-scale geographic information system.

It is felt by many respondents that SCS responsibilities should include heavy involvement in soil interpretations, in soil mapping (including evaluation and update of existing surveys), and in cooperative research efforts with universities.

In short, NCSS needs to continue to be a cooperative endeavor. There will he continued reliance on field technique, field observation, and basic sciences, together with a growing emphasis on finding and refining ways by which NCSS can provide meaningful information to the users and managers of land.

Task Force:	Agronomic/Fertility Capability Classification
Chairman:	Don Goss
Members:	Stan Buol (co-chairman) Wes Fuchs Richard W. Kover Darwin L. Newton Joe D. Nichols Gerald Post Larry Ratliff Oliver Rice
Charge:	Soil Taxonomy doesn't give much emphasis to surface features important to agronomic practices. Technical groupings that may be useful supplements to technical guides and extension need to be proposed and tested. (from the Steering Committee, October 19, 1984.)

Background:

The Fertility Capability Soil Classification System (FCC) was presented to the 1983 National Soil Survey Work Planning Conference by Stan Buol. The Committee on Soil Taxonomy - Soil Fertility recommended "that the FCC be evaluated in each of the four regions, in an MLRA of considerable extent and in a specific county or survey area where there appears to be sufficient soil variability to invoke the widest possible application of the system. Further, that, if possible, the evaluation be in a county where a digitized geographic base is to be available."

This task force is a result of those 1983 recommendations and a request by Richard Arnold and Don McCormack to review the testing that has been done. A request was sent to task force members to relate their experience and evaluation of the FCC. Comments on the FCC were to include experiences using problems or inadequacies of, and possible improvement of the FCC. In addition, some philosophical thoughts on the system were requested. These thoughts could include: Will the FCC bridge the gap between soil classification and soil fertility as it was designed? Does the SCS need to consider such a system? Does the FCC system consider/provide the same information as the capability classes?

Report:

Experience

Extensive testing of the FCC has not been achieved. The FCC program was sent out without specific guidelines on how testing would be conducted and what criteria would be used to judge the system. However, some general comments on testing have been received and are listed below:

1) In some testing areas, FCC groups could be combined because no one could offer different management recommendations.

2) Uncertain about significance of exchangeable aluminum as 60% Al saturation ranges from 1 to 15 milliequivalents of Al.

3) May need some consideration of fertility in the B horizon.

4) Specific management characteristics easily applied to FCC groupings.

5) The gley (g) modifier needs further division or modification. Many Vertisols meet the definition of this criterion, but do not have the management problems of soils with an aquic moisture regime.

6) The dry (d) modifier now includes ustic, aridic, and xeric soil moisture regimes. This modifier needs further subdivision.

7) The textural groups need further divisions, particularly in the sandy-loamy ranges.

8) An additional modifier related to depth to water table could be useful.

9) The Andisols do not fit the system well unless special consideration is given to the texture due to lack of dispersion.

10) Does the FCC code differentiate Grossarenic from Pssament? If not, some provision should be made for this distinction.

Philosophical

In addition to specific comments regarding the characteristics and structure of the FCC, some general comments on use, acceptance, and need were also received:

1) An excellent system to convey technical information to users in an organized manner that is practical and easily understood.

2) Received well by agronomist and fertility people.

3) Fills the gap between our current classification system and any statements we may make on agronomic management of soils.

4) Capability classes provide us with certain groupings related to use and management for certain parameters, but one not nearly as specific as the FCC in its groupings related to soil chemical and physical problems.

5) It would be difficult to tailor the FCC to satisfy all fertility and agronomic practices, but the specific format or delivery system as provided by the FCC is clear and can be modified to serve any particular interpretation.

6) The basic FCC must be kept simple. Simplicity is a great advantage in using FCC. Extensive modifiers confuse the user and complicate the interpretations.

7) A flexible system. General interpretations can be provided with the FCC, and specific interpretations can be added for the application area.

8) Has there been any significant request or expressed need for this type of classification? Possibly the needed information is being abstracted from the current mapping unit descriptions and interpretations.

9) The FCC information should be included in a published soil survey only when there is a demonstrated need and a general concurrence in the agronomy profession that this serves a general need and is wanted.

10) The FCC provides the kind of interpretations that our cooperators furnish. They should be responsible for the coordination and classification before the SCS publishes them.

11) There is a need for both the FCC and the Land Capability Classification.

12) The symbols used by the FCC may be confusing as some are the same as horizon designators but mean something different.

Recommendations:

The 1983 National Cooperative Soil Survey Conference Committee on Soil Taxonomy - Soil Fertility, recommended to test the FCC in each region. Testing in the East and Northeast have shown the FCC to be useful and accurate. However, brief testing in the South, West and Midwest have indicated that the FCC is not currently well suited for'all soils. This was primarily due to the FCC being designed for the tropics, more humid areas, and where acid soils or aluminum toxicity are likely problems. The testing in the more arid regions of the United States has indicated that more divisions are needed to the dry (d) modifier. Also, due to the delicate soil-water relations for rain-fed agriculture in the more arid regions, additional textural divisions should be considered for the surface layer.

Wes Fuchs has spent considerable thought, effort, and time into modifying the original FCC to take into considerations some of the factors mentioned above. This modification was made to evaluate the selection of soils to be used in the EPIC program in relation to productivity. The Fuchs modified FCC is a computer driven system that uses information from the Soils-5 Form to generate FCC codes. It isnot as exacting as the original FCC because of the lack of chemical data. However, the preliminary runs and evaluation of the Fuchs modified FCC indicate the additional divisions and modifiers are important, and significant management interpretations can be made from them. In addition, the modification to use the Soils-5 Form aids in evaluating the system over large areas as the keying in of individual soils is not required.

The FCC was originally designed as a system to group soils requiring similar management or with similar management problems. Thus, there could be soils with differing productivity in the same FCC class. Some comments from people using the FCC have indicated changes that would provide additional groupings relative to productivity. A good point, but would confuse and complicate the design of the system. Future evaluations and testing of the FCC should be done with management of the groups as the primary evaluation criteria.

The task force recommends that the testing of the FCC be continued, either by evaluation of the groupings developed by Wes Fuchs' program, or by Fuchs' modifications being incorporated into the original FCC microcomputer program, and the codes generated by the testing individuals. It is also recommended that an individual be given the responsibility to design and oversee the testing. This individual will have the responsibility of assisting the regions in the evaluation process, providing updated FCC codes from the Fuchs modified FCC program, providing microcomputer programs with the most current modifications, and suggesting testing procedures. The individual will have the authority to request testing in particular MLRA, county, or soil survey areas, and will have the authority to incorporate changes as testing suggest.

Amendments:

The following amendments were recommended at the National Work Planning Conference:

1) An agronomist should lead or at least take a lead role in further testing of the FCC.

2) A name change Should be considered to reflect what the FCC does.

3) The Task Force be continued with a report at the next National Work Planning Conference.

Wes Fuchs FCC modifications.

Surface

Texture/depth	Code	FCC Code
Sandy <20 in.	S	S
Sandv 20-40 in.	s+	s
Sandy 40-60 in.	S#	s
Loamy, Sandy Loam	L+	L
Loamy; Other	L	L
Clay	C	C
Organic	O	O
Coarse Fragments 15-35%	'	'
Coarse Fragments >35%	"	"

Substrata

Texture/depth	Code	FCC Code
Sandy	S	S
Loamy, Non-Silty	L	L
Loamy, Silty	L#	L
Clayey	C	C
Coarse Fragments 15-35%	'	'
Coarse Fragments >35%	"	"
Restricting <20 in.	R#	R
Restricting 20-40 in.	R+	not used
Restricting 40-60 in.	R	not used

Modifiers

Factor	Code	FCC Code
Gley	g	g
Ustic	d	d
Xeric	d+	d
Aridic	d#	d
Low CEC	e	e
Aluminum	a	a
Acid	h	h
P-Fix by Fe	i	i
X-Ray Amorphus	x	x
Vertisol	v	v
Low K reserve	k	k
Basic reaction	b	b
Salinity	s	s
Natric	n	n
Cat Clay	C	c
Water Table <1.5 ft.	w#	not used
Water Table 1.5-3.5 ft.	w+	not used
Water Table 3.5-6.0 ft.	w	not used

Temperature

Regime	Code	FCC Code
Byperthermic	Y	not used
Thermic	T	not used
Mesic	M	not used
Frigid	F	not used

LAND CAPABILITY CLASSIFICATION
TASK FORCE REPORT
1985 NATIONAL SOIL SURVEY CONFERENCE
July, 1985

CHARGE:

Explore problems of using uniform criteria such as climate, slope, and PE (for land capability classification LCC). How can we cross-check, improve, or extend this system? Can we computerize the system?

In addition to this charge, the committee considered several issues related to the 1983 Committee report and other current issues related to LCC and its application.

USE OF LCC -
'The committee evaluated current use of LCC in various parts of the country. The following points summarize this evaluation:

a. LCC is widely used and is valuable to SCS in carrying out its mission. It is used in conservation planning and also for inventorying and monitoring and other activities of broader scope than conservation planning on farms and ranches.

b. LCC classes and subclasses are used hy Agricultural Stabilization and Conservation Service, Farmer's Home Administration, Federal Crop Insurance Corporation, and numerous other federal and state agencies in most states.

c. The cooperator's copy of the capability map is no longer being colored in most of the country.

d. Land capability units (LCU's) are used in less than half of the states responding and where used they are not entirely effective as treatment units.

e. Several pointed out that the individual soils were better to use than LCU's as specific management needs could he identified directly.

ISSUE 1 - Can we use uniform criteria such as climate, slope, and potential evapotranspiration (PE) for ICC?

a. The committee believes that a thorough analysis and evaluation should be initiated to help improve the consistency and accuracy of LCC. Recent Assessment and Planning Staff reports (No. 1 by Lee and Goebel and No. 2 by McCormack and Heimlich) indicate that there are inconsistencies in the ICC placements of soils across the nation.

b. One phase of this activity should he to determine those criteria that can he applied nationally to define LCC classes. If it is demonstrated that it is not appropriate to use a given criteria nationally, the modelling activity should help determine where it should be applied, i.e., regionally, or by states MLRA's or MLRR's.

c. A proposal was received that the activity should be divided into the major kinds of limitations, e.g., erosion, wetness, etc. After workable rating systems are developed for each limitation individually, then their combined analysis and modelling should be carried out.

An example of a modelling system for LCC class for the soil wetness limitation proposed by Keith Young is provided in Table I. The importance of interactions and examples of their treatment is illustrated.

a. The committee compared criteria submitted for Class I from New Mexico, Ft. Worth, and Lincoln (Table 2), in an effort to identify some of the difficulties that must be faced in modelling LCC. A comparison of criteria indicate the need for coordination in:

- depth to bedrock
- available water capacity
- surface texture
- seasonal high water table
- stoniness
- salinity
- rock fragments, surface
- potential evapotranspiration
- slope
- flooding
- wind erosion
- pH
- cumulative dry days
- sodicity

Criteria from Montana indicates that awc > 1.5" was required for the surface foot and 7.5" for the upper 60". A further requirement from Montana is that the soils must be moderately well or well-drained. California requires an awc of at least 0.13 in/in and adds the Thornthwaite indices (> 20) as criteria.

ISSUE 2 - Is Class V needed? The majority of the committee felt that Vw was not useful and that no clear difference exists between Vw and VIw.

The committee supports the 1984 decision of the NHQ staff that Vs was not needed and should be included with VIs.

A proposal has been made that Vw be used for soils of floodplains that experience flooding which renders them unsuitable for cultivated crops. Such soils would be excluded from VIw. This proposal merits further study.

ISSUES DISCUSSED BY THE 1983 COMMITTEE

In 1983, opinion was divided on some of the issues addressed by the previous Committee. Thus, it was considered advisable to further evaluate these issues:

ISSUE 3 - Under what conditions is it not appropriate to assign LCC to both the improved and natural conditions.

The 1983 Committee report indicates that both conditions should be rated where the survey did not separate the two conditions, and implies that both would also be rated where the survey did separate the two conditions. It mentions irrigation and drainage as improvement practices for which separate LCC ratings would be appropriate.

Response of the current committee indicates that rating both improved and natural conditions is not advisable for:

a. practices which are considered temporary, such as terraces and other erosion control practice*.

b. area* where most of the *oil is improved

Most members of the committee prefer that only the existing condition be rated. This is taken to mean that both the improved and natural condition* should be rated, assuming both exist.

RECOMMENDATION: Both the natural and improved conditions should be rated except where the improvement is temporary, such a* most erosion control practice*, or where the entire extent of a soil ha* been improved (and thus the natural condition is not pertinent). Feasibility of improvement, per se, s not a consideration.

ISSUE 4 - How should LCC be applied to soil complexes and soil associations?

The 1983 report indicated that the reaction was mixed to this question, but that the majority supported assiqninq ICC to individual component*. The same reaction was received by the current committee, with 7 of 13 votes favoring this approach.

Recent discussion* at NHQ have resulted in a unanimous opinion that only one capability class should be assigned to complexes and soil associations, due to the very general kinds of uses of this rating. However, it was also pointed out that where on-site investigations are carried out to determine which component exists at a given site, it may not help the user to rate the map unit. A single rating which indicates directly the use potential of the entire map unit is preferable for many decision* about land use and this perhaps is the level of generalization that the capability class should represent. On the other hand, where more specific information to guide soil management is needed, each component must be considered. Thus, the decision appears to hinge on whether general decisions about land use or more detailed decisions about soil management are sought.

RECOMMENDATION: Assign LCC to component*, as specified in current policy. Further study and clarification of the issues is needed.

ISSUE 5 - Should dual subclasses be assigned to map units to indicate both primary and secondary limitations?

The 1983 committee reported almost equally divided opinion, so the issue was reconsidered. A clear concensus (10 to 3) of the current committee voted not to use dual subclasses, in agreement with the 1983 committee concensus.

RECOMMENDATION: Use only single subclasses as current policy indicate*.

ISSUE 6 - Are there adequate subclasses in LCC?

The 1983 committee recommended that the number of subclasses remain the same, but indicated that several suggestions were advanced for additional subclasses. The current committee favors additional breakdowns by an 7-5 margin.

The following subdivisions are generally supported by those who favor additional subclasses:

e - erosion:
    sheet and rill erosion
    wind erosion
w - wetness
    seasonal water table
    flooding
c - climate
    dry
    cold

Additional subclasses for subdividing subclass "s" are in need of further study, based on committee responses.

The symbols used for the possible new subclasses formed by subdividing e, w, and c should avoid use of the old symbols. This is thought to be necessary so that IIe, for example, prior to revision, will not be confused with a different IIe that would exist after revision.

RECOMMENDATION: The addition of new subclasses should be studied further.

SUMMARY OF ACTION ITEMS:

1. Assignments should be made to develop a workplan for analyzing and evaluating LCC and its use throughout the entire country.

2. Send to the states and NTC's for review a proposal that Vw be reserved for soils of floodplains that are unsuitable for cultivated crops.

3. In the future, both the natural and improved conditions should be rated per recommendation of ISSUE 3.

4. Assign further' evaluation of the application of LCC to soil complexes and associations, and the adoption of new subclasses to a future NCSS committee.

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TABLE 1.--LAND CAPABILITY CLASSIFICATION
MODEL - WETNESS

CLASS CRITERIA	I	Ii	111	IV	V	VI	VII	VIII
Wetness								
Water table depth (ft)								
Growing season 1/ by								
Rapid perm	> 4	2-4	1-2	.5-1	+, < .5			
Mod perm	> 6	4-6	2-4	1.1	.5-1	+, < .5		
Slow perm	> 6	4-6	2-4	1.2			+, < 1	
Non-growing season	4-6	2-4	1-2	< 1	+			
Flooding frequency by surface texture (C)oarse; (M)edium; (F)ine	C M F	C M F	C M F	C M F	C M F	C M F	C M F	
Growing season 1/ First period 2/:	N, N, N 4/ R R R-	0, N, N R R	F, O, O	- F -	- - F	- - -	——	
Second period 3/:			O - -	F - -	O O	- F -	- - F	
Non-growing season:	N, N, N R R R	F, F, O, O O	- - F	- - -	- - -	- - -	- - -	

1/ Growing season (WTMonths)

Hyperthermic	7-12
Thermic	3-10
Mesic	4-10
Frigid	6-9
Cryic	6-8
Pergelic	7-9
Isohyperthermic	1-12
Isothermic	1-12
Isomesic	1-12

2/ First period = 1/6th of growing period.

3/ Second period = 1/3 of growing period.

4/ N - None
R - Rare
O - Occasional
F - Frequent

NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE

July S-12. 1985

Report. of Committee - Moisture in Soils

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INTRODUCTION

Three matters are discussed: (1) use-specific soil property records; (2) water state classes for field application; and (3) manual field evaluation of water state. The committee met with National Headquarters Staff in the fall of 1983

The 1981 and 1983 reports discuss approaches to water information records. These efforts indicated a need to link evaluation of the pattern of water states and water transmission rates to specific uses of soil. In this report, a record will be presented that incorporates water related information within a general description of use-dependent agronomic properties for specific uses of a map unit.

SOIL PROPERTIES RECORD

The material to be presented is a joint effort of a large number of Texas Soil Conservation Service personnel, in particular. the area staff at Amarillo, Lubbock, and Pampa, Texas. The work was done by conservation agronomists. civil engineers and soil scientists working together. The intent was to design a record that could be part of the technical guide of a District. Soil Conservation Office. The record format was evaluated by personnel of the Plainview, Texas. District Office. Soil Conservation Service personnel in West Texas are completing records on the major soil and soil use combinations for four counties that should encompass most of the agriculture of KLRA 77.

A sample Soil Properties Record form is table 1. The format is designed for the Texas portion of Major Land Resource Area (MLRA) 77. The idea is to formulate a record format that in broad outline would have national application but. for which particular entries could be changed among MLRA's. A manual has been drafted that explains the soil property records. The material to follow is taken from this manual.

Identification Headings

Location is usually a soil survey area that encompasses a county.

Map Unit is for the specified soil survey area.

Calendar Year Use gives the crop and major cultural practices that would affect soil properties that influence the record for a calendar year.

Rotation is the cropping sequence beginning the year prior to the calendar year of the record. In rotations that involve a fall-planted small grain (usually wheat). the year the grain is harvested is described by the small grain. and the year that the small train is planted is referred to as fallow. A wheat-grain sorghum-fallow rotation has two crops and two fallow periods of about 11 months each.

Water Regime is the relative wetness or dryness of the plant growing portion of the year of the record. The classes wet, average, and dry are employed. Average pertains to precipitation to be expected 6 years in 10. Dry pertains to 2 years in 10 on the dry side, and wet to 2 years in 10 on the wet side.

Operations Schedule gives in chronological order, beginning with the previous calendar year, the kind and date of cultural operations that would ho expected to significantly influence entries in the record.

Date pertains to when the record was completed.

Record Number contains the state abbreviation, the county PIPS Number, and three digits signifying the chronological order of record completion within the location.

The list under Compiled By gives the people with principal responsibility for completing the record.

Column Headings

Line Number is the row position in the record.

Kind of Information is a short description of the entry.

Entry Numbers are unique alpha-numeric numbers assigned to each entry. Explanations in the procedural manual are arranged in ascending numerical order of the Entry Numbers. The first three positions indicate the kind of information. The fourth position specifies whether the entry is for the map unit (letter A) or is use dependent and not specified by the map unit alone (letter B). The fifth and sixth positions specify the procedure employed to measure or to complete the entry.

Map Unit Derived entries are independent. of the use of the soil and are assumed to be constant through the year. Most of these entries are obtained directly from the map unit file. Some involve additional considerations. Use Dependent. Quantities change with the use of the soil, Some are constant through the year and no monthly values are shown. Others change monthly depending on weather conditions, cultural operations, and plant growth patterns. For some entries with monthly values, a yearly value based on the monthly entries may also be given.

Entry Descriptions

To follow are excerpts from the procedural manual under preparation for the Texas portion of MLRA 77.

The Entry Numbers are on the righthand side. The same Kind of Entry may have two definitions if both Map Unit and Use Dependent Values are possible.

WEQ : 001A01

This is the potential soil loss assumed to occur at Garden City, Kansas. for a wide. unsheltered field that is bare and uncrusted. It is based on the percent. aggregates >0.84 mm. The value comes from the National Erosion Handbook.

WEQ I: 001B01

From sieving measurements by the ARS station at Big Spring. Texas. as interpreted using the Texas Erosion Handbook.

WEQ K: 002B01

Soil ridge roughness. Guidelines come from the National Erosion Handbook.

WEQ C: 003801

Determined by the average wind velocity and by surface soil moisture. Guidelines come from the National Erosion Handbook.

WEQ L: 004801

The unsheltered distance across the field from the prevailing or damaging wind direction. Guidelines come from the National Erosion Handbook.

WEQ V: 005B01

Quantity. kind, and orientation of vegetation expressed as an equivalent quantity of flat small grain residue. Guidelines come from the National Erosion Handbook.

WEQ Soil Loss: 006B01

Computed from the previously given factors as described in the National Erosion Handbook.

USLE R: 007A01

Dependent on rainfall intensity and amount. which establishes the number of erosion index units. Values are in the National Erosion Handbook.

USLE K: 008A01

Erodibility factor. It is the soil loss rate per erosion index unit as measured on a unit plot, which has defined dimensions, a uniform 9-percent slope and is in continuous clean-tilled fallow. The erosion index is calculated by summing the products of the total energy and the 30-minute intensity of storms for the year that meets certain criteria. Values are in the National Erosion Handbook.

<u>USLE L:</u> 009A01
The length from the point of origin of runoff to sediment deposition, channel entry, or the edge of the field.

<u>USLE s:</u> 010A01
The percent slope.

<u>USLE LS:</u> 01 1A01
Combines slope length and slope gradient. It is obtained from the National Erosion Handbook.

<u>USLE c:</u> 012801
The factor for the ground surface cover and the management as obtained from the National Erosion Handbook.

<u>USLE P:</u> 013A01
The factor for erosion control practices. Values are from the National Erosion Handbook.

<u>USLE Soil Loss:</u> 014BOl
Computed soil loss based on multiplication of the previously given quantities.

<u>Surface Crust-Resistance/Thickness:</u> 015B01
The crust is removed and air dried. The specimens consist of crust 1/2 inch on edge and 114 inch thick. or the thickness of the crust if less than 1/4 inch thick. The thickness includes the crust proper and any adhering soil material. Specimens are held on edge and crushed between thumb and forefinger. Classes are in the table to follow. A top loading balance. such as is used for weighing mail, may be used to train the fingers. A bar 1/4 inch wide should be placed on the scale to simulate the crust specimen. The specimen may be crushed with the forefinger and thumb of one hand while simultaneously applying the same felt pressure to the scale with the forefinger of the other hand. The scale is read upon rupture of the crust specimen.

Class Name	stress at Rupture lbs
Absent (A)	
Extremely Weak (EW)	Present but not removable
Very Weak (VW)	Removable; <1/4 lb
Weak (W)	114 - 3/4
Moderate (M)	3/4 - 2
strong (S)	2 - 4
very strong (VS)	4 - 10
extremely strong (ES)	>10

Crust. resistance and thickness together may affect infiltration rate?. seedling emergence and wind erosion. Crust expression is used in entries that pertain to the water state. and to Effective Hydrologic Group.

Note: 001
Tillage Zone Thickness extends from the ground surface to the base of deepest evidence of recurring mechanical disturbance by animals or by implements. exclusive of deep plowing for erosion control, commonly 6 to 10 inches.

Note: 002
Bulk densities are for the moist soil, exclusive of rock fragments. Measurements may be by several methods. including gamma probe. clod, core, and excavation.

Upper Tillage Zone Thickness: 016B01
Note 001 applies. The Upper Tillage Zone extends from the ground surface to the base of mechanical disturbance by the most recent tillage operation. commonly 3 to 5 inches.

Upper Tillage Zone Density: 017B01
Notes 001, 002 apply. Bulk densities are predictive of final infiltration rate, resistance to water erosion, low suction water retention. and the general condition of the seedbed(tilth).

Lower Tillage Zone Thickness: 018801
Note 001 applies. The Lower Tillage Zone extends from the base of the most recent mechanical disturbance to the base of the deepest recurring annual or near annual tillage. Thickness may vary from 1 inch to more than 4 inches. It commonly exhibits mechanical compaction. It may be the limiting zone for infiltration. Deep disturbance for wind erosion control that. results in profile modification is excluded. Such deep disturbances commonly change the classification of the soil and would therefore lead to a separate record.

Lower Tillage Zone: 019B01
Notes 001, 002 apply. These bulk densities are predictive of root penetration and final infiltration rate.

Upper Subsoil-Density: 020801
Note 002 applies. The Upper Subsoil is the layer immediately beneath the tillage zone. It may be subject to mechanical compaction. If the overlying Lower Tillage Zone is not compacted, this layer may be the limiting zone for infiltration. Thickness is not specified but generally is less than 6 inches. These bulk densities may affect root penetration and in some instances, final infiltration rate.

Final Infiltration Rate: 021A01
This is based on the permeability of the most restrictive layer within 40 inches of the soil surface as obtained from the Soil Interpretation Record for the soil series.

Final Infiltration Rate: 021801
This is the steady ponded infiltration rate measured with a constant,-head. recording, double ring infiltrometer. A lo-inch diameter ring is seated into the most restrictive part of the near surface tillage zone and upper subsoil. A constant head of 1.5 inches is maintained and infiltration is recorded by water level recorders. The rate is reported after ponding for 24 hours or longer. Crust expression and bulk

densities of the tillage zones and upper subsoil are recorded. The final infiltration rate is used to calculate the Design Intake Family. the Expected Net Intake, the Effective Hydrologic Group. and in the computation of the field available water on a monthly basis.

Design Intake Family: 022A01

The Design Intake Families are generalized relationships between cumulative intake rate and time. The numerical values-given are an estimate of the final intake rate. These estimates have limitations as indicated by the following quote: "There is no simple guideline. such as soil texture, to govern placement of a soil in a specific group. If field experience is inadequate to group the soils properly. field evaluation should be made. Such evaluation provides reliable data for furrow design on specific soils of an area." (Chapter 5. NEH-15 furrow irrigation). The Design Intake Family affects the method of water application, length of run. and time of application.

Design Intake Family: 022801

The Intake Families are generalized relationships between cumulative intake rate and time. The numerical values given are an estimate of the final intake rate. Data using constant-head. recording. double ring infiltrometers are plotted on log paper. The resulting curve is compared to those in Fig. 1-10 of SCS. Engineering Staff (National Engineering Handbook Section 15. Chapter 1) to determine the Design Intake Family. If the curve crosses several intake family curves, it is considered non- typical. and NT should be entered. The Design Intake Family is used to design irrigation systems.

Expected Net Intake: 023B01

The Expected Net Intake is used to plan irrigation schedules. It is the net amount of water that, can enter the soil in 24 hours. A curve is employed that relates the expected Net Intake and bulk density of the Lower Tillage Zone and Upper Subsoil. The time depends on the dominant set time employed in the area. If the time is other than 24 hours. another Entry Number is assigned. In the absence of measurements of final infiltration rates. data for closely similar soils are employed.

Effective Hydrologic Group: 024801

The Hydrologic Group is an estimate of steady ponded infiltration rate for bare soil under wet conditions, including presence of a water table if common to the soil. The assignment is based on the Final Infiltration Rate, as follows:

Final Infiltration Rate in/hr	Effective Hydrologic Group
<.1	D
.1 to .3	C
.3 to .5	B
>.5	A

Most Final Infiltration Rate data are for the uncrusted condition. An adjustment. for crust is advisable. For soils in Hydrologic Group A or D. it is assumed that crust. expression has little influence on runoff.

Hence. the Final Infiltration Rate measurements for the uncrusted condition are used without adjustment. For soils in Hydrologic Group B or C with loam or finer textured near surfaces. the Final Infiltration Rates for the uncrusted condition are adjusted using the following guidelines:

> Hydrologic Group C-Reduce the measured Final Infiltration Rate by one-fourth if the crust is Weak and by one-half if more pronounced than Weak. If the expression is less than Weak, ignore the crust.
>
> Hydrologic Group B-Reduce the measured Final Infiltration Rate by one-fourth if the crust is Moderate or stronger. If the expression is less than Moderate, ignore the crust.

<u>Antecedent Moisture Condition</u>: 025801

The Antecedent Moisture Condition is based on the accumulated 5-day antecedent. rainfall. It is an index of watershed wetness which is used for runoff estimation methods and is used for runoff estimations. Antecedent moisture condition is defined in the National Engineering Handbook #4, Chapter 4. Table 4.2. Antecedent moisture condition is obtained from the pattern of water state classes as found in Entry 030B01. The following is from Texas Engineering Note, Hydrology 210-18-TX5:

> I - Dry (D) 0-10 inches; or Slightly Moist(MS) 0-10 inches and Slightly Hoist or Dry 10-20 inches.
>
> III - Wet (W) 0-10 inches; or Very Hoist (MV) 0-25 inches. and Very Hoist or wetter below.
>
> II - Other

<u>Hydrologic Soil Cover Complexes:</u> 026801

The Hydrologic Soil Cover Complexes are employed to determine the Runoff Curve Number. The first letter denotes the soil use, the second the conservation practices employed, the third the amount of residue, and the fourth the percent. crop canopy. The entry codes are as follows:

<u>Position</u>	<u>Letter</u>	<u>Specification</u>
1	F	Fallow
1	R	Row crops
1	S	Small grain
1	C	Close seeded legumes. meadow
1	P	Pasture or Range
1	W	Woods
2	T	Straight Row
2	0	Contoured. not terraced
2	E	Contoured, terraced
3	B	Not specified
3	P	Poor
3	G	Good
4	P	Poor
4	G	Good
4	B	Not specified

Runoff Curve Number: 027801

The Curve Number for Antecedent Moisture Condition II and the applicable Hydrologic Soil Cover Complex is obtained. This Curve Number is then adjusted for the Antecedent. Moisture Condition if necessary.

Note: 003

Rooting depths are the distance from the ground surface to the specified position.

Rooting Depths, Common: 028B01

Note 3 applies. Distance to the maximum depth of common alive roots. For tap rooted plants, the deepest rooting depth is employed.

Rooting Depths. Few: 029801

Note 3 applies. Distance to the maximum depth of few alive roots.

Note: 004

The soil has been subdivided into major horizons based on differences in texture, bulk density, reaction or structure. The maximum depth is determined by the base of maximum rooting at physiological maturity or to a root restricting layer.

Available Water: 030A01

Note 004 applies. The values come from standard soil survey documents or research reports and apply to each of the major horizons. The values represent the capacity to retain water in the available range and not the actual amount of available water. The lower limit of available water is taken as 0.8 x the 15-bar retention for stress resistant crops and 15-bar for other crops.

Available Water: 030801

Water status is given both as a percent of the total available water and as the water state class for each of the major horizons. A letter designation indicates the water state. DV-Very Dry. DM-Moderately Dry. DS-Slightly Dry. %-Slightly Moist. MM-Moderately Moist, W-Very Moist. WA-Wet with free water, and WN-Wet without free water. The computation of Available Water is quite lengthy and will not be included in this report. Briefly. evapotranspiration is computed for the crop while growing from published relationships. Evaporation from the soil is estimated by a protocol that involves the influence of crop residue and of the tillage operations. A net precipitation (i.e.. water entry into the soil) is computed. This computation involves the cumulative infiltration at 1, 2 or 3 hours. amount of residue. kind of crop. and surface configuration as it affects retardance of surface flow. Irrigation additions are also included. Monthly, the difference between the evapotranspiration and the net. precipitation or water entry is computed. and the available water increase or decrease is calculated accordingly. A key part of the computation is to assign a final infiltration rate as adjusted for crust and for the maximum bulk density of the tillage zone. Relatedly, a time must. be assigned that free water is present at the ground surface. This time is dependent on the crop. tillage practices, and surface configuration.

Available Water Capacity: 031A01

Note 004 applies. The inches of water from field capacity to the lower limit of available water for the crops concerned is computed. The computation involves the manipulation of laboratory-determined water retentions or estimates thereof.

Available Water Present: 032B01

Note 004 applies. The inches of available water that is present. The available water that is present is computed as explained in 030801.

Available Water Deficit: 033B01

Note 004 applies. The inches of water that would be required to brine the soil to field capacity. It is calculated from the difference between the Available Water Present and the Available Water Capacity.

Anticipated Yields: 034801

On the assumption that soil water is limiting and using the information in entries, these are yields calculated from the assumed water regime. An illustration follows for grain sorghum. This equation has only local application. The Entry Number is changed if other equations are employed.

$$\left(\text{Total inches water used by crop} - \text{6.0 inches required to reach boot. stage}\right) \times \text{300-350 lbs grain/inch of remaining water} = \text{Lbs/Ac}$$

Soil Condition Rating Indicies: 035801

These indicies t-ate the degree to which each crop and soil treatment combination affects the soil tilth and organic matter. Instructions are from Section III of the Texas Field Office Technical Guide. This rating would be soil-improving.

Discussion

Carson, Dawson, Gray and Hale counties on the Texas High Plains are being completed on a trial basis. These counties cover a wide range of soils. uses range from cotton in Dawson County to predominantly winter wheat and grain sorghum in Carson and Gray counties. After these counties are complete. the effort will be reviewed and a judgment made whether to extend it to the whole Texas part of MLRA 77. The work for the four counties is about 40 percent completed.

Personnel in the District Office can be trained in 1 day to complete a single calendar year record. After the initial training. one rotation (three calendar year records) can be completed daily. For similar soils to those completed, the time drops to 6 hours for a rotation of three calendar years.

Immediate plans are to have the Beltsville Hydrology Laboratory compute the final infiltration rates and to explore with the ARS group at Bushland the incorporation of their research and modeling capability. We hope to have some water state patterns run by the EPIC model to compare against. the approach now employed for the records. There is the general question of computer generation of quantities and the interweaving of local estimates and measurements with computer-generated quantities. We recognize the need to assemble a body of estimates that rest both on computer computation and on estimates by experienced people. Without use of the computer, the job becomes too great.

The Soil Properties Record format presented was developed with the help of a District conservationist. It is designed to be as part of the Technical Guides of the District Office. The record sacrifices specificity and flexibility in order to avoid being too complex. An alternative approach will be described which has greater flexibility and specificity, but is not suitable directly for District Offices. The entry is identified by a number having five components. As for example:

010 012 006 001

The first entry 010 specifies the kind of measurement or observation. The second entry 012 specifies where vertically the observation or measurement pertains. The third entry 006 indicates where the observation pertains laterally within the tillage determined relief. The last entry 001 gives the antecedent water state history.

For the example we have the bulk density (010) of the upper tillage zone (012), exclusive of the row (006) and for a usual year in terms of the water regime (001). The advantage of this approach is its flexibility and suitability for recording a specific measurement sets. The disadvantage is that the flexibility leads to complexity of kinds of entries and makes the terminology unwieldy. It might be possible to enter hard data sets using this more flexible identification approach and then to output the information in a format more similar to the sample record.

Apart from how to construct the records, what are some of the advantages and implications of use dependent property for map units:

1. The record is interdisciplinary in the process of formation. Conservation agronomists, civil engineers and soil scientists are all involved in the Texas effort. The full range of Soil Conservation Service soil-behavior predicted quantities is covered. This pulls to&ether a wide range of experience. It leads to a broad base of administrative support.

2. A wide range of information is in one place for cross checking and interactive applications. Experience is made numerical an is on paper where it can be subject to quality control.

3. Hard data sets are associated with a specific soil use to which they originally pertained.

4. Modelers need the inputs from these records. They also need to compare these records against model outputs as checks against the models. And finally, they need a format for use-specific temporal output to have a place for their output.. For example. where is the place for the frost. depth models now available in our present soil survey documentation? The answer is that there is no place because we do not specify soil cover in our documentation which is so critical to frost depth. We probably need a hybrid record--partly experience based estimates and measurements and partly model outputs.

5. Soil use can be evaluated by remote sensing. If the map unit and the use are known. then the Soil Properties Record can be a basis for

predicting behavior. It is perhaps not a” exaggeration to raise the question whether remote sensing can reach its potential without some kind of a use dependent data base.

6. The variability of important properties associable with soil concepts would be reduced if soil use and time in the yearly cycle of use were specified. Large reductions would occur in the variability of some properties if the “near surface zone. lateral position in tillage determined relief. and antecedent water state pattern were specified.

7. Soil potentials require much of the infrastructure that is employed in the Soil Property Record. Soil potential computations could be added to the Soil Property Record.

8. Erosion and infiltration are the two most important soil processes for the Soil Conservation Service. They are both use-specific and temporal. Neither process can be addressed satisfactorily without a use-dependent temporal record system. In passing, it might be noted that the bulk density of the Upper Tillage Zone in the record format presented, could be used to adjust erosional K based on soil organization.

9. Much of the product of Basic Soil Services is use-dependent and temporal. We need a record such as presented here to regularize this output,. Can we apply the quality control procedures that have been so well formulated for standard mapping to Basic Soil Service’s without an approach something like what has been presented here?

10. Finally. imagine that you are a District Conservationist who wishes to make the case to a farmer for furrow-diking (small dams across the furrows every 6 feet or so). Recall that the record presented is for a use that involves furrow-diking. The District Conservationist in conversation with a farmer would compare this record to a record where the use is the same but. without furrow-diking. The rule of thumb is that furrow-diking increases the infiltration 40 percent if in every other row and 75 percent if in every row. Presumedly, the soil would be drier if furrow-diking were omitted, and the yields should be lower in most years.

The potential to make comparisons such as this is the basis for the support of the program by line people in West Texas. The record provides an authoritative, numerical statement of the usefulness of conservation practices.

WATER STATE CLASSES

Table 2 presents the set of water state classes. The ensuing discussion is for mineral soil materials. Organic soil materials are not considered. In this report, we will use kilopascals instead of bars (1 bar = 100 kilopascals). The abbreviation for kilopascals is kPa. Three major classes of water state are recognized- Dry, Moist and Wet. Dry and Moist are separated at. 15 bar. Wet is separated from Moist at 1 kPa (0.01 bar). At this suction, water films on sand grains and macroscopic structural surfaces are clearly visible. Three subclasses of Dry are distinguished- Very Dry. Moderately Dry and Slightly Dry. separation between Very Dry and Moderately Dry is at a water content equal to SO percent. relative more than the air dry moisture. This water content is approximated as 0.35 times the retention at 1500 kPa. At this water content, resistence to wind erosion is only slightly higher than at complete dryness (Chepil, 1958, USDA Tech. Bull. 11851. Very Dry soil material should he very subject to wind erosion if otherwise conditions are favorable. The Very Dry class should he applicable to the immediate near surface of a wide range of soils for periods of time ranging from days to several weeks. and to subsurface and subsoil horizons of some Aridisols and certain soils other than Aridisols that are Xeric and Thermic. Moderately Dry is separated from Slightly Dry at a water content equal to 0.8 times the 1500 kPa retention. The suction equivalent to this water content is roughly 10.000 kPa. Drought resistant crops grown in climates that lead to a high evapotranspiration such as grain sorghum in the Southern Plains reduce soil water to below the 1500 kPa retention. For such crops. the limit between Moderately Dry and Slightly Dry may he a reasonable estimate for the minimum water content Furthermore, for a number of soils. the tactile examination of soil material at known water states suggests that 0.8 X 1500 kPa retention is nearer to the concept held by most people of the Hoist-Dry separation than is 1500 kPa retention.

Moist is divided into three subclasses--Slightly Moist, Moderately Moist, and Very Moist. Generically, Slightly Moist is the lower half of the available water range and Moderately Moist is the upper half of the range with the upper limit determined by the water content at field capacity. The idea is to have the class separation (between Slightly Moist and Moderately Moist) where irrigation would he initiated for major grain crops growing under high evaporative demand. By defining such a class limit. the irrigation program in the soil Conservation Service and the National Cooperative Soil Survey can he interrelated.

The separation of Slightly Moist from Moderately Moist and the upper limit of Moderately Moist are interrelated. The upper limit of Moderately Hoist.. referred to as the Upper Water Retention, is the water retention at 5 kPa (0.05 bar). 10 kPa (0.1 bar) or 33 kPa (1/3 bar). depending on whether the soil material is very coarse (class I). moderately coarse (class II), or finer than moderately coarse (class III). Details of the definitions of the three kinds of soil materials are in table.2. The definitions involve, in addition to particle size. organic carbon and bulk density. We would expect that in the future, estimates of unsaturated hydraulic conductivity would replace the material description classes, and perhaps the upper limit would he plant dependent..

Slightly Moist is separated from Moderately Hoist. at the Midpoint Water Retention Differ- which is half the difference between the Upper Water Retention and 1500 kPa retention. For some situations, 0.8 x 1500 kPa may be substituted for the 1500 kPa retention.

Very Moist is the range from the Upper Water Retention to where the soil material is Wet.

Wet refers to soil material in which water films on sand grains and on macroscopic structural surfaces are quite apparent. The soil material is seen to glisten; this glistening decreases markedly as modest drying occurs. Formally, the maximum suction is set at 1 kPa (0.01 bar or 10 cm). A separation within Wet is made on whether free water is present.

Satiation is a term for the presence of free water (Bresler, SSSAJ 41: 1029. 1978). The a from satiation is used in the symbol (WA) for the class with free water. This class encompasses the range from the first appearance of free water to saturation. The concept of saturation is that no airfilled porosity is present. This would be a restriction from how the term is now used in the soil survey.

Only the three major classes. Wet. Moist and Dry, may be employed. Additionally. two of the subclasses within Moist and Dry may be combined as explained in footnote a of table 1.

It is proposed that this overall class set could be used in pedon descriptions. To be most effective, the water state should be early in the body of the description. This is because structure and consistence commonly are dependent on the water state.

The classes may be useful for redefinition of moisture regimes. Perhaps the taxonomic concept of Dry should be on a sliding scale depending on the water regimes being separated. The Midpoint Water Retention Difference might be the water content for separation between Usually Moist and Ustic moisture regimes. The 1500 kPa retention might remain for the separation of Udic and Typic classes of Ustic soils. And finally, 0.8 X 1500 kPa retention might be preferable for the separation of aridic intergrades of Ustic from more moist soils and for within Aridisols. Parallel separations could be made for the Xeric moisture regime.

WATER STATE CALIBRATION SAMPLES

There is a need to develop a tactile and visual concept of what soil materials feel like at different water states. The most direct approach is to have soil scientists feel and examine soil materials at known water states. This approach would not. of course. replace quantitative methods of determining water state. but it would seem useful for the application of the water state classes given previously.

A procedure has been developed for preparation of soil material at standard water state and its storage for extended periods. The water states of concern are the Midpoint Water Retention Difference, the 1500 kPa retention and 0.8 X 1500 kPa retention.

To prepare the soil material, it. is first air-dried and then an estimate or a measurement made of the air-dry moisture. Commonly, the air-dry moisture may be estimated as 10 percent relative of the clay. An amount of water is added equal to the difference between the water content desired and the air-dry moisture. An allowance is made for evaporation during the addition process, and 1/2 to 1 percentage points is added so that the water content obtained will be somewhat in excess of the desired. The water content obtained after this first addition is determined and a calculation is made of the reduction in that water content needed to bring the soil material to the desired water percentage. The soil is then dried in nylon oven bags such as are used for cooking roasts and turkeys. Those bags pass water readily. When the soil in the bag reaches the desired weight, it is transferred to 1/2-gallon canning jars. The shelf life in these jars is measured in years. When used, the soil material is transferred from the 1/2-gallon jars to smaller containers. The smaller amounts of soil are used once and then discarded.

Four tests are made on the soil material for the evaluation of water state:

Color value.--The color value of the soil in an unspecified water state is compared to the color value at air-dryness and when fully moist. This test probably only has usefulness if the full range in color value is 1.5 units or more.

Ball test.--A quantity of soil is squeezed firmly in the palm of the hand to form a ball about 2 to 3 cm diameter. This is done in three to five squeezings. The sphere should be near the maximum density that can be obtained by squeezing. The ball is dropped onto a nonresilient surface. The height in centimeters at rupture is recorded. Usually heights above 100 cm are not measured. Additionally, the manner of rupture is recorded. If the ball flattens and does not rupture. the term “deforms” is used. If the ball breaks into five or less units, the term “pieces” is used. Finally, the term "crumbles" is used if the number of units exceed about five.

Rod test.--The soil material is rolled between thumb and first finger to form a roll 3 mm diameter or less. This roll must remain intact when lifted at one end for recognition of a rod. The minimum length required is 2 cm. If the maximum length is 2 to 5 cm, the rod is *weak*. If the maximum length exceeds 5 cm. the rod is *strong*.

Ribbon test.--The soil material is smeared out between thumb and first finger to form a flattened body about 2 mm thick. The minimum length required for recognition of a ribbon is 2 cm. If the maximum length is 2 to 4 cm, the ribbon is *weak*. If the maximum length exceeds 4 cm. the ribbon is *strong*.

To date about 25 different. soil materials have been tested. The body of information is insufficient to make many generalities. One observation may be valid. It is soil material with predominately swelling-type clays that tend to feel wetter at 1500 kPa retention than do soil materials with several other kinds of clay mineralogies.

For suctions of 33 kPa and below, most soil materials of medium and high bulk density which have intermediate or greater clay percentages are subject to appreciable increases in water content on disaggregation to the extent that occurs in the hand evaluation tests described. An inference from this observation is that although the water content remains constant the suction increases after the hand manipulation required in the evaluation tests. The manifestation of this in the field is that soil material that appears quite moist in place feels drier after being worked in the hands. Increase in suction becomes less important as the suction increases. For medium textures, the suction at the Midpoint Water Retention Difference, which is the lowest suction considered, is commonly in the range of 1 to 2 bars. At this suction, the effect on disaggregation on water retention is probably quite small, and at 1500 kPa and higher suctions the effect should be very small. Therefore, as the test procedure is used. the effect of disaggregation is ignored. If the approach were applied to samples at suctions to approximate field capacity, the increase in suction on hand evaluation may be considerable.

RECOMMENDATIONS

1. NHQ should offer to provide assistance to Texas to incorporate computer generation of quantities and computer encoding and outputting of the information for the Soil Property Record.

2. Present a progress report at the next National Cooperative Soil Survey Conference on the Soil Property Record but do not continue consideration of the Record as a committee subject.

3. Water state classes and tactile field evaluation of water state will be discussed in the new Soil Survey Manual. Neither would seem appropriate subjects for the next National Cooperative Soil Survey Conference.

4. A possible useful activity of a committee for the next National Conference would be to begin to construct a water information record at the Major Land Resource Area level. This data source would be constructed to provide an update and extend the kind of information now provided for soil map units in standard soil surveys. The record might contain:

> Estimates of final infiltration rate by the Green-Ampt approach being developed for the Soil Conservation Service by ARS hydrologists.
>
> Relevent laboratory measurements and computations such as Otto Baumer's water disorption curves and associated derivative quantities.

-- Water regime computations for standardized soil uses of map units hy EPIC. CREAMS, Saxton's approach. or other models.

Runoff computations hy CREAMS, SPUR or other models for idealized landscapes of major soil associations.

Applicable field water related hard data such as water state patterns, infiltration measurements. and runoff.

-- A package of weather descriptive information.

The Major Land Resource Area selected should have within it a typical county which is or will be digitized. have an ARS Soil and Water Group that works in the Major Land Resource Area. and be in an SCS targeted area.

LOCATION: Carson County, Texas
MAP UNIT: Pullman silty clay loam - PuA
CALENDER YEAR USE: Grain Sorghum: Irrigated, [illegible]
ROTATION: Wheat-Grain Sorghum-Fallow

SOIL PROPERTIES RECORD

(Table 2)

WATER REGIME: Average

DATE [illegible] **RECORD** [illegible]

COMPILED BY: Blackwell, Allen, [illegible], Walker

OPERATION SCHEDULE: Prior year: 6 inch irrigation in May; Jul.-Harvest at [illegible] Aug-Sweep 4 inches; Graze volunteer. Current year: Jan.-Sweep 4 inches, [illegible] Fertilize; Mar.-Harrow; May-Sweep; Jun.-Plant; Jul.-Open water furrows & dike alternate furrows; irrigate 5 inches both mid July and mid August; Harvest [illegible]

LINE NO.	KIND OF ENTRY	ENTRY NUMBERS	UNITS	MAP UNIT VALUES	USE DEPENDENT VALUES												
					YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
1	WEQ I	001A01,B01	T/Ac/Y	30		12	21	21	21	21	12	12	12	12	12	12	[illegible]
2	WEQ K	002B01				0.75	0.75	1.0	1.0	0.75	[illegible]	0.50	0.50	0.5	0.50	0.75	0.75
3	WEQ C	003B01			.90												
4	WEQ L	004B01	Ft.	3000													
5	WEQ V	005B01	Lbs/Ac			1400	2700	2700	2700	2400	1900	475	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	WEQ Soil Loss	006B01	T/Ac/Y		0.57												
7	USLE R	007A01		120													
8	USLE K	008A01		0.37													
9	USLE L	009A01	Ft.	400													
10	USLE S	010A01	Pct.	0.5													
11	USLE LS	011A01		0.11													
12	USLE C	012B01			0.24												
13	USLE P	013A01			1.0												
14	USLE Soil Loss	014B01	T/Ac/Y		0.84												
15	Surface Crust-Strength/Thickness	015B01	1/32 in.			W-2	W-2	W-2	W-2	VW-1	VW-1	W-2	W-3	W-3	W-3	[illegible]	W-3
16	Upper Tillage Zone-Thickness	016B01	Inches			4	4	4	4	4	4	4	4	4	4	4	4
17	Upper Tillage Zone-Density	017B01	gm/cc			1.10	1.10	1.20	1.25	1.20	1.25	1.30	1.35	1.35	1.40	1.40	1.45
18	Lower Tillage Zone-Thickness	018B01	Inches			3	3	3	3	3	3	3	3	3	3	3	3
19	Lower Tillage Zone-Density	019B01	gm/cc			1.55	1.55	1.55	1.55	1.60	1.60	1.60	1.60	[illegible]	[illegible]	[illegible]	[illegible]
20	Upper Subsoil-Density	020B01	gm/cc		1.50												
21	Final Infiltration Rate	021A01,B01	in/hr			0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.05	0.05	[illegible]
22	Design Intake Family	022A01,B01		NT													
23	Expected Net Intake (24hrs)	023B01	Inches			4.90	4.90	4.90	4.90	[illegible]	[illegible]	[illegible]	4.80	4.80	4.50	4.50	[illegible]
24	Effective Hydrologic Group	024B01				D	D	D	D	D	D	D	D	D	D	[illegible]	[illegible]
25	Antecedent Moisture Condition	025B01				II	II	II	II	II	II	I	I	I	I	I	II
26	Hydrologic Soil Cover Complexes	026B01				FTGB	FTGB	FTGB	FTGB	FTGB	RTGP	RTPG	RTPG	[illegible]	RTPG	[illegible]	[illegible]
27	Runoff Curve Number	027B01				90	90	90	90	90	87	75	75	75	75	[illegible]	[illegible]
28	Depth Common Roots(or Tap Root)	028B01	Inches								12	20	30	30	[illegible]		
29	Depth Few Roots	029B01	Inches								20	49	50	50	50		
30	Avail. Water,% Total/Water State 0-7 In.	030A01,B01	in., Pct.	1.34		51MM	57MM	65MM	67MM	68MM	55MM	37MS	30MS	[illegible]	[illegible]	[illegible]	[illegible]
31	Avail. Water,% Total/Water State 7-20 In.	030A01,B01	in., Pct.	2.86		47MS	47MS	50MS	51MM	56MM	51MM	41MS	35MS	25MS	[illegible]	[illegible]	[illegible]
32	Avail. Water,% Total/Water State 20-40 In.	030A01,B01	in., Pct.	4.00		20MS	20MS	20MS	20MS	20MS	20MS	20MS	19MS	17MS	15MS	15MS	15MS
33	Avail. Water,% Total/Water State 40-70 In.	030A01,B01	in., Pct.	5.10		10DS	10DS	10DS	10DS	10DS	10DS	10DS	10DS	10DS	10DS	10DS	[illegible]
34	Avail. Water Capacity	031A01	Inches	13.3													
35	Avail. Water Present	032B01	Inches			3.34	3.51	3.71	3.65	3.79	3.58	2.87	2.41	[illegible]	2.07	[illegible]	[illegible]
36	Avail. Water Deficit	033B01	Inches			9.96	9.79	9.59	9.65	9.31	9.72	10.43	10.89	11.07	11.23	[illegible]	[illegible]
37	Anticipated Yields	034B01	Lbs/Ac	4600													
38	Soil Condition Rating Index	035B01			+1.5												
39																	
40																	
41																	

TABLE 2. SOIL WATER STATE CLASSES FOR MINERAL SOIL MATERIALS

Class Name[a]	Symbol	Criteria[b],[c]
Dry	D	>1500 kPa
Very Dry	DV	<(.35 x 1500 kPa retention)
Moderately Dry	DM	>(.35 x 1500 kPa retention) to (.8 x 1500 kPa retention)
Slightly Dry	DS	>(.8 x 1500 kPa retention) to 1500 kPa
Moist	M	1500 to 1 or 1/2 kPa[d]
Slightly Moist	MS	1500 kPa to MWRD[e]
Moderately Moist	MM	MWRD to UWR[f]
Very Moist	MV	UWR to 1 or 1/2 kPa[d]
Wet	W	<1 kPa or 1/2 kPa[d]
Not Satiated	WN	No free water
Satiated	WA	Free water present

Explanation

Very Dry: The maximum rater content is roughly 50 percent relative more than the air-dry moisture. Resistance to wind erosion • t the upper limit is low (Ch 11, USDA Tech. Bull. 1185, 1958). Applicable to a near surface Of a wide range of soils seasonally, and to subsurface and subsoil horizons of some Aridisols and to some soils other than Aridisols with Xeric moisture regimes.

Moderately/Slightly Dry: The separation was made because stress resistant crops such as grain sorghum may reduce the water content appreciably below 1500 kPa retention. me suction at 0.8 times the 1500 kPa retention is near 10,000 kPa.

Slightly Moist: Encompasses the lower half of the usual range of available water. The upper that are subject to water stress such as corn boundary is about where major cultivated crops would be subject to large reduction in yield if evapotranspiration demand were high.

Moderately Moist: The water state is highly favorable to the growth of most cultivated crops and tillage should not be restricted. The boundary to Very Moist is an Upper Water Retention that corresponds to field capacity.

Very Moist: Between the Upper Water Retention and where water films are readily discernible on sand grains and on surfaces of structural units. If the tillage zone is in this state, the soil probably is too wet to till satisfactorily.

Wet: The suctions that set the limits between the Moist and Wet classes are about where water films appear (glistening quite apparent on sand grains and surfaces of structural units). Subdivided on whether free water is present or not. The term satiation is used for the condition where free water is present. It covers from where free water is first observed through complete filling of the pore space with water (latter saturation). Miller and Bresler (SSSAJ. [illegible]:1029, 1978) discuss the term.

---

[a] Two of the three subclasses may be combined for the Dry and Moist classes: DV + DM = D1; DM + Ds = D2; MS + MM = M1; MM + MV = M2.

[b] The criteria are written using both suction and water contents as defined by suction.

[c] Three classes of soil material are defined:

Class I--Sandy or sandy-skeletal family particle size if coarser than loamy fine sand, <2 percent organic carbon, and <5 percent 1,500 kPa retention. For soil material strongly influenced by volcanic ejecta, the field texture must be as above, and the soil material must be nonmedial and weakly or nonvesicular.

Class II--Coarse-loamy family particle size on the basis of the <2 mm or with a sandy or a sandy-skeletal family particle size coarser than loamy fine sand, but otherwise fails Class I, and the bulk density is such that for a particle density of 2.65 mg/m^3 the calculated total porosity is ≥40 percent. For soil material strongly influenced by volcanic ejecta, the field particle size must be sandy or sandy-skeletal and coarser than loamy fine sand and the vesicularity must exceed weak.

Class III--Other than Class I and Class II.

[d] 1/2 kPa only if Class I soil material.

[e] MWRD is the abbreviation for midpoint water retention difference. The concept is the water content at which irrigation should be initiated for major feed grain crops. It is roughly where half of the available water has been exhausted. The upper limit is at or near the water content at field capacity. The lower limit commonly is the retention at 1,500 kPa, but may be a higher suction for stress resistant plants.

[f] UWR is an abbreviation for upper water retention. UWR is at or near the water content at field capacity. UWR is based on laboratory water retention at a suction that depends on characteristics of the soil material and may in the future depend on the plant grown. Guidelines follow for the three classes of soil material:

NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
FORT COLLINS, COLORADO
July 9, 1985
NATIONAL SOIL INTERPRETATIONS RECORD COMMITTEE REPORT

INTRODUCTION

The Soil Interpretations Record (Form SCS-SOI-5) has been extremely valuable in making, interpreting, and using soil surveys since its inception in 1974. Over the years numerous regional and national National Cooperative Soil Survey (NCSS) committees have reported on the revision and expansion of the soil interpretations record and its computer supported data base to meet greater demands for soil data and data manipulation. A few data items were added in 1976 and forestry interpretations were revised in 1984, but no action has been taken on other NCSS committee reports, primarily because of the cost and the possibility that constant revision would interrupt the efficiency with which the data base performed quality control and data access for the soil survey publication program.

The NCSS formed the National Soil Interpretations Record Committee to determine revisions needed in the record and to recommend action to be taken.

CHARGES AND RESPONSES

CHARGE 1 - Identify additional soil properties needed in the Soil Interpretations Record data base. Recommend a method to determine the values for these properties.

There is general agreement that additional soil properties should be included in the data base, but only for those properties for which specific uses have been determined. The following soil properties are recommended for inclusion in the Soil Interpretations Record data base:

Soil Property	Property Value & source
- CEC	Meq/100g, by layer. Use effective CEC (ECEC). For soil with pH<6.0 use CEC determined for Bases plus Aluminum. For soil with pH>6 use Ammonium Acetate. Estimate based on available laboratory data.
- SAR	By layer. Estimate based on available laboratory data.
- $CaCO_3$ eq.	Percent, by layer. Estimate based on available laboratory and field test data.
- Gypsum	Percent, by layer. Estimate based on available laboratory data.

- Toxic Element	A qualitative expression that identifies the element and indicates toxicity based on field documentation and available laboratory data. (Criteria to be determined in coordination with the ARS Animal, Plant Nutrition Laboratory, Ithaca, NY)
- Cobbles & Stones	Percent weight, by layer. Size classes: 3 to 10 inches, >10 inches. Estimate based on pedon descriptions and field test data.
- Ponding	Depth (ft.), duration, and months of year. Estimate based on field documentation.
- AASHTO, Group Index Number	Index, by layer. computer generate from data in the record.

Other recommended additions to the interpretations record are:

- Climate data; drainage, and slope range,
- Providing data for flooding that occurs during the growing season,
- Prime farmland code,
- Fertility capability classification,
- Spaces for additional crops in the yield section (up to 26 crops by using 2 Agronomic entry forms),
- Volume of productivity in cubic meters per hectare for "common trees" and "trees to plant",
- Site index for "trees to plant",
- Providing a specific section for "forest understory vegetation",
- Nationally correlated range site number.
- Provide entries for vegetative types or plant communities under wildlife habitat suitability.

It is recommended that instructions for entering yield data be revised to specify that yields entered will be "annualized" to compensate for crop/fallow systems.

CHARGE 2 - Determine how data in the Map Unit Use File (MUUF) might more easily complement the soil interpretations record data and identify additional map unit data needed in the MUUF.

There is general agreement that a single data base containing the Soil Interpretations Record and the Map Unit Use File is a desirable goal. However, many of the additional items proposed for inclusion in the MUUF, e.g.: physiography; slope position, shape and average length; and elevation range should be determined on site because of variability, or the information could be made available from other sources, thus there is no general agreement for adding these items.

Many of the items suggested for addition to MUUF could eventually be obtained for taxonomic units from the Official Series Description (OSEDS) data base. SCS has been working on a program to extract site characteristic and soil properties from OSEDS that is currently in narrative form. When this is accomplished OSEDS can be revised to store site characteristic data and soil property data in a form similar to the recently issued computerized pedon description format. Soil series in OSEDS and map units in MUUF would be linked with their respective interpretations records in a data base management system (DBMS) so that all data could be manipulated and retrieved in any combination.

CHARGE 3 - Identify interpretations for cropland, woodland, rangeland, and wildlife additional to those now used on Form SCS-SOT-5. Evaluate the additions. Recommend action to be taken for each.

There is general agreement that additional interpretations are needed but that most would be regional in their usefulness. Decision for their development and use should be at the regional level. Definitions should meet requirements for a national data dictionary.

Priority should be given to ensure that soil property data is correct and complete so that interpretations based on the data can be made as needed. There were no recommendations for changes in established procedure to ensure correct data is entered.

The soil interpretations record system currently has the flexibility to generate interpretations to satisfy special needs of states and regions, though there is no repository for maintaining the criteria used to generate these special interpretations. It is recommended these criteria be used to program the respective computer generated interpretation, the interpretation definition and criteria be cataloged and maintained in a data base for access by prospective users.

It is recommended that interpretations of a regional nature be developed by regional inter-agency, inter-disciplinary teams under the auspices of regional NCSS conferences. The interpretations should be reviewed and tested by state staffs and cooperators before the criteria is entered in a data base for general use. National coordination and further development of regional interpretations that may have national application would be the responsibility of national interagency, inter-disciplinary committees under the leadership of the SCS National Leader for Soil Technology. The National NCSS conference would provide general guidance.

It is recommended that criteria for the following practices be circulated nationally for review and comment, programmed, and interpretations generated for testing nationally:

- Tillage,
- Unsurfaced Roads, and
- Fencing.

See attachments 1-3 for the recommended criteria for each practice.

CHARGE 4 - Determine the format needed for form SCS-SOI-5 and SOI-6 so as to accommodate the additional soil properties and interpretations that were identified and recommended for inclusion in charges 1, 2, and 3.

There is general agreement that forms SCS-SOI-5 and 6 be used primarily for data entry. It is recommended that the SOI-5 form be reformatted so that data can be accommodated on five 81/2 x 11 inch pages, a page for:

- Estimated Soil Properties and Soil Ratings and Groups,
- Agronomic,
- Forestry,
- Range, and
- Wildlife and Windbreaks.

See attachments 4 - 8 for the recommended format for each subject area.

There is general agreement an input form would not be required for computer generated interpretations such as sanitary facilities and building site development, etc., though these interpretations would be computer generated on a printout for testing, editing and storage.

CHARGE 5 - Determine the most flexible data entry, storage, and retrieval systems that would make Soil Interpretations Record data available to the greatest number of users and maintain quality control.

There is general agreement that a data base management system (DBMS) would provide the flexibility needed to make the greatest use of the data. Soil interpretation and map unit use data should be in the same data base or linked for easy retrieval of combinations of the data.

Soil Interpretations Record and Map Unit Use data are available now in 3 modes from 2 sources:

- Iowa State University (ISU) - responsible for data entry, quality control and batch retrieval of standard printouts used in the soil survey correlation and publication process. Standard services are available in batch mode to Federal NCSS cooperators(BLM, FS, BIA) through ISU and to State NCSS cooperators (colleges and universities) through SCS state offices. Users are primarily those involved in making soil surveys.

ISU also provides data tapes to users who want to manipulate soils data on their own computer. Users are primarily those needing specific data nationally and have the resources to store, maintain and manipulate the data using their own computer resurces.

- Construction Engineering Research Laboratory (CERL) of the Corps of Engineers - has interfaced interpretations record and map unit use data in an interactive, user friendly mode, available to anyone with a computer terminal having communications. Users are those needing general data of a local, state or national nature.

A third possible source will be from the USDA-Fort Collins Computer Center where the interpretation and map unit USE data are being loaded in system 2,000 DBMS. The system will be tested and evaluated for rational use. If it works, it will be made available to all NCSS cooperators.

It is recommended that a statement be made in each published soil survey pertaining to the availability of computerized soil data bases.

ADDITIONAL COMMENT - Several committee members were concerned about the reliability of the data entered in the soil interpretations record. There is increased use of the data by modelers and others to address complex environmental concerns. Use of NCSS soil data in those projects could have serious implications. The NCSS has an obligation to provide users with data reliability guidance. Developing this guidance is beyond the scope of this committee. It is recommended a small NCSS committee with expertise in this area be formed to develop a practical system for rating the reliability of each soil property. To stimulate thought system might include the following:

Soil Property	Range (SOI-5) of the Taxonomic Class	Modal Concept of the Taxonomic Class	Number of Laboratory Samples Used to Determine Modal	Reliability
% clay	35-45	43	8	8 samples in 10 will be within +1 of modal
pH	5.5-6.5	6.3	4	1 sample in 10 will be within +1 of modal

RECOMMENDED ACTION ITEMS

1. Determine need to add National Pasture & Hayland rating.

2. Determine need to add "Plant Association" designation.

3. Determine "toxic element" criteria and ratings with ARS, Animal, Plant Nutrition Laboratory, Ithaca, NY.

4. Send revised SOI-5 together with definitions of data added to SCS state staffs and to cooperators for review and comment.

5. Finalize revised SOI-5.

6. Meet with interpretations specialists & representatives of disciplines affected to "staff out" all recommended changes to 5.

7. Reprogram to accommodate revised SOI-5.

8. Provide option to retrieve brief series description on single phase interpretation sheet.

9. Provide option to retrieve forest volume in metric or English measure.

10. Enter added property values where possible into data base.

11. Establish inter-disciplinary regional NCSS conference soil interpretation committees and prepare criteria for interpretations of a regional nature as needed.

12. Send criteria for tillage, fencing, and unsurfaced roads to state staffs and to cooperators for review and comment for possible national use.

13. Finalize criteria for interpretations listed in item 6.

14. Establish a data base that lists all national and regional interpretations, provides the criteria for each, and enables a user to retrieve interpretations selected.

15. Write and insert a statement that explains the availability of computerized soil data bases in each soil survey to be published.

16. Clarify instructions for entering yield data for crop/fallow and multi-cropping systems.

17. Continue to develop an OSEDS data base format that enables retrieval of soil property and site data that can be linked with SOI-5 data.

18. Continue to test DBMS's for the most flexible and efficient system.

19. Establish a NCSS national committee to develop and recommend a soil property dependability scheme.

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DRAFT 12/80
MWNTC

TILLAGE

PROPERTY	LIMITS SLIGHT	 MODERATE	 SEVERE	RESTRICTIVE FEATURE
1. DEPTH TO HIGH WATER TABLE (FT)	>2 ---	1-2 ---	0-1 +	WETNESS PONDING
2. FLOODING	NONE, RARE	OCCAS	FREQ	FLOODING
3. USDA TEXTURE	---	CL, SICI	SIC, C	TOO CLAYEY
4. ORGANIC MATTER CONTENT (%)	>4	2-4	<2	CRUSTING
5. PERMEABILITY (IN/HR)(0-24")	w . 2	0.06-0.2	<0.06	PERCS SLOWLY
6. EROSION FACTOR (K x % SLOPE) (SURFACE LAYER)	<2	2-4	>4	ERODES EASILY
7. WIND ERODIBILITY GROUP	---	3, 4L	1, 2	SOIL BLOWING
8. SOIL COMPACTION				COMPACTION
9. SODIUM ADSORPTION RATIO (GREAT GROUP)			>12 (NATRIC)	EXCESS SODIUM
10. SALINITY (MMHOS/CM)	<4	6-S	>8	EXCESS SALT

UNSURFACED ROADS

PROPERTY	LIMITS SLIGHT	MODERATE	SEVERE	RESTRICTIVE FEATURE
1. PERMAFROST			ICE	PERMAFROST
2. DEPTH TO BEDROCK (in)				
HARD	>40 1/	20-40	<20	DEPTH TO ROCK
SOFT	>20	<20	-	
3. DEPTH TO CEMENTED PAN (in)				
THICK (>3")	>40	20-40	<20	CEMENTED PAN
THIN (<3")	>20	>20	-	
4. 2/ 3/ AASHTO GROUP INDEX NUMBER	0-4	5-8	>8	LOW STRENGTH
5. 2/ 4/ AASHTO	Class	A-4, A-5	A-6, A-7, A-8	LOW STRENGTH
6. WATER TABLE (in)	>60	40-60	<40	WETNESS
7. SLOPE	0-30	30-60	>60 1/	SLOPE
8. FLOODING	NONE PROTECTED	RARE	COMMON	FLOODS
9. POTENTIAL FROST ACTION	LOW MODERATE	HIGH		FROST ACTION
10. SHRINK-SWELL	LOW	MODERATE	HIGH	SHRINK-SWELL
11. 5/ Fraction>3 in (Wgt PCT)	<25	25-50	>50	LARGE STONES
12. 6/ USDA TEXTURE	-	SIL, SI, FSL, VFSL, L	-	DUSTY

1/ If slopes are such that hard bedrock is exposed during road excavation - reduce rating to moderate.

2/ Thickest horizon between 10 and 40 inches

3/ GIN = (F-35) [.2 + .005 (LL-40)] + 0.1 (F-15) (PI-10) where F=% pass #200 sieve. If F< 35 and PI> 10 use only part 2 of equation. Use median values.

4/ Use AASHTO classification only when group index is not known

5/ Weighted average to 40 inches

6/ Disregard unless soil is in TOR, ARID or XER suborders, great groups, or subgroups

Unsurfaced roads are those that normally lack surfacing and are expected to carry truck or other automobile traffic when free of snow. The roads consist of the underlying local soil material, or subgrade and the road surface of compacted local soil material, or gravel. The roads may be graded to shed water. Except for a gravel surface, the roads are constructed from the soil at hand.

SCS-SOILS-5
REV.
FILE CODE SOILS-12

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL INTERPRETATIONS RECORD

AGRONOMIC

UNIT NAME ____________________

UNIT MODIFIER ____________________

FOOTNOTE

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE

CROPHC	451	CLASS-DETERMINING PHASE	FERT CAP. CLAS	PRIME FARM LAND CODE	CAPABILITY							
	2											
	3				NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR
CROPS	341											
	2											
	3											
	4											
	5											
	6											
	7											
	8											
	351											
	2											
	3											

FOOTNOTE

YIELDS PER ACRE OF CROPS AND PASTURE

CROPHC	451	CLASS-DETERMINING PHASE									
	2										
	3		NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR
CROPS	341										
	2										
	3	SAME									
	4										
	5	CLASS									
	6										
	7	AS									
	8										
	9	ABOVE									
	351										
	2										
	3										

FOOTNOTE

YIELDS PER ACRE OF CROPS AND PASTURE

CROPHC	451	CLASS-DETERMINING PHASE									
	2										
	3		NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR
CROPS	341										
	2										
	3	SAME									
	4										
	5	CLASS									
	6										
	7	AS									
	8										
	9	ABOVE									
	351										
	2										
	3										

SCS-SOILS-5
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FILE CODE SOILS-12

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL INTERPRETATIONS RECORD

RANGE

UNIT NAME ____________
UNIT MODIFIER ____________

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND

		FOOTNOTE¹ COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS - DETERMINING PHASE & RANGE SITE #		
PHASE	401					
	2			RANGE SITE #	RANGE SITE #	RANGE SITE #
PLANT	411					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	421					
	2					
	3					
	4					
	5					
	6					
	3					
	4					
	5					
	6					
		POTENTIAL PRODUCTION (LBS./AC. DRY WT):				
PRODUC	431	FAVORABLE YEARS				
	2	NORMAL YEARS				
	3	UNFAVORABLE YEARS				

		FOOTNOTE¹ COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS - DETERMINING PHASE & RANGE SITE #		
PHASE	401					
	2			RANGE SITE #	RANGE SITE #	RANGE SITE #
PLANT	411	SAME COMMON PLANT NAMES AS ABOVE				
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	421					
	2					
	3					
	4					
	5					
	6					
	3					
	4					
	5					
	6					
		POTENTIAL PRODUCTION (LBS./AC. DRY WT):				
PRODUC	431	FAVORABLE YEARS				
	2	NORMAL YEARS				
	3	UNFAVORABLE YEARS				

SCS-SOILS-5
REV.
FILE CODE SOILS-[illegible]

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL INTERPRETATIONS RECORD

WILDLIFE & WINDBREAKS

UNIT NAME ____________

UNIT MODIFIER ____________

		FOOTNOTE	WILDLIFE HABITAT SUITABILITY					
		CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS					
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WILDLF	351							
	2							
	3							
	4							
	5							
	6							
		CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS					
WILDLF	351							
	2	SAME						
	3	CLASS						
	4	AS						
	5	ABOVE						
	6							

		FOOTNOTE	WINDBREAKS			
		CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT
WINDBR	351					
	2					
	3					
	4					
	5					
	6					
		CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT
WINDBR	351					
	2					
	3					
	4					
	5					
	6					
		CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT
WINDBR	351					
	2					
	3					
	4					
	5					
	6					

		SYM	FOOTNOTES
NOTES	451		
	2		
	3		
	4		
	5		
	6		
	7		
NOTES	451		
	2		
	3		
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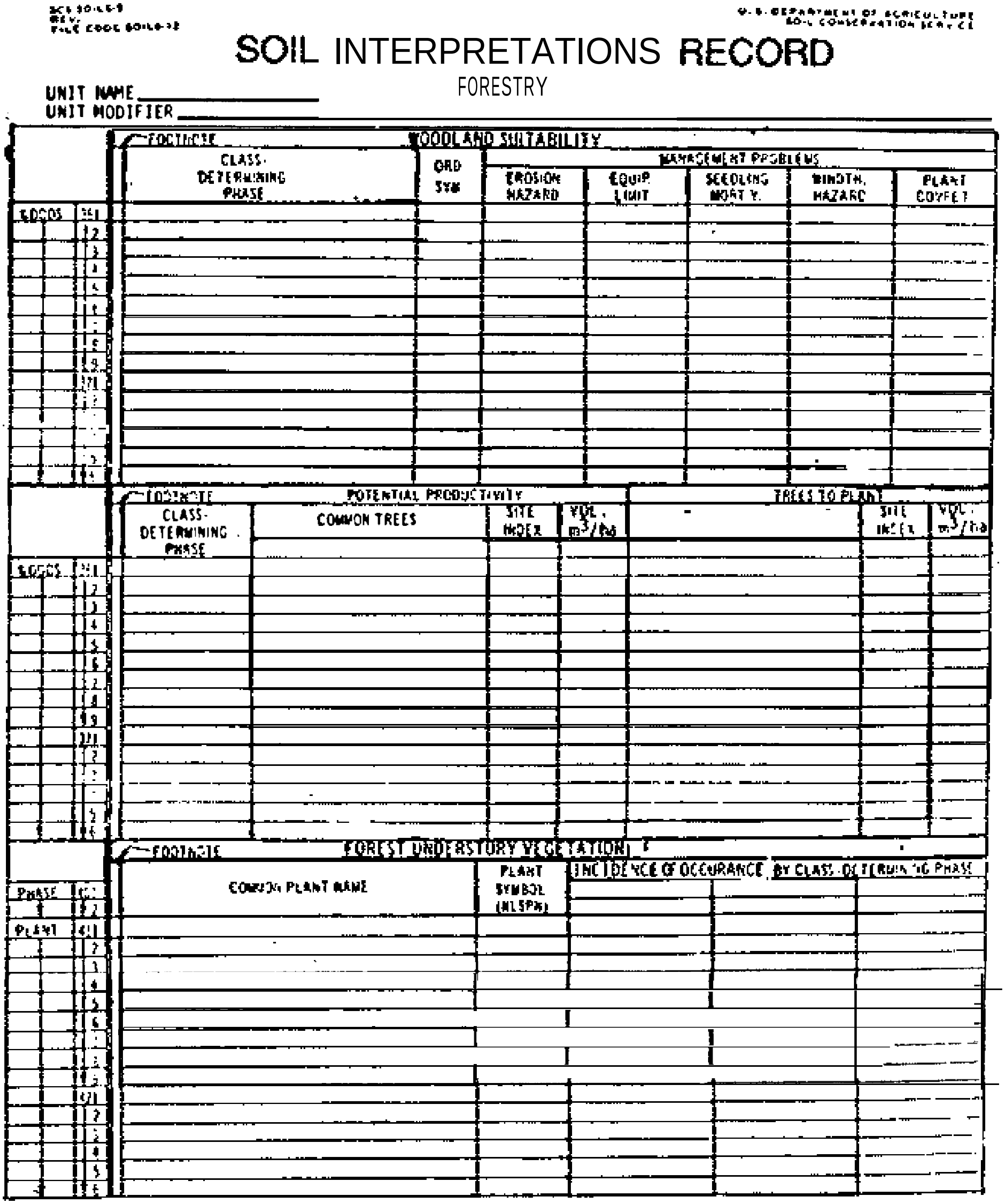
	5		
	6		
	7		



U. S. DEPARTMENT OF AGRICULTURE
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SOIL INTERPRETATIONS RECORD

FORESTRY

UNIT NAME ____________
UNIT MODIFIER ____________

WOODLAND SUITABILITY

FOOTNOTE

CLASS-DETERMINING PHASE	ORD SYM	EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.

(The last five columns stand under MANAGEMENT PROBLEMS.)

POTENTIAL PRODUCTIVITY

FOOTNOTE

CLASS-DETERMINING PHASE	COMMON TREES	SITE INDEX	VOL. m^3/ha

TREES TO PLANT

	SITE INDEX	VOL. m^3/ha

FOREST UNDERSTORY VEGETATION

FOOTNOTE

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	INCIDENCE OF OCCURANCE BY CLASS-DETERMINING PHASE		

PHASE

PLANT

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FILE CODE SOILS-12

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL INTERPRETATIONS RECORD

KEYING ONLY
RECORD NO.

010 UNIT NAME ____ MODIFIER ____
011 MLRA(S) ____ KIND OF UNIT ____
012 STATE ____ RECORD NO. ____ AUTHOR(S) ____ DATE ____ REVISED ☐
CLASSIFICATION AND BRIEF SOIL DESCRIPTION

022		
031		
2		
3		
4		
5		
3		

AN. AIR TEMP.	FROST FREE PD.	PRECIP.	ELEVATION	DRAINAGE	SLOPE RNG

ESTIMATED SOIL PROPERTIES

	DEPTH (IN)	USDA TEXTURE	FRACT. > 10 IN (PCT)	FRACT. 3-10 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3 IN. PASSING SIEVE				CLAY PCT OF < 2MM
					4	10	40	200	
041									
2									
3									
4									
5									
6									

	DEPTH (IN)	LIQUID LIMIT	PLASTICITY INDEX	UNIFIED	AASHTO GROUP CLASSIFICATION	GROUP INDEX	AVAILABLE WATER CAPACITY (IN/IN)
051	SAME DEPTH AS ABOVE						
2							
3							
4							
5							
6							

	DEPTH (IN)	MOIST BULK DENSITY (G/CM³)	ORGANIC MATTER (PCT)	SOIL REACTION (pH)	SALINITY (MMHOS/CM)	SAR ME/LTR	CEC ME/100g	$CaCO_3$ eq (PCT)	GYPSUM (PCT)
061	SAME DEPTH AS ABOVE								
2									
3									
4									
5									
6									

	NON GROWING SEASON FLOODING			HIGH WATER TABLE			BEDROCK	
	FREQUENCY	DURATION	MONTHS	DEPTH (FT)	KIND	MONTHS	DEPTH (IN)	THICKNESS
061								

	GROWING SEASON FLOODING			PONDING			CEMENTED PAN	
	FREQUENCY	DURATION	MONTHS	DEPTH (FT)	DURATION	MONTHS	DEPTH (IN)	HARDNESS
071								

SOIL RATINGS & GROUPS

	DEPTH (IN)	PERMEABILITY (IN/HR)	SHRINK-SWELL POTENTIAL	EROSION FACTORS		WIND EROD GROUP	CORROSIVITY		POTENTIAL FROST ACTION	SUBSIDENCE		HYD GRP
				K	T		STEEL	CONCRETE		INIT. IN	TOTAL IN	
081	SAME DEPTH AS ABOVE											
2							TOXICITY					
3							ELEMENT	RATING				
4												
5												
6												

FENCING

PROPERTY	LIMITS SLIGHT	MODERATE	SEVERE	RESTRICTIVE FEATURE
USDA Texture	-	-	ICE	PERMAFROST
FLOODING	NONE, RARE	OCCASIONAL	FREQUENT	FLOODS
DEPTH TO BEDROCK				
(in) HARD	>40	20-40	<20	DEPTH TO ROCK
SOFT	>20	10-20	<10	
DEPTH TO CEMENTED PAN				
(in) THICK	>40	20-40	<20	CEMENTED PAN
THIN	>20	10-20	<10	
1/ 2/FRACTION 3" (wt pct)	<25	25-50	>50	LARGE STONES
1/ 2/COARSE FRAGMENTS (wt pct)	<25	25-50	>50	SMALL STONES
3/ SHRINK-SWELL	-		HIGH	SHRINK-SWELL
DEPTH TO HIGH WATER TABLE (ft)	>2.0	1.0-2.0	<1.0 +	WETNESS PONDING
SLOPE	<30	30-60	>60	SLOPES
1/ 4/USDA TEXTURE	-	LCOS,LS,LFS,LVFS	COS,S,FS,VFS	TOO SANDY
POTENTIAL FROST ACTION	-	HIGH	-	FROST ACTION
SALINITY (mmhos/cm)	-	>8	-	EXCESS SALT
SOIL REACTION (pH)	-	0.5	-	TOO ACID

1/ Weighted average to 24 inches.
2/ Sum (100 - % passing No. 10 sieve) and fraction 3 in. Use dominant condition for restrictive feature.
3/ Thickest horizon between 0 to 24 inches; if less than 12 inches thick rate moderate.
4/ If soil occurs in udic or aquic moisture regimes, rate one class better if experience confirms.

Fencing is the construction and maintenance of barriers that facilitate the management of animals. The barriers are constructed of metal, or treated or untreated wooden posts buried at least two (2) feet into the soil with at least three (3) wires suspended between the post, but more commonly five (5) wires.

The ratings are based on the soil properties that influence ease of setting posts in the soil to the desired depth, maintaining the desired wire tension, and keeping replacement and maintenance cost to a minimum over the projected life of the fence. Excavations for wooden post holes are commonly made by power auger, while metal posts are driven into the soil. Depth to bedrock and cemented pan, and large and small stones, influence the ease of excavation of post holes and driving posts. Flooding and depth to high water table may restrict the season in which the fence can be constructed. Flooding can also influence maintenance and replacement cost. Depth to high water can influence maintenance cost and require deeper post settings to offset the soil's low strength when saturated. Shrink-swell characteristics of the soil will require deeper post settings or rock-jacks to maintain vertical post alignment. Permanently frozen soil may lose its insulation qualities when setting posts and result in thermokarst topography. Post alignment and desired wire tension is often difficult to obtain on sandy soils due to their in-place low strength. Maintenance can also be a problem due to soil blowing. Frost action characteristics of the soil may result in frost-heaving of the posts. Slope influences the ease of using power augers and transport of supplies. It can also result in surface creep during wetter seasons such as the spring snow melt period. Soil reaction and salinity will influence the type of post used and maintenance cost due to corrosivity.

Soil map units that contain more than 20 percent rock outcrops should be rated SEVERE.

*U.S. GOVERNMENT PRINTING OFFICE: 1988--523-709/D6682

NATIONAL COOPERATIVE SOIL SURVEY

Soil Survey Conference Proceedings

Washington, D.C.
March 28 - April 1, 1983

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Dick Kover	Head Soils Staff	SCS - Portland, OR
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Marc Latham	Soil Scientist	Paris, France
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Name	Title	Agency
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A. J. Smith	Director, Land Resources Development Center	United Kingdom
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James Stone	Soil Scientist	BLM - Denver, CO
Bob Swenson	State Conservationist	SCS - Huron, SD
Charles Tarnocai	Soil Correlation Univ. of Illinois	Ottawa, Canada
Charles M. Thompson	State Soil Scientist	scs - Temple, TX
Marty Townsend	BLM State Soil Scientist	California
Larry P. Wilding	Professor, Texas A&M University	College Station, TX
Keith K. Young	Soil Info. Systems	SCS - Washington, DC

NATIONAL WORK-PLANNING CONFERENCE
AGENDA

National 4-H Center

Monday, March 28 — Chairman. Richard W. Arnold

10:00 - 12:00	Registration
12:00 - 1:00	Lunch
1:00 - 2:00	Welcome and Introduction
2:00 - 3:00	Standing Committee Reports Moisture in Soils - Bob Grossman Confidence Limits - Larry Wilding
3:00 - 4:00	Lead Speaker, Neil Sampson Executive Vice President, NACD
4:00 - 5:00	Lead Speaker, Lee Shields Assistant Director, Public Information, SCS

Tuesday, March 29 — Chairman, Kenneth C. Hinkley

8:30 - 9:00	Invited Guests
9:00 - 9:30	Ground Penetrating Radar - Jim Doolittle, SCS Gainesville, Florida
9:30 - 10:30	Lead Speaker, Rich Duesterhaus Assistant Chief, Midwest, SCS
10:30 - 11:00	Coffee Break
11:00 - 12:00	Lead Speaker, Stan Buol Professor of Soil Science, NCSU
12:00 - 1:00	Lunch
1:00 - 3:00	Group Discussions Group 1 - National Geographical Data Bases Bill Reybold, Chairman Group 4 - Soil Taxonomy-Soil Fertility Dick Rust, Chairman
3:00 - 3:30	Coffee Break
3:30 - 5:30	Group 3 - Update Strategy Ted Miller, Chairman Group 2 - NCSS Image Billy Harris, Chairman

Wednesday, March 30	Chairman, Donald E. McCormack
8:30 - 10:30	Technical Committee Meetings
	Soil Taxonomy Richard, Guthrie, Chairman
	Land Capability Dick Johnson, Chairman
10:30 - 11:00	Coffee Break
11:00 - 12:00	International Activities
	Technical Committee Discussion Soils-5, Dick Kover, Chairman
1:00 - 4:30	Field Trip
Thursday, March 31	Chairman, Richard L. Guthrie
8:30 - 9:30	International Activities
	Soils- 5's continued
9:30 - 10:00	Coffee Break
10:00 - 12:00	Technical Committee Discussions
	Soil Interpretations Joe Nichols, Chairman
	Horizon Designations Richard Fenwick, Chairman
1:30 - 4:30	Issue Committee Reports (45 minutes each) (Discussion Groups)
	National Geographic Data Bases NCSS Image Update Strategy Soil Taxonomy Soil Fertility

Friday, April 1	Chairman, William U. Reybold
8:00 - 11:00	Technical Committee Reports (30 minutes each)
	Soil Taxonomy Land Capability Soil Interpretations Soils-5's Horizon Designations
11:00-12:00	Business Meeting
1:00- 4:00	Steering Committee Meeting

National Work Planning Conference
International Activities
Chairman - Richard Guthrie
Thursday, March 31

Agenda

0800-0815 Recent Developments in the French Classification
-- Marc Latham

0815-0830 Soils Studies of LRD
-- Tony Smythe

0830-0845 Soil Survey Program in New Zealand
-- Ben Clayden

0845-0900 Cold Soils
-- Charles Tarnocai and John Day

0900-0930 SCS International Soils Program
-- Chick Fenwick

Opening Remarks
1983 National Soil Survey Conference
Ralph J. McCracken [1]

We welcome you to Washington and the 1983 version of the Biennial National Soil Survey Conference! We extend a special welcome to those who have come from other countries to participate with us. We continually emphasize that this is a cooperative soil survey program we are discussing--therefore, each of you should feel entirely free to participate and contribute fully.

First, I'll review some events and changes since the last conference two years ago.

With sadness and a real sense of loss we note the passing of Guy D. Smith, the chief architect of Soil Taxonomy. A special symposium on Soil Taxonomy was held during the Soil Science Society of America meetings last December to honor Guy Smith, as many of you are aware. During this symposium, several speakers cited statements from his writings to the effect that a soil classification system must be dynamic and change as new information is obtained, and that we should not allow ourselves to become prisoners of our own Taxonomy. In fact, Guy Smith was among the first to propose significant revisions in Soil Taxonomy after it was published. We must keep Guy Smith's cautions and concerns well In mind- and be ready to review and follow-up promptly proposed revisions and additions to Soil Taxonomy, especially those that are well fortified with useful data and background information. I'm pleased to report that in the Soil Conservation Service we are putting in place additional procedures for accelerating the discussion, revision, and implementation of changes in Soil Taxonomy.

I am also pleased to note the excellent Regional Soil Survey Conferences which have been held in the last year. I was able to attend two of them, and was impressed with the useful committee and workgroup activities and the truly cooperative attitudes displayed. My only concern is that there be more communication and coordination among these regional activities (some of you have been working on this) and that the regional groups become more actively involved in proposing and evaluating adjustments in Soil Taxonomy.

I am also pleased to be able to report the renewal of the Soil Science Institute for mid-career professional development and refreshment of our field soil scientists. Cornell University managed, in excellent fashion, the 4-week course held this year after several years without this important and useful program.

We continue to emphasize in SCS the importance of establishing and maintaining parallel priorities for the soil survey: "project mapping" to complete the soil surveys of our croplands on a high priority basis and for completion of the national soil survey "once-over", and "basic soil services" for interpretations of soil surveys for the benefit of the many

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[1] Deputy Chief for Natural Resource Assessments, Soil Conservation Service.

users. It is encouraging to note that the support of soil surveys by state agencies and local governments continues to grow-now exceeding more than $10 million per year!

The SCS budget for soil surveys has been increased during a period of well-placed concerns about Federal expenditures, testifying to the high degree of importance and priority attached to soil surveys by our agricultural administration and by the Congress. For example, the Fiscal Year (FY) 1979 SCS budget for soil surveys was $44.8 million; the FY 1984 Executive Budget proposes $52.3 million in support of the soil survey. We should work even more diligently to ensure that the soil survey is working in highest priority activities and is as effective as possible to justify the strong vote of confidence in soil survey displayed in this funding support.

We note the recent rapidly accelerating use of digitized soil maps by a number of agencies and organizations and the increasing usage of our SOILS-S and Pedon Date Record Data Bases as symptoms of increased interests in and support of soil survey.

Let's now turn to recent developments outside the National Coopertive Soil Survey which will have impact on it:

The National Soil and Water Conservation Program, based on the RCA Appraisal and the National Resources Inventory, was sent to the Congress on December 21, 1982 by the President. It states top conservation priorities as being erosion control, upstream flood damage reduction and water conservation. Federally supported conservation programs, including supporting programs like the soil survey, are expected to redirect resources to give more emphasis to these national priorities.

The concern about impacts of soil erosion on crop yields continues to grow, in consideration of future food supplies and costs and our future agricultural export capability. In the soil survey we must give even more attention to the collecting and synthesis of solid information about crop yields on eroded and uneroded soils, and about the vulnerability of soils to erosion.

Turning now to matters needing increased attention internally within the National Cooperative Soil Survey:

We see the need for additional emphasis and studies on spatial variability of soil mapping units so that we can give soil survey users a clearer picture of what they may expect to find in them. Qualitative estimates or generalized statements about nature and extent of inclusions no longer are sufficient--we "we the users more definitive information.

A matter of prime importance and high priority is the updating and revision of Soil Taxonomy. Several significant recommendations for changes have been made, and more will be forthcoming as more information becomes available. We must be ready to consider these recommendations and make indicated adjustments in Soil Taxonomy promptly, after appropriate dialogue and discussion has taken place.

Soil scientists have many other opportunities to make significant contributions such as further development of soil potentials as guides to soil survey users, ensuring adequate soil survey data input for the various erosion-productivity simulation models now being developed such as EPIC and ALMANAC, and ensuring soil survey input and usage in land use and planning decisions.

Therefore it should be obvious that this National Soil Survey Conference is an important activity and that your best efforts and thoughts will be needed during these sessions and the subsequent follow-up “back home”.

SUMMARY OF COMMENTS MADE BY
BOB SWENSON, STATE CONSERVATIONIST
AT THE BUSINESS MEETING, NCSS PLANNING CONFERENCE
April 1, 1983

1. This meeting has provided me with reassurance that the evolution of the National Cooperative Soil Survey is being handled properly.

2. After the "once-over survey," the use of soil survey resource data will, continue -- who will gather it? Who will define it, refine it, interpret and perhaps present it? The soil scientist will.

3. Improvements are needed in the use of the soil survey itself. People should be trained In its use or the material should be modified as necessary.

4. It was a pleasure to see a draft policy on digitizing. Federal, state and local plans will be aided by this.

5. There was discussion on "a computer in every office for the storage and retrieval of information." Data must be available for a number of users. ASCS and FmHA are two agencies that may need more specificity for their purposes.

6. National geographic data base. Correlation of information across state lines must be started.

7. Update strategy: It is extremely important that basic soil services are blended so that funds and personnel are properly used.

8. International activities. It was a pleasure to learn of several of the ongoing activities as presented by representatives from other countries.

9. Image of NCSS. This is an important part of planning the future. I am looking at the people who must plan this. We can do a great deal in each state, but we may need a central, dominant theme set forth, as a paragraph or two of written material from this group as a basis.

10. Working arrangements/working together. Where there are problems, we'll need to take action to solve them. Our lives are too short to waste with conflict.

11. This is obviously the only opportunity I will have to express my respect and thanks to all of you for your efforts.

NATIONAL COOPERATIVE SOIL SURVEY CONFERENCE
WASHINGTON, D.C. MARCH, 1983

NATIONAL GEOGRAPHIC SOIL DATA BASE COMMITTEE REPORT
MARCH 31, 1983

INTRODUCTION

A national geographic resource data base is desirable to improve access to and integration and use of resource data. It can be strongly argued that the soil resource provides the unifying framework from which scientific understanding, use, and management of natural resources can be realized. A Geographic Soil Data Base (GSDB) could be the key to establishing a nationally consistent geographic resource data base. The sanction to investigate the establishment of a GSDB is based on the National Cooperative Soil Survey (NCSS) responsibility to improve the quality of life through informed soil management.

The NCSS formed the National Geographic Soil Data Base Committee to investigate and report on (1) needs and objectives, (2) criteria, (3) information and strategy for assembling, (4) operation procedure, (5) products, and (6) quality control of a GSDB. This report describes the committee findings. The plan of work the committee used to prepare the report is Attachment 1.

CHARGES AND RESPONSES

Charge 1 - Determine the need for a GSDB and establish data base objectives.

Need

E-following needs for a GSDB have been identified:

- To efficiently interface soil survey data geographically with other geographic resource data as an aid in resource planning, management, and monitoring at national, regional, state, and local levels.

- To assemble geographically oriented data on natural and cultural yield potentials of soils to be used in market and transportation planning, commodity planning and development, service industry planning and development, and world food policy development.

- To provide easily accessible soil survey data for national and regional resource program evaluation and analyses.

- To document the behavior of soil over large areas and improve our understanding of the soil resource.

Objectives

The following objectives are recommended for a GSDB:

- To provide an efficient computer assisted method for storing, manipulating, retrieving, and displaying spatially-referenced soil data in map and tabular form with the capability to interface the soil data with other spatially-referenced resource and demographic data.

- To assure maximum use of soil survey information in the data base by providing for public access to the soil data via computer terminals, printers, and plotters in national, regional, state and local agency offices.

Charge 2 - Determine the nature of a data base and data base specifications that would best achieve the objective of a GSDB.

It is recommended the GSDB consist of three distinct data bases:

- Soil Survey Geographic Data Base (SSURGO)
- State Soil Association Geographic Data Base (STATSGO)
- National Major Land Resource Area Geographic Data Base (NATSGO)

SSURGO
The Soil Survey Geographic Data Base, presently being developed, is a collection of separate nonintegrated soil survey area geographic data bases. This data base is used to assist farm and ranch conservation planning, and county and multicounty resource planning and management.

Standards and specifications for the soil maps to be digitized are those given in the National Soils Handbook for soil survey maps. The standards and specifications for data to be digitized, accuracy, coordinate values, and magnetic tape requirements for the necessary data files are those given in the National Cartographic Manual for line-segment and cell digitizing methods.

STATSGO
The State Soil Association Geographic Data Base would comprise a collection of integrated state general soil maps. This data base would be used to assist-in multicounty, state, and regional resource planning, management, and monitoring.

Proposed standards and specifications for state soil association maps to be digitized are Attachment 2. Map sheets of the USGS 1:500,000 map series, suggested as the map base do not match well from state to state, and many of the state maps are too large to digitize as a single map sheet. Additional investigation is needed to determine the advantages and disadvantages of using the USGS 1:250,000 map series as the map base for STATSGO. The proposed standards and specifications for digitizing are Attachment 3.

NATSGO
Thetional Major Land Resource Area Geographic Data Base consists of the digitized 1:7,500,000 Major Land Resource Area (MLRA) map. This data base is used to assist in regional and national resource planning, management and monitoring, and program evaluation and analyses.

The 1:7,500,000 MLRA map was compiled from 1:500,000 state land resource area maps prepared using standards and specifications in Soils Memorandum SCS-33, August 14, 1961, and SCS Advisory LIM-7, June 19, 1975, no longer in effect. Proposed standards and specifications for MLRA maps are Attachment 4. The standards and specifications for digitizing are those given in the National Cartographic Manual.

Charge 3 - Determine the information needed in the data base and the strategy for assembling it.

Information Needed

- Digitized map unit delineations,
- Acreage of each map unit,
- Proportionate extent of components by map unit, and
- Soil properties of each component.

Strategy For Assembling

The following strategy is recommended for assembling the information:

Digitized map unit delineations----

Digitized map unit delineations for SSURGO are currently being assembled for individual soil survey areas in line-segment or cell modes. Assembly should continue following proposed SCS national soil map digitizing policy in Attachment 5.

It is recommended that state general soil maps be prepared over a period of 3 years and the map units there on be digitized for STATSGO. Preparation of these maps would involve in part the revision of existing maps and in part the compilation of new maps, in both instances using standards and specifications in Attachment 2, for which approval is pending.

Map unit delineations on the national MLRA map have been digitized for NATSGO.

Acreage of each map unit ----

Acreage of each map unit for the 3 geographic soil data bases is assembled by data processing as the maps are digitized and would be maintained as separate data files for each of the respective data bases.

Proportionate extent of each map unit ----

Proportionate extent of components by map unit for SSURGO are assembled in the Map Unit Use File (MUUF). 1/

1/ The MUUF contains map unit name publication symbol, acres, county, date correlated, MLRA, component and percent of unit, interpretation record number, and other data for over 1,600 correlated survey areas. Form SCS-SOI-6 is used to enter data in the MUUF.

The proposed method for assembling map unit component data for STATSGO is to complete map un't records, Form SCS-SOI-6 for each map unit. It is suggested that components should characterize at least 75 percent of the map unit. As many as seven SCS-SOI-6 forms, accommodating 21 map unit components, could be used. Each component would be assigned a soil interpretation record, Form SCS-SOI-5 number so it could be linked with the soil property data in the Soil Interpretation Record data base. Where 21 components do not account for 75 percent of the unit, similar soils could be grouped, the proportionate extent combined, and the dominant soil used to provide the interpretation record number for the component. A file would need to be created to store this data.

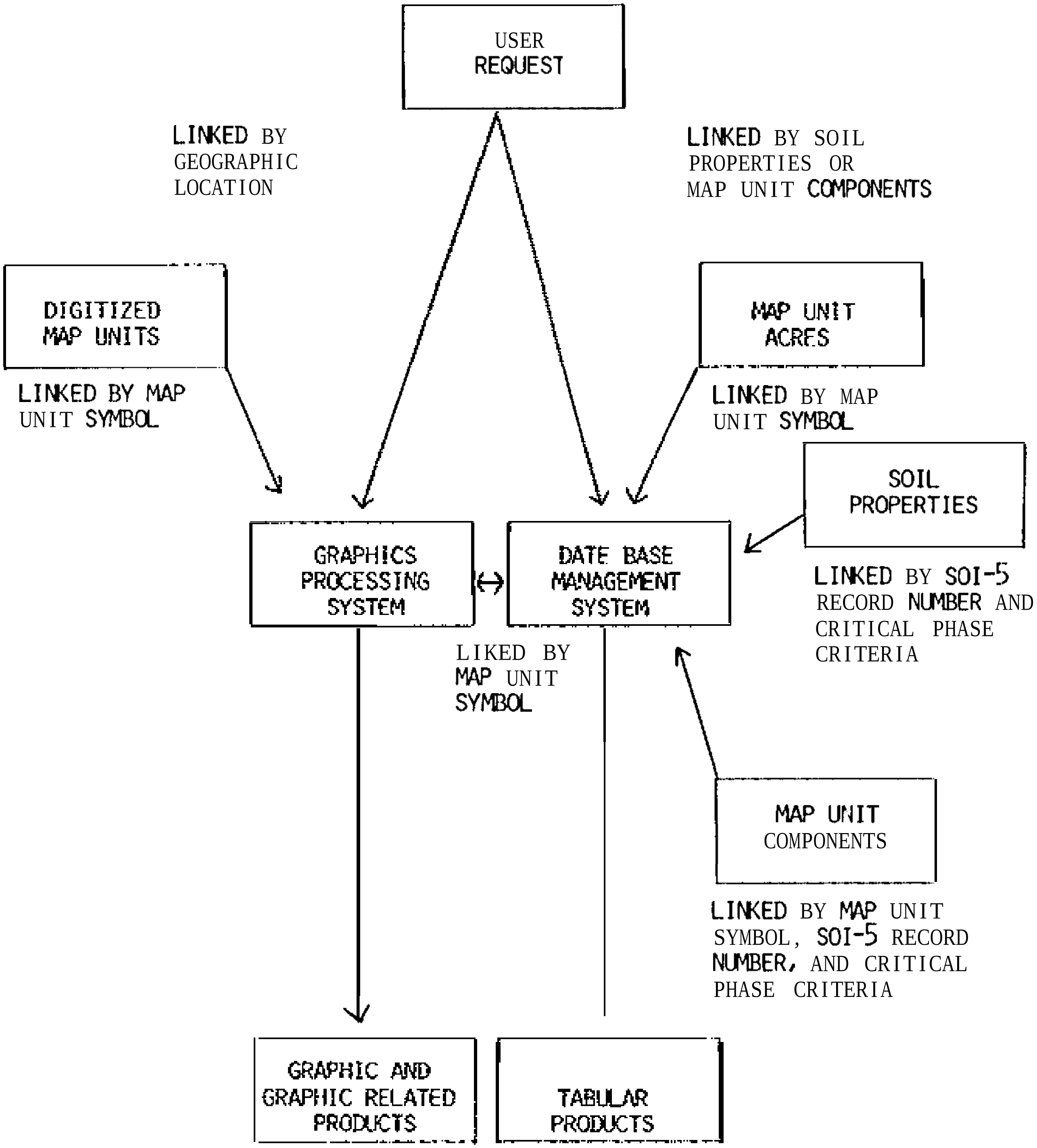
The proposed method for assembling map unit component data for NATSGO is through use of data collectad for the 1982 National Resource Inventory (NRI) 2/. Map units identified in the NRI have been assigned a MLRA and can be expanded statistically to provide map unit composition. Soil interpretation record numbers have been assigned each component so the component can be linked with the soil property data in the Soil Interpretation Record data base. The number of components in the NATSGO data base could be unlimited as the computer could aggregate them based on soil properties of each component and soil property criteria used for a desired interpretation. A file would need to be created to store map unit component data in NATSGO.

Soil properties of each component ----
The soil property data is in the existing Soil Interpretation Records data base.

Charge 4 - Suggest data base operation procedure to satisfy needs and provide information from a national perspective such as status, extent, and expected behavior of soils.

2/ The 1982 NRI used randomly selected sample areas to provide statistical data for non-Federal lands in each state. Soil phase was one of the many data elements collected bv field oersonnel. Data collected is statisticallv significant for state "parts of MLRA's.

The data base operation illustrated below is recommended. A data base management system needs to be established to efficiently store, manipulate, and retrieve the data.



Charge 5 - Suggest products that display data base information such as small scale maps. Provide criteria for small scale maps.

It is recommended that final products from STATSGO and NATSGO take the form of small scale maps, tables, and statistical data. Maps will be generated in line-segment or cell form. Map scale will range from 1:250,000 to 1:20,000,000. Map products will use standard USGS map bases. Map features such as type and borders will be produced from the automated management mapping system.

SCS has equipment that can generate maps using various patterns of black and white cross hatching to identify map units on interpretive maps as well as equipment that will generate "open window" negatives so color maps can be produced without additional cartographic effort.

Final products from SSURGO would be similar to STATSGO and NATSGO except it is recommended SSURGO would be available in local SCS field offices via micro-computers. The computer would display soil maps for ownership tracts. Economic, crop system, and soil management programs would be provided to assist conservation planning decisions for the ownership tract. Interpretive maps would be printed using plotting equipment peripheral to the microcomputer.

Charge 6 - Suggest how quality should be controlled if a GSDB were established.

It is recommended that quality of a GSDB be controlled by:

- Adhering to the standards and specifications identified or described in this committee report.

- Establishing a data base management system.

- Providing user documentation, including a GSDB dictionary and glossary of terms.

- Providing for training programs within SCS to insure the SCS staff can effectively utilize the system and can provide assistance (liaison) to those "outside" the agency interested in gaining access to and utilizing the data base. Such training programs also should be integrated into undergraduate soil science curricula to insure the potential pool of SCS employees has a strong foundation in computer science and data base management activities related to soil resources.

- Establishing a rigorous "feedback" mechanism so that problems encountered in the data base can be efficiently remedied by the data base management staff.

- Assigning responsibility for coordination of GSDB inquiries, use, and feedback response at the state level.

- Establishing a systematic procedure for updating the GSDB.

SUMMARY AND RECOMMENDED PRIORITIES

Summary of Standards and Specifications For Soil Maps and Map Digitizing Necessary for a GSDB

	Data Base		
	SSURGO	STATSGO	NATSGO
Soil Map	Approved	Draft	Approved
Map Digitizing	Approved	Draft	Approved

Summary of Data Files Necessary For a GSDB

	Data Base		
Data File	SSURGO	STATSGO	NATSGO
Digitized map units	Established	Proposed	Established
Map unit acres	Established	Proposed	Established
Map unit components	Established	Proposed	Proposed
Soil properties	Established	Established	Established

Summary of File Management Software Necessary for a GSDB

	Data Base		
Software	SSURGO	STATSGO	NATSGO
Data base management system	Proposed	Proposed	Proposed
Graphics processing system	Proposed	Proposed	Proposed

Recommended Priorities for Establishing a GSDB

1. Obtain approval of draft SCS soil map digitizing policy and digitize soil survey maps accordingly.
2. Establish a data base management system and graphics processing system for the GSDB.
3. Establish a map unit components file for NATSGO using 1982 NRI data to determine components and their extent.
4. Prepare user documentation and a GSDB dictionary.
5. Prepare and implement a user training program.
6. Establish a systematic procedure for identifying user problems with the GSDB and for updating the data base.
7. Prepare and place in operation a data base management system and graphics processing system using micro computers for local offices where digitized soil survey maps are available.
8. Obtain approval of standards and specifications for state soil association maps and for digitizing the maps.
9. Prepare state soil association maps.
10. Establish a map unit components file for STATSGO.
11. Digitize state soil association maps.

The committee recommends a formal structure be developed within USDA to coordinate consistency among soil data sets, soil data values, and soil aggregation structures used by the various agencies in their modeling, analyses, and evaluation programs to help improve the credibility of all soil survey data bases and the image of NCSS.

COMMITTEE MEMBERS

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GEOGRAPHIC DATA BASES -- A USER'S VIEW

Soil science -- just like every other science -- is going through an incredible revolution today. This is not, it seems to me, a revolution in scientific facts or principles, but a revolution in tools and technologies available for recording, storing, analysing, and using the scientific facts that you discover and record. The key to this, of course, is the computer, and the incredible capacity and speed it brings to the task of storing and manipulating information.

Computers are nothing new. You have been using them for years, and every young scientist has been educated in computer use at the same time as he or she has been taught the use of the other tools of the scientific trade. What, is new, however, and of tremendous importance to you and your work, is the amazing speed with which high-capacity computers have become low--priced enough to be available as an every-day working tool.

Today's micro-computer brings the benefits of large databases, graphics capability, and a host of other capabilities to virtually everyone. The paper I am using today, for example, war; composed on a microcomputer that weighs 24 pounds, folds up like a brief case, and costs under $2000 complete with a wide array of software. Yet it has a memory capacity of 64 K and a disk capacity of almost 400 K -- which makes it the equivalent, in many ways, of the huge mainframe computers we were using on college campuses not. too many years ago.

And it will be obsolete in a matter of months.

It will be replaced by machines that are smaller, have more memory, process information faster-, and cost less.

What does all. this mean to the soil scientist, and to the soil survey program? I think it means a great deal.

It means that. there will be many more users who can take advantage of the data you develop. If you convert and store your data in readily accessible digital form, and if you work with users to develop appropriate software to retrieve and manipulate that data, you will. find that soils information will become more and more valuable to a wider and wider variety of decisionmakers.

Don't take me wrong, however, for I don't want to make this transformation sound too easy. It will not be. It is going to take a tremendous amount of work, and some very good decisions at critical points in the process. With the whole technology changing so rapidly , there are too many good ways to make a poor decision and find your whole program going up a blind alley while the rest. of the world continues up another path.

Notes presented by Neil Sampson, Executive Vice President, NACD, at the National Cooperative Soil Survey Conference, Washington, D.C., March 28,1983.

I'd like to share some of my insights on this matter with you today, and I need to tell you at the outset that I do that with some reluctance. I am not a computer expert -- I was educated too long ago. I have owned my own personal computer for the past year, and am slowly learning its intricacies, but I am far from an expert.

I'm also not a soils expert, even though my degree was taken in soil science. It has been too long, and the situation has changed too much.

But I have spent the past few years trying to interpret soil and land data, trying to help devise means of assisting in land use and management decisions, and trying to help conservation districts and the technicians that serve them at the local level come to grips with the new demands that face them. In that whole process, one can hardly fail to form some opinions.

First, let me caution you about being too tied to centralized computer systems and data bases. I think we all thought, a few years back, that the future would be one in which there was a huge central mainframe that we could all access through a terminal on our desk. Those systems do, in fact, exist today and work like a charm for many things. They do a great job of booking airline seats, for example. Until they break down.

What the microcomputer has done, however, is convert that individual work station from a dumb terminal tied to the whims of the mainframe into a free-standing computer that can reach into the mainframe, pull out some data, then work independently. This will greatly enhance the utility of this technology while, at the same time, reducing costs.

What this suggests is that we have to pay attention to the needs of these microcomputers, both in terms of the ways in which the data is stored and the software needed to bring it out and work with it.

It may also be necessary to stay open for innovation in the ways that you get soils data ready for computer storage. I have had only brief exposure to digitizing methods, plotting boards, and the like. But the other day I saw a demonstration where a private consultant claimed to have developed a method of converting a soils map to digital format by simply scanning the map with a videotape camera, then converting the digitized image from the videotape to computer storage.

I don't know the first thing about the process, but my immediate reaction was that it sounded both technically feasible and a tremendous cost-cutter in converting existing maps to digital form. No doubt such a process was not available just a few months ago when you were establishing your methods, but what if it is feasible today? Can you stay flexible enough to take advantage of it?

The by-word in this whole business is that it will probably be completely revolutionized at least once a year for the next few years. In some ways that will make your job easier, but in many ways it will make it more challenging and difficult. It is not too heartening to find yourself halfway through a program and see that it is already outmoded. My guess, however, is that this is the nature of this beast.

Finally, lets never forget why we do all this. We do it so that our information will be of maximum value to users. That makes us stop and think about who those users might be, and what they will need, and when and how they will need it.

There is little doubt in my mind that the future will see a microcomputer in every conservation district office, owned by either the district or the SCS. It will be used, primarily, for the following functions:

Word processing

Record keeping

Transmission of data between offices

Those uses are available today, with off-the-shelf software and a wide variety of affordable computer/printer/modem combinations. At the cost, it is easy to justify an office computer if these were the only functions planned.

But the real future lies beyond. That same computer outfit, with some added software and access to geographic data bases, can become a powerful planning tool that will greatly extend the capability of tomorrow's soil conservation technician.

With the soils data for a farm and a set of farm budgets, a relatively straight-forward planning program can show the conservationist -- and the farmer -- both the soil loss and the economic implications of any combination of conservation practices within reason. This ability to compare a wide variety of options, and display their differences in quantitative terms, will revolutionize conservation planning.

That same type of program, given the necessary inputs, can help a community evaluate the effect of a new development -- or a decision to reject a development proposal. Having soils and other resource information, plus being a trained planner, has already made SCS people widely sought-after in rural communities facing development pressures. It seems almost trite to predict that access to a small computer and the skill to use it will increase that demand.

Again, however, I want to issue some cautions. Learning how to run one of these machines sounds easy when you listen to the salesman, or to the person who already is an expert. But don't be misled.

A farmer- friend tells the story about a farmer- who bought a personal computer to make his farm more efficient, then let the farm go to pieces because he was spending all his time learning how to run the computer.

That sounds funny, but it isn't. I have been going through something like that at NACD. We have purchased a new microcomputer for our Conservation Tillage Information Center, and it has been far harder, and slower, to get it working than I had ever anticipated. First the machines don't come on time, then the software doesn't work, and all the people have to get accustomed to the new machine, and on and on. We are going to get there, but some days I wonder when.

We took on the task of learning how to incorporate microcomputers in the Tillage Information Center for two reasons. The first, and most important, is that we could see no other way to handle the amount of data involved in such a project.

The second reason may have more application to you, however. The second reason is that we feel that NRCD needs to become proficient in computer technology so that we can assist conservation districts and the people who serve them in learning and using this new technology. We figured that if our people weren't familiar with the technology, they would be of little use to the people in the field who had questions.

I expect we will take the same approach to helping spread computer technology that we are taking in helping spread conservation tillage. We won't try to be experts, we'll try to be the clearinghouse that helps bring experts together.

Just as one example: I was in a conservation district not long ago where a district engineer was finishing up a program to analyse irrigation system efficiency. He was doing it on an Apple II, and it looked like a real winner. I don't know if it is fully finished yet, but I would suspect it is.

Last week a district official complained to me that his district had purchased an Apple II, but didn't seem to be getting the use out of it that he thought they should. Could that first district, with the good programs already developed, have something that would be of value to the second? I suspect so, but we won't know until we get some way in which they can talk to each other. Right now, neither knows the other exists. We think one of the functions of a national organization like ours is to help these people find each other, so we are studying ways to begin that process.

We are also working closely with the SCS Washington office to find ways for these local programs to use the data bases being developed by the soil survey program, the inventory and monitoring program, and the many other data programs available to you today. We are also talking with other national organizations, including some that are developing software programs that plan forest management, fertilizer application efficiency, and a host of other farm management applications. Other federal agencies such as Extension are doing a great deal, and there are some of the Land Grant Colleges that are way down the road on this.

It is certain that all we see is just the tip of the iceberg on this situation at this time. But I find it greatly exciting and challenging, and of tremendous importance to the future of the soil survey program.

I know you will continue the outstanding leadership in natural resource data gathering that has characterized the soil survey program from its beginnings. You are the custodians of a pr-crud tradition -- this new technology will make you more even more effective in the future, if you address it constructively, aggressively, and positively.

KEEPING
"COOPERATIVE"
IN THE NATIONAL SOIL SURVEY

Just my luck--to be sandwiched between Neil Sampson and the happy hour, with a bunch of prewritten material.

I wasn't sure whether I wanted to talk with you as an information person, as a membership chairman, or as a long-time advocate of responsiveness in government. Dick Arnold didn't say. ..so forgive me if I blend those three hats this afternoon.

I want to talk about:

-- developing soils information that is useable and explainable;

-- what to do with it after you've got it;

-- blending it with other data or other concerns; and

-- working together.

I haven't mentioned image, a concern of one of your committees, because I think image comes from doing good things and telling people about them in a way that gives credit where credit is due without over-dueing it. We can't afford to spend much money or time on image.

Our country's need for soils information--and our ability to supply it--is changing rapidly because of a number of factors:

First, money and staffing constraints have been serious, and will be for a while. The Office of Management and Budget has put the clamps on Federal publications programs, among other things. You and I might argue that all the moratoria, reports and witchhunts for wasteful, frivolous publications cost much more than the first round of savings.

Nonetheless, it isn't easy to explain some of the things you find, such as "The Adventures of Clearabelle Raindrop" or hundreds of skids of soil surveys which nobody has asked a legislator to provide.

More important, having to question the way you do business once in a while is a healthful thing--you discover some better ways of doing the job at less cost and fewer headaches. We need to dare to be bold!

Remarks by Lee B. Shields, Assistant Director, Public Information Staff, USDA-SCS, at the National Soil Survey Work-Planning Conference, Washington, D.C., March 28, 1983.

Example: Every spring for years we have published a listing of available soil surveys, We used to typeset the whole thing every year. Then somebody got the idea of setting only the introductory material, and just copying the printout for the rest. It got out sooner, cost less, and was almost as easy to read. It still was two or three months out of date when it hit the streets, and got older from there.

We're working now in three ways to improve the process: Running the stuff out on a laser printer so it's almost letterpress quality; making the file easier to update more often; and, perhaps most importantly, working to skip a publication stage all together, by teaching ourselves and field offices to reach into storage and print out a list that is a week old or less. A side benefit: You don't have to give someone the whole list who is interested only in Kansas.

Another example: The Department came out with a Visual Management Manual to standardize and save costs in public printing. Most of the complaints about the Manual have come from amateurs like me who used to spend hours deciding whether a picture looked best at this side of the cover. . .or this side. Or to bleed or not to bleed, as if we're rehearsing Macbeth. Or how to place Aunt Minnie's clever drawing of House on the Rock for best dramatic effect.

Those who work frequently with the Manual are finding that it frees their creative time for things that really matter, and helps many of our publications achieve a more modern look. (I like Felix Summers, but his cartoon work should not be used as a design element.)

My point is that having to question why you have done something in a certain way is usually helpful beyond the objective of cutting costs.

Second, the programs to which soil surveys relate are changing rapidly. I think these shifts should:

-- Change the nature and timing of soil surveys;

-- Increase your questioning of what you do after the soil survey is published, which should be the beginning of our activity and not the culmination; and

-- Raise your curiosity about who uses your stuff, who is likely to understand it, who is more likely to be confused by it, and who needs how much of it.

Where does the soil survey fit, and how differently does it fit, in targeted areas for soil erosion control or water conservation? In areas that use the Land Evaluation and Site Assessment (LESA) system, or that have a new farmland retention program? In urban developments at the "edge of wetness," where growth will nearly double according to the RCA appraisal? In areas where a conservation plan is required by some local or state law or a new federal provision such as Farmers Home Administration's shift in its farm ownership and soil conservation loan programs? In areas where soil or land type makes a big difference in mining rules or costs, or tax assessment?

How well do soil surveys aid farmers who want to try conservation tillage at the edges of its proven adaptability?

How well do soil scientists and their products relate to the majority of Americans who live in cities and think an undisturbed soil is one that never needed an analyst?

A pitch for some help at this point: One of our Public Information ways of doing things differently is a set of teaching materials right up your alley, "Conserving Soil." It has overhead transparencies, ditto masters, and individual lessons--a professional job by professional educators in the Mazer Corporation.

It covers soil science, managing and conserving soils, and critical soil issues for the future--all aimed at young people in 6th through 9th grade, in whatever kind of class can make use of the material.

We're beginning to run out of copies to give away, and looking at ways and places to reprint. But we're not after a wholesale distribution as much as making certain the information is used fully and accurately.

What's in here is some of the same old stuff, but it is packaged in a way that today's teachers find especially helpful, and it is being distributed in a way that--we hope--means people will do more than just stick a copy in a file and say "Isn't that pretty?".

I'm asking you to help get this material used well--and to think just as carefully about the packaging and the distribution of the materials <u>you</u> create.

Third, goals and programs increasingly run across agency lines. The RCA reports acknowledge and influence all the conservation programs of the Department. The Agriculture and Food Act of 1981 as well as recent budget requests and appropriation bills call for interagency cooperaton and even transfers of funds to achieve a unified goal. Secretary Block published his Departmental goals, and soil conservation is high on the list. ASCS launched a Payment-In-Kind Program to draw down surplus stocks and production, yet included as one of its objectives to achieve conservation on the idled acres--on as much as 82 million acres. ASCS and Commodity Credit Corporation are working with SCS and USDA officials on ways to sweeten the conservation side of PIK or create a new conservation effort based on the PIK idea that could get more conservation on the ground whether it's a PIK year or not.

Extension Service issued its crystal-ball report on goals and activities for the rest of this decade or so, and included as a major goal to help more Americans manage the Nation's natural resources.

Some of you deserve credit for helping bring about this kind of interagency cooperation. It's a new kind--where agencies actually dare to influence each other's working agenda, and to be open themselves for better ideas or shared objectives.

The important thing where agencies have said part of their goals are yours too is to hold them to their word--and help them be successful. Let's identify new ways of working together, and then when you write up the success stories, make sure the world knows how good they and you did.

I think that's how you build and sustain a cooperative soil survey-- by influencing each other's agenda, by sharing the credit, and by one more important avenue--when you are out in the country or out of the country representing your agency, share a broader view--explain where the other agencies stand, what their chief concerns or responsibilities are--represent NCSS.

It's important to represent all of NCSS when working with other nations on the quest for world soil policy. It's equally important to represent all of NCSS when explaining intent and progress of world soil policy to people in our country.

I think your image problems can be solved by remembering the old adage that is printed on an RC&D newsletter in West Virginia: "There is no end to what can be accomplished if it doesn't matter who gets the credit."

The time for turf battles and agency or university sensitivities really has, to be at an end.

Fourth, the computer is changing almost every aspect of our daily lives. . .we who produce information about soils, and those who may use the information as one part of economic decisions.

How well does the published soil survey or a special report relate to or serve the needs of a farmer who has a minicomputer and a communications hookup for it, so he can reach the university or the stock market or the airline schedule:! What will he expect? Does he need the whole chapter if he's interested only in one verse?

How well does the soil survey fit the district conservationist or the Extension agent who knocks on the farmer's door with an attache case full of chips and screen and printer? We have an obligation to get ready for a future that is already here!

Shall we create a video game called "The Eighth Approximation"?

Shall we develop the software so that more people can have access to direct data storage and still have the security of files?

Shall we develop the software so that the data sets of different agencies or different overlays can be blended more quickly and more creatively?

Shall we keep up to date--if that's possible--on hardware and software available from others? It is possible to make a costly mistake in equipment; it also is possible to re-invent the print wheel by mistake or ignorance of what's already out there that could be used or adapted. It's time to go modern!

Finally, I wanted to leave you with my strong feeling that we can increase public awareness and understanding, increase the available soils data in more formats, keep up with shifting programs and priorities, be more responsive to landowners and other citizens, and hold down Federal expenditures by increasing our involvement in professional groups.

I don't think there's any better way to develop your own skills or to prepare others for the future than by taking on a challenge in SSSA, ASA, SCSA, ACE, and the rest of the alphabet. Looking around the roan, I'd say that many of us--beginning with me--need to look around for some leaders to replace us over the next decade, and begin shaping them for doing the job right. Let's help them see the value of professional organizations and technical societies.

There's no better way to erase agency turf lines than to get to know each other as human beings through action in a professional group. It is a way of influencing each other's agenda just a little. Sometimes, as you know, it also is a way of meeting your next boss or your next employee.

There's no better way to increase the number and kinds of soil survey information available to the public with a minimum of Federal expenditure

Example: A big part of my standard sermon as SCSA membership chairman is that nothing brings in members quite like chapter activities that are visible, that are interesting, and that relate to local natural resource issues. We're beginning to move membership upward again, thank goodness, and we've done it without issuing free coffee mugs. I think chapter action is doing it.

I offer as a resource to you the SCSA chapters across the U.S. and Canada, which have members from many agencies as well as private industry, farmers and ranchers, teachers, and so on. They are running--or should be--demonstrations, conferences, tours, teacher workshops, publications and position statements, slide presentations, and more.

There's no reason an SCSA chapter can't get involved with you as a member or as a related organization to put something together on soil-related issues that will increase conservation or improve land use and management. There's no reason why an SCSA chapter can't help you and your agencies publicize new soil surveys or other products of yours. There's no reason that the Agricultural Communicators in Education couldn't help at a regional or national level in discussing ways to reach the public more effectively with soil survey information, ways to package it better.

When you do things as a professional group, the clearance routes are shorter and the work is very satisfying. That's not to say that your work doesn't need review by somebody, to make sure it is accurate and usable to the audience. It's just that informal reviews around the table, over the phone, or through electronic mail take less time and hassle.

It is about time that professional organizations and technical societies themselves worked harder to influence each other's agenda, just as agencies are beginning to do. We need more co-sponsored programs and activities, and less worry over who is stealing members from whom, or filling whose void.

If we don't recognize the value of questioning what professional groups ought to be doing, and make some changes, then it's like falling into a cesspool and remembering you can't swim--you end up just going through the movements.

One easier way of helping organizations combine forces is to be a member of several--your specific specialty, plus an umbrella organization such as SCSA, plus anything else that interests you. We need mare soil emphasis in the League of Women Voters. . .garden clubs. .and many more. (Neil, here are my dues for NACD).

I'm tired of hearing about rising dues as a deterrent. The benefits to you and to the people we serve far outweigh whatever the dues slip may read, and the same people who cry about dues and choose between societies because of dues also cry at income tax time that they don't have enough deductions.

I'm not talking about avoiding paying our share of funds to support public purposes--I'm suggesting that in lieu of taxes that may go from the general treasury to support any program, we spend a few bob for specific educational and scientific purposes in which we are interested, and through which we may accomplish something in the private sector that would cost more if the Federal Government had to do it.

Congress and the Administration are going to see to it that as much as possible the programs we believe in will have level funding or maybe a little more or less. Few programs will be cut out altogether. So whatever we can add through private initiative should help the President and the soil and water conservation movement.

A soil survey is no good if it sits there. . .a local chapter is no good if it sits there. I hope you will dare to be bold; to ask the tough questions; to decide what formats and delivery systems will be responsive and relevant; and to help us all work together to change our agencies and our products for the better. Better agency programs and more responsive products improve image all by themselves.

Thank you.

# # # #

UPDATE STRATEGY

Presented by Rich Duesterhaus

The Soil Survey Program has a tremendous future. However, the extent of that future is largely conditioned by the imagination and innovation of the more than 1,600 people working in or paid by the program funds. Today, I want to offer some thoughts that may be controversial. Suggestions for change may be unsettling at first because we are comfortable with what we know, rather than what we don't know. It is frequently easier to do things the same way we did last year. These suggestions are tied to our update strategy. Let me first commend Ted Miller and his committee for a thoughtful review along with recommendations on this major component of the Soil Survey Program.

Now, on to Update Strategy.

Update does not mean remap exclusively. At least to me update means the whole array of things needed to provide out' soils data in the most modern, up-to-date fashion possible. And, in fact, updating is probably needed in most of the country. Most of the soil survey areas that have mapping completed have a need for some level of updating. I don't mean to scare anyone by outlining that immense job for we know that within the limits of the program we would have to update survey areas on a priority basis. We couldn't do it all at once even if we wanted to. However, I think it is safe to say that even surveys that are only 5 years old often have a need for update acitivities. Some update activities are even beginning to include providing automated data bases of the information in a survey area, including digitization of the maps themselves. Other updating activities include additional publications beyond the soil survey report itself, and another round of public information or announcement of the availability of this information, particularly where there has been significant population or other social changes, or where earlier efforts have not reached all of the current potential users. Updating may also include obtaining new base maps, recorrelation development of new interpretations, and information on soils potentials--and yes updating may even include remapping.

We have now come through a whole generation of SCS and cooperating agency people who have focused primarily on the once-over or first time mapping aspect of the Soil Survey Program. This fact, tied with our emphasis over the last couple decades to cost-share with local and state governments for the purpose of first-time mapping, has caused a significant shift of attention away from the total set of components of the Soil Survey Program. Fortunately, this total approach has been revived by the initiative of soil scientists in the last couple of years.

What I would like to offer this morning is food for thought on how to sustain this broader approach to the Soil Survey Program. No criticism of current or past efforts is Intended. Certainly the Soil Survey Program has been at the forefront in using new technology particularly within the Soil. Conservation Service. A workshop just concluded last Friday to develop strategy for the integrated resource management efforts of the SCS recognized the importance of Soil, Survey data to our overall mission. Yet, we must continue to push forward because the Soil Conservation Service and our cooperators must maintain a modern framework for the Soil Survey Program. As I prepared for this morning, the more I thought about updating, the more I saw the need for a relook at how we do business. Updating occurs from the day we begin with the initial legend or initial survey meeting to the day that a user walks in the door to obtain the most recent soil map and accompanying interpretation tables.

Let me talk for a few moments about a soil survey operation that could exist sometime in the future, perhaps 10 years from now, and that could make soil survey update a much more integrated component of the Soil Survey Program.

Let us assume that each state has a soil survey publication for general population consumption--brief, professional, and in color--that indicates and illustrates what the soil survey is, how it can be used, and where to go for further assistance, including peoples' names and/or office locations as well as computer and library files, other soil survey publications, and so forth. Let us also assume that each state has a technical "publication" (which could be a computerized data base) that includes every current soil map unit with an appropriately completed Soils-5 or similar form along with the explanation of the criteria for each of the sections of information on the Soils-5 form. Let us also assume that the soil maps themselves are published in individual sheet format, with a short legend and cross reference to the technical publication, on the best base maps available, usually quad sheets, also that orthophotography has been used to accomplish the soil mapping, and that the maps can be used in either their paper format or that they can be retrieved and printed from a digitized data base. It also may be just as important a part of the soil survey effort to provide a means for retrieving the data and manipulating it, i.e., the provision of mini- or micro-computers for storage and display, as it would be to provide a publication. Let us assume that the current soil survey publication, usually on a county basis, is no longer used. Now, fit update strategy into such an operation. It would be relatively easy to update any of the soil survey components, including remapping, on just those sheets (or areas) that need it rather than an entire set of maps for a county. Then, finally, let us assume that a user is furnished with just the information he or she needs. And, many times it would be possible to individualize a report at very little expense by retrieving the needed information in a format beneficial to the user. All these items are currently possible with today's technology. How much of this technology we can be using 10 years from now will be up to the imagination and the initiative of many managers within SCS.

Some of these things that I mentioned to be conducted at a state level may have to be regionalized if you are dealing with large states or with significant geographic or geologic differences. But the concept would still hold. POP example, we may want to consider that the major land resource areas (MLRA) serve as a basis for some sort of general publication or technical tables (data base).

We need to be concerned about the impact of such changes on our profession. The concern about the lack of opportunities for publishing, for example, could be a real concern on the part of many young soil scientists who are still hoping to author their first soil survey publication. I would suggest, however, that most of these employees can advance the science of their profession and themselves by writing for journals and publishing for professional societies much more than by authoring a fairly standardized document labeled a soil survey. We need to provide the managerial climate and incentives to allow this to happen.

All of the actions necessary to accomplish this kind of soil survey operation might not reduce total costs below our current program. I believe that the delivery of services and data could be much more effective and probably for about the same cost. The use of the information would be enhanced so significantly, however, that some increase could be justified.

UPDATING STRATEGY IS IMPORTANT! !--------and can be used as a means to stimulate a relook at our total effort. At your work planning conference this week I would hope that you would begin to lay the foundations or take steps toward a relook at the overall soil survey framework in which we are working. We need to continue to be willing to devote effort to updating. We need also to maintain an effort that allows us to go beyond the ideas thrown out here when the improvement in technology, funding, and demand for our service occurs.

AGRONOMIC TAXONOMY

By S.W. Buol, Professor of Soil Science, North Carolina State University, Raleigh, North Carolina 27650

Presented at the Work-Planning Conference of the National Cooperative Soil Survey, March 29, 1983, in Washington, D.C.

The most impressive part of the National Cooperative Soil Survey (NCSS) is its attention to interpretations of soil map units. A few years ago I would not have made that statement. In reality , very little professional acknowledgement is likely to come from attempts to improve interpretations. But, publishing a soil survey report that conveyed interpretations about soils to users of soils, in terms they could easily understand, has been the basis of the National Cooperative Soil Survey Program. There has been continued public support for soil surveys. Such attention to the utilization of soil surveys has not been a major part of the soil survey programs in many other countries. Consequently foreign soil scientists are amazed to learn how much of the NCSS program is supported by state and local funds but are totally aghast at our soil survey reports which devote approximately 2 or 4 percent of the volume to soil taxonomy and soil genesis. Sometimes our concern with septic fields and landfills are belittled by our international peers, but they are all covetous of the support we enjoy. While there is no doubt in my mind that the NCSS program is doing a good job, there are always opportunities for improvement.

One area where full support for the soil survey is not realized is the agronomic profession. By agronomic profession I include colleagues in soil fertility soil management, soil testing, as well as extension and crop specialists--in short, our fellow soil scientists or agronomists, according to many definitions. Their flagrant neglect of our soil survey reports has certainly been decried by all of us at one time or another, and despite our individual efforts, which are often successful on a local basis, I believe the overall utilization of soil survey information by this group of professionals to be too low. Several reasons can be advanced in attempts to explain the low utilization rate. Among soil scientists, one often hears that agronomists just aren't scientific enough to understand soils, or they don't get into the field enough to appreciate the real world. While these statements perhaps aren't 100 percent false, they certainly do nothing to improve the situation.

Physical Relationships

A critical look at the fundamental concerns of both groups, soil scientists vs. agronomists, goes a long way in explaining the lack of mutual reinforcement. First, the soil scientist is rightfully concerned with being able to correctly identify and locate identifiable kinds of soils. He would like to be able to go back the next year and find the same thing and have the principal correlator agree with him. The final review may be some 5 to 10 years after he identified a site. To accomplish this, soil scientists, over the some 84 years of survey experience in the United States, have selected soil properties as criteria for soil classification that are somewhat Insensitive to change by expected soil management techniques. We are not totally successful in this respect, but as you all are aware the Spodosol criteria is an attempt to eliminate tne mixing actlon of the plow from affecting the taxonomic placement. Likewise, the 1.8 m from the surface or 1.25 m below the top of the argillic of the Alfisol-Ultisol base saturation limit is deeply placed to avoid the recharge of bases from long term use of lime, a common practice on acid soils. In effect, to the soil scientist a soil is primarily defined by properties that are difficult to alter.

The agronomist's objective is to manage soil properties. He, or she, is concerned with properties that can be changed. In many cases the actual measurement is not different In kind from that made by the soil scientist, but, almost without exception, tne two professions sample different parts of the profile. Soil management is almost exclusively limited to the upper few inches of the soil, with some notable exceptions of drainage and irrigation.

In like fashion, the upper few inches are excluded from soil taxonomlc consideration, again with a few notable exceptions such as categories that utilize various epipedons for class criteria. The family category specifically avoids the surface layer in most soils.

It is really not very useful to argue about whether or not more attention needs to be paid to the subsoil by the agronomist. In several regression studies of variables affecting row crop yields, the properties of the topsoil always are more signifiant to crop growth than subsoil properties. It can be argued that only satisfactory subsoil properties are incorporated In the selection of suitable sites. The folly of prolonging the argument is that the agronomist has almost no technology to change most soil properties below plow depth or subsorbing depths of perhaps 50 cm. Although soil scientists are fond of pointing out the completely controlling influence shallow bedrock, fragipans, duripans, etc. have on land use, we have to remember that these choices of land use have already been made before the working agronomist gets involved. In fact much of the disregard given soil survey information stems from the fact that within any local area most of the soils that are intensively used for a crop are similar in many respects, and those soils not responding to conventional management have been sidelined.

Soil Properties - Agronomic Operations

No attempt will be made to create a definitive list of management practices and of how the presence, absence, or degree of a given soil property influences the agronomic operations. However, there are a few categories of problems that I think we can address. One potential. area is that of fine-tuning soil test interpretations. All soil test procedures attempt to extract an arbitrary fraction of several elements from a soil sample and then predict how much fertilizer will be needed for 60 to 120 days, or longer. There are many situations where this works very well, but the real problems result when interpretations are made in soil material not like where the calibration was developed. The impulse of the agronomist has been to look for a universal extractant, but perhaps by grouping soils according to their management layer ion release and/or fixation properties (i.e. texture, mineralogy, etc.) better interpretations can be made by developing soil group specific conversion factors from soil text extraction quantities to application rates.

Methods of fertilizer application are very much soil property, as well as crop, related. High P fixation favors banding or slow release formulations. One or two side dress applications of nitrogen as routine or emergency recommendations for supplemental N after excessive leaching conditions are based on texture, depth to impeding layer, etc.

Soil management is not only fertilizer and other amendments such as lime but also mechanical operations such as subsoiling, bedding, mulching, no till, and limited till planting. I do not propose that we attempt to compete with soil test or On-Site management services, but rather attempt to present soil properties that address their concerns in a fashion of convenience for them.

Where is the Data?

By now most of you are probably correctly concluding that most of the data needed by agronomists along with the spatial distribution of soil properties can be found in the map units of any modern soil survey report. All the agronomist needs to do is know soil taxonomy, which is easier to learn than plant taxonomy, consult the descriptions of series to pick up the profile differences that are not evident in families, and then determine the surface texture, stoniness, slope, etc. from the various map units. After all, she or he took a soils course and maybe even a soil classification and mapping course, probably belongs to the American Society of Agronomy, and may even subscribe to the Soil Science Society of America Journal. That seems to be about where we in the National Cooperative Soil Survey have left the ball with respect to what some may call our closest academic relatives.

By comparison, how have we treated some of our not-so-close academic relatives? 1 would venture that we have been considerably more energetic In attempting to translate our expertise into their language. For the banker or real estate investors we have estimated yields per acre of all adaptable crops, including range potential, for irrigated, drained, and slope phases. Where applicable we provide a technical classification of each map unit for woodland suitability as well as lists of suitable trees, site index, seedling mortality, etc. We also have wildlife ratings for 10 separate categories for each map unit. In addition there are some 20 technical classifications of each map unit for its suitability or limitation for major uses. These interpretations cater directly to land use planners and in some cases to regulatory functions.

As I stated in the beginning, this is probably the most impressive part of the soil survey program in the United States, when compared to any other nation in the world. Hut, simply, I do not see any effort made to **communicate** with the agronomist, which in reality is one of our continuing links to the managers of most of the land in the United States after we have completed the detailed county soil survey report and deposited it on the library shelf. Fortunately, I think all of us have had at least a few experiences where a district conservationist or a county extension agent, or both, has taken the time to understand the sets of soil properties that went with each map unit in the county and can fluently group map unit 428 with 528 for some uses and declare that they are different for other uses. In my experience such an individual usually, but not always, had a hand in the making of the soil survey. Maybe this is what the individual from the northeast region had in mind when he pointed out during the last soil survey work planning conference just what an unusual professional a soil scientist was. To paraphrase his statement, most professions try to maintain high standards around more and more territory and insist that only highly qualified, like, professionals are allowed to practice the art. Soil scientists spend an equal if not greater amount of their time maintaining high standards but work even harder at assuring that non professionals are allowed to administer the resulting information. I haven't made up my own mind as to whether this Is good or bad, desirable or undesirable, or inconsequential. But, it rather accurately describes what we do for most potential users but not for the agronomist.

Attending to the Agronomist's Needs

Having portrayed what we have done in the way of developing technical classification or interpretive groups, whatever you wish to call the aggregation of map units on our form 5's and ultimately in each soil survey report, hopefully I have created some sympathy for our oftentimes baffled cousin, the agronomist. He has been told to learn series names just in time to see them correlated to another soil temperature family. He has thought he was getting uniformity within a series only to find that eroded phases of that series had a plow layer of clay loam when all the research work at the local state research station was done on a loamy sand type (Uneroded). Also, the research was probably on an A slope phase while 90 percent of that soil in the ***county was*** B to D slope, eroded phase. Since his experiences had taught him that there was a clear difference in performance between a sandy loam plow layer and a sandy clay plow layer he concludes that either the mapping Is wrong because the map unit is not the same "series" he was shown at the local experiment station or that this damn soil classification business is useless--probably both.

On the other end of the spectrum, but equally as damaging to an agronomist's confidence in soil survey, are the taxonomic and mapping separations that are of little or no consequence to agronomist concerns. A recent experience along this line served to alert me to this problem. A very energetic graduate student placed stakes on a 20 m grid over a 5-acre portion of clean cultivated field. After comparing on-site evaluations by independent soil scientists and augering at each stake and producing a computer-generated map, he used ribbons to delineate taxonomic differences, septic interpretation differences, etc. on a one-to-one basis for use on a health department training program. One of our best county agents also attended the program, and as my student ***was*** explaining his work to the health ***department*** personnel I found myself ushered off to the side by one very alarmed county agent. His concern was: How in the world am I going to explain all the differences to the farmers? In fact there were no differences to explain to a farmer. The differences were very significant to the health department personnel because they involved subsurface characteristics, but in showing these differences on our maps we introduce what can only be considered as "noise" to an agronomist.

Some years ago as part of our international program I set out to classify soil management problems in terms of soil properties. During the early course of the work it consisted entirely of informally questioning leading agronomists and soil fertility professionals as to how they evaluated agronomic needs in a new area. I was, so to speak, professionally insulted in that I did not find the use of soil surveys high on anyone's mode of operation. However, I found I could usually have told them almost everything they wanted to know from what we would expect in a map unit description. I could not do this from a taxonomic placement primarily because of the question that emerged to be number one among the agronomists. Simply, they wanted to know: What is the surface texture? As one individual put it, "I first give the soil a kick to see what the texture is." I concluded I didn't have to be too precise about texture if it could be done with a kick but I had better lead off a soil description by giving a surface texture if I am to get an agronomist's attention.

After rather unanimous agreement on surface texture, the background of the individuals made for a rather diverse list of concerns. Certainly pH was high on the list, as was subsoil texture, soil test levels, past cultural practices, and rainfall and temperature. It became apparent that what agronomists wanted to know about soils was far less than what we had stored during most of our soil survey operations. Most of the time the methods were not the same, the units of expression were different, and there was a host of reasons why they did not relate to the various soil survey reports. Most of these apparent problems faded, however, when the agronomists were asked to put "quantitative criteria" on their categories of "high P fixing soils", "rapidly leached soils", "wet soils", etc. It was obvious that they had almost no creditable way of communicating with each other. Consequently, they didn't communicate well, and I think evidence of this lack of communication is reflected in verbal and published statements to the effect that "this is the practice to use in state X, while in state Y or county Z another practice is to be preferred.!! It seems they can usually agree on the political boundaries on a map but that doesn't appear to be a scientifically satisfying way to communicate cause and effect of soil management techniques.

What followed was a series of approximations to express the concerns of agronomists in a formal fashion and with quantitative class limits. As we all now know, essentially all soil properties form a continuous solid series and any class limit is going to fit better in one part of the world than in another. Thus, the limits I use have been arrived at either because they can be conveniently borrowed from soil taxonomy or they can be agreed to by agronomists as limits that are critical to key agronomic technologies. This relationship to technology, although critical for a technical classification, is always time dependent as technologies change.

What has evolved over the last 10 years is known as the "Fertility Capability Soil Classification System" and is presented in Table 1 as it most recently appeared in Geoderma, 27:283-309 by Sanchez, Couto, and myself. There are many questions that have been raised over the years about the system, and perhaps I can address some of the more general ones at this time. I understand we will have an opportunity to discuss this in greater detail this afternoon.

First, the rationale for the system was simply to provide a framework within which problems of soil management, primarily correctable problems, and fertility problems could be quantified for better communication. This always leads to the question: Why is it called "capability" rather than a "problem" or limitation classification? Well, quite simply, that is "Madison Avenue" or "sex appeal". Over the years the popular appeal of the "Land Capability Classification" has always amazed me. It speaks more of limitations and hazards but <u>who wants limits</u>? Think positive!

Anytime you create class limits, procedures have to be specified as we found during the development of taxonomy. Rigid requirements can severely limit the use of a system. Since what is being grouped are soil properties that can be expected to respond similarly to agronomic management, within groups, and different from other groups, one has to apply a form of the law of the minimum. As Professor Emil Truog demonstrated, the "scientific" way to accurately measure a 100-yard football field was to pace the first 99 yards and then measure the final-yard with a micrometer to be sure the field was a "reagent grade" field. Thus, over the years we have added "alternative" methods to define many of the condition modifiers. These are designed to allow the FCC system to be compatible with existing soil surveys and systems of soil characterization. Note that the system is open-ended and additional features considered of local importance can be added as prime (′) or perhaps asterisks (*). I have resisted adding a multitude of other condition modifiers, not because they may not be important, but because it is already a bit longer than I consider ideal.

The concept that FCC attempts to foster is that kinds of soils can be grouped for agronomic interpretations. I do believe soil scientists should take the lead, but with input from agronomists. It should be made clear that we want groups of soils created about which agronomists feel comfortable in making statements and extrapolatory technology, their technology. Interpretative statements about each FCC condition modifier have been suggested (Table 2) but local editing should be encouraged.

Fitting into the NCSS

In this same vein it would be possible to list phases of series with FCC placement on the Soils-5 for each series. Perhaps sample or suggested interpretation could be there or in separate handbooks. It would then form a table or part of a table in the soil survey publication.

We need to be careful about not overstating the use of FCC. It does not make fertilizer recommendations, for example. Soil tests are still the basis for this because the criteria used to place the soil in FCC may be altered, in fact should be altered by the management practice. In this sense each FCC placement is like the drained phase interpretation. Energy is required to keep it drained, as energy is required to keep the plow layer limed and fertilized.

In conclusion, I believe the need for a technical classification of soils according to criteria of significance to agronomists is needed. The FCC system is one attempt, and like all classification systems it only reflects the state of the art. It can and should change with time and data. I do not believe we can develop a system for technical uses after we have collected all the necessary data to prove that the groups are correct, especially in agronomy, where new cultivars, for example, are now available that show tolerance to high Al concentrations. Because methods of management change, the FCC simply provides a basis for grouping soils with which the agronomist can both research and extrapolate his findings with greater confidence than he can to the entire polulation of soils.

Table 1. FCC system.

Type. Texture of plow-layer or surface 20 cm, whichever is shallower:
S = sandy topsoils: loamy sands and sands (by USDA definition);
L = loamy topsoils: < 25% clay but not loamy land or sand;
C = clayey topsoils: > 85% clay;
O = organic soils: > 90% O.M. to a depth of 56 cm or more

Substrata type (texture of subsoil). Used only if there is a marked textural change from the surface, or if. hard root-restricting layer is encountered within 60 cm:
S = wdy subsoil: texture as in type;
L = loamy subsoil: texture "in type;
C = clayey subsoil: texture as in type;
R = rock or other hard root-restricting layer.

Modifiers. Where more than one criterion is listed for each modifier. only one needs to be met. The criterion listed fii is the most desirable one and should be used if data are available. Subsequent critei a are presented for use where data are limited.
g = (gley): soil or mottles ≤ 2 chroma within 60 cm of the soil surface and below all A horizons, or soil saturated with water for > 60 days in most years;
d = (dry): ustic, aridic or xeric soil moisture regimes (subsoil dry > 90 cumulative days per year within 20-60 em depth);
e = (low cation exchange capacity): applies only to plow layer or surface 20 cm. whichever is shallower: CEC < 4 meq./100 g soil by Σ bases + KCl-extractable A, (effective CEC). or CEC < 7 meq./100 g soil by Σ cations at pH 7. or CEC < 10 meq./100 g soil by Σ cations + A, + H at pH 8.2;
a = (aluminum-toxicity): > 60% Al-saturation of the effective CEC within 60 cm of the soil surface, or > 67% acidity saturation of CEC by Σ cations at pH 7 within 60 cm of the soil surface, or > 86% acidity saturation of CEC by Σ cations at pH 6.2 within 50 cm of the soil surface, or pH < 5.0 in 1:1 H_2O within 50 cm, except in organic soils where pH must be less than 4.7;
h = (rid): 10—60% Al-saturation of the effective CEC within 50 cm of soil surface, or pH in 1:1 H_2O between 5.0 and 6.0;
i = (high P-fixation by iron): % free Fe_2O_3/% clay > 0.15 and more than 35% clay, or hues of 7.6 YR or redder ● d granular structure. This modifier is used only in clay (*C*) types; it applies only to plow-layer or surface 20 cm of soil surface, whichever is shallower;
x = (X-my amorphous): pH > 10 in 1*N* NaF, or positive to field NaF test. or other indirect evidences of allophane dominance in the clay fraction;
v = (vertisol): very sticky plastic clay: > 35% clay and > 50% of 2:1 expanding clays. or severe topsoil shrinking and swelling;
k = (low K reserves): < 10% weatherable minerals in silt and sand fraction within 50 cm of the soil surface, or exchangeable K < 0.20 meq./100 g, or K < 2% of Σ bases; if bases < 10 meq./100 g;
b = (basic reaction): free $CaCO_3$ within 50 cm of soil surface (effervescence with HCl), or pH > 1.3;
s = (salinity): > 4 mmhos/cm of electrical conductivity of saturated extract at 25°C within 1 m of the soil surface;
n = (natric): > 15% Na-saturation of CEC within 60 cm of the soil surface;
c = (cat clay): pH in 1:1 H_2O is < 3.5 after drying and jarosite mottles with hues of 2.5 Y or yellower and chromas 6 or more are present within 60 cm of the soil surface;
' = (gravel): a prime (') denotes 15—35% gravel or coarser (> 2 mm) particles by volume to any type or substrata type texture (example: *S'L* = gravelly, sand over loamy; *SL'* = sandy over gravelly loam); two prime marks ('') denote more than 35% gravel or coarser particles (> 2 mm) by volume in any type or substrata type (example: *LC''* = loamy over clayey skeletal. *L'C''* = gravelly loam over clayey skeletal);
% = (slope): where it is desirable to show slope with the FCC, the slope range percentage can be placed in parentheses after the last condition modifier (example: *Sb* (1–6%) = uniformly sandy soil, calcareous in reaction, 1–6% slope).

The soils are classified by determining whether the characteristic is present or not. Most of the quantitative limits are criteria present in Soil Taxonomy (Soil Survey Staff, 1975). The FCC unit then lists the type and substrata type (if present) in capital letters, and the modifiers in lower-case letters, the gravel modifier as a prime (') and the slope, if desired, in parentheses. For example, many Oxisols belong to the FCC unit *C a e i k* (i.e., clayey, Al-toxic, low CEC, high P-fixation by iron, low K-reserves), many Vertisols to *C d v b* (i.e., clayey, dry season, vertic, calcareous), whereas a young alluvial Entisol with no fertility limitations is simply classified as *L* (loamy soil). The absence of modifiers suggests no major fertility limitations, other than nitrogen deficiency.

Table 2. FCC sample interpretation.

Interpretation of types and substrata types

S: high rate of infiltration, low water-holding capacity.

L: medium infiltration rate, good water-holding capacity.

C: low infiltration rates, good water-holding capacity, potential high runoff if sloping, difficult to till; when *i* modifier is present, these (C*i*) soils are easy to till, have high infiltration rates and low water-holding capacity.

O. artificial drainage is needed and subsidence will occur, possible micronutrient deficiencies; high herbicide rates usually required.

SC, LC, LR, SR: susceptible to severe soil degradation from erosion exposing undesirable subsoil; high priority should be given to erosion control.

Interpretation of modifiers

When only one modifier is included in the FCC unit, the following limitations or management requirements apply to the soil. Interpretations may differ when two or more modifiers are present simultaneously or when textural types are different.

g: denitrification frequently occurs in anaerobic subsoil; tillage operations and certain crops may be adversely affected by excess rain unless drainage is improved by tiling or other drainage procedures; good soil moisture regime for rice production.

d: moisture is limiting during the dry season unless soil is irrigated; planting date should take into account the flush of N at onset of rains; germination problems are often experienced if first rains are sporadic.

e: low ability to retain nutrients against leaching, mainly K, Ca and Mg; heavy applications of these nutrients and of N fertilizers should be split; potential danger of overliming.

a: plants Sensitive to Al-toxicity will be effected unless Lime is applied; extraction of soil water below depth of lime incorporation will be restricted; lime requirements are high unless an *e* modifier is also indicated; this modifier is desirable for npid dissolution of phosphate rocks and for good latex flow in rubber Mn-toxicity may occur on some of these Soils.

h: low to medium soil acidity; requires liming for Al-sensitive crops, such as cotton and alfalfa.

i: high P-fixation capacity; requires biih levels of P fertilizer or special P management practices; sources and method of P fertilizer application should be considered carefully; with C texture. these soils have granular soil structure.

I: high P-fixation capacity; amount and most convenient source of P to be determined; low organic N mineralization rates.

v: clayey textured topsoil with shrink and swell properties; tillage is difficult when too dry or too moist. but soils can be highly productive; P-deficiency common.

k: low ability to supply K; availability of K should be monitored and K fertilizers may be required frequently; potential K-Mg-Ca imbalances.

b: calcareous soils; rock phosphate and other non-water-soluble phosphates should be avoided; potential deficiency of certain micronutrients, principally iron and zinc.

s: presence of soluble salts; requires drainage and special management for salt-sensitive crops or the use of salt-tolerant species and cultivars.

n: high levels of sodium; requires special soil management practices for alkaline soils, including use of gypsum amendments and drainage.

c: potential acid sulfate . il; drainage is not recommended without special practices; should be managed with plants tolerant to high water table level.

By using the individual guides for each type, substrata type, and modifiers, it is possible to prepare composite interpretation guidelines for all of the possible FCC-units. More comprehensive interpretative statements are possible when interactions of two or more soil conditions are considered. No necessity is seen for a complete listing of all possible combinations because only a limited number of FCC-units will be found in any area under consideration. At the local level, however. interpretation of the FCC-units found in relation to the main crops and specific farming systems used would be a valuable exten-

Table 2. (continued)

sion tool and local expertise is expected to supplement the following brief statements where experience warrants.

Sample interpretations of FCC units

Lehk: good water-holding capacity, medium infiltration capacity; low ability to retain nutrients for plants, mainly K, Ca, Mg; heavy applications of these nutrients and N fertilizers should be split; requires liming for Al-sensitive crops; potential danger of overliming because of low CEC; low ability to supply K; availability of K should be monitored and K-fertilizers may be required frequently for plants requiring high levels of K.

Lgh: good water-holding capacity, medium infiltration capacity; limitations in drainage so that tillage operations and some crops may be adversely affected unless drainage is improved by tiling or other procedures; strong to medium acid soil; liming required for some crops; excellent soil for flooded rice, as acidity will be eliminated by flooding.

LCgeak: erosion or *other* removal of surface soil will expose undesirable clay-textured subsoil; drainage limited so that tillage operations and some crops may be adversely affected unless drainage is improved by tiling or other procedures; low ability to retain nutrients for plants, mainly K, Ca, Mg; heavy applications of these nutrients and N fertilizer should be split; plants sensitive to Al-toxicity will be affected unless lime is deeply incorporated; however. deep liming practices are difficult because of clay-textured substrate; due to low CEC in the surface, there is . danger of overliming; low ability to supply K; availability of K should be monitored and K fertilizers may be required frequently for plants requiring high levels of K.

L: excellent soil with no major fertility constraints; N deficiency likely with intensive use.

National Cooperative Soil Survey Conference
Washington, D.C. — March 27 - April 1, 1983

Committee on Soil Taxonomy - Soil Fertility

A. The principal charge assigned to this committee was to evaluate the Fertility Capability Classification system as recently proposed by Sanchez, Couto and Buol (Geoderma, 1982) for possible incorporation in a technical soil classification that might be adjunct to Soil Taxonomy.

Dr. Buol, in a presentation to the Conference, outlined the purpose and potential application of the system, particularly in areas outside of the U.S. In many such areas soil surveys have not attained the degree of completion or of detail that is available in the U.S., nevertheless the demand for this interpretation is strong. The system is not only one of fertility considerations hut also includes factors that relate more broadly to productivity. This may pose some problems in application, or implementation, of the FCC system. Dr. Buol proposes that the system is applicable at the series level of Soil Taxonomy or, perhaps better, with phases of series). The system consists of three categorical levels: type (topsoil texture), substrata type (subsoil texture), and 15 modifiers (see Geoderma 28:283-309, 1982). Interpretations can be made from the various FCC-units based on the combinations of properties.

The committee recommends that the FCC-system should be evaluated in the U.S. We recommend that it be evaluated in each of 4 (technical) regions, in an MLRA of considerable extent and in a specific county or survey area where there appears to be sufficient soil variability to invoke the widest possible application of the system. Further, that, if possible, the evaluation be in a county where a digitized geographic base is to be available. It is probable that local usage will identify some modification (or additions) to the proposed (15) modifiers. Phases of the series should be the units evaluated. This testing should involve collaboration with state or local agronomists.

The importance of the soil moisture regime and the water storage capacity of the rooting zone in any such evaluation was pointed out in a presentation by Dr. Ken Olson. The categoric levels of type and substrata type in the FCC system may particularly correlate to this evaluation.

The principal value of the FCC-system in the U.S. context (and elsewhere) may be in evaluation of the intercept point in the idealized curve of yield as a function of nutrient capacity. In other words, an evaluation of inherent fertility. This may be particularly helpful in many forestland, rangeland areas. However, in most cropland areas, the agronomic need is for a capability Lo predict the responsiveness to fertility of various inputs.

B. Accordingly, the second recommendation of the committee, which comes out of discussions held in these Conferences since 1977 (or earlier), is that, in every state, discussions be held with the staff of the Soil Testing Laboratory (of the Experiment Station) to encourage the identification of soil mapping units, where feasible, on soil test report forms. In many states it appears that even soil textures are not identified. In a number of situations, farmers, foresters, and ranchers may not (be able to) reliably report this information. But, in increasing numbers, technicians and agri-consultants are taking (and interpreting) field soil samples and could be sought as cooperators. With the computer processing of such data (being done in most states) it would be possible to develop annual (or longer) summaries which would provide soil specific estimates of soil chemical, and other, properties in the crop, forest, and range considerations.

Necessary corollaries to this recommendation are that (1) subsurface, rooting zone, sampling be encouraged so that a rooting zone measure of nutrient availability be developed (even as Dr. Grossman and the Moisture Committee wishes to characterize a crop- soil specific moisture regime); that (2) all horizon sampling for chemical analysis become regular procedure in characterization studies and that (3) where feasible, sequential testing in the field landscape be used as a means of more sharply defining soil variability in these chemical parameters.

C. The committee reviewed the recent Franklin Parish, Louisiana survey report in which Dr. Bob Miller of LSU had contributed a table of chemical data, by horizons of principal soils and also prepared an interpretation section from this data for fertility management of those soils.

The committee is unanimous in recommending this topic for inclusion in all survey reports where a reliable body of chemical data on the correlated soils has been developed, either by the respective state soil survey lab- and/or the NSSL. The author (party leader) of the report should seek out the appropriate agronomist (soil scientist) very often attached to the Extension Service, to help develop this section.

D. The 4th recommendation is in respect to the role of the National Soil Survey Laboratory in improving our fertility recommendation guidelines. There are several ways in which the committee believes that the Lab can be supportive in this effort. 1) With respect to the FCC system the Lab now Generates most of the chemical parameters needed to classify soils in the proposed system. Some of the FCC classification requires information on the morphology but this is also part of NSSL characterization, wherever conducted. 2) The committee believes that the Lab has a unique opportunity to act as a 'clearing house' for much of this needed chemical data or, more importantly, a national coordinating role in seeking to establish a degree of standardization in analysis and reporting of data. It may not be possible (or desirable) that every lab make every determination in the same way but, given the empirical nature of the data, some standardization is necessary. 3) There are some chemical determinations that could be given new, or added, emphasis by NSSL. We believe more characterization of organic matter, of pretention or release, of certain minor elements, of more detailed mineralogy examination are examples. If budgetary limitations are prevailing, we suggest that some presently made determinations may be given a lower priority.

E. The 5th recommendation permeates most of our prior recommendations. It is that we use this challenge of improving the utilization of our soil surveys with better fertility management guidelines as an opportunity to build cooperation between agencies, particularly at state and local level>, who have manifestly common interest both as makers and users this vast database. We have, with the rapidly developing computer information delivery systems, a medium in which may agencies and individuals can cooperate. Lastly, but not leastly, we must do more talking to our users and less to ourselves.

F. The committee, mainly in correspondence, explored the modification of soil mineralogy classes in Soil Taxonomy to provide clearer inferences about soil fertility. In the nearly 20 years since the class limits were established there has been some improvement in laboratory capability to quantify mineralogy. Some suggestions made were:

1. Sub-classes of mineralogy (e.g., O-20 percent smectite, 20-40, etc) would be more definitive in many fertility interpretations.
2. The class of mixed mineralogy is too general. The kind and nature of components needs to be specified.
3. Mineralogy classes, or sub-classes, in soils developed on volcanic materials needs elaboration.
4. Dual, or surface/subsurface, mineralogy clases should be tested.

No specific recommendations are made on this matter at this time other than to urge continued attention to this problem, possibly with joint collaboration among soil chemists, mineralogists and pedologists.

G. The committee recommends that Soil Taxonomy and Soil Fertility be continued and that the committee role might include monitoring the implementation of its recommendations (if so approved by the Steering Committee).

Committee members and others indicating interest to date:

Stan Buol (NCState)
Hari Eswaran (SMSS)
John Kimble (NSSL)
G. L. Malzer (UofM)
B. J. Miller (LSU)

Gerald Nielsen (HSU)
Gerald Olson (CU)
Ken Olson (CU)
Gerald Post (MNTC)
Jon Vann (USFS)
R. H. Rust, chairman (UofM)

4/7/83

National Work Planning Conference
of the
National Cooperative Soil Survey
March 28 - April 1, 1983

National Issue Committee 3: Update Strategy

Charges:

1. Identifying needs - details worked out by regions.
2. Criteria for justification of update.
    - Quality of existing information
    - Cost to update
    - Value of update for users
3. Priorities for the U.S.
    - Overall objective

Introduction:

Preliminary work for the committee was done by correspondence. committee members were sent charges along with a request to respond with additional ideas and suggestions. The preliminary report was prepared by the committee chairman. The subject was introduced by a lead speaker at the conference in Washington, D.C. and was also discussed in group discussions. The preliminary report was adjusted to incorporate suggestions made during the conference.

Charge 1. Identifying needs

All agree that the first step in evaluating a soil survey for updating is to identify, evaluate and quantify need. This evaluation of need will be carried out jointly, by SCS cooperators and users. All decisions to update published soil surveys will be based on documentation in sufficient detail to verify this need.

Although needs vary between soil survey areas, they are determined to a large extent by demographic trends such as urban. industrial, and population growth; by land use, now and projected, by the extent to which planning decisions at local and county levels use soils information; and by the adequacy of the soils information.

Charge 2. Criteria for justification of update

Wise use of our limited resources dictates that we must have sound justification for updating existing soil surveys. Although certain criteria for justifying updates may have more significance in one survey than in another, there is a definite need for national criteria.

Quality of existing information

The major objective of soil survey is to provide adequate soil information to meet user needs. In evaluating quality then, the ultimate test is to determine, if in fact, the existing survey does meet the needs of most users. The evaluation itself involves a technical, in-depth, evaluation of all aspects of the survey. The standards against which the existing material is compared do include NCSS standards and procedures but the most important standard is the overall standard set by the user. Is the information complete enough and of sufficient quality to meet his needs.

Cost to update

All evaluations for updating should include detailed estimates of time and costs. If done jointly with local or state agencies, or with additional federal agencies, contributions from each should be clearly defined.

Value of update to user

Evaluations and recommendations for updating must include not only reasons and justifications but they must clearly indicate how each item that is inadequate will be improved with the update.

Charge 3. Priorities for the U.S.

Priorities for updating should be set at the national level. They should be based on land use, number and kind of users, the amount and extent of critical conservation problems, and other items as discussed in charges 1 and 2.

Recommendations:

1. That the national office adopt a worksheet similar to attachment 1 and require a" evaluation based on these guidelines for all areas in which updating is proposed.

2. That the national office develop, to the extent possible, specific guidelines for the criteria listed under section III of the worksheet.

3. That all requests for updates must include adequate documentation in addition to the completed worksheet.

4. To assure that priorities are equitable, the national leadership should develop and adopt a weighting system similar to that shown on attachment 2.

Comments:

Memorandum of understanding, correlation document, and the published survey could be referenced for much of the basic data (acreage, scale and kind of base map, etc.). This could be a" alternative to listing the actual data in the worksheet.

The worksheet lists criteria to use in determining adequacy of the survey. Specific guidelines are needed inapplying these criteria to a survey area. For example, is a controlled base map with poor and outdated photographic background adequate? Is an uncontrolled (high altitude or mosaic) base map with high quality up-to-date photography adequate? Is it possible that both may be adequate depending on the particular survey area? What about cartographic detail? Can guidelines be developed as to minimum size delineations relative to land use? Acceptable statistical and sampling procedures for determining map unit accuracy must be stated in national policy. What specific procedures are acceptable? Which one is most desirable? What is the minimum acceptable procedure? Will sampling of NRI blocks suffice?

It may be desirable to assign each of the regional work planning conferences the responsibility of drafting guidelines for specific criteria.

Conference, Discussion and Comments

National Issue Committee 3

The question was raised as to when is a memorandum of understanding required. A memorandum of understanding is required when other people are involved or when someone else's resources are used. Normally a memorandum of understanding is required beginning with category D of the proposed update categories listed on the soil survey evaluation worksheet (attachment 1).

What is adequate documentation? Seemingly this question will be answered when actual criteria and guidelines are developed for completing the items discussed under section III of the proposed evaluation sheet. Conference participants indicated that the most pressing concern for evaluating existing soil surveys is the need for specific criteria and guidelines as indicated in committee recommendation number 2.

Although the evaluation worksheet and the weighting sheet were developed as a" attempt to get uniformity between states, they can be used to evaluate and prioritize updating needs within a" individual state.

Updating multiple soil survey areas, by MLRA, or by complete states has distinct advantages. It permits a uniform approach to soil interpretations and provides for improved coordination of soil classification and correlation over a broad geographic area. The MLRA approach is currently being used to update the Southern High Plains, MLRA-77. Connecticut is updating the completed state into one legend and one manuscript document. Existing soil maps are being reformatted to 1:24,000 7 1/2 minute quads. Many participants are of the opinion that whenever possible, updating should be done on multi-survey areas. Updating, using the quad sheet approach, also has merit.

Recorder:

Committee Members

F. Ted Miller, Chairman

Kenneth C. Hinkley

Charles M. Thompson

Kelso K. Huffman

Ronald Hoppes

Verlyn Saladen

William F. Hatfield

Attachment 1

Soil Survey Evaluation
Worksheet
for
____________________Survey Area

____________________, 19____

I. General Information

Acreage of survey area ____________________

Private ________________ Federal ____________

Date soil survey published ____________________

Date soil survey correlated ____________________

Date field work completed ____________________

Date field work began ____________________

Scale of map ____________________

Kind of base map ________________

Number of published soil surveys available ________________

Major land uses (extent in acres)

Urban ____________________

Cropland____________________

  Dry farmed ____________________

  Irrigated ____________________

  Forest land ____________________

  Rangeland ____________________

  Other ____________________

Major crops in order of extent

____

____

____

____

____

____

____

Agricultural Income $________________

Cropland __________________

  Row crops ____________________

Small grain ____________

Orchards and Vineyards ________

Forest products ____________

Livestock ________________

What is the extent of land use changes in the survey area since the current survey was mapped? (acres)

Conversion to urbanland____________

Conversion from woodland to cropland _________

Conversion from dry farmed to irrigated __________

Conversion to disturbed land (mined) ____________

Other ______________________________

What is the extent of soil erosion within the survey area? (acres)

Slight _______ meets (T) factor Moderate _____less than 2X(T)

Severe _______ 2X or more (T)

What is the extent of salinity problems in the survey area? (acres)

Low ________ 0-4 mmhos Moderate _______ 4-8 mmhos

High ______ 8-16 mmhos Very high ______ 16 + mmhos

II. Needs and User Information

List major current and potential users of soil survey.

(Indicate actual user. not just agency name.)

current	Potential
____________________	______________________
____________________	______________________
____________________	______________________
____________________	______________________
____________________	______________________

Attchmt.1

Uses for soil survey (check items)

Actual	Potential		Actual	Potential	
_____	_____	Conservation Planning	_____	_____	LESA
_____	_____	Target area	_____	_____	Soil potential
_____	_____	RC & D	_____	_____	Watershed planning
_____	_____	Important Farmlands	_____	_____	Riverbasin planning
_____	_____	Environmental impact statements	_____	_____	Hydric soil identification
_____	_____	Farmland retention	_____	_____	Engineering needs
_____	_____	Taxation			

Other needs ______________________________

____

Have local landowners expressed interest in a new soil survey? (explain) __________

____

____

____

Have local planning agencies or government bodies expressed interest in updating the survey? Would they provide financial support? How much? __________

____

____

Have federal agencies expressed interest in updating the survey? __________

____

____

Would an interagency agreement or contract to assist with an update be possible?

____

____

III. Adequacy of existing soil survey

A. Soil Maps

Is quality of base map adequate? ________________

Is scale compatible to land use? ________________

Is cartographic detail satisfactory?______________

Are indentified cultural featuresadequate?_________

Are primary soil lines separating major landscapes accurate?____________

Do landscape boundaries and soil lines coincide? ________________

Do the maps adequately display the soils on the landscape to meet the needs of most users? ____________________

B. Laboratory and Field Investigations

List kinds of laboratory data available.

____

____

List soil related research studies that have been made for soils in this survey area.

____

____

List kinds of laboratory data and research studies needed.

____

____

C. Nap Unit Descriptions - Identify statistical or sampling procedure used to evaluate map unit descriptions and indicate percentages, proportions or number of discrepancies found.

Do map unit descriptions adequately characterize soils in the map unit? ____

Do map unit descriptions provide adequate information about soil patterns and composition within delineations? ______________________

Do map unit descriptions provide adequate information for current land use, treatment and interpretation needs? ______________________

Are existing phase separations adequate for major uses and interpretations? ______________________

Slope ____________ Flooding ____________

Erosion ____________ Other ____________

What is the extent of critical soil characteristics and properties that are not identified for map units, either in the legend or the text?

____

____

____

Are delineations of the same map unit consistent? ____________

____

____

D. Sail Interpretations

Kinds of interpretations in published survey (list)

(Coordinate with use list in Section II)

____________ ____________ ____________

____________ ____________ ____________

Do present soil interpretations meet the current needs of users? ______

(Evaluate in consultation with users.)

____

____

____

What additional interpretations are needed? (list)

____________________ ____________________

____________________ ____________________

How many cases of inadequate interpretaions, as well as inaccurate interpretations are documented in SCS files? ____________________

List and summarize in categories of:

a. Inaccurate interpretations based on old criteria.

____

____

b. Inaccurate interpretations because of inaccurate maps.

____

____

E. Taxonomic units

Are soils classified by standards of Soil Taxonomy? ____________

Are technical data (series descriptions and field notes) adequate to classify by Soil Taxonomy? __________________ If no, explain,

____

____

What is the acreage of unclassified soils in survey area? __________

Are concepts for series used in the present soil survey the same as today's concepts? ______________________________________

Do series overlap with other series? ______________________

Is there overlapping of subgroups in Soil Taxonomy? _______________

IV. Summary and Recommendations

Categorize work to be done and estimate time (man years) and cost.

A. Survey is adequate without further work at present time

Man years ____0____ cost ____0____

Attchmt. 1

B. Mapping units adequate. Update soil interpretations and issue supplemental report.

Man Years ____________________ cost __________________

C. Mapping unit delineations adequate but map unit descriptions not adequate. Update map unit descriptions and interpretations. Issue supplemental report.

Man Years ____________________ cost __________________

D. Mapping unitsadequate. Taxonomic units not to present standards. Recorrelate, update interpretations and text, and issue supplemental report.

Man Years ____________________ Cost __________________

E. Most mapping units adequate; some mapping units inadequate. Remap (supplemental mapping) only those areas needing remapping. Issue supplemental report containing only those maps on which supplemental mapping was done.

Man Scars ____________________ cost __________________

F. Mapping units adequate but not on photographic background or on quality base. Transfer soil lines to new base and issue supplemental report with new maps.

Man Years ____________________ cost __________________

G. Mapping units (delineations) are not adequate by today's standards. Complete remap on new photo base and republish with new text and interpretations.

Man Years ____________________ cost __________________

Attachment 2

Criteria Used in Determining Priority For Updating Existing Soil Surveys

Management Criteria	Weight
1. SCS program needs for technical assistance	( )
2. State and local needs	( )
3. Financial support	
State or local funds	( )
Other federal funds	( )
4. National needs	
Erosion control	( )
Upstream flooding	( )
Water conservation	( )
5. Availability of existing information	0
6. Agricultural Use	
Crops	( )
Forest products	( )
Livestock	( )
7. Land Use Changes	
Conversion to urban land	( )
Conversion from woodland to cropland	( )
Conversion from dry farmed to irrigated	( )
Conversion to disturbed land	( )
8. Land use	
Agricultural land	( )
Urban land	( )
9. Adequacy of soil classification	( )

REPORT OF NATIONAL ISSUES COMMITTEE ON THE NCSS IMAGE

(Final Report)

Committee Members:
- Ed Ciolkosz
- Gary Muckel
- Barbara Osgood
- LeRoy Daugherty
- Chris Johsnnsen
- B. L. Harris, Chairman

Each of the committee members is well acquainted with the NCSS and recognizes it to be a program of great value and one which we individually and collectively strongly support. We recognize that for the most part the NCSS is a healthy program contributing great value to society in general.

The four charges given this committee are not totally separable, therefore a certain amount of overlap will necessarily occur in the response. Following is a compilation of the responses of the committee members and additional ideas developed during discussions at the NCSS National Work-Planning Conference held in Washington, D.C.:

Charge # 1: Develop a strategy for promoting understanding of NCSS--who we are, what we have done, how we operate, and how some of our information can be used. This charge raises the basic question, "Why does the NCSS need an image?" What kind of image do we want to have for a various potential audiences? Is it important for the NCSS to have a well-defined image with the general public? Perhaps it may be more important for the NCSS to have a well-defined and well-recognized image within the various agencies cooperating. Clearly, there are some major problems with the NCSS image within and among various agencies. If it is felt that the NCSS needs a widely recognized public image, then the use of advertising will be necessary. This would involve the use or incorporation of the "Madison Avenue" approach involving newspapers, radio, and television ads. If, on the other hand, we're more concerned about expanding the image of the NCSS with major users and those personnel within other agencies, we will have to work more effectively in incorporating the NCSS into programs of those other agencies. For example, if we want the State Soil and Water Conservation Boards or Commissions and the State Extension Services to help sell the soil survey program, then they must be more directly involved in decision-making and development of soil surveys. It is unrealistic to expect that an agency will wholeheartedly accept the responsibility of selling another agency's program, especially one in which their agency is not even listed as a cooperator in program publications.

Another item of importance regarding the NCSS image is that once an agency has been given or assumed responsibility for some aspect of the soil survey program other agencies, particularly the lead agency, should work with them to get the job done, not do the work for them. This comment carries across-the-board, whether it be for collection of soil samples and laboratory analyses for correlation purposes, selection of potential researchable problems, or educational/informational phases. For example: apparently when a new soil survey report is published and programs for introducing that survey are being planned, in many cases the

SCS District Conservationist directs the entire program, whereas review. of interagency memoranda-of-understanding suggests that the county Extension agent should have this responsibility. Confusions such as this, although relatively minor, establish precedents which when perpetuated to other counties, often leads to a single-agency program, not in keeping with the goals of the National Cooperative Soil Survey.

All too often among other local, state and federal agencies, the soil survey program is looked upon as a" SCS program, with little advice from others.

The committee feels that major efforts directed toward developing a strategy for promoting understanding of the National Cooperative Soil Survey should be directed toward better understanding within the agencies that are both directly and indirectly involved in the soil survey program. This will require major efforts at bringing up-to-date all interagency memoranda-of-understanding, review of present procedures for describing "cooperators of the National Cooperative Soil Survey", and working at developing truly cooperative relationships among the various agencies participating.

There is a clear need to promote understanding of which agencies are included in the NCSS, which surveys or other agency activities are within the NCSS and which are not, and for a clear definition of the NCSS. Explicit definition is needed on authority for membership in the NCSS.

It is recommended that:

1. The effort to improve the NCSS image should be concentrated within the inner circle of the cooperators.

2. An effort should be made to establish the NCSS as a" entity (define it and publish the definition).

Charge # 2: Evaluate needs for publications to help us to be understood (relates in part to confidence limits committee). In general, the committee feels that use of current publications with some modifications and being more responsive will lead to better understanding of the NCSS. Our main publication, The Soil Survey Report, does not eve" mention the NCSS on the outside cover. I" fact, many of the current soil survey reports are a direct afront to all agencies participating in the soil survey, except SCS and Experiment Stations. For example: although many states supply considerable funds to the NCSS, they may not be eve" mentioned as "assisting" on the front cover of those publications for which they are supplying funding.

It was suggested that a logo for the NCSS be developed and used as widely as possible. We should encourage the use of joint publications with joint authorship and sharing of responsibilities for putting the publications together.

It should also be recognized that there are differences between the SCS and universities regarding authorship of publications. SCS does not place a premium on, "or have a reward system for authorship of publications, whereas within universities authorship is a must. These philosophical differences will necessarily lead to different motivation and criteria for cooperation.

Appropriate use of publications and logos which describe the National Cooperative Soil Survey program are imperative. It is also very important that all cooperators within the NCSS receive recognition in black and white for their inputs. It is often observed that agency personnel can easily reject publications and programs of another agency; however, it is difficult to find fault with those publications which have their own agency name on them. Perhaps review of simple psychological impacts of current practices will correct many of the problems without the need for any new four-color type brochures. (Maybe then we can use some four-color processes to brighten up the front covers of the soil survey reports?)

Soil survey reports should mention that further technical information can be obtained from the various members of the NCSS. Also sections such as those dealing with soil formation, could be co-authored by Experiment Station or other agency representatives. Changes such as these would foster further cooperation.

It is recommended that:

1. More recognition be given to cooperators in the soil survey report and in other aspects of the NCSS.

2. An NCSS Newsletter should be established.

Charge # 3: Evaluate conditions of "pulling together" as members of NCSS--our common working together at county and state levels. This charge describes a primary question regarding needed improvements in the NCSS. Members of this committee represent different states and all of the members have multi-state experiences. The most common comment about charge #3 is that cooperation within the NCSS in individual states varies widely from one state to another. In some states, there are excellent relationships among the various NCSS cooperators with frequent meetings, routine correspondence, and contacts one with the others, and in general, model programs for interagency cooperative efforts. However, in other states the NCSS is known as the National "Uncooperative" Soil Survey with little communication taking place and even less cooperative efforts. Obviously, these conditions provide us with an opportunity to make improvements. It is suggested that the SCS, since they provide primary leadership for this program, must also provide the leadership for cooperation. It is felt that we must have effective relationships at the state and local level. There is a great need for willingness to share within the NCSS on cooperative publications, specific researchable problems, informational/educational activities, and work with clientele. There is certainly a need for "open meetings" of members of the NCSS. Some states even provide a rotation of chairmanship of working groups, so that one agency does not dominate. Committee members felt that the place to start for cooperation within the State is at the top administrative positions. Strong encouragement from that level will set in motion those necessary attitude adjustments that lead to cooperative relationships.

It also was mentioned that too often the SCS is viewed as slow-moving, unwilling to adopt or develop new techniques and reluctant to accept advice of other cooperators. Examples given are: too few resources devoted to development of new and better mapping techniques, unwillingness to expand observations in the one to three meter zone eve" though very important to certain users, use of remote sensing techniques, and continuing use of an out-moded information delivery system (soil survey report), and resistance to use of computer technology. Obviously, the same types of critical statements can be made for other cooperators within the NCSS. For example: the reluctance of the State Experiment Stations to provide eve" low-level laboratory analyses and characterization data in support of the NCSS field mapping program in many states, the slow response to identified research needs, limited field assistance, and other such difficulties. Another point of major concern is the lack of educational/informational support from the State Extension Services. Obviously, in many states, additional publications are needed to address specific user concerns which would lead to more widespread adoption and use of the soil survey information developed through the NCSS.

All of these concerns need to be dealt with through a" effective state-level advisory committee. Each agency and individual cooperator of the NCSS should stand ready to accept the responsibilities appropriate for expediting those agreed to actions, not merely to rubber stamp another agency's efforts.

It is recommended that:

A strategy be developed to increase the amount of cooperation in the NCSS. In particular, how all levels of management can be more extensively involved. In this effort examples of cooperation should be collected to use as models for others to utilize.

Charge # 4: Consider the need for information centers or contacts for additional help. In general, the committee members do not see the need for more information centers. It was suggested that the NCSS utilize existing and rapidly expanding geographic information systems where possible. Already many states are well along or have eve" completed storage of soils resource data bases into those geographic systems. It was also suggested that states consider the possibility of forming soil survey information committees. These committees could bring the resources of several agencies to bear on identified informational deficiencies. It was suggested that Extension needs to play a" increasingly more important role in the soil survey information transfer process. It was also suggested that there is a need for more Extension, and other agency personnel, to be involved in soil survey field reviews and at state and local meetings. In those states that do not have Extension personnel to deal with the soil survey, the NCSS cooperators could stress the need for such support.

There is need for a better mode of communications to identify and resolve image problems. Is was suggested that one way of resolving these problems would be for university people to spend sabbatical leaves with the Soil Conservation Service in the Washington, D.C., regional, or state offices. Such a move would require considerations regarding funding and commitment of other resources.

There was also a comment about the mistaken notion that a contact with the Experiment Stations in the various states would automatically result in contacts with Extension personnel. It should be recognized that in most states, the State Experiment Station and the State Extension Service are separate agencies, often housed far apart. Some expansion of contact possibilities could be gained by greater involvement of Extension personnel.

It is recommended that:

We do not need more information centers but we need to better utilize the ones we have, particularly the Extension Service.

Considering the many comments and opportunities for discord at the local, state and national levels within the NCSS, it seems appropriate that some thought be given to establishment of a national level task group to provide focus for receiving and responding to expressed concerns about'the NCSS. Certainly inputs are needed to expedite cooperation among the various involved agencies in some states.

General Recommendation: The committee should be continued.

Respectfully submitted,

B. L. Harris

B. L. Harris
Chairman, NCSS Image Committee

BLH/blb/dw30

Report of Soil Taxonomy Committee
Technical Committee 1 - Richard Guthrie, Chairman

Charges:

1. Reevaluate diagnostic criteria for fragipans

   a. morphological

   b. rooting restrictions

   c. chemical

2. Horizon designations for fragipans and other similar, but nonpedogenic, dense layers (till, paleosols, etc.).

   a. criteria for use of x (must horizon meet all requirements for fragipan or just exhibit brittleness)?

   b. consider use of Cd for dense tills as proposed by North Central Region.

3. Consider the advisability of adding fragic subgroups to Soil Taxonomy for dense, brittle layers which do not meet all requirements for a fragipan.

Members:

Neil Smeck
Pete Veneman
Gordon Huntington
Wayne Hudnall
Roger Haberman
Jim Baker
Bob Rourke

Technical Committee 1 proposes the following as recommendations:

Recommendation 1

Diagnostic criteria fcr fragipans - revise clues 4 and 5 of Soil Taxonomy, page 44, to include the following statement:

"The brittle matrix constitutes 60 percent or more of some subhorizon and is usually the interiors of coarse prisms that are more than 25 cm in diameter. Fine roots are virtually absent in the prism interiors. Bulk density is normally high, ranging from about 1.5 in soils with a moderate amount of clay to about 1.9 in soils with a small amount of clay. When the soil is dry, strength is >40N, and when moist, strength is > 20N (One Newton (N) = 1 kg - m/s^2).

Comments:

1. Morphological criteria are reasonably good, although they often must be applied subjectively in the field. Often one or more of the properties usually associated with fragipans is absent in a horizon that is identified as a fragipan. Degree of expression of fragipan properties has not yet been quantified nor has a unique set of soil forming processes been identified. Several committee members provided a list of properties which are summarized in the recommendations of this committee.

2. Rooting restrictions of fragipans are mainly the result of high bulk density and very firm or hard consistence, Minimum values for bulk density were suggested as a criterion for identifying root-restrictive horizons.

3. Chemical criteria received very little discussion. Most respondents indicated that fragipans are usually acid and do not form in calcareous materials. No new chemical criteria were suggested.

Recommendation 2

Horizon designations - revise horizon designations in Chapter 4 of the Soil Survey Manual as follows:

a. x Fragipan character

This symbol is used with "B" to indicate features resulting from brittleness, high strength, restricted rooting, and polygonal color patterns.

b. d Dense soil materials

This symbol is used with "C" to indicate non-genetic dense layers such as dense basal till.

Comments:

1. The concensus of the committee favors a new subordinate distinction d for horizon designations. Some would prefer to restrict the use of d to dense basal till C horizons, whereas others would prefer a broader application, to include other kinds of restrictive layers. The designation d would normally be used with C horizons.

2. The concensus of the members favors limiting the use of x to genetic horizons, specifically B horizons. It would designate fragipans or "fragipan-like" horizons.

3. The Horizon Designations Technical Committee is also addressing some of the same issues. The recommendations of this committee should be referred to that committee for coordination.

Recommendation 3

Fragic subgroups

Two kinds of "fragic" subgroups are provided:

1. Soils that have a fragipan below 1 meter; and

2. Soils that have a horizon with all the properties of a fragipan except that between 35 and 60 percent of the horizon is brittle.

No recommendations to delete existing subgroups was made, nor were there any new subgroups proposed.

Comments:

Response to the need for Fragic subgroups was mixed. Difficulties with quantifying degree of expression and estimating percentages of horizons having fragic properties make it difficult to establish criteria that can be applied consistently. As fragipans are diagnostic at the family level, Fragic subgroups imply intergrades to Fragi-great groups. Inclusion of soils with some, but not all properties of a fragipan, in Fragic subgroups may not be logical if the subgroups contain soils that are dissimilar otherwise.

No recommendation to delete existing subgroups was made, but new subgroups are not proposed. Criteria for recognition are provided if separations are needed.

Recommendation 4

Committee Status

That Technical Connnittee 1 - Soil Taxonomy - be continued for the next conference and that a current issue in Soil Taxonomy be selected as the charge.

TECHNICAL COMMITTEE 3--LAND CAPABILITY

Presented by Dick Johnson

Charges:

I. Is the Land Capability System still needed? Soils are now rated as prime farmland, unique land, soils of statewide -- importance, etc. Is the Land Capability System still useful and needed since new rating systems have evolved?

Yes, it is still needed. The Land Capability System is still useful and needed. The farmland criteria system--prime farmland, unique land, etc.--does not address the hazards and limitations of soils and is not designed to give guidance in grouping soils into management systems. Large segments of the public and private sectors have been exposed to the Land Capability System and it has been a useful tool for establishing communication between users of soil surveys. In addition, many states, counties, and other political entities have adopted various parts of the capability classification grouping into laws and ordinances that have bearing on land use, taxation, and other purposes. The Land Capability System is used in land evaluation of the LESA system for making land use decisions and serves as a check for the farmland criteria system which is also used in LESA.

II. In a rating system, should the natural condition or the improved condition or both conditions of the map unit be rated?

Hate for natural, improved, or both, depending on how the map units are designed. The capability classification assigned to a map unit should be dependent on how the map unit is designed. If the survey is designed not to separate the natural condition and the improved condition, then capability classifications should be assigned for both conditions. The feasibility of improvement changes through time and is dependent on the desire to make the improvement. Soils feasible for irrigation are a good example. Both a dryland capability and an Irrigated capability are useful and needed. Many counties have soil map units that are both irrigated and nonirrigated, and capability classifications are assigned for both conditions. Wet soils are another example where both conditions are needed. The creditability of a survey is diminished if there are significant areas of undrained soils that are too wet to crop and only the drained capability classification is assigned. Many times the feasibility of drainage is an onsite determination.

Even if drainage is feasible, it may not be desirable or could be prevented by law.

III. <u>How should the Land Capability System be applied to soil complexes and soil associations</u>?

The majority of those who responded to this charge of the committee supported assigning the capability classification to the individual components of soil associations and soil complexes.

Arguments for indivldual components:

A. Since other interpretations are based on the individual components, rating the capability on an individual component basis would lead to more uniform interpretations throughout. Woodland, rangeland, and all other interpretations are now made on an individual component basis. Map unit descriptions give the proportion of each component and the position of each on the landscape which should easily be recognized by the user.

B. A single capability classification assigned to a complex or association often minimizes or obscures the problems of one of the soils and hinders the ability to use the system for other interpretative purposes. For example, complexes of soils with highly contrasting management concerns such as a ridge and swale landscape would obscure either the erosion or wetness management concern if a single capability classification were assigned. To average the capability class or to assign the most restrictive capability classification does not seem adequate.

C. The procedure of assigning a single capability classification differs from one place to another. Some are dominant soil, some average, etc. Assigning a capability classification to components would lead to uniformity.

Arguments for a single capability classification:

A. Components in a complex occur in such a pattern that they cannot be managed separately. This argument was presented by Charles Kellogg on May 23,1966 (SOIL SURVEYS--Placement of Soil Mapping Units in Land Capability Units).

B. Capability classifications assigned to the individual components are more difficult to explain to the user.

An alternative would be to assign a single capability if the management concern is the same for all components and assigning capability to individual components if the management concerns are different for the individual components.

IV. Are there adequate classes and subclasses in the Land Capability System? If not, what classes or subclasses should be added?

Most responses to this charge were that the classes and subclasses were adequate. However, there were several that suggested changes in classes and subclasses. Recommend that classes and subclasses remain the same.

Suggested changes in classes:

Only five or six classes should be recognized since the primary purpose of the land capability classification is for cropland; classes I through IV suitable for cropland, class V suitable for improved pasture, and VI suitable for native pasture. Some thought that classes V and VI could be combined.

Suggested changes in subclasses:

A. Water erosion should be indicated differently from wind erosion. It was suggested that "e" be used for water erosion and "b" be used for wind erosion.

B. The "w" subclasses should be separated for those soils that have high water table problems and for those soils that have flooding problems. It was suggested that "w" be used for soils that have high water table problems and "f" be used for soils that have flooding problems.

C. There were several suggestions for separating the "s" subclass. One was to show "s" for soil properties and "r" for surface stones, boulders, and rocks. Another suggestion was to have subclasses for depth, "d," and for alkalinity or salinity, "a" and "s". It was suggested that the subclasses be assigned in a manner similar to the woodland ordination system.

D. It was also suggested that the "c" subclass for climate be split for low precipitation, short frost-free season, and permafrost.

V. Should dual subclasses be assigned to map units?

No. Responses to this charge were almost equally divided on the use of dual subclasses.

Advantage of dual subclasses:

Dual subclasses would give the land user or planner more information about the hazards and limitations of the soil. For example, a dual subclass of "ew" for wet soils on slopes greater than 2 or 3 percent would indicate a soil had management concerns of wetness and erosion.

Disadvantages to dual subclasses:

A. The system would become unmanageable with the addition of dual subclasses. It would enlarge any state, regional, or national summaries.

B. The secondary subclass should be handled in the map unit description. Assigning dual subclasses would detract from map unit descriptions.

C. Would increase the inconsistency between states and regions in assigning land capability subclasses. The development of guidelines for assigning dual subclasses would be difficult.

Since the secondary management concerns can be handled in the map unit description or land capability unit and the use of dual subclasses would lead to inconsistency and confusion, it is recommended that dual subclasses not be used.

VI. Are the proper hazards being evaluated or noted to arrive at an adequate placement of soils from a degradation of the environment standpoint?

Yes. However, other factors such as air pollution, acid precipitation, soil compaction, and fragile soils may have to be evaluated on the local level. These factors can be handled best in map unit descriptions and not in the Land Capability System.

VII. Should Agriculture Handbook No. 210 be redone?

Most responses favor a reissuance of Agriculture Handbook No. 210 if major changes are made in the system. An Agriculture Handbook is needed for those users outside SCS who would not have access to the National Soils Handbook. Most favored that the system also be a part of the National Soils Handbook for SCS use. Some favored the system being in the National Soils Handbook only.

The major criticism of the system is that classes are not defined precisely enough. This has led to some inconsistency among states. It has been suggested that a computer program could be developed similar to the program for important farmland criteria. The program would have to account for climatic differences.

(1). Recommend that draft prepared for National Soils Handbook be sent out for review after adding changes suggested for charges II and III.

(2). That subclass guides be reviewed and ajusted to reflect dominant management concern and not necessarily "e" having preference.

(3). Recommend that guides for assigning classes be developed by regions and be coordinated between regions where necessary. Computer checks for classes should be developed if practical.

REPORT OF
TECHNICAL COMMITTEE-5
SOILS 5's

Committee member response to the changes assigned to Technical Committee 5 were most gratifying. Only one committee member did not respond. However, responses were received from six individuals not officially [illegible] esigned to the committee. The interest in this subject is undeniable.

The responses were as varied as the number of respondents. They did confirm that the SCS-SOILS-5 form (Soils 5) has been and remains a very emotional issue. The responses also highlighted the different applications of the form by regions and/or agencies.

Among those commenting, there was total agreement that the Soils-5 has been, and continues to be a extremely valuable tool in making, interpreting, and using soil surveys. Without the Soils 5, our soil survey program would not be as advanced as it is today.

On the other hand, the majority of those responding agreed it is time to reevaluate the Soils 5. The main concerns are (1) the format is too rigid and (2) the programs for processing and receiving the Soils 5 are too rigid and require a new program for each new proposed table or output. A concern was also expressed that the Soils 5 does not include all of the soil properties that are needed to make sound soil interpretations and land use decisons.

These, and other concerns will be addressed in more detail under the four specific charges assigned to this committee.

Charge 1

Evaluate the existing SCS-SOILS 5 form to determine if:

a. A new form is needed to include interpretations used by other agencies for woodlands and ecological sites; or

b. The form should be completely reformatted to input soil properties, yields, and vegetative inventories only.

The majority opinion of the committee is that Soils-5 needs to be completely reformatted. There was less agreement on how to do this. The most common suggestion, with variations, is to make two or three separate input forms.

These would be:

1. Estimated soil properties

2. Measured soil properties

3. Agronomic Inventories

Form 1 would cover the existing Tables H, J, and K, and other roil properties to be added as discussed under Charge 2.

Form 2 would come through a marriage of the NSSL and state laboratory data with the Soils 5.

An alternative would be to combine forms 1 and 2 with appropriate codes to indicate if data is measured or estimated. In all probability, such an input form would be page size.

Form 3 would include the Land Capability rubclass, designation as prime farmland, yield data for both irrigated and nonirrigated crops, timber data, native plant cowunities and yields. and wildlife habitat inventories.

The most common comment is regardless of the final content and format, the data must be inputed in a format that will allow for total flexibility to add to and to manipulate and retrieve data in any format desired, preferably via interactive terminals. without writing a new program each time data is wanted in a different format.

The criteria for the interpretations would be maintained in the computer, and it would continue to make the ratings approximations as is done now. New interpretations would be added as needed as long as the soil properties used in the criteria are already inputed via the revised form 5 (forms 1 and 2 discussed earlier). Criteria for other agency or regional interpretations could also be stored and identified by agency or region. Criteria for state or local interpretations could be stored in compatible local computers.

This program would further permit the recall of interpretations in any combination desired by local users. It should also help ensure that only those interpretations needed for the intended use of the survey would be recalled.

Another suggestion is to completely reformat the Soils-5 and the Official Series Descriptions so that they are a single document. Each horizon would include not only color, texture, consistence, structure, roots, pores, reaction and boundary, but would also include the soil properties from the Soils 5 that apply to that horizon, i.e., percent clay, percent O.C., permeability, salts, K value, etc. Most committee members feel we need considerably more study on the inpact of this proposal before it is seriously considered. However, it vould seem feasible to write the revised Soils-5 program in such a way that this proposal could be implemented at a later date if it proves desirable.

Charge 2

Determine additional soil properties to include on the SCS-SOILS-5 to enable computer generation of additional interpretations.

No one soil property gained complete acceptance by the committee; properties some wanted, others did not. Again, regional biases surfaced, The following included all properties suggested by at least one person, many by a number of people:

1. CEC
2. SAR
3. COLE
4. Ponding (depth, duration, months)
5. $CaCO_3$ eq.
6. Base saturation
7. 1/3-bar and 15-bar water contents
8. Soil temperature - upper part

9. Slopes
10. Climatic data
11. Percentage of stones and boulders
12. Mean annual soil temperature
13. Mean summer soil temperature
14. Infiltration rate
15. Toxic elements
16. Fertility status
17. Bulk density (0-5cm or 0-10cm) when most erosion occurs
18. Bulk density of most dense 10 cm in upper 25 cm
19. Final infiltration rate when most erosion occurs
20. Final infiltration when most runoff occurs (use in place of permeability of surface layer)

The above list provides examples of the kinds of soil properties that can, and in fact do, influence different kinds of land uses.

The key to this charge may not be so much which soil properties are added, but that the program be written to permit the addition of soil properties as needed to improve on the uses of our survey.

Charge 3

Determine kinds of interpretations and develop criteria needed for higher order soil surveys, especially those conducted by the Forest Service (FS) and Bureau of Land Management (BLM).

The report of the Soil Interpretation Committee of the Western Region Work Planning conference (copy attached) was distributed to this committee. Host respondents felt these were valid interpretations, although most of the interpretations may have only regional application. Criteria are included for all the interpretations in this report.

Other suggested new interpretations for which criteria need to be developed include:

1. Susceptibility to the information of a tillage pan (susceptibility to compaction)

2. Waste management (disposal)

3. Limitation for tillage systems

    Fall moldboard plow
    Spring moldboard plow
    Full chisel
    Spring chisel
    No till
    Till plant
    etc.

4. Criteria for woodland interpretations

   Seedling mortality (by tree species)
   Windthrov
   Plan competition
   Erosion hazard
   Equipment limitation

5. Skid trails

6. Source of sediment

7. Urban development class ratings (similar to land capability system)

8. Wildlife ratings (proposed in 1978)

9. Define a "annual use sequence" for each survey (see attached paper by Dr. Grossman)

As in charge 2, a key point here is the program needs to be written in such a manner that new criteria for new interpretations may be inputted as they are developed, tested, and approved.

Charge 4

Draft a revised SCS-SOILS-5 as determined by the conference. Design for conversion to metric.

Time and uncertainity about the acceptance of part of this report precluded the drafting of a revised form at this time.

It would be advisable for this conference to retain this committee for another term to:

1. Draft a revised Soils-5 to include additional soil properties as charged by this conference.

2. Develop an agronomic form to expand this information.

3. Develop criteria based on soil properties for interpretations established by this conference.

4. Submit the above listed items to SCS, FS, BLM, Bureau of Indian Affairs (BIA), universities, and other cooperators to field test and return comments prior to the next National Work Planning Conference in 1985.

5. Provide the 1985 conference with proposals on the final revision and implementation of the Soils-S.

If the Soils-5 is reformatted in a program that allows for flexibility in manipulating and retrieving the data, it should also be programed to allow for retrieval in either metric or "standard" units of measure. The program should be such that both systems cannot be used interchangeably for a given job order.

Other suggestions for improvement of the Soils-5, not necessarily tied to a specific charge, are listed here without additional comment:

1. Expand the vegetation section for rangeland and include the four condition classes: excellent, good, fair, and poor.

2. Add eight or ten blank columns for inclusion of plant communities of value as wildlife habitat in the soil survey area.

3. Reorganize interpretations to reflect a more positive approach, i.e., suitabilities vs. limitations.

4. Avoid tables vith large blank areas.

5. Reformat the way we present atones and boulders on the tables.

Present format: STV-S IL, STV-L
Proposed format: STV:SIL, L

The proposed format would be a clear signal that stones and boulders are not textural modifiers when they occur on the soil surface.

6. Keep the input (and output) forms page site, even if it means more pages. This would allow for easier handling storage, and reproduction.

7. Appoint a subcommittee to investigate the feasibility of reformatting our soil interpretation criteria to reflect the cumulative effects of two or more limiting soil properties. This would probably require a numerical rating system of some kind.

Committee members

*Dick Kover, SCS, Chairman
*Jerry Harman, BLM
Gene Grice, SCS
Talbert Gerald, SCS
*Bob Meurisse, FS
James Carley, SCS
Sid Pilgrim, SCS
Keith Young, SCS
Harvey Terpstre, Iowa State University
Larry Munn, University of Wyoming
Harland Dietz, SCS
Carl Thomas, SCS
Terry Johnson, SCS

Others responding:

Earl Blakley, SCS
Dennis Nettleton, SCS
*Ted Miller, SCS
Wes Fuchs, SCS
*Bob Grossman, SCS
Dick Dierking, SCS

*Denotes attendance at the conference.

RECOMMENDATIONS

It is recommended that this committee be continued, and that it address the following charges:

Charge 1

Reformat the SCS-SOILS-5 to input measured soil properties where available, or estimated soil properties where the measured ones are not available; to enlarge the native plant community section; and to revise the wildlife section. Reformatting will be as-directed by the 1983 conference.

Charge 2

Reformat both input and output forms to page size. Make the input form(s) a single page, if possible, otherwise make it a fold out (four-aide) format.

Charge 3

Develop criteria for new interpretations as directed by the 1983 conference. Retain the concept of the present ratings approximation program, to be expanded upon as needed for new or revised interpretations.

Charge 4

Work with ADP specialists to develop a computer program that will allow flexibility in adding to the program and in manipulating and retrieving the data-through an interactive computer.

Charge 5

Field test changes 1 through 4, for at least one field season.

Charge 6

Report back to the conference in 1985 on final proposal for revising the SCS-SOILS-5 and in implementing the proposals submitted.

Technical Committee 4 - Joe Nichols, Chairman

SOIL INTERPRETATIONS

Charges:

1. Soil Interpretations for Pedons - Develop an explanation of making soil interpretations for pedons (taxonomic units). The history and philosophy of this procedure should be explained. Coordination, data storage, and retrieval should be addressed as a philosophy and procedure. Explain application of soil interpretations for pedons such as onsite investigations and modeling, such as soil moisture or yield models. How do we, or should we, make soil interpretations at different levels of Soil Taxonomy? Begin with soil series. Address the part of soil phases in interpreting levels of Soil Taxonomy.

2. Soil Interpretations for Soil Maps - Explain the procedure for adapting soil interpretations for soil pedons to soil areas or soil maps. Do we make any interpretations for soil maps of the five orders of soil survey, including soil maps generalized by cell procedures and by cartographic procedures where legends are also simplified? What kinds of interpretations should be made for soil maps of the different orders of soil survey?

3. Guides for Soil Survey Interpretations - Present soil interpretation guides are: (a) essentially those that weigh soil characteristics such as soil potentials or yield models; (b) those that do not weigh soil characteristics such as interpretations for septic tank filter fields; and (c) those that report observations or measurements on soils such as tree growth and yields, and crop yields. Make a listing of the guides now in use.

National Work-Planning Conference - Technical Conittee 4 Members

David Anderson, Soil Conservation Service, Fort Collins, CO
Randy Brown, University of Florida, Gainesville, FL
Ray Diedrick, Soil Conservation Service, St. Paul, MN
Kermit Larson, Forest Service, Rosslyn, VA
Gerald Latshaw, Soil Conservation Service, Portland, OR
Donald McCormack, Soil Conservation Service, Washington, D.C.
Dave Moffitt, Soil Conservation Service, Lanham, MD
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Roy Smith, Soil Conservation Service, Lincoln, NE
Al Southard, Utah State University, Logan, UT
Byron Thomas, Bureau of Land Management, Portland, OR

A History and Philosophy of Making Soil Interpretations Related to Soil Surveys

Abstract - Interpretations were generalized for family, forestry, and range uses in the first 30 years of the soil survey. In the middle 1930's soil map scales increased from 1 to about 4 inches per mile for use in on-farm planning. Use of interpretations grew rapidly. Complex soil mapping units were first recognized in this period. Multitaxa mapping units began in 1934 and the concept of taxonomic units and mapping units followed, likely as a result of the multitaxa unit concept. World War II was the beginning of rapidly accelerating interpretations for engineering uses. Improved interpretations for forestry and rangeland were made in the late 1940's. In the late 1960's, and early 1970's, the concept of Orders of soil surveys was developed. Better coordination of interpretations and computer storage and retrieval was accomplished during the late 1970's.

Early interpretations for soils tended to be for soils collectively. Even after soils began to be recognized as natural occurring bodies, interpretations were made in general for large bodies of soils.

The 1900 Report of the Field Operations of the Division of Soils, USDA (second report) has a section on a survey in the Raleigh area of North Carolina. There were 18 soil types. Interpretations are given in the mapping unit descriptions and are for suited uses for kind of crops, forest, and fruit trees. There is information on tillage in some of the mapping units. and mention of the need for fertilizer in other units. The only quantatative figures are for crop yields. Negative features or negative suitabilities are not given. No inclusions we're mentioned in the map units. I assume the writers were describing the dominant soil in each map unit, then interpreting that soil for uses. The common map scale during this period was 1" equals 1 mile.

By the middle 1920's there was slightly more detail in the interpretations in the mapping units. Some rather specific fertilizer recommendations were being made. There were some statements on soil erodibility and the effect of erosion. Dr. H. H. Bennett was able to get attention from emphasizing the erosion of the soils during this period. The naming and explanation of surveys had changed little by this time. Dr. C. E. Kellogg made a statement in his Pamphlet on Soil Interpretations that less thought was given to soil survey interpretations in the first 30 years of the survey. Soil classification had been evolving during this period. Part of the influence was due to the study of the soil in the U.S., and part due to the translation of Glinka's work on soil classification.

In the middle 1930's the use of the soil survey for on-farm planning was emphasized. The summary of the Annual Report of the Soil Erosion Service for 1934 states that the small scale maps made by the USDA (meaning the Bureau of Plant Industry, Soils, and Agricultural Engineering) were of too small a scale for planning, and they were making their own larger scale maps. We then had two soil survey programs until 1952.

Recorded events in recognized publication follow testing in the field by several years. The first correlation of a multitaxa unit, documented in a soil survey report, was in 1934 in Nebraska. This event may have marked the largest single change in the concept of a taxonomic unit and mapping unit in the history of the survey. Soil scientists had to consider taxonomic and mapping units separately and think about interpretations for each named soil. The effects of this new procedure spread slowly, as some surveys had no complex units into the late 1930's. The concept of taxonomic units and mapping units with inclusions of other soils developed during this time. The concept is well explained in the 1951 Soil Survey Manual. The kinds of mapping units are also explained in this document.

The 1940's were the beginning of the rapidly accelerating rate of making and using soil survey interpretations. Engineering interpretations of soils were begun during World War II. They continued after the War with the cooperation of the Bureau of Public Roads. Interpretations for engineering uses focused attention on the use of interpreting soils on larger and smaller scale maps than normally used for planning on farms. Onsite use presented special problems in communication with engineers and planners.

In the late 1940's interpretations were improved for forest and rangeland use. In 1955 Or. Kellogg reported in his annual report to his supervisor that interpretations in soil survey reports included: engineering predictions; forest site indices; range site; capability groupings; and other special groupings.

In the 1960's the use of soil maps in planning grew rapidly. Much of the planning was for broader scale generalized maps. L. I. Bartelli, Leonard Wohletz, and many others worked on the rapidly expanding use of such maps. The interpretive maps for various uses were often colored. The program of interpretive maps being generated from computer-stored data was worked on by people all over the Country. This program expanded greatly when the SCS's Southern Regional Technical Center introduced such a program, adapted from the USFS's MIADS computer mapping system. Computer generated maps brought another problem into focus, and that was that the easiest way to rate each cell was to give it one rating. The option for dual ratings was given, but no one took the option. Although interpretations were made by taxonomic unit, assignment of limitation ratings was done by some sort of averaging of the taxonomic interpretations, or taking the most limiting interpretation.

In the late 1960's soil mapping increased on land where low intensity uses, such as range or low value forest lands, were predominant. The terms "detailed" and "reconnaissance" soil survey did not adequately explain the new kinds of survey. Reconnaissance soil survey was a dirty word to some makers and users of soil surveys. A national task force produced the concept of Orders of soil survey in 1973. This system forced soil scientists to look much closer at the kind of mapping unit. Characterization of mapping units had been done by quite a number of researchers on a statistical basis. The transect methods used by many, and tailored and defined by Steers and Hajek for Order 3 mapping, added greatly to the characterization of soil mapping units.

Coordination of soil survey interpretations across State lines was edicted by an SCS Advisory in 1943. Considerable effort went into coordination of interpretations by phases of series. Coordination of soil survey interpretations was greatly improved with the adoption of the Soils Interpretations Form SCS-SOILS-5 because the information began to receive wider use. Guides for many of the non-agricultural interpretations were assembled and improved at this time. We have well developed techniques for using these coordinated interpretations with Order 2 surveys. They can be adopted to Order 1 surveys without major problems. We have not solved all of the problems of interpreting Order 3 and Order 4 surveys. We may not have the best answer to making interpretive maps using any order of survey.

We now have relatively precise techniques for designing soil mapping units, using kinds of mapping units, orders of soil surveys. varying map scales, the concept of minimum delineation, and a classification system that allows use of any of the categories of classification. Our techniques of interpretations have lagged behind our capability to divide, combine, scribe. and store in a computer.

I.2 Coordination, Data Storage, and Retrieval as a Philosophy and Procedure

Coordination of interpretations is necessary if we are to properly utilize the benefits of classification and the interaction between soil classification and interpretations. At this time coordination of interpretations is only by phases of soil series. If families are to be widely used, we would need to coordinate them for use.

Data storage and retrieval has greatly increased the coordination of the phases of series level with the SCS-SOILS-5 form--Iowa State University project. Data can be retrieved through the SCS NTC's for manuscript tables, through SCS State Office Harris terminals for interpretive tables and single phase interpretations, and through the CERL (Corps of Engineer Research Laboratory) program at the University of Illinois for special projects. The data from the Iowa State University Laboratory can be adjusted for soil survey areas with word processing equipment at NTC's, and to a lesser extent with the Harris equipment at SCS State Offices.

1.3 Application of soil interpretations for pedons

1.31 Onsite investigations - After the phase of the soil series is identified at the site, the interpretations can be taken from the Soil Interpretation Record. Some engineers prefer using the actual data from soil tests for engineering uses from the survey area rather than the estimated properties from the soil interpretation record.

1.32 Modeling - Data for modeling usually must be taken from several sources. Climatic data is usually taken from the nearest weather station, although averages could be used. Similarly, average data for soil characteristics from the ranges or from a specific site can be used. USDA-ARS personnel working on the epic model prefer to use physical and chemical data from an actual site, rather than from an average situation.

1.4 How do we or should we make soil interpretations at different levels of soil taxonomy? Begin with soil series.

1.41 Soil Series - We make interpretations for phases of series. This is the taxonomic unit. The interpretations are made by using the applicable guide with selected soil characteristics or observations in yield estimates.

1.42 Soil Families - We have limited experience interpreting soil families. Certainly phases would be required. Interpretations could be made by using the applicable guide, then using the range in soil characteristics applicable for the family. Fewer uses could be interpreted--at least as narrowly. An exmaple is where the family could include ratings for septic tank filter fields from slight to severe because of permeability or soil depth variations. Interpretations by observations should present no particular problems. Interpretations for families could be coordinated and used as in our "SOILS-5" program.

1.43 Subgroups - We still need phases. However, the range of soil characteristics here would be so wide that going to guides would likely be a lesson in frustration. A skilled soil interpreter could adapt observations. They could examine a few guides such as the wildlife guide, and make some broader interpretations. Interpretations should be at a broader scale, such as farming, grazing, pasture, forestry, etc. Although interpretations are difficult to give for specific uses, a soil interpreter could select areas that would be the best place to look for uses such as a new highway location, by avoiding floodplains, mountains, wet soil, high shink-swell clays, etc.

1.44 Great Groups - Again, phases would be needed. Not much would be gained by going to guides. Interpretations should be from observations or from a highly skilled soil interpreter. Interpretations should be on a broader scale, such as for farming, saw logs, firewood, grazing, etc. Soil maps using Great Groups would be small scale, i.e., 1:250,000 to 1:1,000,000.

1.45 Suborders and Orders. Soil maps of these categories would be made principally as an exercise in soil classification. Only very broad interpretations could be made from such an exercise.

1.5 Soil phases as we use them are very helpful, but not without problems. My definition of a soil phase is that it is a subdivision of a classification category. This is the concept in the 1951 Soil Survey Manual. The new draft of the manual, though, allows attributes, such as character of the deeper substratum, that are outside the classification system to be used as phases. Using gullied phases and rocky phases seems to be straying too far from the concept. Soil families were designed to be useful for interpretations. They would be much more useful if depth had been included at the family level. We can use depth at the phase level and would need to do so for many families.

The soil phase is a necessary technique for dividing soils from classification categories into useable limits. Slopes are a good example where phasing is preferred to building in slope groups at a higher level (which I assume would be an alternative) because the effect of slope on soil properties varies with the properties.

2. Soil Interpretations for Maps

2.1 - Procedure for adapting soil interpretations for soil pedons to soil areas or soil maps - While the committee did not agree unanimously, the majority stated that we interpret only taxonomic units. An example is where Alpha and Beta soils are in a complex and the range site is different for each soil. We shift our interpretations from the two taxonomic units to the map for use by the ranchers and range conservationist. We tell them, though, that within the delineations are to two range sites. We don't tell them in tables that there are other included soils and they likely do not want to know. We do tell them about inclusions in the mapping unit description if they care to read this information.

Where there is only one soil named, the interpretations are shifted directly from the taxonomic unit to the soil areas. Inclusions are mentioned only in the mapping unit and not in the tables. We are careful to explain that soil maps are for planning of relatively extensive uses. If people are interested in onsite type interpretations, they need an onsite investigation survey or examination for any use that requires an area smaller than the minimum-size delineation on the map. My idea also is that the soil map and the onsite investigation are only for planning or very simple design of low cost construction, such as terraces. A high cost project should involve testing. An example is that a football stadium might be larger than the minimum delineation, but would require that testing be used in the design because of the cost of making a mistake.

Multitaxa units are most useful when the location of the soils within the delination is not important to the user. An example would be in a delineation to be farmed, where the farmer needs to know that a complex exists in the field and that part of the field is shallower than the rest, but he doesn't need to know where the areas are. They are too small to be treated separately. This is also true for a rancher using an Order 3 association of two soils. The stocking rate may need adjusting, but the rancher can't afford to fence each soil separately.

2.2 - Interpretations for soil maps of Orders of survey - Attachments 1, 2, and 3 give examples of Orders and uses. This question is the most critical and controversial of the problems listed. Some items generally agreed upon include:

2.21 - We do not have many problems interpreting Order 1 and 2 soil surveys.

2.22 - We do not have problems on techniques for interpreting Order 4 and 5 surveys.

2.23 - We do have problems and disagreements interpreting Order 3 soil surveys.

2.24 - Generally, but not unanimously agreed, that we can interpret for septic tank, dwellings, roads and streets, etc. in Order 3, but not Order 4. The vote was 8 to 2.

2.25 - The vote on splitting legends was about 6 to 5 to split legends.

2.26 - The majority favored placing Order 2 and 3 surveys in the same tables for interpretations (7 to 2). I have never favored this, but am willing to give up.

2.27 - The committee agreed that they would be more willing to go to higher categories if interpretations were easier to make (9 to 3).

2.28 - The committee was not willing to go to higher categories if naming three soils still did not name 75 percent of the soils in a mapping unit. This question must have not been worded correctly as the majority of the group did agree that phases of families should be used in Order 3 mapping (7 to 2).

2.3 - When we make an interpretive map the delineations can be given one rating (the usual method) shaded by degrees for up to about 8 levels, or given intermediate ratings such as slight and moderate. The interpretations are made for the taxonomic named parts of the mapping unit.

National Work Planning Conference
Technical Committee 4
Charge No. 3

Guides for Soil Survey Interpretations

Present soil interpretation guides use three methods of presentations. The method and the interpretations for each method are listed under a, b. and c. There is a somewhat indistinct boundary between soil interpretations and observed soil properties. An example is available water capacity (AWC), which is a measured soil property but can also be estimated from guides. Such properties are not a part of this list.

a. Essentially those methods that weigh soil characteristics.

1. LESA, Land Evaluation
2. Soil Erosion Factor (K factor)
3. Soil Potentials
4. Wildlife Habitat Suitability - Potential as a Habitat for:

    Open Wildlife
    Rangeland Wildlife
    Wetland Wildlife
    Woodland Wildlife

5. Yield models - EPIC

b. Those methods that do not weigh soil characteristics.

1. Building Site Development

    Dwellings With Basements
    Dwellings Without Basements
    Lawns, Landscaping and Golf Fairways
    Local Roads and Streets
    Shallow Excavations
    Small Commercial Buildings

2. Construction Material

    Gravel
    Roadfill
    Sand
    Topsoil

3. Recreational Development

    Camp Areas
    Paths and Trails
    Picnic Areas
    Playgrounds

Charge No. 3 (Continued)

4. Sanitary Facilities

Daily Cover for Landfill
Sanitary Landfill (Area)
Sanitary Landfill (Trench)
Septic Tank Absorption Fields
Sewage Lagoon Areas

5. Water Management

Drainage
Embankments, Dikes and Levees
Excavated Ponds Aquifer Fed
Grassed Waterways
Irrigation
Pond Reservoir Area
Terraces and Diversions

6. Other

AASHTO
Capability Units
Frost Action
Hydrological Group
Potential Frost Action
Prime Farmland
Soil Corrosivity
T Factor
Unified Engineering Classification
Wetlands
LL
PI
AASHTO Engineering Classification
Unified Engineering Classification

Wildlife Habitat Suitability - Potential for Habitat Elements

Conifer Plants
Grain & Seed
Grass & Legume
Hardwood Trees
Shallow Water
Shrubs
Wetland Plants

Woodland Suitability - Management Problems

Equipment Limitations
Erosion Hazard
Plant Competition
Seedling Mortality
Windthrow Hazard

Charge No. 3 (Continued)

c. Those methods that report observations on measurements on soils.

1. Crop Yields
2. Grass Yields
3. Pasture Yields
4. Tree Growth and Yield--including windbreaks

Recommendations.

1. That we use the phrase "We interpret phases of taxons."

2. That we continue to better quantify interpretations by determining those soil characteristics that are the best predictors of uses and build them into guides.

3. Phases should be subdivisions of taxons or at least be compatible with taxons such as substratum phases. Rock outcrops and gullied land do not meet this criteria and should not be used as phases of soil series.

4. As evidenced by comments from committee members, and by answers on the questionnaire, we can agree reasonably well on what we should interpret. Agreement was not as good as interpreting the order of soil survey. At least part of the problem may be the complexity of our map unit design. We can vary our map units with orders of survey, kinds of mapping units, and categories of classification. There are 5 orders, 4 kinds of surveys, and 6 categories, for a possible 120 combinations. We regularly have. or should have, 15-30 possible combinations in the South. We may have trouble explaining this much variation to ourselves, and even more to the user.

   One concept would be to maintain a certain level of predictability of mapping units by varying one or more of our three components. This is seemingly our goal at this time, as the soil handbook mentions no more than 25 percent non-limiting inclusions under kinds of mapping unit.

   The following table lists as option 1 what we are doing now. Does the handbook refer to Orders 1 to 5 or only 1, 2. and 3? Option 2 allows for a progressive reduction in predictability with increasing orders.

Order of Survey	Percent Named and Similar Soils	
	Option 1	Option 2
1	75	80
2	75	75
3	75	70
4	75	65
5	75	60

   The recommended procedure is intended to be compatible with the recommendation of Committee 5 of the 1981 National Technical Work Planning Conference on confidence limits in charge 1.

National Work Planning Conference
of the
National Cooperative Soil Survey
March 28 - April 1, 1983

Committee Number 6: Horizon Designations Technical Committee.

Charges:

1. Solicit and summarize problems relating to field application of new horizon designations.
2. Develop paper on philosophy of new horizon designations and define concepts we are attempting to get at with these designations.
3. Evaluate need for additional subordinate designations.
4. Evaluate past studies and define current problems in achieving uniform application in identifying paralithic contacts.

Introduction:

The preliminary work for the committee was done by correspondence. A set of questions was circulated with request for comments on those questions and on concepts not covered by the questions. The preliminary report was prepared by the committee chairman. A discussion session was held at the conference in Hashington, D.C. The preliminary report was adjusted to incorporate the later suggestions made during the conference.

Charge 1. Problems relating to field application of new horizon designations.

Recommendations:

1. For future use of the new horizon designations. Definitions of some of the designations need additional explanation and clarification.
2. Quantitative figures be given where possible to replace such wording as "significant."
3. Suffixes a, e, and i need clarification when used with the 0 horizon of Histosols and other wet soils with histic epipedons vs the use in subdivisions of the 0 horizon of dry Histosols and the thick duff layers over dry mineral soils.

Other Important Comments:

a. General consensus is that present designations are appropriate for describing and identifying subordinate distinctions within master horizons. There seems to be some question as to whether the definitions are adequate. Most of the inadequacy of the definitions relates to quantitative values for nodules, carbonates, sodium, sesquioxides, silica, silicate clay, plinthite, fragipan character, gypsum, and soils more soluble than gypsum. Guidelines for use of the letter "c" state that the symbol indicates a "significant accumulation....other than silica." The inconsistency among soil scientists in use of this symbol seems to relate to the term "significant."

b. Questions have come up about the use of CB and C/R. These two horizons are not given as examples in Chapter 4, although it is implied in Chapter 4 that these are legitimate designations to use. On page 42 of the 1/79 Draft, it is stated that the designation "C/B" is not used. This wording was left out of the present draft. In most cases, we probably have not used the designations CB or C/B even though the C material may have made up the greater volume. It seems the B part which represents pedogenic processes, though smaller in total volume than the C part, is more important and should be listed first, as BC or B/C. If we are going to allow CB and C/B, examples should be given on page 4-43.

c. The use of suffixes a, e, and i has caused some confusion when applying them to dry Histosols and duff layers. Some would prefer that these suffixes be used only with wet Histosols and other wet soils with histic epipedons. The would like to use subdivisions of the O horizon (O1, O2, etc.) to describe dry Histosols and thick duff layers over dry mineral soils. As Chapter 4 is presently written, the examples on pages 4-48 and 4-49 under "Sample Horizon Sequence" and on page 4-50 under "Depth and Thickness or Horizons and Layers" seem to support this approach. If the intent of Chapter 4 is for suffixes a, e, and i to be used with all O horizons and arabic numerals should be used only to subdivide identical O horizons, as Oi1, Oi2, etc., then all examples on pages 4-48, 4-49, and 4-50, and elsewhere in Chapter 4 where O1 and O2 are used should be corrected using letter suffixes a, e, or i. Another problem concerning the O horizon is where does the soil surface start? (page 4-27). The way Chapter 4 is now written, we can have the same soil that is shallow in Soil Taxonomy and moderately deep in Chapter 4. A good example would be a soil that has lithic contact at 18 inches and a 6-inch O horizon over the mineral soil.

d. There have been questions about the use of Bw designation immediately under a Bs designation. In the old system, some Spodosols which have had a horizon sequence of O1-A1-A2-B21ir-B22-B3-Cx. In the new system, would the sequence be Oi-A-E-Bs1-Bs2-BC-CR or Oi-A-E-Bs-Bw-BC-Cr? Although the B22 horizon in the old system contains considerably less iron and organic matter than the horizon immediately above it, many still prefer to designate it Bs and not Bw. It would seem reasonable to not allow the use of a Bw designation immediately under a Bs or Bhs designation.

e. There is some confusion about the use of "t" with transition horizons such as BA, BE, EB, or BC. This is no different than under the old system where some used "t" with B1 or B3 horizons while others preferred not to do this. It is stated in the first paragraph of page 4-47 of Chapter 4 that: "Lower case letter suffixes are not used with transitional horizons unless needed for explanatory purposes." In most cases Blt and B3t horizons in the old system will convert to Bt horizons in the new system. Could it be clearly spelled out in Chapter 4 which lower case suffixes can be used with transition horizons and which ones are not allowed. Perhaps some type of table can be developed to illustrate this.

f. In the area of organic soils, we should be using hemic, fibric, sapric, and limnic as texture designations. This is in keeping with Soil Taxonomy. Suggest the master horizon designation "L" for limnic material be reinstated.

g. As presently written in Chapter 4, the suffix "w" cannot be used in combination with t, h, s, g, and a number of other suffixes. It is, however, allowed with x. Suggest this not be allowed.

h. Additional clarification is needed in the proper use of the designation Oi, Oa, Oe, AB, BA, E/B and B/E horizons and the proper use of prime symbols.

Charge 2. Philosophy of new horizon designations and concepts we are attempting to get at with these designations.

Recommendations:

1. Develop composite of committee members' responses to charge 2. A paper can then be developed on philosophy of new horizon designations and concepts for using the horizon designations.

Other Important Comments:

a. Criteria for soil series differentia are based upon significant differences in soil properties which include related pedogenic horizon differentiation - if present. The significance can be reflected in the nature or degree of expression of one or more horizons. Horizon designations should connote and identify soil forming processes, but should be supported by well-documented morphologic descriptions.

b. Horizon designation is a method whereby information about a particular horizon is quickly transmitted or communicated. It is a method of highlighting some of the major morphological and pedogenic features. Symbols should be used only for this purpose. They should not be used in an attempt to convey all of the information that is observed and described in a horizon.

c. We arrive at connotative symbols by observation, experience, etc., of what we believe is the genetic development pathway in the pedon we are describing. We put them on the field as part of the word description of the soil. That is, a symbol summation of our interpretative observations about the genetic meaning of the properties we described in the profile description.

d. Horizon designations are helpful in interpreting the word description of the soil properties we have described in the word picture of the individual horizon and soil pedon. The horizon designations are most useful when accompanied by a description of the observed properties made by examination of the soil (pedon). They, plus the description, furnish an estimate of what the describer thought was the genetic development at the site when he described it.

e. There are presently six (6) master horizon symbols and some twenty-two (22) subordinate symbols available for use. The six master horizons seem about optimum for use. Twenty-two subordinate symbols seem excessive. Someone has previously observed that about seven to ten items for remembrance and immediate recall is about all that the average individual can handle. Have we gone overboard in our attempt to convey information about a soil horizon by symbolization? Can we, or do we want to symbolize color, texture, structure, pH, and all the other properties of a soil? Symbolization could be developed by which all properties of a soil could be described and no narrative description would be necessary. The presently existing symbolization might contribute to a decreasing quality of clear and concise descriptions of soils. Some describers seem to believe that if a property is indicated by a symbol there is no need for a narrative. Symbols are helpful to soil scientists to some extent but are also confusing in that some of symbols might be indicative of a diagnostic horizon.

f. Some soil scientists would like to see the new horizon designations equivalent to the diagnostic horizons of Soil Taxonomy. They would like to be able to classify the soils by looking at the horizon designations (e.g., "t" would be equivalent to argillic, "w" equivalent to cambic, "h" or "s" equivalent to spodic; etc.). It is difficult to explain to some users of soil survey information that genetic horizons are not the equivalent of diagnostic horizons of Soil Taxonomy. It would, of course, be good and would make things simpler if they were.

Since diagnostic horizons of *Soil Taxonomy* are quantitatively measured properties used to separate classes, it is impossible for them to ever consistently be equivalent to genetic horizons.

g. We use horizon designations to indicate some unique observable property of the soil. Designations are used to express the investigator's qualitative (and to some extent quantitative) judgement about certain soil properties. The rules for using horizon designations should be such that most investigators, looking at the same layer, will use the same designation in describing it. It is important that horizon designations be applied uniformly. To help maintain uniformity in the application of horizon designations among investigators, there should be some kind of minimum quantitative requirement built into the definition of each symbol. For example, "x" would not be used unless there was enough genetic brittleness to influence use and management of the soil, say 30 percent or more of the volume; a "t" would not be used unless there was "common" (25 to 50 percent) ore "many" (more than 50 percent) clay films; etc. It is difficult to build quantitative requirements into the definitions of horizon designations, but if we could, it would lead to more objective descriptions and a more uniform application of horizon designations. We need to get away from such vague terms as "significant" and "enough" in our definitions.

h. We arrive at connotative symbols by letting symbols represent as few soil properties as possible. For example, "t" should always translocated clay and nothing else; "x" should represent genetic brittleness or fragipan character; "r" should represent weathered bedrock that can be dug with difficulty with a spade; etc. As presently written, some of our symbols are too broadly defined (e.g., "r" is allowed to cover too many materials). By narrowing the definitions, symbols will become more connotative. Symbols with some kind of minimum quantitative requirements and narrow definitions will be helpful in determining properties of the soil at future dates and also serve the purpose for which they are intended.

Charge 3: Evaluate need for additional subordinate designations.

Recommendations:

1. Recommend that the suffix "d" be introduced for dense, unconsolidated sediments to indicate dense, root- restricting layers that are nongenetic. The following definition is suggested:

   d-- Dense unconsolidated sediments. This symbol is used with "c" to indicate naturally occurring or manmade, unconsolidated sediments with high bulk density, Roots do not enter except along fracture planes.

2. Recommend that the definition for the suffix "r" be changed to the following:

   r-- Weathered or soft bedrock. This symbol is used with "c" to indicate soft bedrock or saprolite, such as weathered igneous rock; partly consolidated soft sandstone, sillstone, and shale. Roots cannot enter except along fracture planes. The material can be dug with a spade.

Other Important Comments:

a. Reclamation of surface mined areas often result in soils with numerous compacted layers. These layers are relatively thin and horizontally discontinuous but they inhibit root growth. Possibly this condition also merits a special suffix.

b. No one in the Northeast is happy with the use of "r" to indicate dense glacial till. The northeast, therefore, is in favor of introducing "d" for "dense layers" or "densipan" to indicate dense till or other root restricting layers that are nongenetic. This could be any dense layer that has developed from stress loading or other nongenetic processes such as dense till; lacustrine; dense consolidated gravelly layers; hardpan developed from the activities of modern man; etc. If we do not adopt "d" to indicate dense till, we in the Northeast would prefer that "r" be discontinued for this use and no subscript used. We would prefer to just describe the properties of the dense till in the C horizon description and let it go at that.

c. Many people feel that Cr horizons should be used only on soft rock (paralithic material) and should not be used on firm unconsolidated sediments such as glacial till or other material that is dense enough to inhibit root growth. This feeling was strongly expressed at the NCRWPC at Fargo, North Dakota, this past spring. We recommend the two be separated.

Charge 4: Evaluate past studies and define current problems in achieving uniform application in identifying paralithic contacts.

Recommendations:

1. The following are recommended changes in the definitions in Soil Taxonomy:

   Lithic contact

   A lithic contact is a boundary between soil and coherent underlying material. Except in RupticLithic subgroups the underlying material must be continuous within the limits of a pedon except for cracks produced in place without significant displacement of the peices. Cracks should be few, and their average horizontal spacing should be 10 or more. The underlying material must be sufficiently coherent when moist to make hand digging with a spade impractical, although it may be chipped or scraped with a spade. Chunks of gravel size that can be broken out must not, when air dry or drier, slake within 24 hours when placed in water. The underlying material considered here does not include diagnostic soil horizons such as a duripan or a petrocalcic horizon. (A hardness by Mohs scale of 3 or more when the rock is composed of a single mineral may be used to help define a lithic contact.)

Paralithic contact

A paralithic (lithiclike) contact is a boundary between soil and continuous coherent underlying material. It differs from a lithic contact in that gravel size chunks of the underlying material that can be broken out when air dry or drier will slake within 24 hours when placed in water. When moist, the material can be dug with difficulty with a spade. The material underlying a paralithic contact is commonly a partly consolidated sedimentary rock such as sandstone, siltstone, or shale, and its bulk density or consolidation is such that roots cannot enter. There may be cracks in the rock, but the horizontal spacing between cracks should be 10 cm or more. (A hardness by Mohs scale of less than 3 when the rock is composed of a single mineral may be used to help define a paralithic contact.)

2. The following are recommended changes in the definitions in Chapter 4 of the Soil Survey Manual.

C horizons or layers

Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of O, A, E, or B horizons. Most are mineral layers, but limnic layers, whether organic or inorganic, are included. The material of C layers may be either like or unlike that from which the solum presumably formed. A C horizon may have been modified even if there is no evidence of pedogenesis.

Included as C layers are sediments, saprolite, unconsolidated bedrock, and other geologic material that commonly will slake within 24 hours when air dry or drier chunks are placed in water and, that when moist can be dug with a spade. Some soils form in material that is already highly weathered, and such material that does not meet the requirements of A, E, or B horizons in overlying horizons. Layers, some of which will not slake in water having accumulations of silica, carbonates, or gypsum or more soluble salts are included in C horizons, even if indurated, unless these layers are contiguous to an overlying genetic horizon; when they are a B horizon.

R Layers Hard Bedrock

Granite, basalt, quartzite, and indurated limestone or sandstone are examples of bedrock that are designated R. Air dry or drier chunks of an R layer when placed in water will not slake within 24 hours and the R layer is sufficiently coherent when moist to make hand digging with a spade impractical, although it may be chipped or scraped. Some R layers, when fractured, can be ripped with heavy power equipment. The bedrock may contain cracks, but these are few enough and small enough that few roots can penetrate. The cracks may be coated or filled with clay or other material.

3. The following are recommended changes in the definitions in section 407.1(a)(3)(XXIV) of the National Soils Handbook.

   Soft Bedrock

   Soft bedrock is likely to be sufficiently soft so that excavations can be made with trenching machines, backhoes, or small rippers and other equipment common to construction of pipelines, sewerlines, cemeteries, dwellings or small buildings, and the like. It can be dug with difficulty when moist with a spade.

   Hard Bedrock

   Hard bedrock is likely to be sufficiently hard or massive when not fractured to require blasting or special equipment beyond what is considered normal in this type of construction (i.e., pipelines, sewerlines, cemetaries, dwellings, or small buildings). If fractured it can be excavated.

4. The following are recommended changes in the Soil Interpretations Record (SCS-SOILS-5 form).

   a. The symbols UWB and WB should be eliminated since the determination of weathered or unweathered is not significant to the interpretations. Instead the presence of bedrock will be indicated by writing in the words HARD BEDROCK or SOFT BEDROCK as appropriate.

   b. On the soil interpretation record an additional term is to describe bedrock. That term is Fractured. This would eliminate the need to classify excavatable fractured hard bedrock as SOFT in order to obtain the correct interpretations. An additional blank should be added under the bedrock column for Fractured.

c. If the rock is fractured the horizontal spacing of the fractures will be entered in this column. If the rock is not fractured, this column will contain a dash. If the soil contains both soft bedrock and hard bedrock, and the hard bedrock occurs at depths of less than 60 in the profile, the "depth" column will indicate the depth to the hard bedrock.

	BEDROCK	
DEPTH	HARDNESS	FRACTURED

The above recommended charges are to be sent out for review for comments and suggeted changes before they can become a final complete recommendation.

Recommend that this committee not be continued.

Committee Members:

Louis Buller
Terry Cook
Richard Fenwick - Chairman
John Meetze
Ivan Ratcliff
Jerry Simonson
Horace Smith
Marty Townsend
Robert Turner

NATIONAL TECHNICAL WORE PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

March 28 to April 1, 1983

Report of Standing Committee II - Moisture in Soils

MEMBERS
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INTRODUCTION

The report consists of a body and three appendices. The first appendix gives detailed instructions for completion of the water information records. The second discusses application of the records. The third is the set of records completed since the 1981 meetings. The 1981 report contains additional records. The records for the 1981 report were mostly done by committee members through correspondence with the current chairman. For this report, the chairman provided instruction on completion of the records locally and participated in their completion. Travel by the chairman was paid for by the AgRISTARS project; the assistance of R. H. Gilbert is greatly acknowledged.

Twenty sessions were held with regional and state SCS people, with about half in the Northeast. At most of the sessions, the senior state office soil survey staff was present. Usually only one record was completed in a session. The objective was to train people, obtain their reaction, and become exposed to problems. It was not to complete a large number of records. One hundred and two people participated in the exercises. Thirty-eight of the people were from disciplines other than soil science, such as conservation agronomists and hydraulic engineers.. The committee wishes to thank all the participants, and in particular the people from disciplines other than soil science.

The record for the Harney series has facing pages which explain the entries in general terms; Examination of the Harney record may be a good initiation to the format. In brief, the first page of the record contains information that pertains to the soil series. The back side and additional pages provide information on combinations of mapping concepts that involve the series under consideration plus specific uses of the mapping concept. The information maybe based entirely on estimates with little or no supporting data; or it may be based on the extension of some data to make estimates; or finally, it may represent the reduction and generalization of a considerable body of measurements to a standard format. The 1981 report contains several records of the last kind. No such records were developed for this report. The record for the Kyle series from the 1981 report is included to illustrate a record that involves a reduction of a large body of data. The use of the record to reduce extensive sets of measurements is an important application. Extensive sets of field measurements are scarce and expensive. In order for them to be utilized in the soil survey program, they commonly need to be reduced to a format that would be generally understandable and would facilitate comparison to estimates.

Comparison of the records for Kuma (Aridic Argiustoll) with those for Harney (Typic Argiustoll) illustrates how soil use and landscape relationships may change the relative water regimes from what would be predicted from taxonomic placement. Kuma is taxonomically drier but the water regime assigned differs little from the example for Barney. A map and a summary follows the Kuma record.

SPECIAL TOPICS

Computed Pattern of Water States

The EPIC model (Erosion-Productivity Impact Calculator) has the capability with slight modifications of calculating the yearly pattern of water states (Item 8 of the soil moisture record) for up to 10 layers. The calculated water state pattern is specific for a given laboratory data set (Item 4), a particular long-term weather station record (Item 3), and a soil use (Item 6). J. R. Williams, ARS, Temple, Texas, has been so kind as to make the computations for Estacado Deep Chisel, for Vergennes and for Sharpsburg winter wheat. The computations of the pattern of water states by the EPIC model are in the appendix containing the set of records under the appropriate soil series. Comparisons are made individually in the appendix. At this juncture, too little has been done to generalize. It is hoped that in the future, the pattern of water states can be initially computed by a model. People with a knowledge of the particular soil and its use would then evaluate and modify the computed pattern to produce the final record.

Comparison of Water Information Records Completed by Different Soil Scientists

Consistency in completion of water information records among soil scientists was explored for the Sharpsburg silty clay loam, 2 to 5 percent slopes, mapping unit as it occurs in southeastern Nebraska. Corn under conservation tillage and winter wheat were both evaluated. Three experienced soil survey leaders, currently working where Sharpsburg is mapped, participated first in a session at which a water information record for an appreciably different soil from Sharpsburg was completed. Each of the three soil scientists was then interviewed on separate days during the remainder of the week and water information records were completed independently. The soil scientists were not strongly coached. A few guidelines were established, however, and obvious errors were pointed out. One guideline was that if Dry, the zone would be considered Slightly Dry.

Another guideline was that Slightly Dry does not occur beneath the upper most 25 cm. These guidelines are based on observations by the chairman during the 1974 drouth in southeast Nebraska. Additionally, the soil scientists were asked to consider the relationship between the rooting depth listed and the depth to which the soil would reach Slightly Moist. The comparisons are encouraging. The differences between 50 and 150 cm are probably in part related to the rooting depth estimations.

Tactile Evaluation of Water State Class

There is need to standardize tactile concept for the limits of the water state classes listed under Item 8 in the appendix which describes completion of the records. Work is in progress by the chairman with the Nevada SCS staff to supply soil material desorbed under 1500, 200, and 600 kPa. This soil material would be packaged in small quantities. The containers would be opened on a once only basis and then discarded. At intervals, the soil survey party would make a tactile examination of samples at known moisture suction to cover a range in textures. The current problem is to find cheap packaging that has a long enough shelf life to be practicable. The moistening procedure is simple and could be done locally.

Complete Temporal Characterization

The water information record is part of a larger need for the temporal characterization of soils under specified uses. At least five groups of characteristics would stem to be involved: (1) surface cover and configuration of the ground surface; (2) temperature of the upper part of the soil; (3) mechanical and water related properties of the near surface including strength and waterflow and retention; (4) root occurrence; and (5) the patterns of water state. Only the last is treated on a temporal basis in the current water information record.

Two preliminary examples of more general temporal records art included in the appendix of water information sheets. The records for Estacado were an initial attempt. Texas has a water management team for the High Plains working at Lubbock and Amarillo, Much effort has been expended on characterization of the tillage plan which strongly influences infiltration and root penetration by cotton. An appreciable body of bulk density information and final infiltration rate by the double ring method art available for the tillage zone of soils of the area. Bulk density and final infiltration rate art inversely related. Further, the Curve Number is affected by the infiltration rate and so is linked to the bulk density of the zone subject to compaction. The sheet is incomplete. Temporal rooting depths would be added as would estimates of low suction water retention as related to change in bulk density.

The other example is for the Sharpsburg series as used for winter hwtat. The soil occurs in southeastern Nebraska. The writer has collected considerable temporal data on near surface characteristics of Sharpsburg as used for winter wheat, which art summarized in Item 7. The regular water information record was completed independently by three experienced soil scientists. Information from one of the regular records is incorporated in the more complete temporal record.

RECOMMENDATIONS

1. Continue the Activity

Characterization of the water regime and the physical properties of the soil surface and near surface art needs which art becoming increasingly important as we shift into post mapping activities. Neither can be addressed unless soil use is specified and both require a temporal approach.

2. Develop An Overall Temporal Soil Properties Record

This would be a general objective which we would shift into as occasion permits. The sheets should eventually include surface cover and agronomic roughness; near surface temperatures; physical near surface properties such as consistence and bulk density; infiltration rate and other water entry evaluations; root information; and near surface water retention at low suction as related to bulk density. Such records would be used to assemble measurements and to apply modeling approaches such as the Gupta-Larson work in Minnesota on tillage zone bulk densities.

3. Emphasize Water Information Records for the High Plains (Texas, Oklahoma, Kansas, and Nebraska) the Northeast, and Nevada

These are areas where there is interest in water information records. Together they would encompass much of the range of soils of the country. The effort should involve reducing the major sets of field measurements which are available as well as obtaining estimates. Training would be conducted in evaluation of water state by tactile evaluation of samples at known water suction. For the High Plains, a more complete temporal data record would be employed in order to record the information now being collected.

4. Explore Computer Generation and Manipulation

Most of the information is generated from existing records, and this can be computerized.

The only truly primary information in the present sheets is the rooting depth, cover changes through the year, and the pattern of water states. Improvements can be made by using a model Otto Baumer is developing to compute water retention at suctions for which measurements are not available. The EPIC model or a similar approach would be employed to compute a preliminary pattern of water states. Other quantities can be modeled and the values used for initial estimates. Water contents can be attached to the water state classes. This then permits the computation of heat capacity, actual shrink-swell, crack expression, and probably other quantities. Finally, the pattern of water states can be used to generate diagrams for soil survey applications showing depths to water tables, dry zones, and other aspects of the water regime.

5. Increase Formalization

The modest effort since 1981 has involved about 100 people for varying lengths of time and at considerable expense. People have cooperated generously in the spirit of an exploratory effort. Much information has been exchanged and there is a widely held appreciation that the project makes sense. We need now to make major improvements in the record which would require large inputs by certain people. Such inputs cannot be requested unless the project is sanctioned as a National Office objective. The first step would seem to be an early small meeting to decide on objectives for the next 2 years. Several technical decisions need to be made and particularly as regards aspects of the record that impinge on the new Soil Survey Manual.

Appendix: Explanation of "Soil Survey Water-Related Information"

This is the second explanation and is referred to . . Explanation B. The record consists of two or more pages. Items 2 and 3 on the first page pertain to the series and Item 4 to both series and a phase or phases. The second and/or additional pages pertain to combinations of mapping concepts and specific soil uses involving the soil series stipulated on the first page.

ITEM 1

The number of records refers to the additional sheets beyond the series sheet as of the date indicated.

ITEM 2

The graph is for a station near the center of occurrence of the soil series. The discussion to follow is from a paper in publication by J. A. Thompson, et al., rir1.d "Computer Program for Obtaining Diagrams of Climatic Data and Soil and Water Balance."

The diagrams are obtained with a computer and a Calcomp plotter using the Fortran program CLIPLOT (available from the National Soil Survey Laboratory).

These diagrams give a simplified graphic picture of the soil moisture regime of a whole soil. They are based on average monthly values from long-term records for precipitation and temperature. The diagrams include potential evapotranspiration (PE) calculated from air temperature and from the available water capacity (AWC).

PC is calculated according to the Thornthwaite formulation and is adjusted for yearly temperature regime and day-length. Available water capacity is taken as the water retention difference to 2 meters or to the first impervious layer, whichever is shallower. An approximation may be obtained from the AWC for the correlated soil series. Utilization is defined as the PE needed to remove water retained in the soil at a tension of less than 1500 kPa. Deficit is the PE occurring while the soil is at or below 1500 kPa moisture. The calendar date when deficit begins is given.

Recharge begins when precipitation exceeds PE and continues until the available water capacity is filled or PE again exceeds precipitation. Surplus exists when precipitation satisfies available water capacity and continues to exceed PE. The period of surplus can be interpreted as the time when runoff from the soil is most likely, or for pervious soils, through-flow is the greatest.

Equal area projection is used to determine the location of vertical lines separating utilization from deficit in the diagram area UD or recharge from surplus in the diagram area RS. Four conditions are tested: 1, if AWC and RS exceed UD; 2, if AWC and UD exceed RS; 3, if RS and UD exceed AWC; or 4, if none of these conditions exist.

ITEM 3

The table gives the calculated soil moisture regime for the taxonomic moisture control section based on monthly precipitation and PE normals. The climate station is near the center of occurrence of the soil series. The calculation scheme was developed by Franklin Newhall (retired), climatologist, Soil Conservation Service. The table may be obtained through the Harris system. The computer program, MREG, for this purpose addresses a tape file of climate data with one control card.

The explanation to follow is taken from an unpublished paper by Newhall, "Calculations Of Soil Moisture Regimes from the Climatic Record":

The soil moisture profile: Extends from the surface down to a depth such that the available water capacity (AWC) between the surface and that depth is 200 mm.

The soil moisture control section (MCS): The upper boundary is the lowermost depth that dry (tension >1500 kPa but not air dry) soil will be brought to field capacity by 25 mm of water. The lower boundary is the depth to which the available water capacity of a soil is filled by 75 mm of water moving downward from the surface.

Movement of moisture into the soil: The model assumes that moisture enters the soil from the top and fill each increment of soil to field capacity before entering the next increment. When the wetting front reaches the bottom of the soil moisture profile, excess moisture is assumed to be lost by deep percolation of by runoff.

Movement of moisture out of the soil: Except for excess moisture, removal is only by evapotranspiration. It is assumed that in the early phase of the depletion process, one unit of PE removes one unit of moisture. In later phases, one unit of PE removes less than one unit of moisture; less and less is removed as less and less water remains in the soil moisture profile.

Climatological factors: These are the year-by-year record of monthly total precipitation (MP) and of the normal monthly potential evapotranspiration (PE). Monthly precipitation, MP, is assumed to be distributed within the month according to the following rules: a) one-half of MP, called "HP," (for "heavy precipitation") occurs during the principal storm of that particular month. This moisture is assumed to enter the soil instantaneously at the middle of the month and to be added, without loss to any moisture already in the soil except when AWC is exceeded. This moisture is dissipated at a rate proportional to the available water in the soil; b) the other half of MP, called "LP," (for "light precipitation") occurs in several light rains and is dissipated at the full rate of PE for this month. None of the light precipitation enters the soil except when LP is greater than potential evapotranspiration and AWC is not exceeded. The amount actually that enters the soil, or, if LP <PE, is lost from the soil, is called net moisture activity (NMA).

The second climatological factor, potential evapotranspiration, PE, is estimated from Thornthwaite's formula. Where available, the published monthly average PE values are used. For other stations, long-term averages are calculated. PE is assumed to be distributed uniformly over all days of the month. The PE available to remove moisture from the soil moisture profile is reduced by the PE required to dissipate LP.

The Soil Moisture Diagram. The conceptual diagram used in the computer model consists of 200 individual 1 mm increments of the assumed available water capacity of 200 mm. Each of these increments or layers is divided into 200 segments to cover the range from 1500 kPa retention to field capacity. These segments, each 1/200 of 1 mm, are the units that are manipulated by the computer. During accretion, moisture is added first to fill the top increment from left to right and then to fill successively lower increments. By convention, the lowest increment to undergo accretion during the HP or LP event is filled completely at the end of the event.

The model for depletion is quite different. It is assumed that more energy or more units of potential evapotranspiration are needed to remove moisture as the soil dries and as the drying layer occurs deeper in the soil. This concept is applied in the calculation through the assumption that along any diagonal (referred to as a "slant") of the soil moisture diagram, moisture is assumed to be removed with equal ease. It is assumed that for the first few slants, one unit of potential evapotranspiration removes one segment of moisture and that for subsequent slants progressively more units of potential evapotransporation are needed to remove one unit of moisture until in the driest condition and for the last increments of the diagram as many as five units of PE are needed to remove one unit of moisture.

ITEM 4

Column A

Two sets of depths are usually given. The upper is for the pedon as sampled. The lower is the limits selected for depicting the pattern of water states (Item 8).

Column B

This is the lower water content limit of the Wet water state class (Item 8). It is not commonly run in the laboratory. Measurements can be made in the field with tensiometers. We use approximations made by adding to the measured retention at 33 or 10 kPa an amount of water equal to a portion of the calculated air-filled porosity for that tension:

Particle Size[a]	Portion Of Air-filled Porosity 33 kPa	 10 kPa
Sandy [b], Coarse-loamy	0.30	0.45
Other	0.40	0.35

The value calculated for the measured 10 kPa retention is used if available.

[a] >2 mm excluded; otherwise family particle size rules apply.

[b] Use 0.40 if 6 kPa retention.

Column B may be useful as an estimate of maximum water holding capacity. The difference between cols. B and F may be used as the maximum water retention energetically available to plants.

Columns C through G

These entries are based on laboratory determinations. Retention at 33 kPa may be available but not at 10 kPa. A rough estimate of the retention at 10 kPa may be obtained b, adding one-fourth of the calculated air-filled porosity at 33 kPa to the retention at 33 kPa. Retention at 200 kPa is assumed to separate the water considered readily plant available in an energetic sense from that which is difficultly ● rrilabla. Most of the common field crops adapted to usually moist soils or intergrades thereto do not undergo ● oaolicllly important stress if the tension is below 200 kPa in the major part of the depth of common or many roots. The separation at 200 kPa may have little application for plants adapted to the natural water regime of soils drier than the intergrades to usually moist. 200 kPa is about the lowest tension at which retention measurements can be I-on sieved samples thereby reducing the cost. 0.. tb. . of 33 and 1500 kPa retention for an ● aCi"L*.

Columns H and I

Hydraulic Conductivity is recorded for the saturated condition and at 5 kPa tension. Both pertain to vertical inplace orientation. Vertical saturated hydraulic conductivity is the same as the permeability of the S-5 soil property table. The estimates on the S-5 property table are based on guidelines relating morphology and on measurements on car.. 8 x 8 cm (O'Neil, 1952. SSSAP 10:312). Macroscopic features (structural planar mid., animal burrows, etc.) commonly determine th. saturated hydraulic conductivity. These features usually are widely spaced. Hence, the specimen on which measurements usually are made may not contain representatively the controlling features. Resultingly, the reported values may be too low.

Unsaturated hydraulic conductivity commonly is measured for several tensions and so-called K-curves are obtained. The 5 kPa value was selected because many of the field determinations currently are by the instantaneous profile method and at appreciably lower tension than 5 kPa they may not yield data for shallow horizons. Similarly, some laboratory methods also fail at appreciably lower tensions. For many purposes, values at tensions near 1 kPa would b. useful. In the future. classes of K curves may be specified.

Columns J-L

These are standard laboratory determinations. The >2 mm includes up to 25 cm diameter material.

Columns J and K permit conversion changing of volume percent water (Cols. B-G) to weight percentage . . <2 mm basis. Multiply b, the quantity

$$\frac{1}{J-\frac{JxK}{100}}$$

where th. letters refer to column designations. Modifications are needed if the >2 mm contains appreciable water.

ITEM 5

This is reference information and explanation for Item. L-4. List the record number for AWC under Item 2 and the pedon number under Item 4.

ITEM 6

Soil Mapping Concept(s): For Order 2 maps, this is usually the naming ph... of the up unit. The concept, however, may b. . named inclusion. The mapping concept is usually described by combination of taxa (series, commonly) and nontaxonomic criteria (near surface texture, slope, erosion, etc.). Commonly the concept is the naming ph.'. of . map unit.

Soil Use(s): These are 12-month segments of the soil-use continuum for the soil mapping concept selected that because of kind of plants or type of management including tillage practices 'r' expected LO have . pattern of water states and/or surface or near-surface water movement differing appreciably from other uses. The sequences selected should involve major plants and rotations. Actual sequences would be grouped if no useful purpose would be served by separation. Large physical differences in the tillage-affected zone, . . well . . water-related properties, would be differentiating criteria. But here the focus is on water.

Typifying Surveys: These are published soil surveys in which th. 'oil mapping concept for the use under consideration is well exemplified.

ITEM 7

Part A

Major plants are listed far the soil use in Item 6. Maximum yearly depth of occurrence is . ssigned for th. common 'ad few abundance cl..... of fin. and/or very fine roots. The cl..'.. follow those in "Soil Taxonomy" (Soil Survey Staff, 1975. USDA Handbook 436). If the plants are annuals, the depths are for near physiological maturity. Depths under irrigation may be given. For future application, it is suggested we implement th. suggestions of Harold Taylor presented in the 1979 report of this committee and reduce the abundance cl." limits for dicots relative to monocots.

Part B

These water retention sums use the root depths in Part A and the water retention values of Item 4. After adjustment for electrical conductivity (Col. L of Item 4; Otto Baumer, NSSL), the... water retention sums may be employed . . available water capacity estimates. The values for the bu. of few roots for 10-1500 kPa may be particularly useful . . an estimate of available water capacity.

For depths to the base of to- roots, the calculation is straight forward. The calculation is somewhat more complex for the zone from the surface to the adjusted lower limit of few roots. It is assumed that in the zone of few roots, ml, part of the water retained between 10 and 1500 kPa is utilized. The rationale is that water movement at tensions above 10 kPa is slow and that utilization by plants depends importantly on root extension. Therefore, properties indicative of high soil strength and hence difficulty of root extension, would indicate a reduced utilization of water. Presumedly water in the 10-200 kPa range would move more readily to roots than that in the 200-1500 kPa range. Furthermore, it is assumed that as the proportion of the water held above 1500 kPa increases relative to the water in the 200-1500 kPa range that the average tension of the 200-1500 kPa water rises and movement to roots is slower. Guidelines follow based on these generalizations for the percent of laboratory retention that is included. The soil property statements apply to half or more of the zone in question. The adjustments are only made for annual plants or for perennials that are not adapted to 'soil' drier than usually moist. For perennials adapted to 'soil' drier than usually moist, the full 10 to 1500 kPa retention is employed.

Soil Properties	10-200 kPa	200-1500 kPa Ratio of Water Retained: 200-1500/1500 kPa ≥0.5	 <0.5
		Pct	
Very friable or friable, and <35% clay; or, one of the following: strong granular of any size; strong fine blocky or subangular blocky, or strong very fine prismatic	80	70	50
Not above and >35% clay, or firm or stronger	50	30	10
Other	70	50	30

An attractive alternative is to obtain field-determined plant available water through direct measurement. Water content with depth is determined at or near physiological maturity for years where there has been strong water deficiency during the major part of the growing season following wetting to field capacity or above appreciably below the depth of water extraction. Water desorption measurements are made as deemed useful (commonly at least 1500 kPa retention). The 10 kPa water retention estimate is used . the upper limit. The volume percent differences between 10 kPa and the field-determined minimum values are reported for the depth zones of Item 4. The depth of appreciable water extraction by roots is taken . where the water content exceeds the mean of the 10 and 200 kPa retention estimates from Item 4; or, if desorption data are unavailable or at variance with the field water measurements, it is the depth where over the underlying 50 cm there is little or no change in water content. Place the information on field-determined plant available water in a footnote. Finally, the method may be inappropriate in most years for soils drier than ustic or xeric because wetting below the depth of rooting does not occur. In unusually wet years, however, it may be appropriate.

Part C

Infiltration Rate is the flux passing across the soil surface into the soil. Specify the kind of infiltrometer in Item 9. Infiltration decreases with time as the soil wets. Hence, time in the wetting process must be specified and antecedent water content is also useful. Usually values for relatively wet conditions are given.

Intake Rate is a concept used to make recommendations on furrow irrigation (SCS Staff, National Engineering Handbook, section 15). It pertains to the curve on a log-log scale of cumulative infiltration versus time. Values are obtained by furrow irrigation tests.

Hydraulic Conductivity is discussed under Item 4. Surficial hydraulic conductivity pertains to the depth affected by tillage, tree harvest and the like, including compaction.

ITEM 8

Part A

This is an estimate by month of the annual water state sequence. The second row is used to indicate a frozen condition. The moisture class selected should describe the wetter 1/2 of the depth interval for the wetter half of the month. The water state classes and symbols follow:

Class Name	Symbol	Suction Range: Sandy	Suction Range: Coarse-loamy < 2 mm and Bulk Density < 1.55 Mg/m³ [a/], [b/]	Suction Range: Other
Dry[c/]	D	> 1,500	> 1,500	> 1,500
Slightly Dry	DS	1,500-10,000	1,500-10,000	1,500-10,000
Very Dry	DV	> 10,000	> 10,000	> 10,000
Moist	M	1/2-1,500	1-1,500	1-1,500
Highly Moist	MH	1/2-5	1-10	1-33
Moderately Moist	MM	5-50	10-100	33-200
Slightly Moist	MS	50-1,500	100-1,500	200-1,500
Wet[d/]	W	< 1/2	< 1	< 1
Not Satiated	WN	≤ 1/2	≤ 1	≤ 1
Satiated	WA	≤ 1/2	≤ 1	≤ 1

[a/] Apply family particle size criterion to < 2 mm only.

[b/] If particle density departs appreciably from 2.65 Mg/m³, use bulk density at which total porosity is 42 percent.

[c/] Assume that water retention at 10,000 kPa is 80 percent of that at 1,500 kPa.

[d/] Soil material is satiated at the first appearance of free water. The material is usually not saturated at initial satiation.

The wet class has been subdivided based on whether free water is present. The water content where free water first appears is referred to as satiation (Miller and Bresler, 1978. SSSAJ 41:1020). This water content is calculated in the same fashion as the values for the wet state (Col. 3, Item 4) except the factors are increased by .05.

Flooding and Ponding (PND-FLD) follow definitions in the National Soils Handbook. Entries are only made for average years. If Ponded, a P is shown. If flooded, a two-symbol designation is used. The letter is the frequency class and the arabic number (1, 2, 3, 4) is the duration class beginning with the shortest duration. The frequency pertains to the 12-month period, not to a single month.

The table may be used in several ways: 1) to record field experience gained in soil mapping and its quality control, 2) to abstract and generalize from specific measurement data sets, 3) to record specific data sets, and 4) a combination of 2) and 3).

Part B

Rows have been allotted for monthly runoff class and for Curve Number (CN). It is suggested that more effort be put on Curve Number assignments than on runoff.

Either the runoff classes current in the National Soils Handbook or employ the classes to follow which offer the advantage of being more subject to verification. In either case, complete only for average and wet years.

> The concept of runoff here involves the ratio of runoff to the total water received by the soil (rain and melted snow) exclusive of rainstorms that exceed the 10-year, 1-hour intensity for the area (USDC Tech. paper 40 or other publications).

Class	Water Received That Runs Off Pct	Guidelines
Very High (VH)	>80	Mainly steep soils with very low infiltration rates such as wet swelling clays.
High (H)	50-80	Mainly moderately steep soils with low infiltration rates.
Moderate (M)	30-50	Gently sloping soils with moderate infiltration rates, or steeper soils with high infiltration rates.
Slight (S)	10-30	Nearly level or very gently sloping soils, or steep soils with very high infiltration rates.
Very Slight (VS)	<10	Level or nearly level soils, or soils with extremely high infiltration rates.

Curve Numbers specify the relationship assumed between daily runoff and daily precipitation. The concept has been thoroughly developed by Service hydrologists for the design of mechanical structures (for example, pond size versus watershed area). Assignment of Curve Numbers should follow Service guidelines (SCS Staff, National Engineering Handbook, Section 4) with certain modifications to account for the effects of a frozen condition or shallow depths to free water, as follows:

Assume Hydrologic Group D if Wet with free water (WA) above 50 cm, or if WA above 100 cm and Wet without free water (WN) above 50 cm. Otherwise, use the assigned Hydrologic Group. The zone of free water must be continous, not perched.

For months that 0-25 cm is both Wet and Frozen and adjacent months 0-25 cm is Frozen, the CN is 98. If 0-25 cm is Frozen, but other conditions are not met, the CN is the higher two values: 96 or the CN based on considerations other than whether frozen or not. Do not consider the frozen state as a factor if the soil lacks cementation due to ice in the upper 25 cm. Provisionally, assign antecedent moisture class II while Frozen to soils with aridic or torric moisture regimes and to soils that are Dry 0-25 cm.

Otherwise, equate the antecedent moisture classes with the water state classes as follows:

I - Dry 0-25 cm; or Slightly Moist 0-25 cm,
and Slightly Moist or Dry 25-50 cm

III - Wet 0-25 cm; or Highly Moist 0-25 cm,
and Highly Moist or wetter below

II - Other

Part C

Indicate the months in which the soil water state most critically determines erosion and plant growth. Do for 6 years in 10 only.

ITEM 9

This follows Item 3. It is important that the user be able to evaluate the origin of the information in the sense of whether it rests on certain specific data sets, on generalizations from data sets, or is a generalization from field experience with little or no specific quantitative information. Further, there should be sufficient information about the soil use to apply table 9.1 (or related tables) of Section 4 of the National Engineering Handbook. This requires dates for major tillage operations, when 50 percent cover occurs, and the land use by which table 9.1 should be entered at different times in the year. Also, the time when water use by crops reaches a maximum and declines is useful.

APPENDIX: APPLICATION OF THE WATER INFORMATION SHEET

GENERAL

Soil Use Concept

Water related information should be ordered by concepts that include use of the soil.. There are three reasons:

- Hard data are obtained for specific soil uses and to be most usefully applied, must be related to that use.
- Soil use has potentially a very large influence on both water transmission values and the pattern of water states.
- Soil water information is used not in general sense but relative to specific uses of the soil.

The concept of soil plus use should be highly plant related. Furthermore, it should be directly applicable to SCS activities.

Quality Control

To exercise quality control over concepts of the field soil water regime, the concepts must first be recorded. Without a program for recording our concepts of the water regime, we largely lack a quality control program over a very important aspect of soils.

Data Reduction and Assembling

A standard format is needed that can be used for both hard data and for estimates. Unless estimates and hard data have a common format, the value of the hard data for evaluation of the estimates is reduced. The format should be rather constant over time and be relatively simple in order that nonspecialists can easily use the information.

Link to Land Use Information

The determination of land use for specific areas is being pursued through remote sensing at a number of institutions. Much of the hydrological information on the water information sheet is keyed to land use. It should be feasible to use remotely sensed information on land use for areas with soil survey maps to apply the water information sheet to specific parcels of land.

CURRENT NONAGRICULTURAL INTERPRETATIONS

The comments to follow pertain to our set of nonagricultural interpretations. These interpretations are less dependent on water regime than would be soil uses that are related more directly to plant growth.

Septic Tank Absorbtion

Dryer soils should perform satisfactorily at lower permeability. We could possibly reduce the permeability for severe l-imitation if Slightly Moist or Dry 24 to 60 inches all months of the year for a soil use relevant to house sites.

Sanitary Landfill (trench)

Trafficability affected by the water state at shallow depths. No explicit trafficability limitation now. Perhaps Highly Moist or Wetter is a limitation.

Sanitary Landfill

Highly Moist or Wetter might offer severe limitations.

Daily Cover For Landfill

The monthly water state largely determines if soil can be removed and spread easily. Perhaps a more favorable pattern of water states would permit use of less favorable soil material. Highly Moist or Wetter probably is a limitation.

Shallow Excavation

The pattern of water states would specify by month when the soil is moist and least favorable to excavate. Dry or Highly-Moist and Wetter would be unfavorable commonly; Moderately Moist would be very favorable.

Dwellings Without Basements

Shrink-swell can be calculated for the actual water state. This actual shrink-swell may be less than the total shrink-swell that we now report. Construction would change the water regime and hence the actual shrink-swell. So both total and actual must be considered depending on application. We would also have the depth frozen for a given use.

Local Road and Street

Ease of grading and excavation would be determined in part by the patterns of water states.

Lawns Landscaping and Golf Fairways

Trafficability is strongly influenced by the pattern of water states. Presently inferences are largely based on composition and water table depth. Plant growth is strongly affected by the pattern of water states. AWC would be of less importance in soils that are no wetter than Slightly Moist most of the time while plant growth occurs.

Construction Material

The ease of excavation is affected by the pattern of water states.

Top Soil

Excavation is strongly influenced by the pattern of water states as is also the ease of establishing vegetation or reclamation of the borrow area.

Irrigation

Intake rates, rooting depths, and AWC estimates related to rooting depths, may help with design. Information about these are on the sheet. The pattern of water states would pertain to assessing the advantage of irrigation.

Grassed Waterways

Rooting depths, AWC as related to rooting depths, and the pattern of water states should help predict grass growth.

Recreational Development

Trafficability may be inferred in part from the pattern of water states. The water information sheet places emphasis on near surface water transmission, including infiltration, which is very important for this use. Prediction of dusty conditions requires information on water state of the near surface. Plant growth is closely related to the pattern of water states.

Soil Construction Material

Quality of soil material can be reduced if the pattern of water states becomes more suitable for plant growth. AWC can be lower if water deficits are less.

Off-road Motorcycle Trails

Trafficability is affectedby the pattern of water states of the upper 50 cm.

OTHER APPLICATIONS

Define Wetlands

Perhaps the depth and duration drier than Wet could be used. Such a direct definition would be based on actual conditions for specified uses.

Define Prime Farmland

Perhaps one could exclude soils that are Slightly Moist or Dry in all parts above 100 cm during a specified portion of the growing season. The AWC required could be reduced as the amount of time during the growing season that the soil is Slightly Hoist or Dry above 100 cm decreases. Calculation of AWC could be based in part on rooting depth.

Shrink-Swell

Knowing the water state pattern and COLE, one can calculate the bulk density of the fabric between cracks, the field extensibility, and the crack space (see example for Kyle).

Heat Capacity, Thermal Conductivity

Could use the water content *ranges* for the water state classes to calculate heat capacity and thermal conductivity ranges (see example for Kyle).

Runoff Estimates

We could drop our present runoff classes which are not used in favor of the Curve Number which is widely used. We would have a link between our soil mapping concepts and an important quantity used to plan conservation practices.

Infiltration Application

Provides a format to assemble infiltration information and link it to soil mapping concepts.

Construction of Diagrams for Aspects of Water State Pedons

The zones of free water, dry zones, etc., can be shown graphically.

Erosional "T"

Rooting abundance information. could be used for soils where water is not limiting to provide statements on the thickness of the soil that is exploitable by roots. This thickness could be used to define the depth of soil on which erosional "T" would be computed.

Brief descriptions follow for the soil series for which water related information records have been prepared.

ACUFF: Fine-loamy, mixed, thermic Aridic Paleustolls. The soils occur on gentle slopes with gradients of less than 5 percent and are developed in sandy outwash or old alluvial materials which have usually been modified by wind. Runoff is slow to medium and permeability is moderate. The environment is semiarid to dry, subhumid, warm temperate, continental with annual precipitation of 430 to 530 mm. The Thornthwaite index is 22 to 34 and the mean annual air temperature is 57° to 64° F. The soils are found over a large area of the southern High Plains and the Rolling Plains of Texas. Principal crops are cotton, grain sorghum, and wheat.

BORNSTEDT: Fine-silty, mixed, mesic Typic Haploxerults. The soils occur on terraces at 400 to 650 feet elevation. Slopes are 0-30 percent. Runoff is slow to moderate and permeability is slow. The soils have cool, moist winters and warm, dry summers. Average July air temperature is 65° F and average January temperature is 37° F. The mean annual air temperature is 52°-55° F. Mean annual precipitation is 1,220 to 1,650 mm. The frost-free period is 140-200 days. The soils are used for various row crops, berries, nursery crops, cereal grain, and hay and pasture. The soil is restricted to the Willamette River Valley.

BOSQUE: Fine-loamy, mixed, thermic Cumulic Haplustolls. The soils occur along flood plains of streams in central Texas. They have formed in calcareous alluvial sediments. The runoff is slow to medium and permeability is moderate. Flooding occurs every 1 to 10 years except where protected by dikes or dams. The mean annual temperature ranges from 64° to 70° F. The annual precipitation is 710 to 890 mm and the Thornthwaite index is 44 to 64. The principal uses are for sorghums, small grains, pecan orchards, and Bumudagrass pastures. The soils occur mainly in the Grand Prairie and Cross Timbers areas of north-central Texas.

BRIDGEHAMPTON: Coarse-silty, mixed, mesic Typic Dystrochrepts. The soils occur on outwash terraces and till plains and are formed in silty materials underlain by either stratified outwash of sand, gravel, and cobbles, or coarse glacial till. Source of material is mainly gneiss, granite, and schist with some sandstone, conglomerate, and shale. Slopes are mostly 0 to 8 percent and range from 0 to 15 percent. Runoff is slow or medium and permeability is moderate. Mean annual temperature is 45 to 50° F. Annual precipitation is 1,070 to 1,270 mm and the frost-free season is 135 to 195 days. The principal crops are sod, potatoes, nursery stock, silage, corn, and hay. The soils are found in Long Island, New York, southern Rhode Island, southeastern Connecticut, and Vermont.

CHARLTON: Coarse-loamy, mixed, mesic Typic Dystrochrepts. The soils are developed on till-covered uplands. The glacial till is derived mainly from schist and gneiss. Slopes generally range from 2 to 35 percent but reach 45 percent. Runoff is medium to rapid and permeability is moderate or moderate to rapid. Areas cleared of stones are used mainly for hay, pasture, silage, corn, and orchards. The stony areas are largely in forests of oaks, hickories, white pine, hemlock, red maple, sugar maple, gray birch, yellow birch, white ash, and beech. The soils occur in Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

CULLEN: Clayey, oxidic, thermic Typic Hapludults. The soils occur on upland ridges and aide slopes on the Piedmont Plateau. They are formed in residium from mixed, basic and acidic, crystalline rock. Slopes are dominantly 2 to 15 percent but range from 0 to 25 percent. Runoff is medium to rapid and permeability is moderate. The mean annual temperature is 57° to 63° F snd the mean annual precipitation is 1,070 to 1,190 cm. The soils are mostly under cultivation or in pasture. Crops include small grain, corn, soybeans, cotton, bay, pasture, and some fruits. The soils are found in Virginia.

ESTACADO: Fine-loamy, mixed, thermic Calciorthidic Palcustolls. The soils occur on nearly level to gently sloping upland plains. Slopes range from less than 1 to about 18 percent. Parent material is presumed to be alluvial and eolian sediments. Surface runoff is slight and permeability is moderate. The average annual precipitation ranges from 410 to 560 mm with a marked summer maximum. The Thornthwaite index ranges from 560 to 860 mm. The soils are used mostly for dry farming and irrigated cropland. They occur in the High Plains of West Texas and possibly eastern New Mexico.

FALLBROOK: Fine-loamy, mixed, thermic Typic Haploxeralfs. The soils are gently rolling to very steep and occur on round hills at elevations of 200 to 300 feet, or as high as 3,500 feet on south facing slopes. They formed in material weathered from granite and closely related granitic rocks. Usually the rock is deeply weathered. Runoff is medium to very rapid and permeability is moderately slow. Mean annual precipitation is 300 to 460 mm. Average January temperature is 47° to 50° F. Average July temperature is about 70° F. Average annual temperature is 60° to 66° F. The freeze-free season is 250 to 320 days. The soils are used mostly for grazing but a subordinate part is used for irrigated avocados, citrus, truck crops, and for nonirrigated small grain and hay. Noncultivated areas are mainly in annual grasses and forbs with considerable shrubs. The soil occurs in the foothills on the east side of the San Joaquin Valley in the west part of southern California.

HADLEY: Coarse-silty, mixed, nonacid, mesic Type Udifluvents. The soils are formed in alluvial deposits consisting mainly of very fine sand and silt. Flooding by stream overflow ranges from once or twice a year to once in 5 to 10 or more years. Flooding generally occurs during spring runoff or during periods of high rainfall in the fall. Runoff is medium and permeability is moderate or moderately rapid. Mean annual precipitation ranges from 710 to 1,400 mm. Mean annual air temperature is 45° to 50° F. Mean annual growing season is 120 to 180 days. The soils are commonly used for hay, pasture, and silage corn. In Massachusetts and Connecticut, they are used for truck crops, potatoes, and tobacco. The soils are found in Connecticut, Massachusetts, New Hampshire. Vermont, Maine, and eastern New York.

HARNEY: Fine, montmorillonitic, mesic Typic Argiustolls. The soils occur on uplands that have slightly concave or convex surfaces. They are formed in loess usually several feet thick. Slope gradient commonly is 0 to 3 percent but ranges 0 to 8 percent. Runoff is slow or medium and permeability is moderately slow. Mean annual temperature ranges from 52° to 57° F and mean annual precipitation from 480 to 870 mm. The Thornthwaite index ranges from 32 to 46. The soils are mostly cultivated; wheat and sorghums are the principal crops. The soils are found in west-central Kansas.

HAZLETON: Loamy-skeletal, mixed, mesic Typic Dystrochrepts. The soils occur on nearly level to very steep uplands and are developed in material weathered from acid gray and brown sandstone. Runoff is medium and permeability is moderately rapid to rapid. Slopes are usually convex with gradients from 0 to 80 percent. Annual precipitation is 910 to 1,520 mm. Average annual temperature is 47° to 55° F. The average annual growing season is 110 to 180 days. The soils are used mostly for woodlands of mixed oaks, maple, cherry, and occasional conifers. The soils are found in Kentucky, Maryland, New Jersey, Pennsylvania, West Virginia, Virginia, and possibly Ohio.

HOLDREGE: Fine-silty, mixed, mesic Typic Argiustolls. The soils occur on uplands with a plain or convex surface and are formed in calcareous lotss. Slope gradients art commonly 0 to 4 percent and ranged from 0 to 11 percent. Runoff is slow or medium and permeability is moderate. The mean annual, temperature ranges from 50° to 56° F and the mean annual precipitation ranges from 460 to 610 mm. Most of the area is cultivated and much is irrigated. Sorghum and corn are the principal row crops. Wheat is the principal small grain. The soils are found in south-central Nebraska and north-central Kansas.

KUMA: Fine-silty, mixed, ❑ esic Pachic Argiustolls. The soils occur on nearly level to gently undulating upland flats and drainageways. They are formed in medium to moderately fine textured, calcartous eolian deposits with an age discontinuity marked by paleosol. Runoff is slow to medium and permeability is moderate to slow. At the type location, the mean annual precipitation is about 430 mm, with peak periods in the spring and early summer. Mean annual temperature is 50° F. The mean summer temperature is 72° F. The soils are used for grazing and for dry and irrigated cropland. They are found in eastern Colorado and western Kansas.

MANOR: Coarse-loamy, micactous, mesic Typic Dystrochrepts. The soils occur on strongly dissected uplands in the northern Piedmont Plateau with slopes ranging from 0 to 60 percent. They are formed in residuum (saprolitt) from highly micaceous acid crystalline rocks, most commonly rather soft mica schists. Runoff is medium to rapid and permeability is moderate. The soils are used for general crops, orchards, and pastures. Large areas are in nonfarm uses. Cutover and second growth areas have some shortleaf pine and Virginia pint. The soils art found in Pennsylvania, Delaware, Maryland, the District of Columbia, Virginia, and North Carolina.

MATAPEAKE: Fine-loamy, mixed, mesic Typic Hapludults. The soils occur on uplands in the northern part of the Atlantic Coastal Plain. The slope gradient commonly is 1 to 10 percent but ranges 0 to 30 percent. The soils are formed in a silty mantle overlying sandy, unconsolidated marine sediments. Runoff is medium and permeability is moderate. The mean annual temperature is 45° to 55° F and the mean annual precipitation is about 1,000 mm. The soils are used for general crops, truck crops, orchards, and pastures. Cutover and second growth woodlands have some loblolly pine, Virginia pine, or shortleaf pint. The soils are found on the Coastal Plain of New Jersey, Delaware, Maryland, and Pennsylvania.

RRINEBECK: Fine, illitic, ❑ tsic Atric Ochraqualfs. The soils occur on glacial lake plains and have slope gradients from 0 to 15 percent. They are formed in glaciolacustrint deposits high in clay. Surface runoff is slow and permeability is slow. Annual precipitation is 760 to 1,140 mm. Average annual temperature is 46° to 52° F and the growing season ranges from 120 to 160 days. Much of the area has been cleared and artifically drained and is used for bay, pasture, small grains, and corn. A significant acreage is idle and reverting to woodland. The soils art found on the Erie and Ontario Lake Plains; the Hudson, Mohawk, and St. Lawrence Valleys; and the Allegheny Plateau of New York.

SHARPSBURG: Fine, montmorillonitic, mesic Typic Argiudolla. The soils occur on convex ridgetops, upland divides, and convex side slopes and on high benches. Typically, they occur on narrow ridgetops having elopes of 2 to 9 percent. The full range of slopes is from 0 to 18 percent. They have formed in 6 to 14 feet of loess that contains less than 5 percent sand. Surface runoff is medium to rapid and permeability is moderately slow. Mean annual temperature is 47° to 58° F bnd mean annual precipitation is 710 to 810 mm. The soils are used for corn, soybeans, small grain, and hay. They are found in southwestern Iowa, northwestern Missouri, northeastern Kansas, and southeastern Nebraska.

VKRGKNNES: Very-fine, illitic, ❑ esic Glossaquic Hapludalfs. The soils occur in glaciolacustrine and tsturine deposits of cblcartous clays. Slopes are long, commonly 2 to 6 percent but range up to 50 percent. Runoff is medium to rapid and permeability is very slow. The mean annual air temperature is 44° to 52° F. Mean annual precipitation is 810 to 910 mm and the mean growing season is 140 to 165 days. Snow covers the ground 2 to 4 months. The soils are used for hay, pasture, and to a lesser extent, for silsge corn and apple orchards. The soils are found in northwestern Vermont end northern New York bordering Lake Champlain and in the upper St. Lawrence River Valley.

WINOOSKI: Coarse-silty, mixed, nonacid, me-sic Aquic Udifluvents. The soils occur on nearly level flood plains and are formed in recent alluvial deposits of very fine sand and silt. Slope gradients are 0 to 3 percent. Flooding ranges from once or twice a year to once in 5 to 10 or more years. Stream overflow generally occurs during late winter or spring and during periods of high rainfall. Permeability is moderate or moderately rapid. Mean annual precipitation ranges from 1,020 to 1,270 mm and mean annual air temperature from 45° to 52° F. Mean annual growing season is 120 to 200 days. The soils are used mainly for hay, silage, corn, and pasture, and to some extent for truck crops, potatoes, and tobacco. The soils occur in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and eastern New York.

ITEM 7

Part	Quantity
A	**Rooting Depth, cm** Plants: Base Common: 60 Adjusted Base Few: 100
B	**Root-related Retention Difference Sums, cm** Base Common 10-200 kPa: 6 10-1500 kPa: 9 Adjusted Base Few 10-200 kPa: 10 10-1500 kPa: 12
C	**Water Movement, cm/day** Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):

Acuff Loam, 0-1 percent slopes; grain sorghum, dryland, chiseled

Typifying Survey(s):

Lubbock County, Texas

Compiler(s):

A. L. Newman
L. C. Brockman
G. L. Lane
J. C. Williams
L. F. Ratliff
W. W. Fuchs
R. B. Grossman

ITEM 8

Part A

Depth cm	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0-20	D	D	D	MS	MV	MV	MS	D	D	MS	D	D	D	D	D	D	MS	MS	D	D	D	D	D	D		D	D	MV	MV	MV	MS	D	D	MV	MS	[illegible]
20-50	D	D	D	MS	MV	MV	MS	D	D	D	D	o	D	D	D	D	MS	MS	MS	D	D	D	0	D	0	D	D	MS	MV	MV	MS	D	D	MS	MS	MS
50-100	MS	MS	MS	MS	MV	MV	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MV	MV	MV	MS	MS	MS	MS	MS
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MV	MV	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
PND-FLD																																				
Part B																																				
Runoff CN	64	64	64	64	81	81	60	60	60	60	60	60	64	64	64	64	64	64	60	60	60	60	60	60	64	64	64	81	81	81	60	60	60	78	60	60
Part C																																				
Erosion																																				
Growth																																				

ITEM 9

Item 6

Conventional tillage and "se pattern. Disk twice In spring after April 1. Plant about May 15 In shallow lister furrows. Light cultivation twice with knives at shallow depth to cut Weeds. Harvest by October 1; leave stalks.

Item 7:

Ref. Nos.

Part A - Explanation A Base common top of tillage pan if not chiseled. Base of few roots top of strong carbonate accumulation.

Part B - Explanation A

Part C - Explanation A

Item 8:

Part A - Explanation A Information for driest year from Ratliff, et al., (in press). For wettest year assume that in both spring and fall have more precipitation than usual.

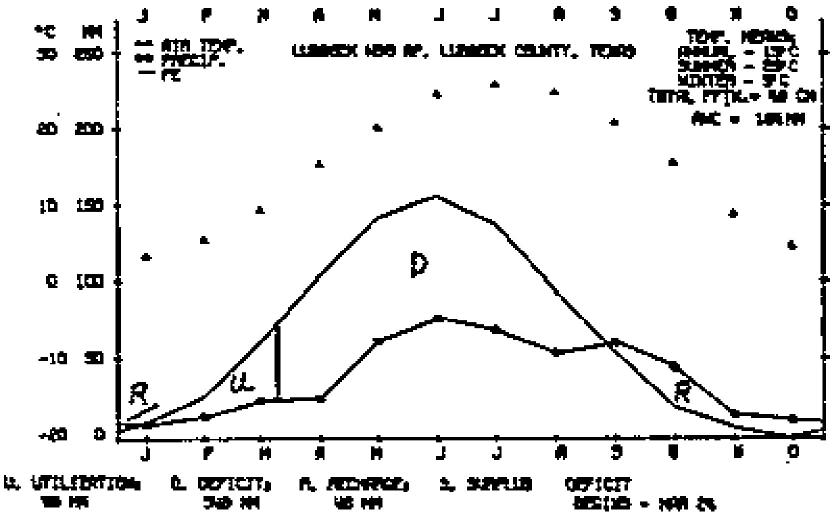
Part B - Explanation A Hydrologic Group B

Part c **- Explanation** A

Ratliff. L. F. J. T. Ritchie, and D. K. Carrel In press. Soil Survey Laboratory Data, field measurements and field measured soil water limits for some soils of the United States. Soil survey Investigations Report______. USDA-SCS.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Acuff
Aridic Paleustolls, fine-loamy, mixed
thermic

No. Records:

ITEM 3

```
LUBBOCK WSO AP, LUBBOCK COUNTY, TEXAS    N3339 W10149  3254'              STATION #  415411       PRECIPITATION RECORD  1951-1974
                                              JAN    FEB    MAR     APR    MAY    JUN    JUL    AUG    SEP    OCT    NOV    DEC    YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS        5.8    5.9    9.9    15.7   20.6   24.9   26.2   25.2   21.3   15.1    9.4    5.6   15.3
NORMAL POTEN. EVAPOTRANSPIRATION MM IN 74      5     14     20     63    106    144    159    141     93     57     22      6    ...
NORMAL PRECIPITATION MILLIMETERS               4     15     24     37     69     79     71     56     63     47     14     12    495

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY
      PERCENT PROBABILITY      - - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - -
1               100            DRY SOME/ALL PARTS MCS   90 OR MORE DAYS CUMULATIVELY      WHEN SOIL TEMP 5 DEG C OR HIGHER
2                60            DRY SOME/ALL PARTS MCS   6/10 OR MORE OF DAYS CUMULATIVELY WHEN SOIL TEMP 5 DEG C OR HIGHER
3                40            DRY ALL PARTS MCS        1/2 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
4                20            DRY ALL PARTS MCS        3/4 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
5                95            MOIST SOME/ALL PARTS MCS 90 OR MORE DAYS CONSECUTIVELY     WHEN SOIL TEMP 8 DEG C OR HIGHER
6                70            DRY ALL PARTS MCS        45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER SUMMER SOLSTICE
7                15            MOIST ALL PARTS MCS      45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME:   THERMIC                 ESTIMATED FROM NORMAL AIR TEMPERATURES
SOIL  MOISTURE   REGIME    USTIC                   ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 5, 6, 7
```

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5kPa	Bulk Density	Volume >2mm	EC
	<kPa					))					
cm	Vol. Pct						<———cm/day———	———>	g/cc	Pct	mmhos/cm
0- 13	35	29	20	15	-11	18			1.19	0	0.27
13- 36	32	29	25	20	15	14			1.54	0	0.22
36- 65	33	31	27	21	16	15				0	
65-111	9	26	21	15	13	13			1.54	0	
111-135	30	27	21	16	11	16			1.48	3	0.2
135.154	17	16	14	10	9	7			1.89	27	0.5
154-225	37	35	32	20	10	25				3	0.7
0- 20	33			17	13				1.[a]	0	
20- 50	33			21	16				1.55	0	
50-100										0	
100-150 50 100 30	22			16 12	14 9				1.50	10	
150-200	37			20	10				1.50	3	

a/ Estimate for tilled condition after settling due to wetting.

ITEM 5

Ref. Nos.

Item 1: Explanation A

Item 2: Explanation A AWC to 100 cm. Assume carbonate restricts at that depth.

Item 3: Explanation A

Item 4: Explanation A

Pedon S81TX-303-001 for A-G and J-L columns. Column E based on estimation from S80TX-303-002. S81TX-303-008 from grassland. Lacks tillage pan commonly found in cultivated areas. Lower block are estimates for depths in Item 8.

SOIL SURVEY WATER INFORMATION SHEET

ITEM 2

ITEM 1

Series:
Bornstedt
Typic Haploxerults
Fine-silty, mixed, mesic

No. Records:
1

ITEM 3

ESTACADA, CLACKAMAS COUNTY, OREGON N4516 W12219 410F STATION # 352693-1 PRECIPITATION RECORD 1951-1970

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	4.1	6.0	7.2	9.6	12.9	15.9	18.3	18.2	15.9	11.3	7.1	4.8	11.0
NORMAL POTEN. EVAPOTRANSPIRATION MM (W 4)	11	19	30	47	76	93	114	105	76	46	22	14	657
NORMAL PRECIPITATION MILLIMETERS	267	249	173	115	88	65	17	35	59	141	202	232	1618

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	------------- CRITERIA FOR MOISTURE CONTROL SECTION (MCS) -------------		
1	15	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	9	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5 kPa	Bulk Density	Volume >2 mm	EC
	<-------------kPa------------->										
cm	<----------Vol. Pct---------->						<---------cm/day-------->		g/cc	Pct	mmhos/cm
0-20	38	36	32	25	17	19			1.50	0	
20-53	41	37	33	25	17	20			1.42	0	
53-71	40	38	35	27	18	20			1.52	0	
71-84	40	39	37	29	21	18			1.54	0	
84-122	43	42	40	33	26	16			1.47	0	
122-178	38	34	32	30	27	7			1.58	0	
0-20	38	36	32	25	17	19					
20-50	41	37	33	25	17	20					
50-70	40	38	35	27	18	20					
70-150	40	39	37	31	25	13					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A *Complete AWC to 84 cm. From Record No. OR0538.*

Item 3: Explanation A

Item 4: Explanation A
Pedon S70OR-003-003. 10, 33, and 1500 kPa retention measured. 1 and 200 kPa retention estimated. Latter assumed as midpoint between 33 and 1500 kPa retention.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Winter Wheat Base Common: 70 Adjusted Base Few: 80
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 8 10-1500 kPa: 14 Adjusted Base Few 10-200 kPa: 9 10-1500 kPa: 14
C	Water Movement, cm/day Infiltration Rate: Intake Rate: See ITEM 9 *Surficial Hydraulic Conductivity* Saturated: 5 kPa:

ITEM 6

Soil Mapping Concept(s):
Bornstedt silt loam, 0-8 percent
slopes

Soil Use(s):
Continuous winter wheat, conventional tillage

Typifying Survey(s):
Clackamus Area, Oregon
(in publication)

Compiler(s): Date:
R. E. Bright, State Cons. Eng., SCS, Portland, OR 2/83
R. A. Dierking, Soil Scientist, WNTC
M. E. Freckleton, State Cons. Agron., SCS, Portland, OR
G. L. Green, Asst. State Soil Scientist, SCS, Portland, OR
R. B. Grossman, Soil Scientist, SCS, Lincoln, NE
G. J. Latshaw, State Soil Scientist, SCS, Portland, OR
E. A. Ross, Water Mgt. Eng., SCS, Portland, OR
R. S. Wadleigh, Hydraulic Engr., SCS, Portland, OR

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	WN	WN	WN	WN	MM	MS	MS	MS	MS	MM	MM	WN
20-50	WN	WN	WN	WN	MM	MS	MS	MS	MS	MS	MM	WN
50-70	WA	WA	WA	WA	MM	MM	MM	MS	MS	MS	MS	WA
70-150	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS
END-FLD												
Part B												
Runoff CN	95	95	95	95	83	67	67	67	80	91	84	93
Part C												
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	MM	WN	WN	MM	MM	MS	MS	MS	MS	MS	MM	MM
20-50	MM	WN	WN	MM	MM	MS	MS	MS	MS	MS	MS	MM
50-70	MM	WN	WA	WA	MM	MM	MS	MS	MS	MS	MS	MS
70-150	MS	MS	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS
END-FLD												
Part B												
Runoff CN	83	93	93	93	83	67	67	67	80	80	84	84
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	WA	WA	WN	WN	MM	MM	MS	MS	MS	WN	WN	WN
20-50	WA	WA	WA	WN	MM	MM	MM	MS	MS	MM	MM	WN
50-70	WA	WA	WA	WA	WA	MM	MM	MM	MS	MS	MM	MM
70-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
END-FLD												
Part B												
Runoff CN	97	97	95	95	95	83	83	67	80	97	93	93
Part C												
Erosion												
Growth												

ITEM 9

Item 6:
Mostly in 4-6 percent slope range. Not terraced. Moldboard plow September 15. Disk harrow and plant October 20. 15 cm spacing. 50 percent cover by December 1 average years. In Dry years, 50 percent cover January 1 and in Wet years, March 1. Advantageous to completely invert wheat straw to reduce root diseases.

Item 7:

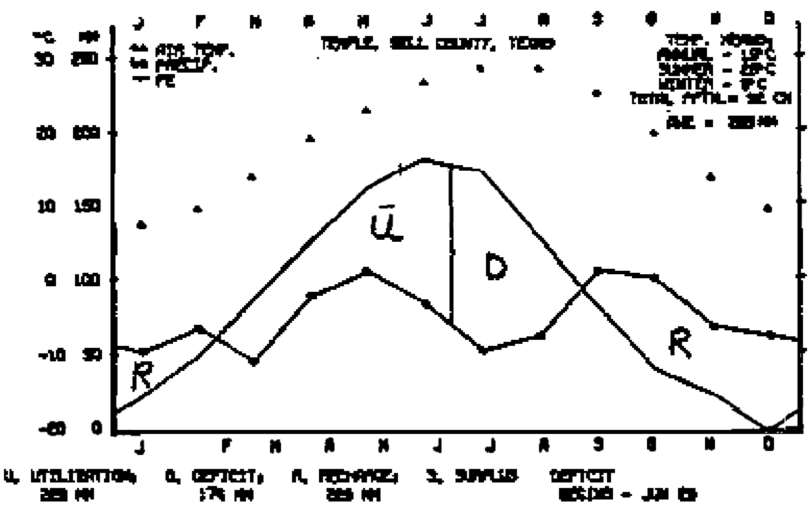
Part A - Explanation A	*Strong root restriction lower B horizon.*
Part B - Explanation A	
Part C - Explanation A	Maximum sprinkler rate 0.8 cm/hr in Oregon State irrigation guides.

Item 8:

Part A - Explanation A	MH, 1-33 kPa retention; MM, 33-200 kPa; MS, 200-1500 kPa.
Part B - Explanation A	Hydrologic Group C. Assume straight row fallow September and October. Use small grain guides other months. Water state class MH considered wet for antecedent class placement.
Part C - Explanation A	

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Bosque
Cumulic Haplustolls, fine-loamy,
mixed, thermic

No. Records:

ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	9.8	11.8	14.3	19.5	23.2	27.6	29.4	29.0	25.4	20.1	14.7	9.8	19.1
NORMAL POTEN. EVAPOTRANSPIRATION MM BY TW	17	25	55	88	129	161	184	174	130	75	42	24	[illegible]
NORMAL PRECIPITATION MILLIMETERS	39	70	48	91	108	89	34	44	107	102	67	63	914

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - -		
1	65	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	16	DRY SOME/ALL PARTS MCS	6/10 OF MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	5	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	46	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	99	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: THERMIC ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME USTIC ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 2, 3, 6, 7

AND MOISTURE REQUIREMENT IS TYPIC FOR:
HAPLUSTALFS, PALEUSTALFS, USTOCHREPTS, ARGIUSTOLLS, CALCIUSTOLLS, HAPLUSTOLLS, NATRUSTOLLS, PALEUSTOLLS
[illegible]

AND MOISTURE REQUIREMENT IS NON-TYPIC FOR:
DURARGIDS, HAPLARGIDS, PALEARGIDS, CALCIORTHIDS, CAMBORTHIDS, DURORTHIDS, PALEORTHIDS, TORRIFLUVENTS, TORRIORTHENTS, TORRIPSAMMENTS

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<——— Pressure - kPa ———>										
cm	<——— Vol. Pct ———>						<——— cm/day ———>		g/cc	Pct	mmhos/cm
0- 15	39	38	35	29	19	19			1.43		
~~15- 51~~	~~40~~	~~38~~	~~35~~	~~31~~	~~21~~	~~17~~			~~1.38~~		
~~51- 86~~	~~39~~	~~37~~	~~33~~	~~29~~	~~20~~	~~17~~			~~1.40~~		
~~86-127~~	~~38~~	~~36~~	~~32~~	~~29~~	~~19~~	~~17~~			~~1.39~~		
~~127-183~~	~~36~~	~~34~~	~~32~~	~~30~~	~~22~~	~~12~~			~~1.57~~		
~~183-239~~	~~38~~	~~38~~	~~36~~	~~34~~	~~24~~	~~14~~			~~1.55~~		
0- 25	39			30	20				1.45a/		
25- 50	40			31	21				1.38		
50-100	39			29	20				1.40		
100-150	37			29	20				1.50		
150-200	37			32	23				1.55		

a/ Estimate for tilled condition after settling due to wetting.

ITEM 5

		Ref. Nos.
Item 1:	Explanation A	
Item 2:	Explanation A	AWC to 150 cm
Item 3:	Explanation A	
Item 4:	Explanation A	

Columns A-G and J-L pedon S87TX027-002. Taxadjunct to series. Differs by having more silt and more carbonate. In carbonatic family. Lower block estimates for depths in Item 8.

ITEM 7

Part **Quantity**

A Rooting Depth, cm
Plants:
Base Common: 170
Adjusted Base Few: 200

B Root-related Retention Difference Sums, cm
Base Common
10-200 kPa: 11
10-1500 kPa: 27
Adjusted Base Few
10-200 kPa: 12
10-1500 kPa: 29

C Water Movement, cm/day
Infiltration Rate:
Intake Rate:
Surficial Hydraulic Conductivity
Saturated:
5kPa:

ITEM 6

Annual Use Sequence(s):

Bosque clay loam, 0-1 percent slopes; cotton, no winter crop, conventional tillage.

Typifying Survey(s):

Bell County, Texas

Compiler(s):

W. W. Fuchs
L. F. Ratliff
R. B. Grossman

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	MS	MS	MS	D	D	D	MS	MS	MV	MV
25- 50	MV	MV	MV	MV	MV	MS	D	D	D	MV	MV	MV
50-100	MV	MV	MV	MV	MV	MS	MS	D	D	MV	MV	MV
100-150	MV	MV	MV	MV	MV	MV	MV	MS	MS	MV	MV	MV
150-200	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
PND-FLD												
Part B												
Runoff CN	81	81	81	81	81	64	60	60	64	81	81	81
Part C												
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	MV	MV	MS	D	D	D	MS	MS	MS	MV
25- 50	MV	MV	MV	MV	MV	D	D	D	D	MS	MS	MV
50-100	MV	MV	MV	MV	MV	MS	D	D	D	D	MS	MS
100-150	MV	MV	MV	MV	MV	MV	MV	D	D	D	D	MS
150-200	MV	MV	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS
PND-FLD												
Part B												
Runoff CN	81	81	81	81	81	64	60	60	64	64	64	81
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	MV	MS	MS	MS	D	D	MS	MS	MS	MS
25- 50	MV	MV	MV	MV	MV	MV	MV	D	D	MV	MV	MV
50-100	MV	MV	MV	MV	MV	MV	MV	MS	D	MS	MV	MV
100-150	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
150-200	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
PND-FLD												
Part B												
Runoff CN	81	81	81	81	81	81	60	64	60	81	81	81
Part C												
Erosion												
Growth												

ITEM 9

Item 6:

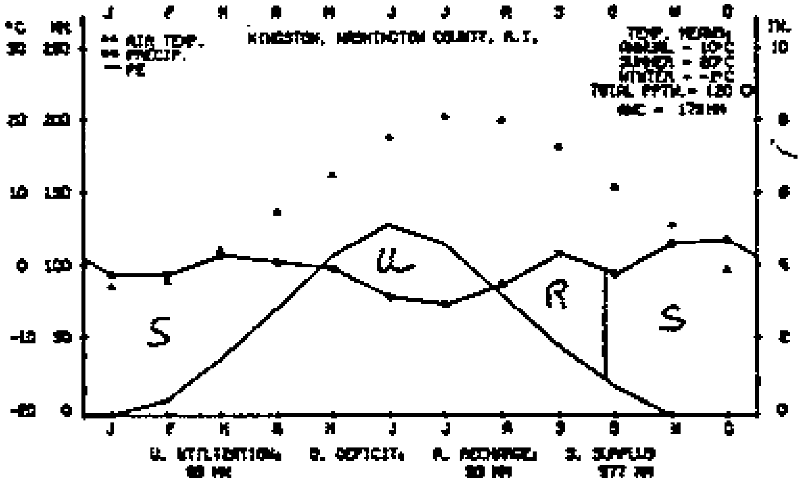
Harvest and shred stalks plus disk in same operation. December-February put in beds. May disk subsequently if weedy. Plant April 15-May 1. Cultivate once or twice plus herbicides. Defoliate late August-early September. Harvest September 1-October 1.

Item 7: **Ref. Nos.**
Part A - Explanation A
Part B - Explanation A
Part C - Explanation A

Item 8:
Part A - Explanation A
Part B - Explanation A Hydrologic Group B.
Part C - Explanation A

SOIL SURVEY WATER INFORMATION SHEET

ITEM 2



ITEM 1

Series:
Bridgehampton
Typic Dystrochrepts
Coarse-silty, mixed, mesic

No. Records:
1

ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-2.5	-1.6	2.6	7.9	13.1	18.2	21.6	20.5	16.1	11.2	6.0	-0.1	9.5
NORMAL POTEN. EVAPOTRANSPIRATION MM TH 48	0	0	9	37	73	109	133	110	81	47	19	0	616
NORMAL PRECIPITATION MILLIMETERS	97	77	120	100	102	81	76	90	111	97	110	116	1203

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS)	- - - - - - - - - - - - - -	
1	34	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	3	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5 kPa	Bulk Density	Volume >2 mm	EC
	<------------kPa					------------->					
cm	<----------Vol. Pct					---------->	<--------cm/day	-------->	g/cc	Pct	mmhos/cm
0-25	40	35	27	18	9	26			1.08	0	
25-53	36	32	26	16	6	26			1.27	0	
53-78	37	34	28	17	6	28			1.34	0	
78-97	31	29	22	13	4	24			1.44	0	
97-102	28	24	18	10	2	22			1.47	3	
102-107	18	12	6	2	1	11			1.60	25	
107-150	16	10	3	1	1	9			1.60	25	
0-25	40	35	27	18	9	26					
25-50	36	32	26	16	6	26					
50-100	34	31	26	15	5	26					
100-150	16	10	3	1	1	9					
150-200	16	10	3	1	1	9					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A   AWC calculated to 100 cm.

Item 3: Explanation A

Item 4: Explanation A
Pedon S59RI-005-002. Estimated 1, 10, and 200 kPa retention. Estimate bulk density bottom two horizons. Assume 200 kPa halfway between 33 and 1,500 kPa for upper five horizons. For bottom two horizons, assume 200 kPa is 1,500 kPa plus 20% of difference betwen 33 and 1,500 kPa. Assume 150-200 cm same as 100-150 cm.

ITEM 7

Part **Quantity**

A Rooting Depth, cm
  Plants:
  Base Common: 50
  Adjusted Base Few: 100

B Root-related Retention Difference Sums, cm
  Base Common
    10-200 kPa: 8
    10-1500 kPa: 13
  Adjusted Base Few
    10-200 kPa: 15
    10-1500 kPa: 23

C Water Movement, cm/day
  Infiltration Rate:
  Intake Rate:
  Surficial Hydraulic Conductivity
    Saturated:
    5 kPa:

ITEM 6

Soil Mapping Concept(s):
Bridgehampton silt loam, 0-3
  percent slopes

Soil Use(s):
Continuous silage corn with rye
grass cover.

Typifying Survey(s):
State of Rhode Island

Compiler(s): Date:
R. B. Grossman, Soil Scientist, SCS, Lincoln, NE 2/11/83
L. A. Quandt, Soil Correlator, NENTC, SCS,
  Broomall, PA
R. A. Shook, Jr., Asst. State Soil Scientist,
  SCS, Amherst, MA
E. H. Sautter, State Soil Scientist, SCS, Amherst, MA
F. L. Zaik, State Resource Conservationist, SCS,
  Amherst, MA

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	WA	WA	WA	MH	MM	MH	MS	MS	MM	MM	MH	MH
	F	F	F									
25-50	WN	WN	WN	MH	MH	MH	MM	MS	MS	MM	MH	MH
50-100	WN	WN	WN	WN	WN	WN	MH	MM	MM	MM	MM	MH
100-150	WN	WN	WN	MH	MH	MH	MH	MH	MH	MM	MM	MH
150-200	WN	WN	WN	MH	MH	MH	MH	MH	MH	MH	MH	MH
PND-FLD												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	WA	WA	WA	MM	MM	MS	MS	MS	MS	MM	MH	MH
	F	F	F									
25-50	MH	MH	MH	MM	MM	MM	MS	MS	MS	MM	MM	MH
50-100	MH	MH	MH	MH	MH	MH	MM	MS	MS	MS	MM	MM
100-150	MH	MH	MH	MH	MH	MH	MM	MM	MM	MM	MM	MM
150-200	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH
PND-FLD												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	WA	WA	WA	WN	MH	MH	MM	MM	MH	MH	WN	WN
	F	F	F									
25-50	WN	WN	WN	WN	MH	MH	MH	MH	MH	MH	WN	WN
50-100	WN	WN	WN	WN	WN	WN	MH	MH	MH	MH	WN	WN
100-150	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN
150-200	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN
PND-FLD												

Part B

	J	F	M	A	M	J	J	A	S	O	N	D
Runoff (Average)												
CN (Average)	96	98	96	92	81	81	78	60	81	76	88	88
Runoff (Driest)												
CN (Driest)	96	98	96	81	81	81	60	60	64	76	88	88
Runoff (Wettest)												
CN (Wettest)	96	98	96	88	92	92	78	78	92	85	88	88

Part C

	J	F	M	A	M	J	J	A	S	O	N	D
Erosion (Average)												
Growth (Average)												
Erosion (Driest)												
Growth (Driest)												
Erosion (Wettest)												
Growth (Wettest)												

ITEM 9

Item 6:
Disk April 15. Plant May 1. 50% cover June 15. August 15 pass maximum water retention. Harvest September 1. Plant rye grass by September 15. October 15 rye grass covers 50% of surface; 100% by November 1.

Item 7:
Part A - Explanation A

Part B - Explanation A

Part C - Explanation A

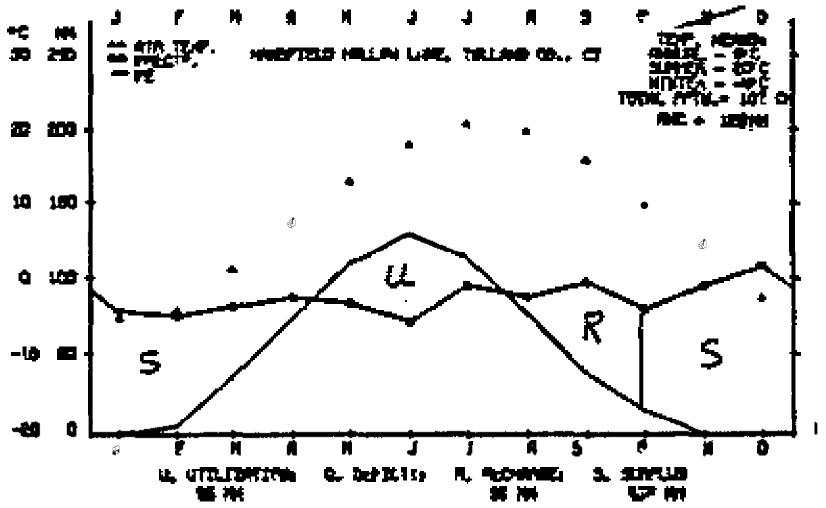
Item 8:
Part A - Explanation A MH, 1-33 kPa; MM, 33-200 kPa; MS, 200-1500 kPa; DS, 1500 kPa retention to 0.8 times 1500 kPa retention. Shift from silt loam to very gravelly sand at 100 cm interrupts capillary continuity leading to lower suction M-100 cm. Used climate table in State of Rhode Island survey as guide to departures in precipitation from average year in dry and wet years.

Part B - Explanation A Hydrologic Group B. Assume small grain October through March. In wet year, assume planting delayed. If 0-25 cm MH, consider Antecedent III.

Part C - Explanation A

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Charlton
Typic Dystrochrepts, coarse-loamy, mixed, mesic

No. Records:

ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-4.6	-3.7	1.4	7.8	13.5	18.9	21.3	20.3	16.2	10.6	4.4	-2.1	8.6
NORMAL POTEN. EVAPOTRANSPIRATION MM [illegible]	0	0	3	37	76	112	132	117	80	41	16	0	616
NORMAL PRECIPITATION MILLIMETERS	81	76	94	99	96	74	96	95	105	83	98	111	1072

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS)	- - - - - - -	
1	10	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	3kPa			
	<——kPa——>										
cm	<——Vol. Pct——>						<——cm/day——>		g/cc	Pct	mmhos/cm
0- 3											
3- 15	34	26	18	12	7	19			1.32	2	
15- 41	29	22	14	11	7	15			1.44	5	
41- 66	28	21	14	9	5	16			1.43	10	
66-112	21	16	11	8	5	11			1.70	15	
112-137	20	13	7	5	3 a/	10			1.65 a/	15	
0- 20	36			12	7				1.50 b/	2	
20- 50	29			11	7				1.45	7	
50-100	21			8	5				1.65	12	
100-150	20			5	3				1.65	15	
150-200	20			5	3				1.65	15	

a/ Estimates

b/ Estimate for tilled condition after settling due to wetting.

ITEM 5

Ref. Nos.

Item 1: Explanation A

Item 2: Explanation A Assume fine sandy loam surface horizon texture with 0.16 AWC. Also, 0.13 AWC for second and 0.11 for third horizon. Calculate to 100 cm.

Item 3: Explanation A

Item 4: Explanation A Pedon S58CT-7-1 in Soil Survey Investigation Report 20. Water retention from Hill, D. E. and Sheerin, A. E. 1969. The Charlton Soils Bulletin 706. Connecticut Agricultural Station. Estimate 200 kPa as half way between 33 and 1500 kPa retention. Lower block estimates for depth intervals of Item 8.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Corn Base Common: 50 Base Few: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 6 10-1500 kPa: 8 Base Few 10-200 kPa: 10 10-1500 kPa: 11
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):
Charlton Fine sandy loam, 3-8 percent slopes corn silage-hay with conventional tillage.

Typifying Survey(s):
Tolland County, Connecticut

Compiler(s):
Ed Sauttar
Loyal Quandt
Oliver Rice
Carl Langlois
Bob Grossman

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 20	WA	WA	WA	MV	MV	MV	MS	MS	MS	MV	MV	MV
	F	F	F									
20- 50	WA	WA	WA	WN	MV	MV	MS	MS	MS	MV	MV	MV
	F	F	F									
50-100	MV	MV	MV	MV	MV	MV	MV	MS	MS	MS	MV	MV
100-150	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
150-200	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
PND-FLD												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 20	WA	WA	WA	MV	MV	MS	MS	D	D	MS	MV	MV
	F	F	F									
20- 50	WA	WA	WA	WN	MV	MS	MS	MS	MS	MS	MV	MV
	F	F	F									
50-100	MV	MV	MV	MV	MV	MV	MS	MS	MS	MS	MV	MV
100-150	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
150-200	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
PND-FLD												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 20	WA	WA	WA	WN	MV	MV	MV	MV	MV	MV	WN	WN
	F	F	F									
20- 50	WA	WA	WA	WN	MV	MV	MV	MV	MV	MV	WN	WN
	F	F	F									
50-100	MV	MV	MV	WN	MV	MV	MV	MV	MV	MV	MV	MV
100-150	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
150-200	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
PND-FLD												

Part B

Runoff CN	J	F	M	A	M	J	J	A	S	O	N	D
Average - 6 years in 10	96	98	96	69	79	79	57	57	57	79	73	73
Driest 2 years in 10	96	98	96	69	79	62	57	57	57	62	73	73
Wettest 2 years in 10	96	98	96	84	79	79	75	75	$5	79	87	87

Part c

Average - 6 years in 10	J	F	M	A	M	J	J	A	S	O	N	D
Erosion					X	X				X		
Growth						X	X					

ITEM 9

Item 6:

Two years of corn and 3 years of hay. Grass hay predominately. Moldboard plow late April. Disk early May. Plant late May. 50% cover early July. Harvest late September-early October. Cover crop of rye early October. Pertains to first year of hay.

Item 7: Ref. Nos.
Part A - Explanation A No adjustment for base of few roots

Part B - Explanation A

Part C - Explanation A

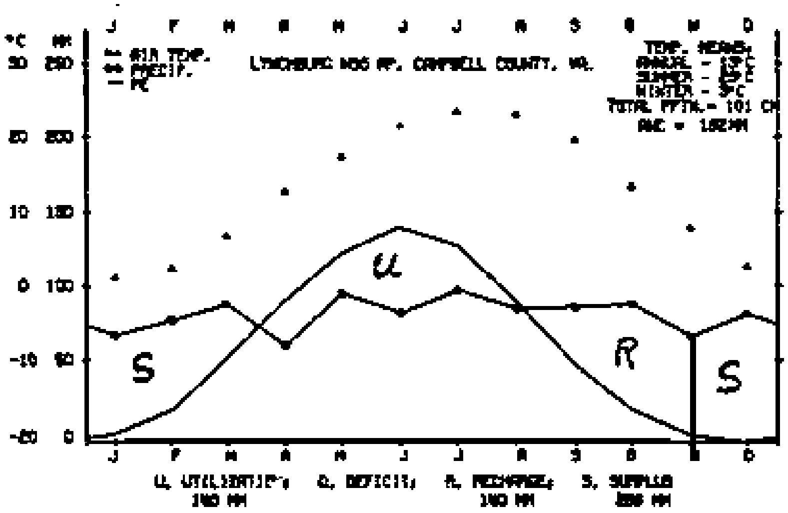
Item 8:
Part A - Explanation A Assume dryness, wetness pertain to growing season.

Part B - Explanation A Hydrologic Group B. Assume contoured.

Part C - Explanation A

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Cullen

Typic Hapludults, clayey, mixed, thermic

No. Records:

ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	[illegible]	[illegible]	7.5	13.5	17.9	22.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NORMAL POTEN. EVAPOTRANSPIRATION MM IN 60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NORMAL PRECIPITATION MILLIMETERS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	CRITERIA FOR MOISTURE CONTROL SECTION (MSC)		
1	25	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	[illegible]	DRY SOME/ALL PARTS MCS	[illegible] OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	[illegible]	DRY ALL PARTS MCS	[illegible] OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	[illegible]	DRY ALL PARTS MCS	[illegible] OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	[illegible]	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	[illegible]	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	[illegible]	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: MESIC — ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME: UDIC — ESTIMATED FROM PROBABILITY VALUES ON LINES 1, 3, 5, 6, 7

AND MOISTURE REQUIREMENT IS TYPICAL FOR [illegible] SERIES(SOIL)

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5kPa	Bulk Density	Volume >2mm	EC
	<———kPa———>										
cm	<———Vol. Pct———>						<———cm day———>			Pct	mmhos cm
0- 10	29	27	25'	17	9	18			g1.58	20	I
20	29	27	25	18	12	15			1.73	8	
20- 46	46	46	45	39	33	13			1.46	2	
46- 72	47	46	43	39	34	12			1.28	2	
	52	51	49	44	38	13			1.28	tr	
132-157 97 132	60 52	51 57	50 53	44 36	38 19	13 2 a			0.88 1.29	..	
0- 25	29			18	11				1.50a/	13	
25- 50	45			39	33				1.46	2	
50-100	50			42	36				1.28	1	
100-150	56			39	29				1.09	0	
150-200	60			36	19				0.88	0	

a/ Estimate for tilled condition after settling due to wetting.

ITEM 5

Ref. Nos.

Item 1: Explanation A

Item 2: Explanation A Use 0.16 for AWC of surface horizon. Computed for 150 cm depth.

Item 3: Explanation A

Item 4: Explanation A

Pedon S77VA-013-001. Assumed retention 33 kPa for third horizon of 31.3 percent. 200 kPa assumed half way between 33 and 1500 kPa retention. Calculated total porosity for 10 and 1 kPa retention using particle densities adjusted for extractable iron and for organic matter if either or both appreciable. Lower block estimates for depths in item 8.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Corn Base Common: 40 Adjusted Base Few: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 3 10-1500 kPa: 6 Adjusted Base Few 10-200 kPa: 5 10-1500 kPa: 6
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):

Cullen loam, 2-7 percent slopes; corn-winter wheat-soybeans (no till), corn portion.

Typifying Survey(s):

Charlotte County, Virginia

Compiler(s):

Dick Googins, Soil Scientist
Niles McLoda, Soil Scientist
Dean Rector. Soil Scientist
Jim Ware, Soil Scientist
Glen Anderson. Conservation Agronomist
Pete Saunders, Hydrologist
Loyal Quandt, Soil Scientist
Gob Grossman, Soil Scientist

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	WN	WN	WN	MV	MS	MS	MS	MS	MS	MS	MV	MV
25- 50	WN	WN	WN	MV	MS	MS	MS	MS	MS	MS	MV	MV
50-100	MV	WN	WN	WN	WN	MV	MV	MS	MS	MS	MS	MV
100-150	MV	MV	WN	WN	MV	MV	MV	MS	MS	MS	MS	MS
150-200	MV	MV	WN	WN	WN	MV	MV	MS	MS	MS	MS	MS
PND-FLD												
Runoff												
CN	95	95	95	88	66	66	66	66	66	75	80	80

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	WN	WN	MV	MV	MS	D	D	D	D	MS	MS	MV
25- 50	MV	MV	MV	MV	MS	MS	D	D	D	MS	MS	MS
50-100	MS	MV	MV	MV	MV	MS	MS	D	D	D	MS	MS
100-150	MS	MS	MV	MV	MV	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MV	MV	MV	MV	MS	MS	MS	MS	MS	MS
PND-FLD												
Runoff												
CN	95	95	88	88	66	66	66	66	66	75	75	80

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	WN	WN	WN	WN	MV	MV	MV	MS	MS	MV	MV	MV
25- 50	WN	WN	WN	WN	MV	MV	MV	MV	MS	MV	WN	WN
50-100	WN	WN	WN	WN	MV	MV	MV	MV	MV	MV	MV	WN
100-150	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN
150-200	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN	WN
PND-FLD												
Runoff												
CN	95	95	95	95	82	82	82	82	66	88	80	80

Part C

	J	F	M	A	M	J	J	A	S	O	N	D
Erosion												
Growth												

ITEM 9

Item 6:

Small grain: Plant October 15-Nov. Harvest June 15, leave residue.

Soybeans: Plant by July 1. No till planter. Harvest Nov. 1-15, leave residue.

corn: Plant April 15. no till. Harvest October 1-15. Chisel and disk before plant small grain.

The year considered: soybean stubble. corn, wheat.

Item 7: Ref. Nos.

Part A - Explanation A

Part B - Explanation A

Part C - Explanation A

Item 8:

Part A - Explanation A Droughts 2-4 year cycle. No frost in soil usually. Snow in some years. Snow melts and infiltrates.

Part B - Explanation A Hydrologic Group C. "red table 9.1A in SCS Hydrology Handbook. which is designed for conservation tillage.

Part C - Explanation A

SOIL SURVEY WATER RELATED INFORMATION

ITEM 1

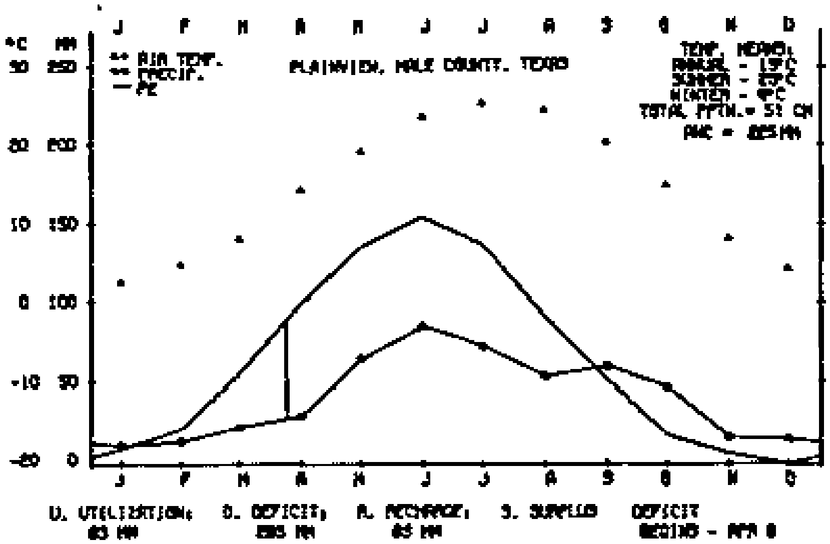
Series:

Estacado
Calciorthidic Paleustoll
Fine-loamy, calcareous, thermic

No. Records:

5

ITEM 2



ITEM 3

PLAINVIEW, HALE COUNTY, TEXAS   N3411 W10142 3370F   STATION # 417079   PRECIPITATION RECORD 1951-1976

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	2.9	5.3	8.7	14.7	19.7	24.0	25.8	24.8	20.8	15.3	8.4	4.4	14.6
NORMAL POTEN. EVAPOTRANSPIRATION MM TH-48	4	9	25	57	102	138	157	148	94	54	19	7	813
NORMAL PRECIPITATION MILLIMETERS	13	15	24	31	67	87	75	56	62	49	17	14	515

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - -		
1	49	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	75	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	30	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	5	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	58	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	60	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	35	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	30-1500	Saturated	5kPa			
	<------------------------kPa------------------------>										
cm	<------------------------Vol. Pct------------------------>						<--------cm/day-------->		g/cc	Pct	mmhos/cm
0-19	39	35	29	22	17	18			1.44	TR	.81
19-28	39	36	30	23	18	18			1.43	TR	.42
28-47	41	33	27	21	15	18			1.29	TR	.53
47-77	37	33	26	19	13	20			1.45	TR	.64
77-119	35	31	26	20	16	16			1.48	TR	.23
119-184	33	26	22	18	15	11			1.40	TR	.22
184-220	34	28	24	20	17	11			1.36	TR	.24
0-20				22	17				1.44		
20-50	40	34		22	16				1.34		
50-80	37	33		19	13				1.45		
80-150	35	29		20	16				1.44		
150-200	34	26		20	17				1.36		

ITEM 5

Ref. Nos.

Item 1: Explanation A

Item 2: Explanation A

Item 3: Explanation A AWC to 150 cm.

Item 4: Explanation A
Pedon S81-189-001. 10 and 200 kPa estimated by procedure by Otto Baumer.
1 kPa calculated from 10 kPa estimate.

ITEM 6

Annual Use Sequence(s):

Estacado clay loam 0-1 percent slopes
Upland flats
Continuous cotton, dryland, shallow cultivation

Typifying Survey(s):
Hale County, Texas

Compiler(s):
Mickey Black, Area Conservationist, Lubbock, TX
Dan Blackstock, Soil Scientist, Lubbock, TX
Bob Grossman, Soil Scientist, Lincoln, NE
Myron Hamken, Area Engineer, Lubbock, TX
Dennis Haffendorf, Conservation Agronomist, Lubbock, TX
Fred Pringle, Soil Scientist, Amarillo, TX
Mike Risinger, Soil Scientist, Lubbock, TX
Greg Sokora, Irrigation Engineer, Lubbock, TX

Month Assembled:
12/82

ITEM 7

Part (u/metre)	Observation	Kind Year	Yearly Values	S	O	N	D	J	F	M	A	M	J	J	A
A	Thickness	Average	10	10	10	10	10	10	10	10	10	10	10	10	10
Data for	Bulk Density			1.30	1.30	1.30	1.10	1.10	1.10	1.10	1.10	1.25	1.25	1.25	1.25
Mech. Bulked	1 kPa Ret.														
	10 kPa Ret.														
- cm															
- Mg/m³															
- Vol Pct															
- Vol Pct															
- cm/day	Thickness	Wet	10	10	10	10	10	10	10	10	10	10	10	10	10
	Bulk Density			1.30	1.30	1.30	1.30	1.10	1.10	1.10	1.10	1.25	1.25	1.30	1.30
Data for	Thickness	All	15	15	15	15	15	15	15	15	15	15	15	15	15
Mech. Comp.	Bulk Density		1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
	1 kPa Ret.														
	10 kPa Ret.														
	Sat. HC		5	5	5	5	5	5	5	5	5	5	5	5	5
	Thickness														
	Bulk Density														
B	Base Common	Average	30												
Rooting Depth	Base Few		80												
- cm															
	Base Common														
	Base Few														
C	Common 10-200	Average	4												
Root-related	Common 10-1500		5												
Water Retention	Few 10-200		9												
- cm	Few 10-1500		10												

ITEM 8

Depth cm	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
Part A																																				
0-20	MS	MS	MS	MS	DS	DS	MS	MS	MM	MM	MS	DS	DS	DS	DS	DS	DS	DS	DS	DS	MS	MM	MS	DS	MS	MS	MM	MS	MS	MS	MS	MM	MM	MM	MS	MS
20-50	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	DS	DS	DS	DS	DS	DS	DS	DS	MS	MS	MS	DS	MS	MS	MM	MM	MM	MS	MS	MS	MS	MM	MS	MS
50-80	DS	DS	MS	MS	MS	MS	MS	MS	MS	MS	MS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	MS	MS	MS	MS	MS	MS	MS	MM	MS	DS
80-150	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	MS	MS	MS	MS	DS
150-200	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS
[illegible]																																				
Part B																																				
CN-1	85	85	85	81	81	81	81	81	83	83	83	83	85	85	85	81	81	81	81	81	83	83	83	83	85	85	85	81	81	81	81	83	83	85	85	85
CN-2	65	65	65	64	64	64	64	64	83	81	65	62	65	65	65	64	64	64	64	64	67	81	65	62	65	65	80	81	81	64	64	81	83	82	68	65

ITEM 9

ITEM 6:
Two diskings or one disking and moldboard plowing in January or February; list in March or April; plant in mid-May; harvest in November or December; shred in December or January.

ITEM 6:
Part A - Explanation B

Part B - Explanation A

Part C - Explanation B Saturated hydraulic conductivity from double ring infiltrometer measurements by Pringle. Intake family is 0.5 inch; computation from ITEM 7 is being explored.

ITEM 8:
Part A - Explanation B MM class 33-200 kPa retention; DS class 1500 to 0.8 times 1500 kPa retention. Partly based on neutron probe observations by Risinger.

Part B - Explanation B CN-1 assumes antecedent II and poor hydrologic condition. CN-2 adjusted for water state and cover.

ITEM 5

Annual Use Sequence(s):

Estacado clay loam, 0-1 percent slopes
Upland Flats
Continuous cotton, dryland, deep chiseled

Typifying Survey(s):

Hale County, Texas

Compiler(s):

Mickey Black, Area Conservationist, Lubbock, TX
Dan Blackstock, Soil Scientist, Lubbock, TX
Bob Grossman, Soil Scientist, Lincoln, NE
Myron Nanken, Area Engineer, Lubbock, TX
Dennis Neffendorf, Conservationist Agronomist, Lubbock TX
Fred Pringle, Soil Scientist, Amarillo, TX
Mike Risinger, Soil Scientist, Lubbock, TX
Greg Sokora, Irrigation Engineer, Lubbock, TX

Month Assembled:
12/82

ITEM 7

Part (subunits)	Observation	Kind Year	Yearly Values	S	O	N	D	J	F	M	A	M	J	J	A
A	Thickness	Average	15	15	15	15	15	15	15	15	15	15	15	15	15
Data for	Bulk Density			1.30	1.30	1.30	1.10	1.10	1.10	1.10	1.10	1.25	1.25	1.25	1.25
Mech. Bulked	1 kPa Sat.														
	10 kPa Sat.														
- cm															
- Mg/m³															
- Vol Pct															
- Vol Pct															
- cm/day	Thickness	Wet	15	15	15	15	15	15	15	15	15	15	15	15	15
	Bulk Density			1.30	1.30	1.30	1.10	1.10	1.30	1.10	1.30	1.25	1.25	1.30	1.30
Data for	Thickness	Average		10	10	10	10	0	0	0	0	5	10	10	10
Mech. Comp.	Bulk Density			1.45	1.45	1.45	1.45	1.30	1.30	1.30	1.30	1.30	1.40	1.45	1.45
	1 kPa Sat.														
	10 kPa Sat.														
	Sat. HC			7	7	7	7	18	18	18	18	10	11	7	7
	Thickness	Wet		10	10	10	10	0	0	0	0	5	10	10	10
	Bulk Density			1.50	1.50	1.50	1.50	1.30	1.30	1.30	1.35	1.35	1.45	1.50	1.50
	Sat. HC			5	5	5	5	18	18	18	15	15	7	5	5
B	Base Common	Average	60												
Rooting Depth	Base Few		80												
- cm															
	Base Common														
	Base Few														
C	Common 10-200	Average													
Root-related	Common 10-1500														
Water Retention	Few 10-200														
- cm	Few 10-1500														

ITEM 8

Average - 6 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
Part A												
0-20	MS	MS	MS	MS	DS	DS	MS	MS	MM	MM	MS	DS
20-50	MM	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MS
50-80	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MS
80-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
200-210												
Part B												
CN-1	79	79	79	76	75	75	75	75	75	78	79	79
CN-2	76	59	59	58	57	57	57	75	75	78	75	59

Driest 2 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
Part A												
0-20	DS	DS	DS	DS	DS	DS	DS	DS	MS	MM	MS	DS
20-50	MS	DS	DS	DS	DS	DS	DS	MS	MM	MM	MS	MS
50-80	DS	DS	DS	DS	DS	DS	DS	MS	MS	MS	MS	DS
80-150	DS	DS	DS	DS	MS	MS	MS	MS	MS	MS	MS	DS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
200-210												
Part B												
CN-1	79	79	79	76	75	75	75	75	75	78	79	79
CN-2	60	60	60	58	57	57	57	57	75	78	58	60

Wettest 2 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
Part A												
0-20	MS	MS	MM	MS	MS	MS	MS	MM	MM	MM	MS	MS
20-50	MM	MM	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM
50-80	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM
80-150	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
200-210												
Part B												
CN-1	81	81	81	76	75	75	75	76	76	79	81	81
CN-2	77	77	77	60	57	57	57	76	76	77	78	77

ITEM 9

ITEM 6:
One disking in January or February followed shortly or immediately by one chisel pass 35-40 cm deep; listing in March or April; plant middle of May; harvest November or December; shred December or January.

ITEM 7:
Part A - Explanation B
Part B - Explanation B
Part C - Explanation B Saturated hydraulic conductivity from double ring infiltrometer measurements by Pringle. Intake family is 0.75 inch; computation from ITEM 7 is being explored.

ITEM 8:
Part A - Explanation B MM class 200-33 kPa retention; DS class 1500 to 0.8 times 1500 kPa retention. Partly based on neutron probe measurements by Risinger.
Part B - Explanation B CN-1 is for antecedent II and poor hydrologic condition. CN-2 is adjusted for cover and water state. Assumes physical properties for average year except for wettest 2 years in 10, for which use wet year.

Pattern of Water States by EPIC Model

Estacado clay loam, 0-1 percent slopes. Continuous cotton, dryland, deep chiseled.
Lubbock, Texas Airport, weather station. Pedon 58TX-189-001.

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	D	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	D
		w			d	d		w				d
20-50	MS	MS	MS	MS	MS	MM	MS	MS	MS	MS	MS	MS
				d	d		d		d			
50-80	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
				d	d	d	d		d			
80-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	w	w	w	w	w	w	w	w	w	w	w	w
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	w	w	w	w	w	w	w	w	w	w	w	w

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	D	D	D	D	D	MS	D	D	D	D	D	D
					d	d	d					
20-50	MS	MS	MS	MS	MS	MS	MS	D	D	D	MS	D
	w	w	w		d	d		d	d		w	
50-80	MS	MS	MS	MS	MS	MS	MS	D	D	MS	MS	MS
	w	w	w							w	w	w
80-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	w	w	w	w	w	w	w	w	w	w	w	w
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	w	w	w	w	w	w	w	w	w	w	w	w

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	MS	MS	MS	MM	MM	MM	MM	MS	MS	MM	MS	MS
							w			w	d	
20-50	MS	MS	MS	MM	MM	MM	MM	MS	MS	MS	MM	MS
								d	d	d	w	
50-80	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
				d	d	d	d	d				
80-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	w	w	w	w				w	w	w	w	w
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	w	w	w	w	w	w	w	w	w	w	w	w

NOTE: "d" in second row means EPIC class drier than that assigned by SCS personnel. "w" means EPIC class wetter. Blank means classes are the same.

Above 80 cm: 26% EPIC placements drier and 9% wetter.

Below 80 cm: 96% EPIC placements wetter.

Annual Use Sequence(s):
Estacado clay loam, 0-1 percent slopes
Upland flats
Continuous cotton, dryland, deep chiseled, furrow diked

ITEM 6

Compiler(s):
Mickey Black, Area Conservationist, Lubbock, TX
Dan Blackstock, Soil Scientist, Lubbock, TX
Bob Grossman, Soil Scientist, Lincoln, NE
Myron Nanken, Area Engineer, Lubbock, TX
Dennis Neffendorf, Conservation Agronomist, Lubbock, TX
Fred Pringle, Soil Scientist, Amarillo, TX
Mike Risinger, Soil Scientist, Lubbock, TX
Greg Sokora, Irrigation Engineer, Lubbock, TX

Typifying Survey(s):
Hale County, Texas

Month Assembled:
12/82

ITEM 7

Part (w/units)	Observation	Kind Year	Yearly Values	S	O	N	D	J	F	M	A	M	J	J	A
A	Thickness	Average													
Data for	Bulk Density			1.45	1.45	1.45	1.45	1.30	1.30	1.40	1.40	1.45	1.55	1.55	1.45
Mech. Comp.	1 kPa Ret.														
Not Diked	10 kPa Ret.														
- cm	Sat. HC			7	7	7	7	17	17	13	13	7	4	4	7
- Mg/m³															
- Vol Pct															
- Vol Pct															
- cm/day	Thickness														
	Bulk Density														
Data for	Thickness	Average													
Mech. Comp.	Bulk Density			1.45	1.45	1.45	1.45	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.45
Diked Part	3 kPa Ret.														
	10 kPa Ret.														
	Sat. HC			7	7	7	7	17	17	17	17	17	17	17	7
	Thickness														
	Bulk Density														
B	Base Common	Average	40												
Rooting Depth - cm	Base Few		80												
	Base Common														
	Base Few														
C	Common 10-200	Average													
Soil-related	Common 10-1500														
Water Retention	Few 10-200														
- cm	Few 10-1500														

ITEM 8

Average - 6 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
Part A												
0-20	MS	MS	MS	MS	DS	DS	MS	MM	MM	MM	MS	MS
20-50	MM	MM	MS	MS	MS	MS	MS	MM	MM	MM	MM	MS
50-80	MM	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM
80-150	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
[illegible]												
Part B												
CN-1	79	79	79	76	75	75	78	78	79	83	83	79
CN-2	79	79	61	60	57	57	50	68	69	70	69	48

Driest 2 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
Part A												
0-20	DS	DS	DS	DS	DS	DS	DS	MS	MM	MM	MS	DS
20-50	MS	DS	DS	DS	DS	DS	DS	MM	MM	MM	MM	MS
50-80	MS	MS	DS	DS	DS	DS	DS	MS	MM	MM	MS	MS
80-150	DS	DS	DS	DS	MS	MS	MS	MS	MS	MS	MS	DS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
[illegible]												
Part B												
CN-1	79	79	79	76	75	75	78	78	79	83	83	79
CN-2	62	62	62	60	57	57	47	68	69	70	69	79

Wettest 2 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
Part A												
0-20	MM	MS	MM	MS	MS	MS	MM	MM	MM	MM	MM	MS
20-50	MM	MM	MM	MM	MS	MS	MM	MM	MM	MM	MM	MM
50-80	MM	MM	MM	MS	MS	MS	MS	MM	MM	MM	MM	MM
80-150	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MS	MS
[illegible]												
Part B												
CN-1	79	79	79	76	75	75	78	78	79	83	83	79
CN-2	75	75	77	76	57	57	68	68	69	71	69	75

ITEM 9

ITEM 6:
One disking in January or February followed shortly or immediately by one chisel pass 35-40 cm deep; listing in March or April and install furrow dikes 10 cm high and 2-3 cm apart in alternate rows; plant middle of May; harvest November or December; shred December or January. Furrow dikes removed with last cultivation.

ITEM 7:
Part A - Explanation B
Part B - Explanation B
Part C - Explanation B Saturated hydraulic conductivity from double ring infiltrometer measurements by Pringle. Intake family is 0.75 inch; computation from ITEM 7 is being explored.

ITEM 8:
Part A - Explanation B MM class 33-200 kPa retention; DS class 1500 to 0.8 times 1500 kPa retention. Partly based on neutron probe data by Risinger. Assumed first dry or wet year after average year.
Part B - Explanation B CN-1 assumes antecedent II and poor hydrologic condition. CN-2 adjusted for water state and cover, and reduced by 10 while furrow dikes present.

SOIL SURVEY WATER INFORMATION SHEET

ITEM 2

ITEM 1

Series:
Fallbrook
Typic Haploxeralfs
Fine-loamy, mixed, thermic

No. Records:
1

ITEM 3

ESCONDIDO, SAN DIEGO COUNTY, CALIFORNIA N3307 W11705 660F STATION # 042863-1 PRECIPITATION RECORD 1951-1980

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	11.6	11.9	13.0	15.1	17.4	19.7	22.9	23.4	22.6	18.2	14.3	11.7	16.7
NORMAL POTEN. EVAPOTRANSPIRATION MM (P TO)	28	31	43	50	61	90	128	126	101	71	43	30	850
NORMAL PRECIPITATION MILLIMETERS	76	53	55	35	7	3	1	3	5	8	40	56	342

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	CRITERIA FOR MOISTURE CONTROL SECTION (MCS)		
1	100	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP > 5 DEG C OR HIGHER
2	45	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP > 5 DEG C OR HIGHER
3	55	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP > 5 DEG C OR HIGHER
4	5	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP > 5 DEG C OR HIGHER
5	45	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP > 8 DEG C OR HIGHER
6	100	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	75	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2 mm	EC
	1	10	33	200	1500	10-1500	Saturated	5 kPa			
	<------------		kPa			------------>					
cm	<----------		Vol. Pct			---------->	<---------cm/day	--------->	g/cc	Pct	mmhos/cm
0-6	29	22	14	9	4	18			1.42	4	
6-15	27	21	19	11	5	16			1.60	6	
15-30	26	22	19	14	9	13			1.78	2	
30-51	28	27	26	22	17	10			1.78	3	
51-71	30	30	28	24	19	11			1.73	2	
71-119	26	24	23	18	13	11			1.80	8	
119-173	22	20	17	12	9	11			1.81	14	0.18
173-216											
216-229											0.07
0-30	27	22	18	12	7	15					
30-70	29	28	27	23	18	11					
70-120	26	24	23	18	13	11					
120-170	22	20	17	12	9	11					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A Record Number SOILS-5 form CA0546. AWC to 125 cm.

Item 3: Explanation A

Item 4: Explanation A
Pedon S64CA-037-002. 33 and 1500 kPa retention measured. 1, 10, and 200 estimated. Last assumed as midpoint between 33 and 1500 kPa retention.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Soft chess, wild oats, bur clover; oaks Base Common: 70 (annuals) Adjusted Base Few: 120 (annuals)
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 5 10-1500 kPa: 9 Adjusted Base Few 10-200 kPa: 8 10-1500 kPa: 14
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5 kPa:

ITEM 6

Soil Mapping Concept(s):
Fallbrook sandy loam, 0-3 percent slopes

Soil Use(s):
Annual Range, Fair Condition

Typifying Survey(s):
San Diego Area, California

Compiler(s):
R. A. Dierking, Soil Scientist, WNTC
A. R. Ford, Soil Scientist, WNTC
R. B. Grossman, Soil Scientist, NSSL, SCS, Lincoln, NE
L. K. Langan, Soil Scientist, WNTC
E. L. Spencer, Soil Scientist, WNTC
M. S. Yee, Soil Scientist, WNTC

Date:
2/83

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-30	MM	MM	MS	MS	DS	DS	DV	DV	DV	DV	DV	MS
30-70	MM	MM	MM	MM	MS	DS	DV	DV	DV	DS	MS	MM
70-120	MM	MM	MM	MM	MM	MM	MS	DV	DV	DV	DV	MS
120-170	MM	MM	MM	MS	MS	MS	MS	DV	DV	DV	DS	MS
PND-FLD												
Part B												
Runoff Cn	69	69	69	79	62	62	62	62	62	62	62	69
Part C												
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-30	MS	MM	MS	MS	DS	DS	DV	DV	DV	DV	DV	DS
30-70	MM	MM	MM	MM	MS	DS	DV	DV	DV	DS	MS	MS
70-120	MS	MM	MM	MM	MM	MM	MS	DV	DV	DV	DV	DS
120-170	MS	MM	MS	MS	MS	MS	MS	DV	DV	DV	DV	DV
PND-FLD												
Part B												
Runoff Cn	69	69	69	79	62	62	62	62	62	62	62	62
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-30	MM	MM	MM	MS	DS	DS	DV	DV	DV	DS	MS	MM
30-70	MM	MM	MS	MM	MS	DS	DV	DV	DV	DS	MM	MM
70-120	MM	MM	MM	MM	MM	MM	MS	DV	DV	DV	MS	MM
120-170	MM	MM	MS	MS	MS	MS	MS	DV	DV	DV	DS	MS
PND-FLD												
Part B												
Runoff Cn	69	69	69	79	62	62	62	62	62	62	62	69
Part C												
Erosion												
Growth												

ITEM 9

Item 6:
Exclusive of oak trees. Assume 10 percent ground surface covered by oak trees.

Item 7:

Part A - Explanation A

Part B - Explanation A

Part C - Explanation A

Item 8:

Part A - Explanation A — Field water information used from Soil Survey Investigation Report No. 21. Assumed average precipitation for period of measurement. MM, 1-33 kPa retention; MM, 33-200 kPa; MS, 200-1500 kPa; DS, 1500 retention to 0.8 times 1500 kPa retention; DV, 0.8 times 1500 kPa retention or less water.

Part B - Explanation A — Hydrologic Group B. Fair Hydrologic Condition December through March except for Dry years.

Part C - Explanation A

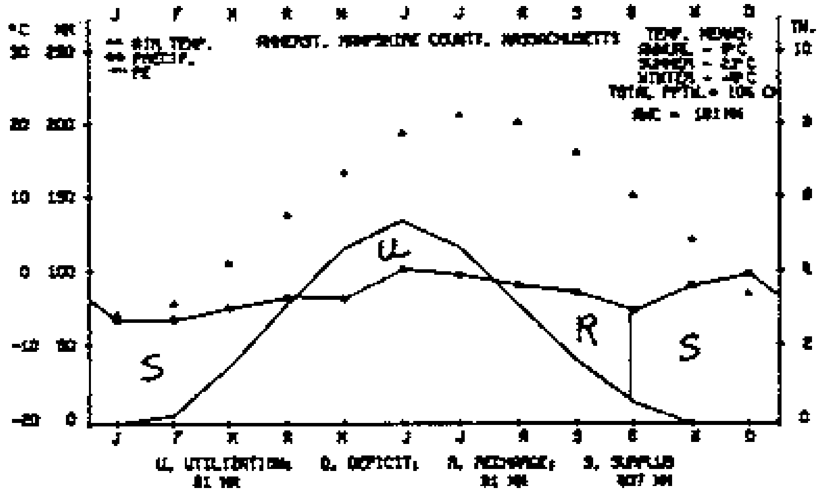
SOIL SURVEY WATER INFORMATION SHEET

ITEM 1

Series:
Hadley
Typic Udifluvents
Coarse-silty, mixed,
nonacid, mesic

No. Records:
1

ITEM 2



ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-5.5	-3.9	1.4	8.1	13.9	19.3	21.7	20.7	16.6	10.6	4.8	-2.4	8.8
NORMAL POTEN. EVAPOTRANSPIRATION MM [illegible]	0	0	5	37	88	118	137	119	81	45	14	0	635
NORMAL PRECIPITATION MILLIMETERS	76	78	78	89	84	104	108	93	88	76	93	101	1062

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - -		
1	20	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5 kPa	Bulk Density	Volume >2 mm	EC
	<-----------	-----	kPa	-----	-----	----->					
cm	<----------	-----	Vol. Pct	-----	-----	---->	<--------cm/day	-------->	g/cc	Pct	mmhos/cm
0-26	34	31	25	15	5	26			1.40	0	
26-49	46	44	42	23	5	39			1.28	0	
49-61	42	38	32	19	6	32			1.18	0	
61-77	42	38	33	20	6	32			1.20	0	
77-121	43	41	37	18	9	32			1.29	0	
121-178	36	34	30	18	6	28			1.38	3	
0-30	36	33	27	16	5	28					
30-50	46	44	42	23	5	39					
50-100	42	39	34	19	7	32					
100-150	39	37	33	18	7	30					
150-200	36	34	30	18	6	28					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A AWC calculated to 100 cm.

Item 3: Explanation A

Item 4: Explanation A
Pedon S70MA-008-002. 1, 10, and 200 kPa retention estimated. 200 kPa retention midpoint of 33 and 1500 kPa retention.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Base Common: 75 Adjusted Base Few: 150
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 14 10-1500 kPa: 24 Adjusted Base Few 10-200 kPa: 26 10-1500 kPa: 42
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5 kPa:

ITEM 6

Soil Mapping Concept(s):
Hadley silt loam, 0-3
percent slopes

Soil Use(s):
Continuous silage corn with rye
grass cover.

Typifying Survey(s):
Hampshire County, Central Part, MA

Compiler(s):

Date: 2/10/83

B. J. Ritger, Resource Conservationist, SCS, Amherst, MA
S. J. Claughton, Water Resource Specialist, SCS, Amherst, MA
D. G. Grice, State Soil Scientist, SCS, Amherst, MA
R. B. Grossman, Soil Scientist, SCS, Lincoln, NE
S. V. Hundley, Asst. State Soil Scientist, SCS, Amherst, MA
L. A. Quandt, Soil Correlator, NENTC, SCS, Broomall, PA
J. A. Wesoloski, Civil Engineer, SCS, Amherst, MA

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-30	WA	WA	WA	MH	MM	MM	MS	MS	MM	MM	MM	WN
	F	F	F									
30-50	WA	WA	WA	WN	MM	MM	MS	MS	MS	MM	MS	MM
	F	F	F									
50-100	WN	WN	WN	WN	MM	MM	MM	MS	MS	MS	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLO												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-30	WA	WA	WN	MM	MS	MS	MS	MS	MM	MM	MM	MM
	F	F	F									
30-50	WN	WN	WN	MM	MM	MS	MS	MS	MM	MM	MM	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
PND-FLO												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-30	WA	WA	WA	WN	MM	MM	MM	MM	MM	WN	WA	WA
	F	F	F									
30-50	WA	WA	WA	WA	WN	MM	MM	MM	MM	WN	WA	WA
	F	F	F									
50-100	MM	WA	WA	WA	WN	MM	MM	MM	MM	MM	WN	MM
100-150	WN	WN	WN	WN	WN	WN	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	WN	WN	MM	MM	MM	MM	MM	MM
PND-FLO												

Part B

Runoff CN	J	F	M	A	M	J	J	A	S	O	N	D
Average - 6 years in 10	96	98	96	92	81	81	60	60	81	76	89	88
Driest 2 years in 10	96	98	96	81	81	64	60	60	81	76	76	88
Wettest 2 years in 10	96	98	96	95	88	81	81	78	90	92	89	88

Part C

	J	F	M	A	M	J	J	A	S	O	N	D
Erosion												
Growth												

ITEM 9

Item 6:
Moldboard plow April 15. Harrow, disk and plant May 15. 50% cover July 1. Harvest September 15. Plant rye grass October 1. 50% cover by December 1. Not conservation tillage.

Item 7:
Part A - Explanation A

Part B - Explanation A

Part C - Explanation A

Item 8:

Part A - Explanation A	MH, 1-33 kPa; MM, 33-200 kPa; MS, 200-1500 kPa; DS, 1500 kPa retention to 0.8 times 1500 kPa retention. Used climate table from soil survey report for difference in precipitation from average year for dry and wet years.
Part B - Explanation A	B Hydrologic Group. Used small grain guides October 1 until April 1. MH assumed as wet for antecedent water state.
Part C - Explanation A	

Harney Record Overview

The front side of the water information record pertains to soil series. The backside and additional pages would pertain to combinations of mapping concepts and specific uses of there mapping concepts.

Item 1. Harney is a deep loess derived soil occurring in the eastern Part of western Kansas. Three and one-half million acres have been correlated as being in Harney map units.

Item 2. This is a computer generated water balance diagram using long-ten monthly averages for a weather station central to tbe occurrence of the Harney series. John Thompson developed the software. The evapotranspiration is by the Thornthwaite Method. The Available Water Capacity (AWC) is from the SOILS-5 form.

Item 3. This table uses monthly average vrpotranspiration and precipitation for tbe same weather station to which Item 2 applies. The model tests the computed water regime of the Moisture Control Section (MCS) against seven taxonomic criteria. The model assumes that half of the monthly precipitation occurs as a single storm and all of this water enters the Moisture Control Section. The other half of the monthly precipitation occurs as light storms which do not directly affect the Moisture Control Section. They do, however, satisfy evapotranspiration demand. Kind of plants and runoff are not considered.

Item 4. The upper set of entries are water related data for a pedon that represents the Harney series. Principal emphasis is on the set of volumetric water contents at auctions which are also limits for the water state classes to be discussed in Item 8. Note that 1 kPa ≈ .01 bar. Usually 33 and 1,500 kPa retention are available and the 1 and 200 kPa retention values would be estimated. The estimates for 1 sod for 10 kPa were made by filling a portion of the calculated air-filled porosity at 33 kPa retention witn water and then adding this water to the volume of water measured at 33 kPa. We would, in the future, shift to statistical based estimates that involve texture as well as air-filled porosity.

The lover set of data are for the depth intervals used in Item 8 to characterize the pattern of water states. Values in the lower table establish the range in volumetric water content far the water state classes of Item 8. For example, Slightly Moist is defined as between 200 and 1,500 kPa. For the O-25 cm zone, the volumetric water content for this class is 25-17 percent.

Item 5. This is explanatory information for the other items an the page

Item 6. This gives the mapping concept and the use of this mapping concept to which the information in Items 7-9 applies. About 1.5 million acres have been correlated under the map wit name stipulated here. In Item 9, the soil use through the year is documented in sufficient detail that the Curve Number can he calculated.

The compilers include an SCS hydraulic engineer. Commonly a resource conservationist or someone in another agronomically related position would be present. Agronomic knowledge is needed to define and describe the soil use. Hydrology input is advantageous for evaluation of the Curve Number (Item 8, part B).

Item 7. Part A gives the depth to the base of common roots and to the base of few roots (the depth of rooting). The depth listed is the maximum for the year.

Part B gives the amounts of water in centimeters between stipulated suction values from the soil surface to the rooting depths given in part A. The data in Item 4 arc used for the computations. Tbe values relate a laboratory water retention determination and a specific use as this determines a rooting depth. For annuals and perennials adapted to more moist soils, the laboratory water retention values for the zone of few roots arc reduced. The reduction is determined by the suction range, the strength of the soil as this pertains to root growth resistance, and texture.

Part C is where information on near-surface water movement is recorded. For the example, the furrow irrigation intake rate is shown. The information is not related to time during the year. It would be the intent in the future to expand this Item to give monthly entries if such information is available.

Item 8, Part A. This gives the month-by-month pattern of water states for standard depth zones over • 12-month period beginning with planting of winter wheat in September. To follow is an explanation of the classes.

Class Name	Symbol	Suction Range Sandy	 Coarse-loamy < 2 mm and Bulk Density < 1.55 Mg/m³ a/, b/	 Other
Dry c/	D	> 1,500	> 1,500	> 1,500
Slightly Dry	DS	1,500-10,000	1,500-10,000	1,500-10,000
Very Dry	DV	> 10,000	> 10,000	>10,000
Moist	M	1/2-1,500	1-1,500	1-1.500
Highly Moist	MH	1/2-5	1-10	1-33
Moderately Moist	MM	5-50	10-100	33-200
Slightly Moist	MS	50-1,500	100-1,500	200-1.500
Wet d/	W	≤ 1/2	≤ 1	≤ 1
Not Satiated	WN	≤ 1/2	≤ 1	≤ 1
Satiated	WA	≤ 1/2	≤ 1	≤ 1

a/ Apply family particle size criteria to < 2 mm only.

b/ If particle density departs appreciably from 2.65 Mg/m³, we bulk density ● ubicb total porosity is 42 percent.

c/ Assume that rater retention ● t 10,000 kPa is SO percent of that at 1,500 kPa.

d/ Soil material is satiated at the first appearance of free water. The material is usually not saturated at initial satiation.

Assignment of the water state pattern requires consideration of the fallow period. during the summer prior to planting and the decrease in the ● vapotranspirrtion of the winter wheat as it reaches maturity after about June 1. Both would suggest a more moist soil than the climate might indicate. The rooting depths from Item 1 are used in assessing the pattern of water states. The precipitation and ● vapotranspir=tion information in Item 3 is useful in establishing the pattern of water states for average years. For comparison of wet and dry years with average years, the tables in published ● oil surveys that give monthly precipitation valuer for average years and for both wet and dry years are very useful.

The water state patterns are for the area between terrace basins. Field studier indicate that deep percolation occurs in the terrace basins. Presumably, the pattern of water states in lower depths would be more moist for the terrace basins. The pattern of water states presented here may not be appropriate for concerns involving deep movement of chemicals. For this, the pattern within the terrace basins may be the □ =re relevant.

Item 8, Part B. This gives monthly Curve Numbers. The Curve Number specifies a relationship between daily runoff and daily precipitation. The Curve Number depends on the kind of cultural practice, the vegetative cover, and the antecedent water state. The information in Item 9 for Item 6 is used to establish the cultural practice and the vegetative cover month by month, and the antecedent water state is determined from part A of Item a. Standard SCS guidelines are largely employed. Departures from these standard guidelines are made to introduce the influence of near-surface frozen conditions, define the antecedent water condition in terms of the water state classes used herein, ● nd permit seasonal change in water table depth to determine the Hydrologic Croup.

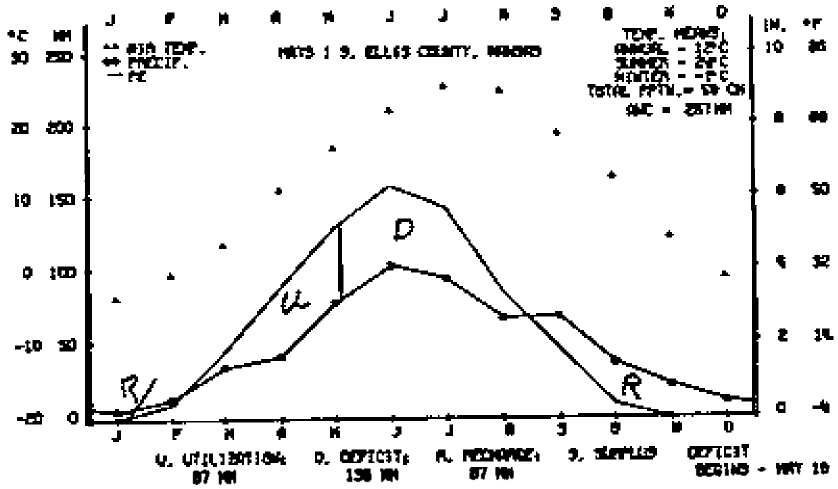
SOIL SURVEY WATER INFORMATION SHEET

ITEM 1

Series:
Harney
Typic Argiustolls
Fine, montmorillonitic,
mesic

No. Records:
1

ITEM 2



ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-3.2	-0.1	3.9	11.4	17.1	22.4	25.6	24.9	19.0	13.0	4.7	-0.8	11.5
NORMAL POTEN. EVAPOTRANSPIRATION MM BY TW	0	0	20	56	90	131	160	145	69	45	10	0	728
NORMAL PRECIPITATION MILLIMETERS	9	16	36	43	80	105	96	69	70	35	22	11	590

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - -		
1	55	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	15	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	5	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	85	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	10	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	50	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5 kPa	Bulk Density	Volume >2 mm	EC
	<------------kPa------------>										
cm	<----------Vol. Pct---------->						<--------cm/day-------->		g/cc	Pct	mmhos/cm
0-18	35	33	30	23	15	18			1.51	0	
18-25	40	39	38	30	22	17			1.50	0	
25-36	39	38	36	30	23	15			1.50	0	
36-61	39	38	35	32	28	10			1.47	0	
61-79	39	38	36	32	27	11			1.50	0	
79-122	41	38	34	27	19	19			1.30	0	
122-152	42	40	36	28	20	20			1.32	0	
0-25	37	35	32	25	17	18					
25-50	39	38	36	31	25	13					
50-100	40	38	36	30	26	14					
100-150	42	40	36	28	20	20					
150-200	42	40	36	28	30	20					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A AWC calculated to 150 cm.

Item 3: Explanation A

Item 4: Explanation A
Pedon S81KS-165-001. Bulk density and 33 kPa retention estimated for 2, 3, 5, 6 horizons. 200 kPa average of 33 and 1,500. 1 and 10 kPa estimated for all horizons. Assume 150-200 cm zone same as lowermost 50 cm measured. Water retention difference of 0.07 for horizon 4 is low. The calculated air-filled porosity, however, at 33 kPa retention is only 9.2 percent. Assuming 5 percent air-filled porosity would permit raising the water retention difference to 0.12, which is still somewhat low. The maximum water retention difference is only 0.16. In short, the 33 kPa retention may be low, but the porosity relationships do not indicate a large error.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Base Common: 40 Adjusted Base Few: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 3 10-1500 kPa: 6 Adjusted Base Few 10-200 kPa: 7 10-1500 kPa: 11
C	Water Movement, cm/day Infiltration Rate: Intake Rate: 0.3 inch Family Surficial Hydraulic Conductivity Saturated: 5 kPa:

ITEM 6

Soil Mapping Concept(s):
Harney silt loam, 1-3 percent slopes

Soil Use(s):
Wheat harvest year of winter wheat, sorghum, fallow rotation with conservation tillage.

Typifying Survey(s):
Ellis County, Kansas
Rush County, Kansas

Compiler(s): Date:
M. L. Barker, Soil Scientist, SCS, Lincoln, NE
S. R. Base, Soil Correlator, SCS, Lincoln, NE
L. E. Brown, Asst. State Soil Scientist, SCS, Salina, KS
R. B. Grossman, Soil Scientist, SCS, Lincoln, NE
D. R. Jantz, Soil Scientist, Garden City, KS
R. E. Mayhugh, Soil Correlator, SCS, Salina, KS
N. E. Roth, State Soil Scientist, SCS, Salina, KS
C. E. Watts, Soil Scientist, SCS, WaKeeney, KS
L. H. Wetter, Hydraulic Engineer, SCS, Salina, KS

ITEM 8

Part A

Depth	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
cm	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
0-25	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	DS	DS	MS	MS	MS	MS	MS	MM	MM	MS	DS	DS	DV	DV	MH	MH	MH	MH	MH	MH	MH	MM	MM	MM	MM	MM
					F	F											F	F											F	F						
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MH	MH	MH	MH	MH	MH	MH	MM	MM	MM	MM	MM
					F	F											F	F											F	F						
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
PRO-FLO																																				
Part B																																				
Runoff																																				
Cv	69	69	69	69	96	96	84	69	50	50	50	50	69	69	69	69	96	96	69	50	50	50	50	50	84	84	84	84	96	96	84	69	69	84	69	69
Part C																																				
Erosion																																				
Growth																																				

ITEM 9

Item 6:
Contoured and terraced. Excludes concave terrace basins in which deep percolation occurs. 20 percent or more residue cover at all times. Fallow after harvest of grain sorghum in previous year. No tillage over winter of previous year. Disk in May or early June and once or twice more before planting in mid-September. Wheat covers 50 percent of ground surface by November 1 except in dry years. Harvest late June. Till once with sweeps (undercutters) sometime during the summer.

Item 7:

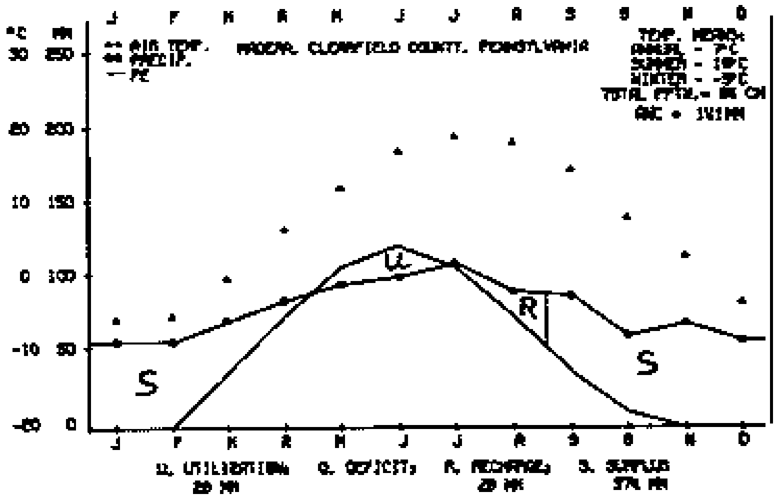
Part A - Explanation A	
Part B - Explanation A	Possibility raised by Wetter that winter wheat would be intermediate between annuals and perennials.
Part C - Explanation A	Intake rates from Kansas guides.

Item 8:

Part A - Explanation A	MH, 1-33 kPa; MM, 33-200; MS, 200-1500; DS, 1500 kPa retention to 0.9 times this retention. Assume does not dry to DS below surface zone. For Dry year, assume previous Fall dry and dry through the year depicted. Used table 1 in Rush County, Kansas, soil survey report to evaluate departures in precipitation of wet and dry years. Wheat has not failed under summer fallow for long time. Much discussion how to reconcile excess of precipitation over transpiration after wheat matures and observed water states in lower part of available water range. Assumed high runoff in June, July before till due to compaction. Also, assumed much of precipitation that enters soil June, July, August evaporates.
Part B - Explanation A	Table 9.1A of Hydrology Handbook used. C Hydrologic Group. Assume Antecedent III if surface layer MH.
Part C - Explanation A	

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Hazleton
Typic Dystrochrepts
Loamy-skeletal, mixed, mesic

No. Records:

ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-5.6	-5.2	-0.5	6.7	12.7	17.5	19.2	18.3	14.6	8.2	2.7	-3.4	7.1
NORMAL POTEN. EVAPOTRANSPIRATION MM IN 3N	0	0	0	35	74	[illegible]	122	106	75	37	11	0	[illegible]
NORMAL PRECIPITATION MILLIMETERS	77	57	76	69	96	[illegible]	118	91	86	61	69	77	[illegible]

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - -		
1	0	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: MESIC ESTIMATED FROM NORMAL AIR TEMPERATURES
SOIL MOISTURE REGIME UDIC ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 5, 6, 7
AND MOISTURE REQUIREMENT IS "TYPIC" FOR
[illegible]

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10–1500	Saturated	5kPa			
	<---------------kPa--------------->										
cm	<---------------Vol. Pct--------------->						<-------cm/day------->		g/cc	Pct	mmhos/cm
0- 5	33	30	24	17	9	21			1.0 a/	25	
5- 20	35	32	26	18	9	23			1.12	17	
20- 60	29	28	25	17	8	20			1.38	28	
60-105	12	11	11	8	4	7			1.53	66	
105-180	11	10	10	7	3	7			1.55	70	
180-225	11	10	10	7	3	7			1.55	70	
0- 20	35			18	9				1.30 b/	20	
20- 50	29			17	8				1.38	28	
50-100	12			8	4				1.53	66	
100-150	11			7	3				1.55	70	
150-200	11			7	3				1.55	70	

a/ Estimate   b/ Estimate for tilled condition after settling due to wetting.

ITEM 5

Ref. Nos.

Item 1: Explanation A

Item 2: Explanation A Uses AWC to 100 cm

Item 3: Explanation A

Item 4: Explanation A Pedon S73PA017-12, Pennsylvania State University data. Sampled in woods. Assume same in cultivated fields. Lower block estimates for depth intervals of Item 8.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Corn Base Common: 50 Base Few: 75
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 6 10-1500 kPa: 11 Base Few 10-200 kPa: 7 10-1500 kPa: 13
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):

Hazleton channery silt loam, 3-8 percent slopes; corn, conventional tillage.

Typifying Survey(s):

Clearfield County, Pennsylvania

Compiler(s):

John Spitzer, Agronomist
Tim Murphy, Hydraulic Engineer
Garland Lipscomb, Soil Scientist
George Martin, Soil Scientist
Loyal Quandt, Soil Scientist
Bob Grossman, Soil Scientist

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 20	WA	WA	WA	MV	MV	MV	MV	MS	MS	MV	WN	WN
	F	F	F									
20- 50	WN	WN	WN	MV	MV	MV	MV	MV	MV	MV	WN	WN
	F	F	F									
50-100	WN	WN	WN	MV	MV	MV	MV	MV	MV	MV	MV	WN
100-150	WN	WN	WN	MV	MV	MV	MV	MV	MV	MV	MV	WN
150-200	WN	WA	WN	MV	MV	MV	MV	MV	MV	MV	MV	WN
PND-FLD												
Part B												
Runoff CN	98	98	96	81	81	81	78	78	78	81	92	96
Part C												
Erosion				X	X	X						
Growth						X	X	X				

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 20	WN	WN	WN	MV	MS	MS	MS	D	D	MS	MV	WN
20- 50	WN	WN	WN	MV	MV	MV	MS	MS	MS	MS	MV	WN
50-100	WN	WN	WN	MV	MV	MV	MV	MS	MS	MS	MS	MV
100-150	WN	WN	WN	MV	MV	MV	MV	MV	MV	MV	MV	MV
150-200	WN	WN	WN	MV	MV	MV	MV	MV	MV	MV	MV	MV
PND-FLD												
Part B												
Runoff CN	98	98	96	81	81	81	60	60	60	64	81	96
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 20	WA	WA	WA	WA	WN	MV	MV	MV	MV	MV	WN	WA
20- 50	WN	WN	WN	WN	WN	MV	MV	MV	MV	MV	WN	WN
50-100	WN	WN	WN	WN	WN	MV	MV	MV	MV	MV	MV	WN
100-150	WN	WN	WN	WN	WN	MV	MV	MV	MV	MV	MV	WN
150-200	WN	WN	WN	WN	WN	MV	MV	MV	MV	MV	MV	WN
PND-FLD												
Part B												
Runoff CN	98	98	96	92	92	81	78	78	78	81	92	96
Part C												
Erosion												
Growth												

ITEM 9

Item 6:

Typical rotation 2 years corn for silage followed by 2 years of hay, usually alfalfa. Second year of corn considered here. Moldboard plowing used in conventional tillage.

Item 7:	Ref. Nos.
Part A - Explanation A	No adjustment for base of few roots. Range of 250 mm precipitation between driest and wettest years (2 years in 10). Assume differences in precipitation among kinds of years occur largely in the growing season.
Part B - Explanation A	
Part C - Explanation A	
Item 8:	
Part A - Explanation A	
Part B - Explanation A	Hydrologic Group B
Part C - Explanation A	

SOIL SURVEY WATER RELATED INFORMATION

ITEM 1

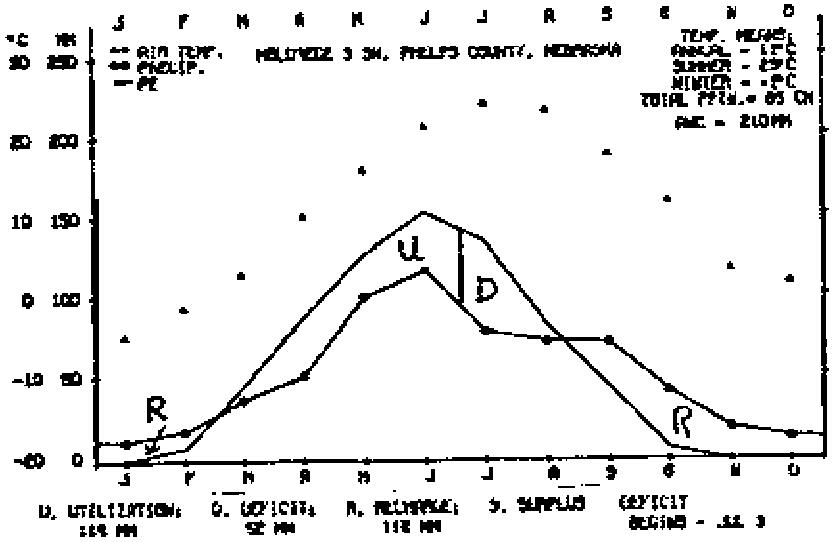
Series:

Holdrege
Fine-silty, mixed, mesic
Typic Argiustoll

No. Records:

1

ITEM 2



ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-4.5	-0.9	5.2	10.6	16.4	21.7	24.6	23.7	18.1	12.3	3.7	-2.0	10.6
NORMAL POTEN. EVAPOTRANSPIRATION MM 3+ 57	0	0	8	45	89	129	155	137	85	46	8	0	702
NORMAL PRECIPITATION MILLIMETERS	13	19	30	51	105	119	80	74	73	42	20	14	648

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - -		
1	40	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	5	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	70	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5kPa	Bulk Density	Volume >2mm	EC
	<------------------------kPa					---------------------->					
cm	<------------------------Vol. Pct					---------------------->	<--------cm/day	---------->	g/cc	Pct	mmhos/cm
0-15	40	38	35	26	16	22			1.48	0	
15-23	42	39	34	26	18	21			1.38	0	
23-43	43	38	34	26	18	20			1.36	0	
43-58	42	40	37	31	21	19			1.45	0	
58-74	42	40	36	29	21	19			1.46	0	
74-92	43	41	35	26	17	24			1.43	0	
92-122	45	43	32	23	14	29			1.36	0	0.47
122-152	49	48	31	22	13	35			1.32	0	
0-25	40	38	35	26	16	22					
25-50	43	38	34	27	18	20					
50-100	43	41	35	26	17	24					
100-150	48	47	31	22	13	33					
150-200	48	47	31	22	13	33					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A

Item 3: Explanation A

Item 4: Explanation A Pedon S79NE-073-02. 150-200 cm values assumed same as bottom horizon of pedon. 1 and 200 kPa retention estimated.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Base Common: 60 Adjusted Base Few: 150
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 7 10-1500 kPa: 12 Adjusted Base Few 10-200 kPa: 21 10-1500 kPa: 30
C	Water Movement, cm/day Infiltration Rate: 70 Intake Rate: 0.5 inch family Superficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):

Holdrege, silt loam 0-1 percent slopes, continuous corn, furrow irrigate, conservation tillage

Typifying Survey(s):

Phelps County, NE

Compiler(s):

J. Culver, State Soil Scientist
D. W. DeMoude, Soil Scientist
M. L. Dixon, Soil Scientist
R. B. Grossman, Soil Scientist
D. E. Kerl, Soil Scientist
R. S. Pollock, Soil Scientist

W. E. Reinsch, Conservation Agronomist
K. E. Sautter, Soil Scientist
D. E. Snyder, Hydraulic Engineer

(Completed 1/83)

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MS	MS	MM	MM	MS	MS	MS	MS
	F	F	F									
25-50	MS	MM	MM	MM	MM	MS	MM	MM	MS	MS	MS	MS
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Pond-Flood												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MS	MS	DS	DS	MS	MS	MM	MM	MS	DS	MS	MS
	F	F	F									
25-50	MS	MS	MS	MS	MS	MS	MM	MM	MS	MS	MS	MS
	F	F	F									
50-100	MS	MS	MS	MS	MS	MS	MM	MM	MS	MS	MS	MS
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F	F									
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS

Part B

Runoff CN	J	F	M	A	M	J	J	A	S	O	N	D
Average - 6 years in 10	96	96	96	75	75	57	75	75	57	57	57	57
Driest 2 years in 10	96	96	75	57	57	57	75	75	57	57	57	57
Wettest 2 years in 10	96	96	96	75	75	75	75	75	75	75	75	75

Part C

Erosion Growth

ITEM 9

Item 6:

Primary tillage (disk) in April with second disking late April keeping more than 20 percent of surface covered with crop residue. Plant late April or early May. Harvest October 15-November 15. Graze after harvest. 600 mm of irrigation water applied. Irrigation July and August.

Item 7:

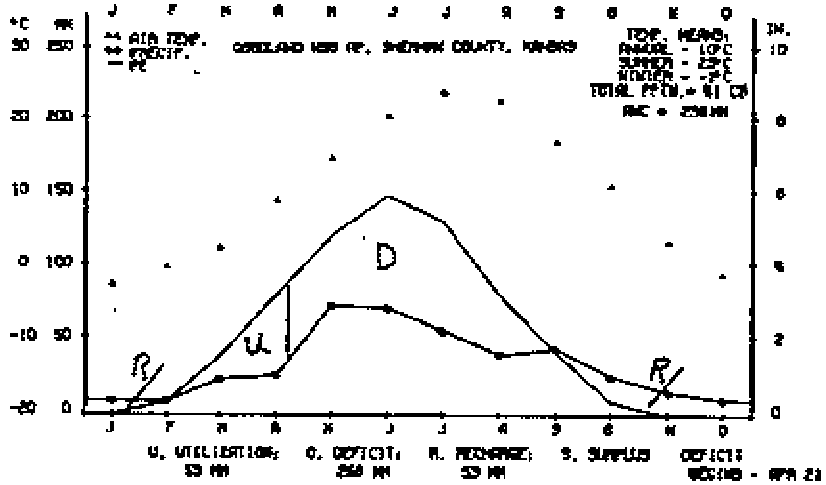
Part A - Explanation A	Deeper for irrigated use.
Part B - Explanation A	
Part C - Explanation A	Intake rate from Nebraska guides. Infiltration rate from Illinois AES Bull.:760. 1979. Measured on conventional tillage. Should be somewhat higher for conservation tillage.

Item 8:

Part A - Explanation A	MM, 1-33 kPa; MM, 33-200 kPa; MS, 200-1500 kPa; DS, 1500 kPa retention to 0.8 times 1500 kPa retention.
Part B - Explanation A	Used table 9.1A of Hydrology Handbook.
Part C - Explanation A	

SOIL SURVEY WATER INFORMATION SHEET

ITEM 2



ITEM 1

Series:
Kuma
Pachic Argiustolls
Fine-silty, mixed, mesic

No. Records:
1

ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-2.4	0.2	2.8	9.3	15.1	20.8	24.3	23.6	17.3	11.5	3.4	-0.9	10.4
NORMAL POTEN. EVAPOTRANSPIRATION MM (T-W)	0	0	8	39	81	122	150	133	82	46	9	0	667
NORMAL PRECIPITATION MILLIMETERS	9	9	24	27	74	72	57	41	45	26	15	10	409

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	------------- CRITERIA FOR MOISTURE CONTROL SECTION (MCS) -------------		
1	100	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	80	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	40	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	40	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	70	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	20	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5 kPa	Bulk Density	Volume >2 mm	EC
	<------------kPa------------>										
cm	<----------Vol. Pct---------->						<---------cm/day--------->		g/cc	Pct	mmhos/cm
0-13	39	34	31	22	13	21			1.30	0	
13-28	39	37	32	25	18	19			1.33	0	
28-46	41	39	35	30	24	15			1.36	0	
46-64	41	38	34	28	22	16			1.30	0	
64-81	40	38	34	29	22	16			1.32	0	
81-97	39	37	33	28	23	14			1.40	0	
97-119	39	37	33	27	20	17			1.40	0	
119-152	38	35	31	24	17	18			1.37	0	
0-25	39	35	31	23	15	20					
25-50	41	39	35	30	24	15					
50-100	40	38	34	28	22	16					
100-150	38	35	31	25	18	18					
150-200	38	35	31	25	18	18					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A AWC calculated to 150 cm.

Item 3: Explanation A

Item 4: Explanation A
Pedon S81KS-179-001. Bulk density and 33 kPa estimated for 1, 4, 6 horizons. 200 kPa average of 33 and 1,500. 1 and 10 kPa estimated for all horizons. Assume 150-200 cm zone same as lowermost 50 cm measured. The measured water retention differences range from 0.12-0.14. These are rather low.

ITEM 7

Part — Quantity

A Rooting Depth, cm
  Plants:
  Base Common: 40
  Adjusted Base Few: 100

B Root-related Retention Difference Sums, cm
  Base Common
    10-200 kPa: 5
    10-1500 kPa: 7
  Adjusted Base Few
    10-200 kPa: 9
    10-1500 kPa: 14

C Water Movement, cm/day
  Infiltration Rate:
  Intake Rate: 0.5 inch Family
  Surficial Hydraulic Conductivity
    Saturated:
    5 kPa:

ITEM 6

Soil Mapping Concept(s):
Kuma silt loam, 0-1 percent slopes

Soil Use(s):
Harvest year of winter wheat-fallow rotation: conservation tillage.

Typifying Survey(s):
Rawlins County, Kansas
Sheridan County, Kansas

Compiler(s): Date:

W. L. Barker, Soil Scientist, SCS, Lincoln, NE
S. R. Base, Soil Correlator, SCS, Lincoln, NE
L. E. Brown, Asst. State Soil Scientist, SCS, Salina, KS
R. B. Grossman, Soil Scientist, SCS, Lincoln, NE
D. R. Jantz, Soil Scientist, Garden City, KS
R. E. Mayhugh, Soil Correlator, SCS, Salina, KS
W. E. Roth, State Soil Scientist, SCS, Salina, KS
C. E. Watts, Soil Scientist, SCS, WaKeeney, KS
L. H. Wetter, Hydraulic Engineer, SCS, Salina, KS

ITEM 8

Part A

Average - 6 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
0-25	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	DS	DS
					F	F						
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS
					F	F						
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
PND-FLD												
Part B												
Runoff												
CN	69	69	69	69	96	96	69	69	50	50	50	50
Part C												
Erosion												
Growth												

Driest 2 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
0-25	MS	MS	MS	MS	MS	MS	MS	MS	DS	DV	DV	DV
					F	F						
25-50	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS
					F	F						
50-100	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
PND-FLD												
Part B												
Runoff												
CN	69	69	69	69	96	96	69	50	50	50	50	50
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	S	O	N	D	J	F	M	A	M	J	J	A
0-25	MM	MM	MM	MM	MM	MH	MH	MM	MM	MM	MM	MM
					F	F						
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
					F	F						
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
PND-FLD												
Part B												
Runoff												
CN	69	69	69	69	69	84	84	69	69	69	69	69
Part C												
Erosion												
Growth												

ITEM 9

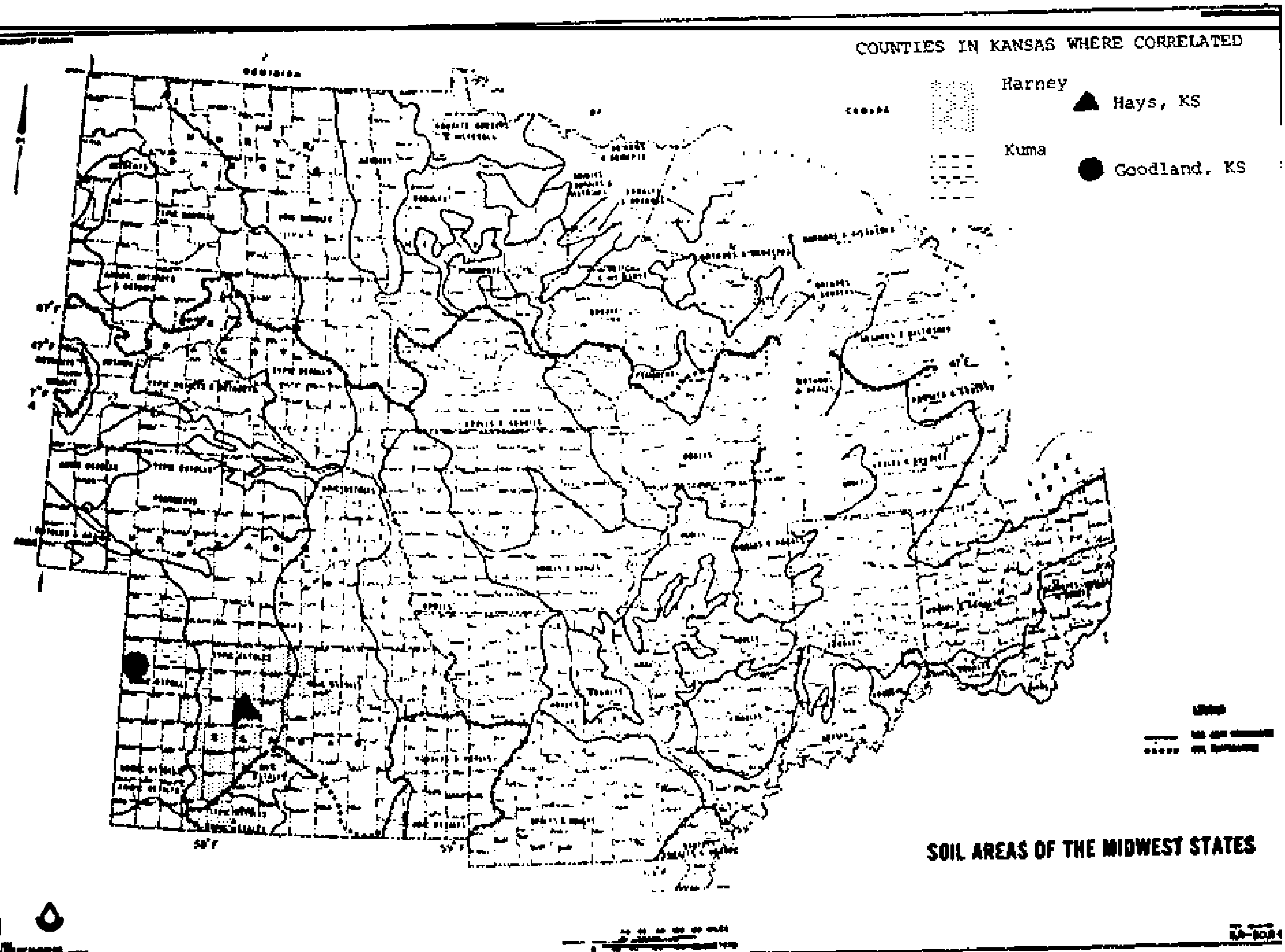
Item 6:
No contour or terrace. Plant September 1. Harvest late June or early July. Fallow after harvest and through Fall, next Spring and Summer until plant again 14 months later. Undercut with sweeps after harvest (assume herbicide not used). Follow with successive sweeps as needed to control weeds.

Item 7:

Part A - Explanation A	
Part B - Explanation A	Possibility raised by Wetter that winter wheat would be intermediate between annuals and perennials.
Part C - Explanation A	Intake rates from Kansas guides.

Item 8:

Part A - Explanation A	MH, 1-33 kPa; MM, 33-200; MS, 200-1500; DS, 1500 kPa retention to 0.8 times this retention. Assume does not dry to DS below surface zone. For Dry year, assume previous Fall dry and dry through the year depicted. Only marginally different from the wheat harvest year for the winter wheat-sorghum-fallow rotation of Harney silt loam, 1-3 percent slopes. Climate less moist (ITEMS 2, 3) but less runoff, perhaps greater deep water movement, and a longer fallow period. This annual use sequence follows 14 months of fallow compared to 11 months for the Harney. The effective difference in time is the difference in the periods between wheat maturity (June) and grain sorghum maturity (September).
Part B - Explanation A	Table 9.1A of Hydrology Handbook used. B Hydrologic Group. Assume Antecedent III if surface layer MH.
Part C - Explanation A	



SOIL AREAS OF THE MIDWEST STATES

COMPARISON OF HARNEY AND KUMA MOISTURE REGIMES

By ITEM 3:

Probability dry some/all parts moisture control section-

s 55%
100%

By ITEM 8:

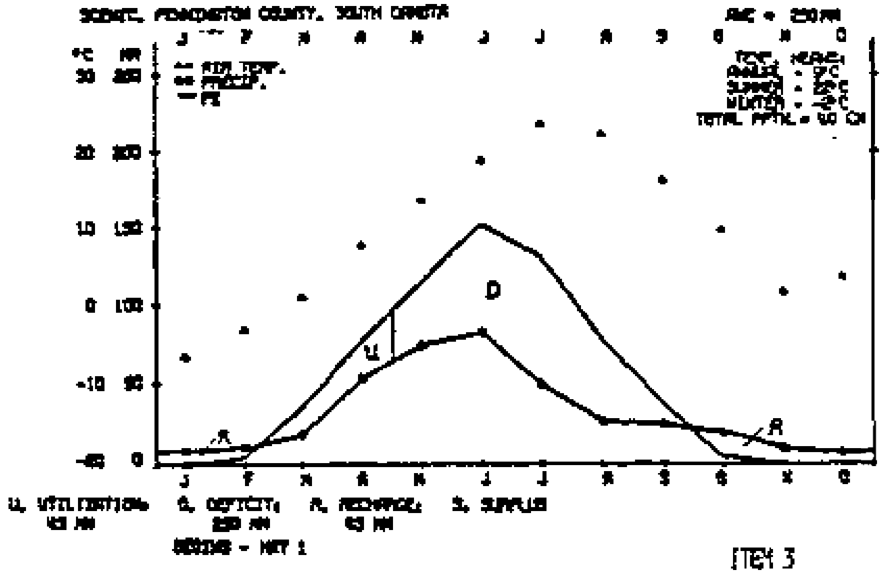
Record for Kuma given. A "d" in the row beneath indicates that Kuma drier than Harney.

Depth	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
cm	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
0-25	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	DS	DS	MS	MS	MS	MS	MS	MS	MS	MS	DS	DV	DV	DV	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
					d	d															d				d	d	d	d	d	d	d			d		
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
																									d	d	d	d	d	d	d			d		
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS

Explanation: Kuma use involves fallow for 14 months prior to wheat planting. Haney's use involves 12 months fallow before planting. The Kuma map unit has 0-l percent slope; the Harney, 1-3 percent.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Kyle

No. Records:

1

ITEM 3

```
DEPTH? PROBABILITY   - - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - - -
1         93         DRY SOME/ALL PARTS MCS   90 OR MORE DAYS CUMULATIVELY      WHEN SOIL TEMP 5 DEG C OR HIGHER
2         69         DRY SOME/ALL PARTS MCS   6/10 OR MORE OF DAYS CUMULATIVELY WHEN SOIL TEMP 5 DEG C OR HIGHER
3         46         DRY ALL PARTS MCS        1/2 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
4          5         DRY ALL PARTS MCS        3/4 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
5         50         MOIST SOME/ALL PARTS MCS 90 OR MORE DAYS CONSECUTIVELY     WHEN SOIL TEMP 8 DEG C OR HIGHER
6         75         DRY ALL PARTS MCS        45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER SUMMER SOLSTICE
7          8         MOIST ALL PARTS MCS      45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME:   MESIC                 CALCULATED FROM ANNUAL AIR TEMPERATURE
SOIL MOISTURE  REGIME:     USTIC                 CALCULATED FROM PROBABILITY VALUES IN LINES 1, 3, 4, 6, 7

AND MOISTURE SUBDIVISION IS "DRY-TYPIC" FOR:
 HAPLUSTALFS, PALEUSTALFS, USTOCHREPTS, ARGIUSTOLLS, CALCIUSTOLLS, HAPLUSTOLLS, NATRUSTOLLS, PALEUSTOLLS
 [illegible]
 [illegible]

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 5 DEG C AND ABOVE.  BEGINS  APR 19   ENDS  NOV 14   DURATION  209 DAYS.
ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 8 DEG C AND ABOVE.  BEGINS  MAY  4   ENDS  OCT 29   DURATION  178 DAYS.
```

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<—— kPa ——>										
cm	<—— Vol. Pct ——>						<—— cm/day ——>		g/cc	Pct	mmhos/cm
0-5	45	41	36	27	20	21			1.12	0	1.5
5-10	45	43	40	32	26	17			1.26	0	0.7
10-70	44	44	42	35	27	17			1.37	0	0.6
70-150	44	43	41	36	27	16			1.36	0	3.5

ITEM 5

		Ref. Nos.
Item 1:	Explanation A	
Item 2:	Explanation A	
Item 3:	Explanation A	
Item 4:	Explanation A	1

1. Pedon 79SD-071-1. In a fine family and hence taxadjunct to series. 1 and 10 kPa retention calculated.

ITEM 6

Annual Use Sequence(s):
Kyle Silty Clay, 1-6% slopes
Range, fair, cool and warm season

Typifying Survey(s):
Meade County, Southern Part

Compiler(s):

M. W. Smalley
R. B. Grossman

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Buffalograss, Blue Grama, Western Wheatgrass Base Common: 30 Adjusted Base Few: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 3 10-1500 kPa: 5 Adjusted Base Few 10-200 kPa: 9 10-1500 kPa: 17
C	Water Movement, cm/day Infiltration Rate: 40 Intake Rate: NA Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 8

Part A

Depth cm	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0-25	D	D	MS	MV	MV	MV	D	D	D	D	D	D																								
	F	F	F									F																								
25-50	D	D	D	MS	MS	MS	D	D	D	D	D	D																								
	F	F																																		
50-100	D	D	D	D	D	D	D	D	D	D	D	D																								
		F																																		
100-150	D	D	D	D	D	D	D	D	D	D	D	D																								
		F																																		
150-200																																				
PND-FLD																																				

Part B

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Runoff																																				
CN	86	86	86	86	86	86	72	72	72	72	72	86																								

Part C

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Erosion																																				
Growth																																				

ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	1
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	1
Part C - Explanation A	

1. Hanson, C. L., Kuhlman, A. R., and Lewis, J. K., 1978. Effect of Grazing Intensity and Range Condition on Hydrology of Western South Dakota Ranges. South Dakota State Agr. Exp. Sta. Bul. 647. Water content measurements with neutron probe twice a month through the growing season 1963-1972. Used only data for moderate grazing intensity. During this period, precipitation exceeded the long term average by 2.1 inches. The 1963-72 pattern of water states is considered average, but is on the wet side and is close to being for the wettest 2 years in 10. Two of the six access tubes in Pierre soil and four in Kyle. The water retention values employed to place the field moisture in classes were calculated by weighting Kyle 79SD-071-1 twice that of Pierre 79SD-071-2.

Kyle: Ustertic Camborthid, very-fine.
Range, Fair condition

Derivative Quantities from field water state information and laboratory determinations of bulk density and water retention.[a]

	APR-JUNE	REST OF YEAR
water	25-20	<20
Dbi	1.48 - 1.60	1.60 - 1.87
Dbil	1.41 - 1.44	1.44 - 1.52
COLEi	0.026 - .053	.053 - .110
CSPi	5 - 9	9 - 17
Cv	0.63 - 0.58	0.58 - 0.30

Water = Weight percent
Dbi = Bulk density intermediate water content exclusive of shrinkage from 33 kPa water retention. g/cc
Dbil = Bulk density intermediate water content inclusive of shrinkage from 33 kPa water retention. g/cc
COLEi = Coefficient Linear Extensibility from 33 kPa retention to intermediate water content.
CSPi = Crack Space Percent from 33 kPa retention to intermediate water content.
Cv = Volumetric heat capacity. Use Dbil. Assume 0.20 for dry solids. cal/g/deg.

[a] Pedon S79SD-071-1. In fine family, not very fine.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2

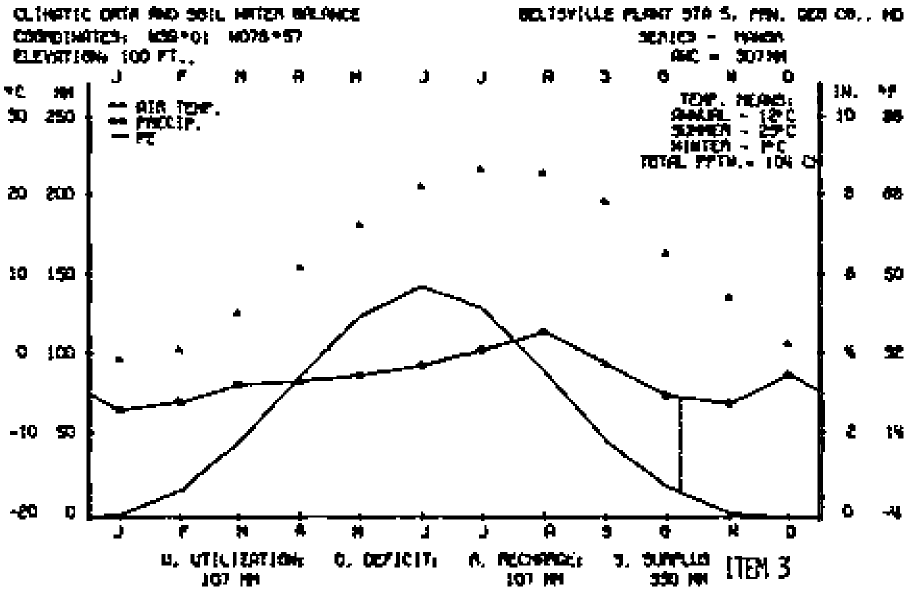
ITEM 1

Series:

Manor

No. Records:

1



ITEM 3

BELTSVILLE PLANT STA S. PAN. GEO CO., MD N3901 W07657 100F STATION # 180765 PRECIPITATION RECORD 1957-1976

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-1.5	1.9	5.6	11.3	16.6	21.5	23.8	23.2	19.5	13.6	7.5	1.7	12.8
NORMAL POTEN. EVAPOTRANSPIRATION MM I= 55	0	1	16	46	87	125	145	132	92	49	20	5	715
NORMAL PRECIPITATION MILLIMETERS	67	72	83	85	89	95	105	116	96	74	71	85	1044

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MSC) - - - - - - - - - - - -		
1	10	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	1	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<-------------- kPa -------------->										
cm	<-------------- Vol. Pct -------------->						<------ cm/day ------>		g/cc	Pct	mmhos/cm
0- 10	37	33	27	17	8				1.3	5	
10- 20	36	35	32	20	9				1.5	5	
60	33	31	28		15				1.6	7	
80-160	30	28	26	19	13				1.7	15	

ITEM 5

		Ref. Nos.
Item 1:	Explanation A	J. A. Thompson supplied
Item 2:	Explanation A	J. A. Thompson supplied
Item 3:	Explanation A	
Item 4:	Explanation A	Pedons S74DC1-1,2. Bulk density, 33 and 1500 kPa retention on three horizons per pedon.

ITEM 7

Part **Quantity**

A Rooting Depth, cm
Plants: Corn, Soybeans
Base Common: 50
Adjusted Base Fev: 90

B Root-related Retention Difference Sums, cm
Base Common
10-200 kPa: 6
10-1500 kPa: 10
Adjusted Base Fev
10-200 kPa:
10-1500 kPa:

C Water Movement, cm/day
Infiltration Rate:
Intake Rate:
Surficial Hydraulic Conductivity
Saturated:
5kPa:

ITEM 6

Annual Use Sequence(s):
Manor loam, 3-8 percent slopes
Corn-soybeans; no till

Typifying Survey(s):

Montgomery County, Maryland

Compiler(s):

Dave Yost, State Soil Scientist
Loyal Quandt, Soil Correlator
Helen Moody, Hydrologist
Milt Meyer, Soil Characterization Specialist
Bob Grossman, Research Soil Scientist

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	MV	MS	MS	MS	MS	MS	MV	MV	MV	MV
	F	F										
25- 50	MV	MV	MV	MV	MV	MV	MS	MS	MS	MV	MV	MV
50-100	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS	MV	MV
100-150	MV	MV	MS	MS	MS	MS	MS	MS	MS	MS	MV	MV
150-200	MV	MV	MS	MS	MS	MS	MS	MS	MS	MS	MV	MV
DRN-FLD												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25		MV	MV	MS	MS	D	D	D	MV	MV	MV	MV
25- 50		MV	MV	MV	MV	MS	MS	MS	MS	MV	MV	MV
50-100		MV	MV	MV	MV	MS	MS	MS	MS	MS	MV	MV
100-150		MV	MV	MS	MS	MS	MS	MS	MS	MS	MV	MV
150-200		MV	MV	MS	MS	MS	MS	MS	MS	MS	MV	MV
DRN-FLD												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	MV	MV	MV	MV	MS	MV	MV	MV	MV	MV
25- 50	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
50-100	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
100-150	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
150-200	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
DRN-FLD												

Part B

		J	F	M	A	M	J	J	A	S	O	N	D
Runoff	Average												
CN	Average	96	96	71	71	71	71	52	52	71	71	71	71
Runoff	Driest												
CN	Driest	96	96	71	71	71	52	52	52	71	71	71	71
Runoff	Wettest												
CN	Wettest	96	96	71	71	71	71	71	71	71	71	71	71

Part C

		J	F	M	A	M	J	J	A	S	O	N	D
Erosion	Average												
Growth	Average												
Erosion	Driest												
Growth	Driest												
Erosion	Wettest												
Growth	Wettest												

ITEM 9

Item 7: **Ref. Nos.**
Part A - Explanation A

Part B - Explanation A

Part C - Explanation A

Item 8:
Part A - Explanation A

Part B - Explanation A

Part C - Explanation A

Item 6:

Stover not removed. Assume corn.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 1

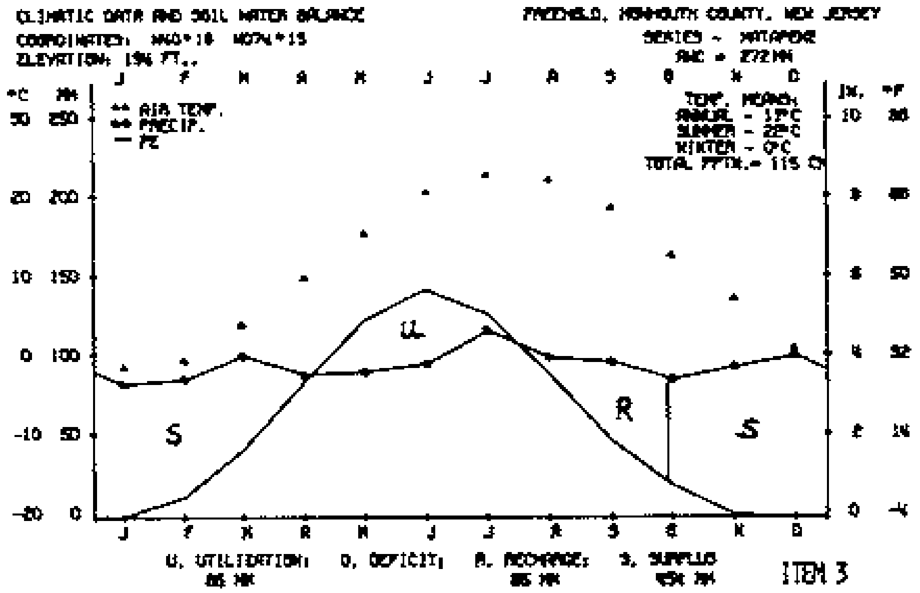
Series:

Matapeake

No. Records:

1

ITEM 2



ITEM 3

```
FREEHOLD, MONMOUTH COUNTY, NEW JERSEY    N4014 W07415   1947              STATION # 283181        PRECIPITATION RECORD  1947-1976
                                              JAN    FEB    MAR    APR    MAY    JUN    JUL    AUG    SEP    OCT    NOV    DEC    YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS       -1.1   -0.2    4.3   10.2   15.8   21.0   23.3   22.6   18.8   13.0    7.3    1.5   11.4
NORMAL POTEN. EVAPOTRANSPIRATION MM IN 92       0      3     11     42     85    124    144    129     91     49     21      2    659
NORMAL PRECIPITATION MILLIMETERS               88     67    102     98     92     97    118    131     96     87     93    102   1153

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY
       PERCENT PROBABILITY          - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MSC) - - - - - - - - - - - - - -
1               15                 DRY SOME/ALL PARTS MCS   90 OR MORE DAYS CUMULATIVELY      WHEN SOIL TEMP 5 DEG C OR HIGHER
2                0                 DRY SOME/ALL PARTS MCS   6/12 OR MORE OF DAYS CUMULATIVELY WHEN SOIL TEMP 5 DEG C OR HIGHER
3                0                 DRY ALL PARTS MCS        1/2 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
4                0                 DRY ALL PARTS MCS        3/4 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
5              100                 MOIST SOME/ALL PARTS MCS 90 OR MORE DAYS CONSECUTIVELY     WHEN SOIL TEMP 8 DEG C OR HIGHER
6                0                 DRY ALL PARTS MCS        45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER SUMMER SOLSTICE
7              100                 MOIST ALL PARTS MCS      45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER WINTER SOLSTICE
```

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<---kPa---										
cm	<---Vol. Pct--->						<---cm/day--->		g/cc	Pct	mmhos/cm
0- 30	41	37	34	24	10	27	6		1.47		
30- 60	43	38	36	29	16	22	6		1.52		
60- 90	40	35	33	25	15	20	1		1.65		
90-150	22	17	16	13	10	7	6		1.85	15	

ITEM 5

Ref. Nos.

Item 1: Explanation A

Item 2: Explanation A J. A. Thompson supplied

Item 3: Explanation A J. A. Thompson supplied

Item 4: Explanation A Pedon S58NJ-12-1 on p. 84 of Soil Survey Investigations Report No. 26. For 1 kPa retention added 1 percentage unit to measurements at 2 kPa. Other data are measured.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Base Common: 60 Adjusted Base Fev: 90
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 7 10-1500 kPa: 15 Adjusted Base Fev 10-200 kPa: 9 10-1500 kPa: 16
C	Water Movement, cm/day Infiltration Rate: 24 Intake Rate: Surficial Hydraulic Conductivity Saturated: 6 5kPa:

ITEM 6

Annual Use Sequence(s):
Metapeake silt loam, 0-2 percent slopes;
Corn-soybeans; conventional tillage

Typifying Survey(s):
Middlesex County, New Jersey
Salem County, New Jersey

Compiler(s):

D. D. Ashford, State Resource Conservationist
W. J. Busscher, Professor, Rutgers
C. F. Eby, Asst. State Soil Scientist
S. D. Goodman, Soil Scientist
R. B. Grossman, Research Soil Scientist
J. Huddleston, Hydrology Engineer
W. C. Kirkham, State Soil Scientist
L. A. Quandt, Soil Correlator, Upper Darby

ITEM 8

Part A

Depth cm	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV F	W F	W	MV	MS	MS	D	D	MS	MS	MV	MV	MV F	W F	MS	MS	MS	D	D	D	D	MS	MS	MV	W F	W F	W	W	MV	MV	MS	MS	MS	MV	MV	W
25- 50	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS	MV	MV	MV	MV	MV	MS	MS	MS	D	D	MS	MS	MS	MS	MV	MV	MV	MV	MV	MV	MS	MS	MV	MV	MV	MV
50-100	MV	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS	MS	MS	MS	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
100-150	MV	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS	MV	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS	MS	MS	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
150-200																																				
PND-FLO																																				

Part B

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Runoff																																				
CN	96	96	90	86	81	64	60	60	60	60	78	78	96	96	78	64	64	64	60	60	60	60	60	78	96	96	90	90	81	81	60	60	78	78	78	90

Part C

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Erosion																																				
Growth																																				

ITEM 9

Item 7:	Ref. Nos.
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	Intake rate from 1967 New Jersey Irrigation Guide. Sprinkler irrigation
Item 8:	
Part A - Explanation A	
Part B - Explanation A	For March average year assume half way between Roman I and II.
Part C - Explanation A	

SOIL SURVEY WATER INFORMATION SHEET

ITEM 2

ITEM 1

Series:
Rhinebeck
Aeric Ochraqualfs
Fine, illitic, mesic

No. Records:
1

ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-6.6	-4.3	2.4	8.8	14.7	18.6	19.8	17.8	13.8	8.7	3.6	-3.6	7.6
NORMAL POTEN. EVAPOTRANSPIRATION MM K= .87	6	8	9	37	76	113	134	114	72	47	12	3	581
NORMAL PRECIPITATION MILLIMETERS	68	75	117	98	101	112	96	91	98	89	116	117	1031

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - -		
1	0	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5 kPa	Bulk Density	Volume >2 mm	EC
	<------------kPa------------->										
cm	<-----------Vol. Pct----------->						<---------cm/day--------->		g/cc	Pct	mmhos/cm
0-22	50	47	43	31	18	29			1.06	0	
22-31	41	41	40	35	29	12			1.54	0	
31-57	40	40	40	36	32	8			1.57	0	
57-89	41	41	41	35	30	11			1.57	0	
89-162	45	45	45	36	27	18			1.48	0	
162-200	47	47	47	41	35	12			1.44	0	
0-25	49	47	43	31	19	27					
25-50	40	40	40	36	31	9					
50-100	42	42	42	35	30	12					
100-150	45	45	45	36	27	18					
150-200	47	47	47	41	35	12					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A AWC calculated to 100 cm.

Item 3: Explanation A

Item 4: Explanation A
Pedon S76NY-029-001. Very low air-filled porosity at 33 kPa. Water retention below surface horizon. Estimated 1, 10, and 200 kPa retention. Assume 200 kPa retention mean of 33 and 1500.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Base Common: 40 Adjusted Base Few: 90
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 4 10-1500 kPa: 8 Adjusted Base Few 10-200 kPa: 6 10-1500 kPa: 10
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5 kPa:

ITEM 5

Soil Mapping Concept(s):
Rhinebeck silt loam, 3-8
percent slopes

Soil Use(s):
Silage corn in a corn-hay
rotation.

Typifying Survey(s):
Erie County, New York (not published)

Compiler(s): Date:
R. D. Babcock, Soil Scientist, SCS, Syracuse, NY 2/7/83
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E. J. Putnam, Hyd. Engr., SCS, Syracuse, NY
L. A. Quandt, Soil Correlator, NENTC, SCS,
Broomall, PA
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Syracuse, NY
J. W. Warner, Jr., Soil Scientist, SCS, Syracuse, NY

ITEM 8

```
                                        Part A
        Average - 6 years in 10      Driest 2 years in 10          Wettest 2 years in 10
Depth  :  :  :  :  :  :  :  :  :  :  :  :   :  :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :  :
 cm    :J :F :M :A :M :J :J :A :S :O :N :D  J :F :M :A :M :J :J :A :S :O :N :D   J :F :M :A :M :J :J :A :S :O :N :D

  0-25 :WA:WA:WA:WN:MM:MH:MS:MS:MM:MM:MH:WA WA:WA:WN:MH:MM:MS:MS:DS:MS:MS:MM:WA  WA:WA:WA:WA:WA:MH:MS:MS:MH:WN:WA:WA
       :F :F :F :  :  :  :  :  :  :  :  :F F :F :F :  :  :  :  :  :  :  :  :F  F :F :F :  :  :  :  :  :  :  :  :F
 25-50 :WA:WA:WA:WA:MH:MM:MS:MS:MS:MM:MH:WN WA:WA:WN:MH:MM:MM:MS:MS:MS:MS:MM:MM  WA:WA:WA:WA:WA:MH:MM:MS:MH:WN:WA:WA
       :F :F :F :  :  :  :  :  :  :  :  :  F :F :F :  :  :  :  :  :  :  :  :   F :F :F :  :  :  :  :  :  :  :  :
50-100 :WA:WA:WA:WA:WN:MH:MM:MS:MS:MM:MH:WN WA:WA:WN:MH:MH:MM:MS:MS:MS:MM:MM:MH  WA:WA:WA:WA:WA:WN:MN:MM:WN:WN:WA:WA
       :F :F :  :  :  :  :  :  :  :  :  :  F :F :  :  :  :  :  :  :  :  :  :   F :F :  :  :  :  :  :  :  :  :  :
100-150:WA:WA:WA:WA:WN:WH:MM:MM:MH:MM:MH:WA WA:WA:WA:WN:MH:MM:MM:MM:MM:MM:MM:MH  WA:WA:WA:WA:WA:WA:WN:MH:WN:WA:WA:WA
       :  :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :
150-200:WA:WA:WA:WA:WA:WA:MH:MM:MM:MM:WH:WA WA:WA:WA:WA:WS:MH:MM:MM:MM:MM:MH:WN  WA:WA:WA:WA:WA:WA:WA:WA:WA:WA:WA:WA
       :  :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :
PND-FLD:  :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :
                                        Part B
Runoff :  :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :
CN     :98:98:96:95:91:91:76:76:89:95:95:96 98:98:96:95:91:91:76:76:76:75:88:96  98:98:96:95:95:97:97:76:96:95:95:96
                                        Part C
Erosion:  :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :
Growth :  :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :
```

ITEM 9

Item 6:
Second year corn in a 3-year corn, 3-year hay rotation. Conventional tillage. Plowed May 1. Disk and plant by May 10. 50% cover by July 1. Chemical weed control. Physiological maturity September 15. Harvest October 1. Seed with rye grass immediately after harvest. 30-50 percent cover by November 1. Drainage tile 17 m (50 foot) spacing at 60-90 cm depth. No terraces.

Item 7:
Part A - Explanation A In pedon description (see Item 4) have common roots 30-60 cm depth for grass, clover.

Part B - Explanation A

Part C - Explanation A

Item 8:
Part A - Explanation A MH, 1-33 kPa; MM, 33-200 kPa; MS, 200-1500 kPa; DS, 1500 kPa retention to 0.8 times 1500 kPa retention. Used as guidelines precipitation differences between average and wet and dry years from climate table of an applicable soil survey report.

Part B - Explanation A Hydrologic Group D. Small grains guidelines October 1 to May 1. MH assumed as Wet for antecedent water state.

Part C - Explanation A

SOIL SURVEY WATER RELATED INFORMATION

ITEM 1

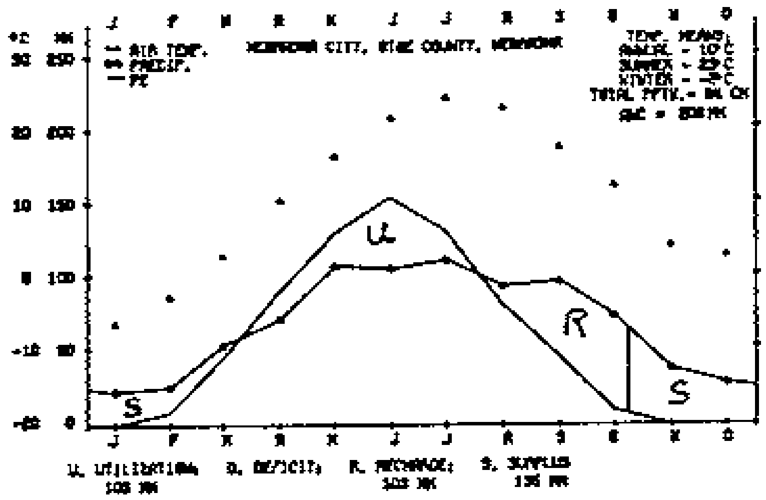
Series:

Sharpsburg
Fine, montmorillonitic, mesic
Typic Argiudoll

No. Records:

6

ITEM 2



ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-4.1	-2.9	3.1	10.8	16.6	21.9	24.7	23.2	17.8	12.6	4.4	-3.0	10.3
NORMAL POTEN. EVAPOTRANSPIRATION MM (= 52	0	0	8	46	92	131	156	137	83	47	10	0	706
NORMAL PRECIPITATION MILLIMETERS	23	24	55	73	109	107	115	95	96	74	38	28	840

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - -		
1	10	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk	Volume	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa	Density	>2mm	
	<-------------------kPa------------------->										
cm	<-------------------Vol. Pct------------------->						<---------cm/day--------->		g/cc	Pct	mmhos/cm
0-16	45	42	35	25	15	27			1.34	0	
16-26	43	41	36	26	16	25			1.38	0	
26-41	42	38	36	28	19	19			1.39	0	
41-65	41	39	36	30	23	16			1.43	0	
65-94	42	41	38	33	25	16			1.47	0	
94-112	43	40	37	30	25	15			1.51	0	.25
112-160	44	42	38	30	21	21			1.40	0	
160-183	45	44	40	30	20	24			1.37	0	
0-25	45	42	35	25	15	27			1.34		
25-50	42	38	36.	28	20	18			1.40		
50-100	42	41	36	33	25	16			1.46		
100-150	44	42	38	30	22	20			1.40		
150-200	45	44	40	30	20	24			1.37		

ITEM 5

Item 1: Explanation A	For series as occurs in Nebraska.
Item 2: Explanation A	AWC calculated to 100 cm; from S-5 property table. Nebraska City intermediate precipitation.
Item 3: Explanation A	
Item 4: Explanation A	Pedon S73NE-55-306 1 and 200 kPa retention estimated.

ITEM 6

Annual Use Sequence(s):
Sharpsburg silty clay loam, 2-5 percent slopes; second year corn, over 20 percent residue

Typifying Survey(s):
Otoe County, NE
Lancaster County, NE

Compiler(s):
D. W. DeMoude
R. B. Grossman
(completed 1/83)

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Base Common: 60 Adjusted Base Few: 120
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 7 10-1500 kPa: 11 Adjusted Base Few 10-200 kPa: 12 10-1500 kPa: 20
C	Water Movement, cm/day Infiltration Rate: 90 Intake Rate: 0.5 inch family Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 8

Part A

	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
Depth cm	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MM	DS	MS	MM	MM	MM	MM	MM	MM	MS	MS	DS	DS	DS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F											F	F											F	F										
25-50	MM	MM	MM	MM	MM	MM	MS	MS	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	MM	MM	MM
	F	F	F										F	F	F										F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MS	MS	MM	MM	MM	MS	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MM	MM	MM	MW	MW	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MW	MW	MW	MW	MW	MM	MM	MM	MM	MM	MW	MW
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MW	MW	MW	MW	MW	MM	MM	MM	MM	MM	MW	MW
AMD-FLO																																				
Part B																																				
Runoff																																				
CN	96	96	70	70	70	70	51	51	70	70	70	70	96	96	70	70	51	51	51	51	51	70	70	70	96	96	70	70	70	70	70	51	70	70	70	70
Part C																																				
Erosion																																				
Growth																																				

ITEM 9

Item 6:
Contoured and terraced. The map unit occurs on the summit of the ridges. Disk twice in April keeping over 20 percent crop residue on surface. Field cultivate once. Plant May 1-15. Cultivate once or twice. Harvest November 1-15. Cattle graze after harvest.

Item 7:

Part A - Explanation A

Part B - Explanation A

Part C - Explanation A Infiltration from Illinois AES Bull.: 760. 1979. Measured on conventional tillage. Probably higher for conservation tillage. Intake notes from Nebraska guides.

Item 8:

Part A - Explanation A MW, 1-33 kPa; MM, 33-200; MS, 200-1500; DS, 1500 kPa retention to 0.8 times this retention. Assume does not dry to DS below surface zone based on measurements under bromegrass in 1976 drought. For Dry Year, assume previous Fall dry and dry through the year depicted.

Part B - Explanation A Table 9.1A of Hydrology Handbook used. B Hydrologic group. Assume Antecedent III if surface layer MW.

Part C - Explanation A

ITEM 7

Part	**Quantity**
A	**Rooting Depth, cm** **Plants:** **Base Common:** 75 **Adjusted Base Few:** 100
B	**Root-related Retention Difference Sums, cm** **Base Common** **10-200 kPa:** 9 **10-1500 kPa:** 15 **Adjusted Base Few** **10-200 kPa:** 11 **10-1500 kPa:** 18
C	**Water Movement, cm/day** **Infiltration Rate:** 90 **Intake Rate:** 0.5 inch family **Surficial Hydraulic Conductivity** **Saturated:** **5kPa:**

ITEM 6

Annual Use Sequence(s):

Sharpsburg silty clay loam, 2-5 percent slopes; second year corn, over 20 percent residue

Typifying Survey(s):

Otoe County, NE
Lancaster County, NE

Compiler(s):

D. E. Kerl, Soil Scientist
R. B. Grossman, Soil Scientist
(Completed 1/83)

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MS	MS	MM	MM	MM	MM
	F	F	F									
25-50	MM	MM	MM	MM	MM	MM	MM	MS	MS	MM	MM	MM
	F	F										
50-100	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												
Part B												
Runoff												
CN	96	96	96	70	70	70	70	51	70	70	70	70
Part C												
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MS	MS	MS	DS	DS	MS	MS	MS	MM
	F	F	F									
25-50	MM	MM	MM	MM	MM	MM	MS	MS	MS	MM	MM	MM
	F	F										
50-100	MS	MS	MS	MM	MM	MM	MM	MS	MS	MS	MS	MS
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
PND-FLD												
Part B												
Runoff												
CN	96	96	96	70	70	70	51	51	51	70	70	70
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MM	MS	MM	MM	MM	MM
	F	F	F									
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F										
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												
Part B												
Runoff												
CN	96	96	96	85	85	70	70	70	70	85	70	7
Part C												
Erosion												
Growth												

ITEM 9

Item 6:

Contoured and terraced. The map unit occurs on the summits of the ridges. Disk twice in April keeping over 20 percent crop residue on surface. Field cultivate once. Plant May 1-15. Cultivate once or twice. Harvest November 1-15. Cattle graze after harvest.

Item 7:

Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	Infiltration from Illinois AES Bull.: 760, 1979. Measured on conventional tillage. Should be somewhat higher for conservation tillage. Intake rate from Nebraska guides.

Item 8:

Part A,- Explanation A	MH, 1-33 kPa; MM, 33-200; MS, 200-1500; DS, 1500 kPa retention to 0.8 times this retention. Assume does not dry to DS below surface zone based on measurements under bromegrass in 1974 drought. For Dry year, assume previous Fall dry and dry through the year depicted.
Part B - Explanation A	Table 9.1A of Hydrology Handbook used. B Hydrologic Group. Assume Antecedant III if surface layer MM.
Part C - Explanation A	

Pattern of Water States by EPIC Model

Sharpsburg silty clay loam, 2-5 percent slopes. Second year corn, over 20 percent residue.
Nebraska City, Nebraska, weather station. Pedon 73NE-055-004.

Depth cm	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MS	MS	MM	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	D	D	MS	MS	MM	MM	MM	MM	MM	MM	MS	MS	MS	MM	MM	MM
	d	d				d		w		d	d	d		d	d				w	w	d	d		d			d	d	d		d	d	d			
25-50	MS	MS	MS	MM	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS
	d	d	d				d			d	d	d		d	d		w							d			d	d	w		d	d	d	d	d	d
50-100	MS	MS	MS	MS	MS	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MS	MS	MS	MS	MS
	d	d	d	d	d						d	d				d	d	d	w						d	d	d	d				d	d	d	d	d
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
													w	w	w	w	w	w	w	w	w	w	w	w												
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM

NOTE: "d" in second row means EPIC class drier than that assigned by SCS personnel. "w" means EPIC class wetter. Blank means classes are the same. Three independent assignments were made by SCS personnel. The class assignments by two of the three people were used for the comparison with EPIC.

Above 100 cm: 51% EPIC placements drier and 5% wetter.

Below 100 cm: 0% EPIC placements drier. For dry years, 33% of EPIC wetter and 0% drier. Other kinds of years, complete agreement.

ITEM 7

Part	**Quantity**
A	**Rooting Depth, cm** Plants: Base Concept: 50 Adjusted Base Fam: 100
B	**Root-related Retention Difference Sums, cm** Base Concept 10-200 kPa: 7 10-1500 kPa: 11 Adjusted Base Fam 10-200 kPa: 11 10-1500 kPa: 17
C	**Water Movement, cm/day** Infiltration Rate: 90 Intake Rate: 0.5 inch family Surficial Hydraulic Conductivity Saturated: 3kPa:

ITEM 6

Annual Use Sequence(s)

Sharpsburg silty clay loam, 2-5 percent slopes.
Second year corn; over 20 percent residue.

Typifying Survey(s)

Otoe County, NE
Lancaster County, NE

Compiler(s)

S. R. Base, Soil Scientist
R. B. Grossman, Soil Scientist
H. E. Sautter, Soil Scientist
D. E. Ulrich, Soil Scientist

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MS	DS	DS	MS	MM	MM
	F	F										F
25-50	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MM
	F	F	F									
50-100	MS	MS	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												
Part B												
Runoff												
CN	96	96	70	70	70	70	70	51	51	51	70	96
Part C												
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MS	DS	DS	DS	MS	MS	MM
	F	F										F
25-50	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
	F	F	F									
50-100	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												
Part B												
Runoff												
CN	96	96	70	70	70	51	51	51	51	51	51	96
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F										F
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												
Part B												
Runoff												
CN	96	96	85	85	85	70	70	70	70	70	70	96
Part C												
Erosion												
Growth												

ITEM 9

Item 6:

Contoured and terraced. The map unit occurs on the summits of the ridges. Disk twice in April keeping over 20 percent crop residue on surface. Field cultivate once. Plant May 1-15. Cultivate once or twice. Harvest November 1-15. Cattle graze after harvest.

Item 7:

Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	Intake rate from Nebraska guides. Infiltration from Illinois AES Bull., 760. 1979. Measured on conventional tillage. Should be somewhat higher for conservation tillage.

Item 8:

Part A - Explanation A	MW, 1-33 kPa; MM, 33-200; MS, 200-1500; DS, 1500 kPa retention to 0.8 times this retention. Assume does not dry to DS below surface zone based on measurements under bromegrass in 1974 drought. For Dry year, assume previous Fall dry and dry through the year depicted.
Part B - Explanation A	Table 9.1A of Hydrology Handbook used. B Hydrologic Group. Assume Antecedent III if surface layer MW.
Part C - Explanation A	

COMPARISON OF THREE ESTIMATES OF PATTERN OF WATER STATES

Sharpsburg silty clay loam, 2-5 percent slopes.
Second year corn; **over** 20 percent residue.

Sautter's evaluation given.

ITEM 6

Part A

Depth	Average – 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
cm	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MS	DS	DS	MS	MM	MM	MS	MM	MM	MM	MS	MS	DS	DS	DS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F										F	F	F										F	F	F										F
25-50	MM	MM	MM	MM	MM	MM	MM	MS	MS	MS	MS	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM
	F	F	F										F	F	F										F	F	F									
50-100	MS	MS	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM

▒ - Three estimations differ by one class or more.

BLANK - Three estimations the same.

NOTE: With very few exceptions, the range for the three evaluations is two classes.

ITEM 7

Part	Quantity
A	**Rooting Depth, cm** **Plants:** **Base Common:** 50 **Adjusted Base Few:** 100
B	**Root-related Retention Difference Sums, cm** **Base Common** 10-200 kPa: 7 10-1500 kPa: 11 **Adjusted Base Few** 10-200 kPa: 11 10-1500 kPa: 17
C	**Water Movement, cm/day** **Infiltration Rate:** **Intake Rate:** 0.5 inch family **Surficial Hydraulic Conductivity** **Saturated:** **5kPa:**

ITEM 6

Annual Use Sequence(s):

Sharpsburg silty clay loam 2-5 percent slopes: winter wheat, conventional tillage

Typifying Survey(s):

Otoe County, NE
Lancaster County, NE

Compiler(s):

D. W. DeMoude, Soil Scientist
R. B. Grossman, Soil Scientist
(Completed 1/83)

ITEM 8

Part A

Average - 6 years in 10

Depth an	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MS	MS	MS	MM	MM	MM	MM	MM	MM
	F	F										
25-50	MM	MM	MM	MM	MS	MS	MS	MS	MM	MM	MM	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLO												

Driest 2 years in 10

Depth an	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MS	DS	DS	DS	MS	MS	MS	MM	MM
	F	F										
25-50	MM	MM	MM	MS	MS	MS	MS	MS	MS	MS	MS	MM
	F	F	F									
50-100	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
100-150	MM	MM	MM	MM	MS	MS	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLO												

Wettest 2 years in 10

Depth an	J	F	M	A	M	J	J	A	is	O	N	D
0-25	MM	MM	MM	MM	MS	MS	MM	MM	MM	MM	MM	MM
	F	F										
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MH	MH	MH	MM	MM	MM	MM	MM	MM	MM	MM	MH
150-200	MH	MM	MH	MM	MM	MM	MM	MM	MM	MM	MH	MH
PND-FLO												

Part B

Runoff CN	J	F	M	A	M	J	J	A	S	O	N	D
Average - 6 years in 10	96	96	70	70	51	51	70	72	72	72	70	70
Driest 2 years in 10	96	96	70	51	51	51	51	53	53	53	72	72
Wettest 2 years in 10	96	96	70	70	70	70	70	72	72	72	70	70

Part C

	J	F	M	A	M	J	J	A	S	O	N	D
Erosion:												
Growth :												

ITEM 9

Item 6:

Map unit occurs on the summits of ridges. Contoured and terraced. First year after soybeans of two consecutive years of wheat. Harvest July 1-15. Moldboard plow or disk August 1-15. Disk or harrow twice before October 1. Plant October 1-15. Assume average weediness.

Item 7:

Part A - Explanation A

Part B - Explanation A

Part C - Explanation A Intake rate from Nebraska guides.

Item 8:

Part A,- Explanation A MH, 1-33 kPa; MM, 33-200; MS, 200-1500; DS, 1500 kPa retention to 0.8 times this retention. Assume does not dry to DS below surface zone based on measurements under bromegrass in 1974 drought. For Dry year, assume previous Fall dry and dry through the year depicted.

Part B - Explanation A Table 9.1A of Hydrology Handbook used. B Hydrologic Group. Assume Antecedent III of surface layer MH.

Part C - Explanation A

ITEM 7

Part	Quantity
A	**Rooting Depth, cm**
	Plants:
	Base Common: 30
	Adjusted Base Few: 60
B	**Root-related Retention Difference Sums, cm**
	Base Common
	10-200 kPa: 5
	10-1500 kPa: 8
	Adjusted Base Few
	10-200 kPa: 7
	10-1500 kPa: 11
C	**Water Movement, cm/day**
	Infiltration Rate:
	Intake Rate: 0.5 inch family
	Surficial Hydraulic Conductivity
	Saturated:
	5kPa:

ITEM 6

Annual Use Sequence(s):

Sharpsburg silty clay loam, 2-5 percent slopes; winter wheat, conventional tillage

Qualifying Survey(s):

Otoe County, NE
Lancaster County, NE

Compiler(s):

D. E. Karl, Soil Scientist
R. B. Grossman, Soil Scientist
(Completed 1/83)

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MS	MS	MS	MM	MM	MM	MM
	F	F	F									
25-50	MM	MM	MM	MM	MM	MS	MS	MM	MM	MM	MM	MM
	F	F										
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												
Runoff												
CN	96	96	96	70	70	51	51	72	72	72	70	70
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MS	MS	DS	DS	MS	MM	MM	MM	MM
	F	F	F									
25-50	MM	MM	MM	MM	MM	MS	MS	MS	MS	MM	MM	MM
	F	F										
50-100	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MM
100-150	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
PND-FLD												
Runoff												
CN	96	96	96	70	70	51	51	53	72	72	70	70
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MH	MH	MH	MM	MM	MM	MM	MH	MM	MM
	F	F	F									
25-50	MM	MM	MM	MH	MM	MM	MM	MM	MM	MM	MM	MM
	F	F										
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												
Runoff												
CN	96	96	96	85	85	70	70	72	72	85	70	70
Erosion												
Growth												

Part B rows: Runoff, CN. Part C rows: Erosion, Growth.

ITEM 9

Item 6:

Map unit occurs on the summits of ridges. Contoured and terraced. First year after soybeans of two consecutive years of wheat. Harvest July 1-15. Moldboard plow or disk August 1-15. Disk or harrow twice before October 1. Plant October 1-15. Assume average weediness.

Item 7:

Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	Intake rate from Nebraska guides.

Item 8:

Part A.- Explanation A	MH, 1-33 kPa; MM, 33-200; MS, 200-1500; DS, 1500 kPa retention to 0.8 times this retention. Assume does not dry to DS below surface zone based on measurements under bromegrass in 1974 drought. For Dry year, assume previous Fall dry and dry through the year depicted.
Part B - Explanation A	Table 9.1A of Hydrology Handbook used. B Hydrologic Group. Assume Antecedent III if surface layer MH.
Part C - Explanation A	

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Base Common: 50 Adjusted Base Few: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 7 10-1500 kPa: 11 Adjusted Base Few 10-200 kPa: 11 10-1500 kPa: 17
C	Water Movement, cm/day Infiltration Rate: Intake Rate: 0.5 inch family Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):

Sharpsburg silty clay loam, 2-5 percent slopes; winter wheat, conventional tillage

Typifying Survey(s):

Otoe County, NE
Lancaster County, NE

Compiler(s):

S. R. Base, Soil Scientist
R. B. Grossman, Soil Scientist
K. E. Sautter, Soil Scientist
D. E. Ulrich, Soil Scientist

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MS	DS	DS	MS	MS	MM	MM
	F	F										F
25-50	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-PLD												
Runoff												
CN	96	96	70	70	70	51	51	53	53	53	70	96
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MS	MS	MM	MM	MM	DS	DS	DS	MS	MS	MS	MS
	F	F										F
25-50	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
	F	F	F									
50-100	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-PLD												
Part B												
Runoff												
CN	96	96	70	70	70	51	51	53	53	53	53	96
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F										F
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-PLD												
Runoff												
CN	96	96	85	85	70	70	70	72	72	72	70	96
Erosion												
Growth												

ITEM 9

Item 6:

Map unit occurs on the summits of ridges. Contoured and terraced. First year after soybeans of two consecutive years of wheat. Harvest July 1-15. Moldboard plow or disk August 1-15. Disk or harrow twice before October 1. Plant October 1-15. Assume average weediness.

Item 7:

Part A - Explanation A

Part B - Explanation A

Part C - Explanation A Intake rate from Nebraska guides.

Item 8:

Part A - Explanation A MW, 1-33 kPa; MM, 33-200; MS, 200-1500; DS, 1500 kPa retention to 0.8 times this retention. Assume does not dry to DS below surface zone based on measurements under bromegrass in 1974 drought. For Dry year, assume previous Fall dry and dry through the year depicted.

Part B - Explanation A Table 9.1A of Hydrology Handbook used. B Hydrologic Group. Assume Antecedent III if surface layer MW.

Part C - Explanation A

ITEM 6

Mapping Concept(s):
Sharpsburg silty clay loam, 2-5 percent slopes

Month Assembled:
3/83

Compiler(s):
S. F. Base, Soil Scientist, Soils Staff, SCS, Lincoln, NE
R. B. Grossman, Soil Scientist, NSSL, SCS, Lincoln, NE
M. E. Sautter, Soil Scientist, SCS, Syracuse, NE
D. E. Ulrich, Soil Scientist, Con. Sur Div., Syracuse, NE

Soil Use(s):
Winter wheat; conventional tillage

Typifying Survey:
Lancaster County, NE
Otoe County, NE

ITEM 7

Identification Nos.	Yearly Values	S XXXX	O AAXX	N XXXX	D XXXB	J XXXX	F XCXX	M XXXX	A XXXX	M XXXX	J XXXX	J DDXX	A EXXX
01 01 004 04 01		1.2	1.5	1.3	1.2	1.2	0.8	0.8	0.8	0.8	0.8	2.5	1.2
02 01 004 04 02		1.5	1.5	1.5	1.5	1.5	1.2	1.2	1.2	1.2	1.2	4.0	2.0
03 01 005 06 01		0	0	0									0
04 01 005 04 03		50	0	0									50
05 02 001 06 01			0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.3		0
06 02 001 05 03		0.2											0.2
07 06 006 05 03		30											30
08 03 001 01 01		12	12	12	12	12	10	10	10	10	10	12	12
09 03 008 01 01		fm1sb	fm1sb	fm3sb	fm3sb	fm3sb		f2sb	f2sb	f2sb	f2sb	f2sb	c3sb
10 03 009 01 01		mvfr	mvfr	mvfr			fluid	mvfr	mvfr	mvfr	mvfr	mfr	mfr
							2307						
11 06 010 01 01		.90	.90	1.00	1.10			1.25	1.25	1.25	1.25		
12 05 010 01 02		.90	.90	.90	1.00			1.10	1.10	1.10	1.10		
13 04 010 01 01		1.40	1.40	1.40									

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MS	DS	DS	MS	MS	MM	MM
	F	F										F
25-50	MM	MM	MM	MM	MM	MS	MS	MS	MS	MS	MS	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MS	MS	MM	MM	MM	DS	DS	DS	MS	MS	MS	MS
	F	F										F
25-50	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
	F	F	F									
50-100	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-25	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F										F
25-50	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
	F	F	F									
50-100	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
100-150	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
150-200	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
PND-FLD												

Part B

Runoff CN	J	F	M	A	M	J	J	A	S	O	N	D
Average	96	96	70	70	70	51	51	53	53	53	70	96
Driest	96	96	70	70	70	51	51	53	53	53	53	96
Wettest	96	96	85	85	70	70	70	72	72	72	70	96

ITEM 9

Item 6:
Map unit occurs on the summits of ridges. Contoured and terraced. First year after soybeans of two consecutive years of wheat. Harvest July 1-15. Moldboard plow or disk August 1-15. Disk or harrow twice before October 1. Plant October 1-15. Assume average weediness.

Item 7:
This is an exploratory format for temporal surface and near surface measurements and observations. Measurements by R. B. Grossman. The monthly column headings contain a code to fix times when major events occur to the nearest week: A = Plant; B = Freeze; C = Thaw; D = Harvest; E = Primary tillage; X = Not designated. The identification number has five components. The first is the listing sequence; the second (see below) gives the position or subzone to which the information applies; the third describes the feature or observation; the fourth gives the orientation and/or location; and the fifth the water state history as it pertains to the datum.

Some entries pertain to a small part of the month. Additional lines are used to give beneath the datum a 4-digit number. The first two digits give the weeks; 13 indicates the first 3 weeks and 14 the whole month.

Component 2	Component 3	Component 4	Component 5
01 Ground surface	001 Thickness, cm	01 Interrow	01 Usual
02 Immediate near surface	004 Roughness SD, cm	04 Normal to tillage configuration	02 Dry
03 Mechanically tilled	005 Smoothness, Pct	05 Not specified	03 > 25 mm rain in 1 hour
04 Mechanically compacted	006 Drop Shatter, cm	06 Exclusive of row	
05 0-5 cm	008 Structure		
06 Crust	009 Consistence		
	010 Bulk Density, Mg/m^3		

Item 8:
Part A - Explanation 3 Assume does not dry to 50 below surface zone used on measurements under bromegrass in 1974 drought. For Dry year, assume previous fall dry and dry through the year depicted.

Part B - Explanation 3 Table 9.1A of Hydrology Handbook. B Hydrologic Group.

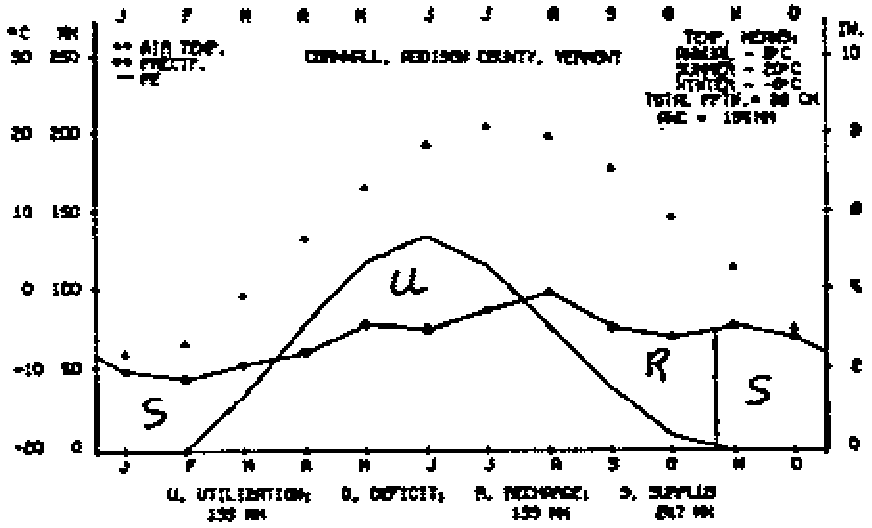
SOIL SURVEY WATER INFORMATION SHEET

ITEM 1

Series:
Vergennes
Glossaquic Hapludalfs
Very-fine, illitic,
mesic

No. Records:
1

ITEM 2



ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-7.4	-6.4	-0.4	7.0	13.5	18.9	21.2	20.0	15.9	9.7	3.2	-4.3	7.5
NORMAL POTEN. EVAPOTRANSPIRATION MM IN 66	0	0	0	36	88	119	133	116	71	40	10	0	617
NORMAL PRECIPITATION MILLIMETERS	51	46	53	63	81	77	89	104	79	72	79	72	862

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	CRITERIA FOR MOISTURE CONTROL SECTION (MCS)		
1	0	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2 mm	EC
	1	10	33	200	1500	10-1500	Saturated	5 kPa			
	<-------------kPa------------->										
cm	<-----------Vol. Pct----------->						<---------cm/day--------->		g/cc	Pct	mmhos/cm
0-12	46	38	36	29	21	17			1.06	0	
12-20	45	40	36	30	24	16			1.18	0	
20-47	51	47	44	37	29	18			1.38	0	
47-66	48	47	45	38	31	16			1.32	0	
66-91	45	44	40	36	31	13			1.39	0	
91-150	45	44	40	37	34	10			1.39	0	
0-20	47	40	38	31	24	17					
20-50	51	47	44	37	29	18					
100-150	46	45	42	37	32	13					
			40	37	34	10					
150-200	45	44	40	37	34	10					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A AWC calculated to 100 cm.

Item 3: Explanation A

Item 4: Explanation A
Pedon S57NY-016-001. Assume 91-150 cm horizon has same values as superjacent horizon except 1500 kPa retention increased proportional to difference in clay percentage. 10, 33 and 1500 kPa measured on other horizons. 1 and 200 kPa retention estimated. Assume that 200 kPa retention midway between 33 and 1500 kPa retention. Assume 150-200 cm same as 91-150 cm.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Corn Base Common: 60 Adjusted Base Few: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 5 10-1500 kPa: 10 Adjusted Base Few 10-200 kPa: 6 10-1500 kPa: 10
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5 kPa:

ITEM 6

Soil Mapping Concept(s):
Vergennes clay, 2-6
percent slopes

Soil Use(s):
Corn year of a corn-legume
rotation.

Typifying Survey(s):
Addison County, Vermont

Compiler(s):
R. J. Croft, Water Res. Coord., SCS, Burlington, VT
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W. Zabiloski, Sanitary Spec., VT ACD Burlington, VT

Date:
2/8/83

ITEM 8

Part A

Average – 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	WN	WA	WA	WN	MH	MM	DS	MS	MM	MH	MH	WN
	F	F	F									F
20-50	WA	WA	WA	WN	MH	MM	MS	MS	MM	MH	MH	WN
	F	F										
50-100	WN	WN	WA	WA	MH	MH	MM	MM	MM	MM	MH	WN
100-150	WN	WN	WA	WA	WA	MM	MM	MM	MM	MM	MH	WN
150-200	WA	WA	WA	WA	WA	MM	MH	MM	MH	MH	MH	WA
PND-FLD												
Runoff												
CN	98	98	97	97	97	91	76	76	91	97	97	97
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	WN	WN	WA	WN	MM	MS	DS	DS	MS	MM	MH	WN
	F	F	F									F
20-50	WN	WA	WA	WN	MM	MM	MS	MS	MS	MM	MM	MH
	F	F										
50-100	WN	WN	WA	WN	MH	MH	MM	MM	MM	MM	MM	MH
100-150	WN	WN	WA	WA	WN	MH	MM	MM	MM	MM	MH	WN
150-200	WA	WA	WA	WA	WA	MH	MH	MH	MM	MH	MM	WN
PND-FLD												
Part B												
Runoff												
CN	98	98	97	97	91	91	76	76	76	91	97	97
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-20	WA	WA	WA	WN	MH	MM	MM	MM	MH	MH	WA	WA
	F	F	F									F
20-50	WN	WA	WA	WA	WN	MH	MM	MM	MM	MH	MH	WN
	F	F										
50-100	WA	WA	WA	WA	WA	MH	MM	MM	MH	MH	WN	WN
100-150	WA	WA	WA	WA	WA	MH	MH	MH	MH	MH	WN	WA
150-200	WA	WA	WA	WA	WA	WA	WN	WN	WN	WN	WA	WA
PND-FLD												
Runoff												
CN	98	98	97	97	97	97	91	89	96	97	97	97
Erosion												
Growth												

ITEM 9

Item 6:
No water control practices or erosion control terraces. Second year silage corn of 2 years corn and 4 years alfalfa rotation. Plow October 15. Disk twice in Spring and plant June 1. Harvest October 1. True Vergennes in taxonomic sense. Assume 50 percent cover by corn in July. In wet year, 50 percent cover in August but not July.

Item 7:
Part A - Explanation A

Part B - Explanation A

Part C - Explanation A

Item 8:
Part A - Explanation A MH, 1-33 kPa; MM, 33-200 kPa; MS, 200-1500 kPa; DS, 1500 kPa retention to 0.8 times 1500 kPa retention. Used climate table of applicable soil survey for precipitation difference for dry and wet years from average.

Part B - Explanation A Hydrologic Group D. MH considered Wet for antecedent water state class.

Part C - Explanation A

Vergennes clay, 2-6 percent slopes. Corn year of a corn-legume rotation.
Cornwall, Addison County, Vermont, weather station. Pedon 557VT-016-001.

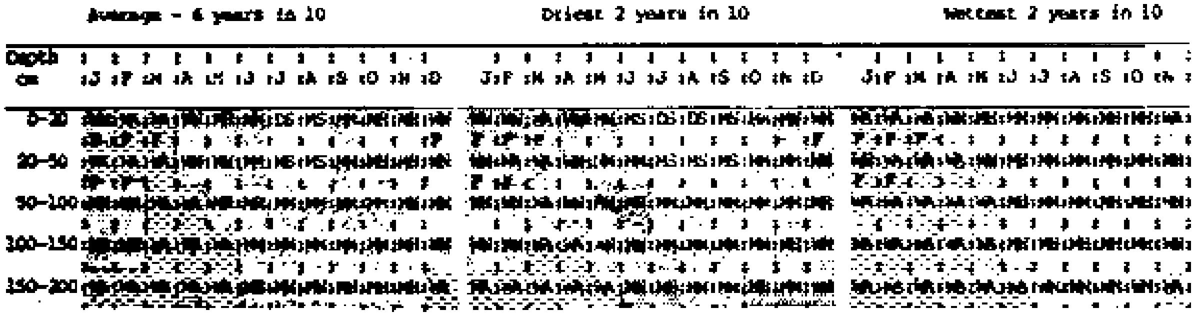
```
        Average - 6 years in 10              Driest 2 years in 10                  Wettest 2 years in 10
-----------------------------------------------------------------------------------------------------------------
Depth  :  :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :     :  :  :  :  :  :  :  :  :  :  :
 cm   :J :F :M :A :M :J :J :A :S :O :N :D    J:F :M :A :M :J :J :A :S :O :N :D    J:F :M :A :M :J :J :A :S :O :N :D
-----------------------------------------------------------------------------------------------------------------
  0-20 :MH:MH:MH:MH:MH:MM:MS:MS:MS:MM:MH:MH  MH:MH:MH:MH:MM:MS:MS:MS:MS:MS:MM:MH  MH:WN:WN:MH:MH:MH:MM:MM:MH:MH:MH:MH
       :d  id :d :d :  : :w :   :d  :d :  :d  d  :d  :d  :d  : : :w :w : :d :d :d  d :d :d :d :   :w :  :  :  :  :d :d
 20-Y) :MM:MH:MH:MH:MH:MM:MS:D :MS:MS:MS:MM  MS:MM:MH:MH:MH:MS:D :D :D :MS:MS:MS  MH:WN:WN:MH:MH:MH:MS:MS:MS:MM:MM:MH
       :d :d :d :d : : :  :d :d :d :d :d    d :d :d id :w :d :d :d :d :d :d :d  d :d :d :d :d :  :  :d :d :d :d :d
50-100:MS:MS:MS:MM:MM:MM:MS:D :D :MS:MS:MS  MS:MS:MS:MS:MS:MS:D :D :D :D :MS:MS  MS:MM:MM:MH:MH:MH:MM:MS:MS:MS:MS:MS
       :d :d :d :d :d :d :d :d :d :d :d :d  d  :d :d :d :d :d :d :d :d :d :d id  d :d :d :d :d :   :d :d :d :d :d :d
100-150:MM:MH:MH:MH:MH:MM:MM:MM:MM:MM:MM:MM  MM:MM:MH:MH:MM:MM:MM:MM:MM:MM:MM:MM  MH:MH:MH:MH:MH:MH:MH:MH:MH:MH:MH:MH
       :d  :d :d :d  id : : : :  : :d :d    d :d :d  :d  :d :d : : : : :d :d   d :d :d :d :d :  :  :  :  :  :d :d
150-200:MM:MH:MH:MH:MH:MM:MM:MM:MM:MM:MM:MM  MM:MM:MM:MM:MM:MM:MM:MM:MM:MM:MM:MM  MH:MH:MH:MH:MH:MH:MH:MH:MH:MH:MH:MH
       :d id :d :d :d :d :d :d :d :d :d :d  d  :d :d :d :d id :d : : :d : :d   d :d :d :d :d :d :d :d :d :d :d :d
```

NOTE: "d" in second row means EPIC class drier than that assigned by SCS personnel. "w" means EPIC class wetter.
Blank means classes are the same.

EPIC placements generally drier.

PATTERN OF WATER STATES

Vergennes clay 2-6 percent slopes
corn year of a corn-legume rotation



▤ Free water

▦ Wet without free water; Highly Moist

░ Moderately Moist

BLANK Slightly Moist, Dry

Vergennes soils are classified very-fine, illitic, mesic Glossaquic Hapludalfs.

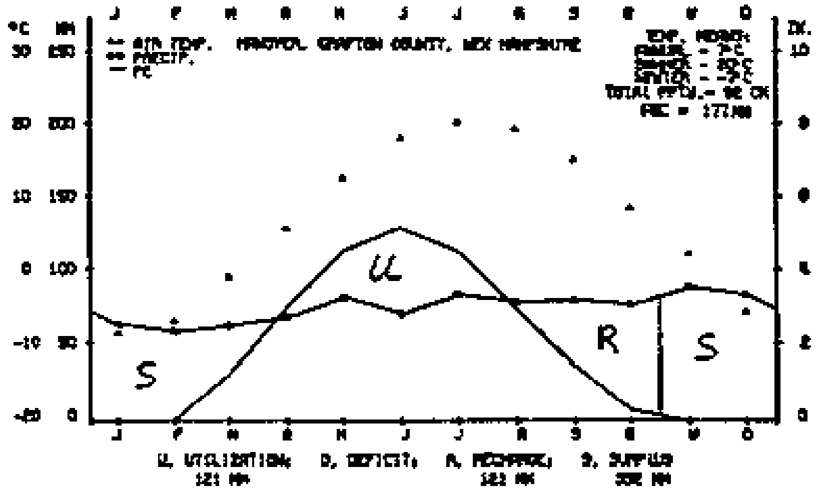
SOIL SURVEY WATER INFORMATION SHEET

ITEM 1

Series:
Winooski
Aquic Udifluvents
Coarse-silty, mixed,
nonacid, mesic

No. Records:
1

ITEM 2



ITEM 3

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
NORMAL AIR TEMPERATURE DEGREES CELSIUS	-8.1	-6.6	-0.9	6.3	12.9	18.4	20.7	19.7	15.0	9.2	2.6	-5.2	7.1
NORMAL POTEN. EVAPOTRANSPIRATION MM IN TO	0	0	0	31	77	116	132	116	71	30	0	0	573
NORMAL PRECIPITATION MILLIMETERS	66	61	69	71	84	91	86	81	84	79	91	66	929

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - -		
1	0	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention										
	1	10	33	200	1500	10-1500	Hydraulic Conductivity Saturated	5 kPa	Bulk Density	Volume >2 mm	EC
	<------------kPa------------>										
cm	<----------Vol. Pct---------->						<---------cm/day--------->		g/cc	Pct	mmhos/cm
0-30	50	49	47	29	10	39			1.24	0	
30-35	50	49	47	29	10	39			1.24	0	
35-45	52	52	50	29	7	45			1.16	0	
45-55	49	48	45	26	6	42			1.18	0	
55-65	48	47	45	26	7	40			1.24	0	
65-78	45	44	43	25	7	37			1.40	0	
78-100	40	39	38	22	6	33			1.49	0	
100-125	38	37	35	20	5	32			1.54	0	
125-165	35	33	28	16	4	29			1.43	0	
0-20	50	49	47	29	10	39					
20-50	51	50	48	29	7	42					
50-100	44	43	41	24	6	36					
100-150	37	35	31	18	5	31					
150-200	35	33	28	16	4	29					

ITEM 5

Item 1: Explanation A

Item 2: Explanation A AWC calculated to 100 cm.

Item 3: Explanation A

Item 4: Explanation A
Pedon S62NH-005-002. Assume 30-35 cm zone same as 0-30 cm and 150-200 cm zone as 125-165 cm. 1, 10, and 200 kPa values estimated. 200 kPa retention taken as midpoint between 33 and 1500 kPa retention.

ITEM 7

Part	Quantity
A	Rooting Depth, cm

Plants:
Base Common: 65
Adjusted Base Few: 100

B Root-related Retention Difference Sums, cm
Base Common
10-200 kPa: 14
10-1500 kPa: 26
Adjusted Base Few
10-200 kPa: 19
10-1500 kPa: 35

C Water Movement, cm/day
Infiltration Rate:
Intake Rate:
Surficial Hydraulic Conductivity
Saturated:
5 kPa:

ITEM 6

Soil Mapping Concept(s):
Winooski silt loam

Soil Use(s):
Continuous silage corn

Typifying Survey(s):
Carroll County, NH
Sullivan County, NH

Compiler(s):	Date:
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G. W. Stevens, Water Res. Coord., SCS, Durham, NH	

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-23	WA	WA	WA	WN	MM	MM	MM	MS	MS	MM	MM	WA
	F	F	F								F	F
20-50	WA	WA	WA	WA	MM	MM	MM	MS	MS	MM	MM	WN
	F	F	F	F								
50-100	WA	WA	WA	WA	WA	WA	MM	MM	MM	MM	WN	WA
100-150	WA	WA	WA	WA	WA	WA	WN	MM	MM	MM	WA	WA
150-200	WA	WA	WA	WA	WA	WA	WA	WN	WN	WN	WA	WA
PND-FLD	F	F	F	F	R	R	R	R	R	R	O	O

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-23	MM	MM	MM	MM	MM	MS	MS	MS	MS	MM	MM	MM
	F	F	F								F	F
20-50	MM	MS	MM	MM	MM	MM	MM	MS	MS	MM	MM	MM
	F	F	F	F								
50-100	MM	MM	MM	WN	WN	MM	MM	MS	MS	MM	MM	MM
100-150	MM	WN	MN	WN	WN	MM	MM	MM	MM	MM	MM	MM
150-200	WN	WA	WA	WA	WA	WN	MS	MM	MM	WN	WN	WN
PND-FLD												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0-23	WA	WA	WA	WN	WN	WN	MM	MM	MM	MM	MM	WA
	F	F	F								F	F
20-50	WA	WA	WA	WA	WA	WN	MM	MM	MM	MM	WN	WA
	F	F	F	F								
50-100	WA	WA	WA	WA	WA	WA	WN	MM	MM	MM	WA	WA
100-150	WA	WA	WA	WA	WA	WA	WA	MM	MM	WN	WA	WA
150-200	WA	WA	WA	WA	WA	WA	WA	WN	WN	WA	WA	WA
PND-FLD												

Part B

Runoff	J	F	M	A	M	J	J	A	S	O	N	D
CN (Average)	98	98	96	95	97	81	81	60	64	76	96	98
CN (Driest)	96	96	96	89	81	81	81	60	64	76	96	96
CN (Wettest)	98	98	96	95	95	92	81	78	81	76	96	98

Part C

	J	F	M	A	M	J	J	A	S	O	N	D
Erosion												
Growth												

ITEM 9

Item 6:
Moldboard plow May 15. Apply 10-20 ton manure. Harrow in. Plant 17,000 heat unit variety May 25. August 1, 50 percent cover. Aerial seed winter rye August 15. Harvest September 10. No large reduction water use prior to harvest. Maximum 30% cover by winter rye in Fall; 50% cover May 1.

Item 7:

Part A - Explanation A	Common roots to 65 cm and few to 100 cm for pedon S62NH-005-002 (Item 4); perennial grass.
Part B - Explanation A	
Part C - Explanation A	

Item 8:

Part A - Explanation A	MH, 1-33 kPa; MM, 33-200 kPa; MS, 200-1500 kPa; DS, 1500 kPa retention to 0.8 times 1500 kPa retention. Used climate table of applicable soil survey report for difference from precipitation for average year for dry and for wet years. Flooding frequency classes from 2/28/80 Nat. Soil Interp. Bull. 33-0-6. Refers to probability for the succession of months with same frequency class, not for months taken separately.
Part B - Explanation A	Hydrologic Group B. Assume small grain October 1 to May 1. Row crop other months. MH is considered Wet for antecedent water state class but not for Hydrologic Group adjustment for wet conditions.
Part C - Explanation A	

NATIONAL TECHNICAL WORK PLANNING CONFERENCE
OF THE NATIONAL COOPERATIVE SOIL SURVEY

COMMITTEE 5: CONFIDENCE LIMITS FOR SOIL SURVEY INFORMATION

I. COMMITTEE MEMBERS:

Dr. L. P. Wilding - Co-Chairman
Dr. F. P. Miller - Co-Chairman
Mr. C. M. Thompson
Dr. B. L. Harris
Dr. E. M. Rutledge

II. INTRODUCTION

At the 1979 National Technical Work Planning Conference (NTWPC) of the National Cooperative Soil Survey (NCSS), this committee set out to deal with both short-range and long-range objectives. The short-range objectives were to develop narrative material that could be incorporated into soil survey reports to better communicate the (a) objectives of the soil survey, (b) how the soil survey was made, (c) its applicability and limitations, (d) relative magnitude of soil property variability in a landscape unit, (e) example probability statements of confidence limits, (f) generalized aspects of soil water movement, and (g) schematics of soil-geology-hydrology relationships. An additional charge was to develop methods to coordinate cooperative planning efforts to obtain crop yield and climatic data by major soils prior to and during the soil survey of an area.

The long-range plans were to address the following items: (a) develop alternative procedures to assess taxonomic and interpretive confidence limits map units, (b) to encourage Regional Committees and NCSS cooperators to continue testing alternative approaches to quantify soil survey information and procedures, and (c) to program redirection of NCSS emphasis and efforts toward greater quantification of map unit composition as interlinked with soil performance interpretations.

During the 1981 NTWPC of the NCSS a report was submitted summarizing activities of the short-range charges. The committee developed a narrative statement entitled "About this Soil Survey," which addressed items a, b, and c of the short-range charges. It also submitted model narrative statements on expressing confidence limits of map unit composition and various formats to communicate confidence limits (item d). In Appendices of the 1981 report, schematics and narratives illustrating hydrological water movement in soils and soil-geology-hydrology relationships were provided (items f and g). No report was made of long-range activities because this aspect was not yet addressed.

III. COMMITTEE SHORT-RANGE ACCOMPLISHMENT AND RECOMMENDATIONS

A. ACCOMPLISHMENTS

1. After the 1981 NTWPC, narrative statements "About This Soil Survey" and model statements on "Confidence Limits for Map Units" were submitted by Committee 5 to the Director of Soil Survey for field review and subsequent implementation. Field review of the document was completed by 8/1/81 with a draft of the prewritten section entitled "How This Survey Was Made" prepared from review comments and distributed for further review and testing. This was completed by 6/7/82. Attached (Appendix A) is a copy of this document. While the new section addresses many of the items proposed by the Committee 5 report and is a distinct improvement over older sections published in pre-1981 soil surveys, it was considered by the leadership of this committee a disappointment in being too general, dulling some of the sharp points made in the Committee 5 report, and in not addressing confidence limits of soil surveys. Committee 5 considers this a major deficiency of the current draft on "How This Survey Was Made." Spatial variability of soils is the norm and relative magnitudes of variability in map units should be communicated to users. This matter is considered further under RECOMMENDATIONS (III B1).
2. A second document drafted in response to the Committee 5 Short-Range Report is a section "Soil Survey Procedures" that will be placed in the National Soils Handbook (Appendix B). Optionally, this section may also be incorporated into soil survey reports following "How This Survey Was Made" to further expand and amplify the latter.

B. RECOMMENDATIONS

1. A section entitled "Variability in Soil Properties" should be added to soil survey reports similar to the draft attached (Appendix C). This would specifically address a matter currently not adequately handled in a straight-forward manner in soil survey reports. The intent of this statement would be to inform users of soil survey reports of probable relative magnitudes of soil properties, ranges in their CV's, and the probable decrease in confidence limits of soil properties with increasing depth In a soil.

2. A generalized section on saturated water movement in soils should be drafted and included in soil survey reports to communicate to users of soil surveys generalized concepts and schematics of vertical and lateral water movement, influence of pore size and planar voids on saturated water movement, the impact of restrictive zones on vertical water movement, surface runoff, interflow, seeps, and topographic influences.
3. Formulation of methods and procedures to obtain crop yield data for named soils within survey areas should be transferred to another committee. It does not fit with either the short-range or long-range objectives of the committee on confidence limits of soil surveys.

IV. LONG-RANGE ACTIVITIES AND RECOMMENDATIONS

A. ACTIVITIES

Committee 5 has been largely inactive since our last report in 1981. It has focused on the pending disposition of narrative material developed for incorporation into soil survey reports, work of Regional Committees on this topic, and evaluation of long-range objectives. The committee leadership has lost some of its enthusiasm because of changing professional roles, the questionable need for development of alternative procedures for taxonomic and interpretive purity of map units, and the disposition of narrative statements previously addressed (under Section III).

Committee 5 has encouraged active participation of Regional Committees to evaluate confidence limits of soil surveys; both the Northeastern and Southern regions have been active in such endeavors. A general consensus of these committees is that no single method of sampling, statistical analyses, nor presentation of data formats and results is applicable to all survey situations. Methodology depends on goals and objectives of the survey and purpose.

Several specific reports have been published (or are in press) that are pertinent to the long-range goal of developing alternative procedures to access taxonomic and interpretive purity of map units. For example, the following reports address this topic:

1. Cline, Richard G. (1981). Use of Probability of Occurrence in Evaluating Map Units. Soil, Air and Water NOTES 81-2. USDA, Forest Service, Northern Region, Missoula, Montana 59807.

2. Arnold, Richard W. (1981). Binomial Confidence Limits as Estimators of Classification Accuracy. Agronomy Mimeo 81-7, Dept. of Agronomy, Cornell Univ., Ithaca, N.Y.
3. Forbes, T., D. Rossiter and A. Van Wambecke. Soil Management Support Services (SMSS) Monograph #4, Soil Conservation Service, USDA, Agronomy Department, New York State College of Agric. and Life Sciences, Cornell Univ.
4. Wilding, L. P. and L. R. Drees (1983). Soil Variability: A Pedologists Viewpoint. Chapter 4. In: L. P. Wilding, N. E. Smeck and G. F. Hall (eds.). Pedogenesis and Soil Taxonomy. I: Concepts and Interactions. Elsevier Publishing Co. (In Press).

V. LONG-RANGE AND GENERAL RECOMMENDATIONS

A. Re-evaluate the need to establish or develop alternative procedures to access taxonomic and interpretive purity of mapping units. Each procedure is likely to be specific to the objective and goals of the survey area in question. The materials and reports cited in section IV-A are general enough to provide general guidelines for this purpose.

B. Continue to encourage Regional Committees and NCSS cooperators to test alternative approaches to quantify soil survey procedures.

C. Continue to focus NCSS efforts to quantify map unit composition interlinked with soil performance interpretations.

D. Continue the committee to pursue short-range and long-range charges but with change in leadership and membership composition.

APPENDIX A

$I04How This Survey Was Made

$I01This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

$I01The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

$I01Commonly, individual soils on the landscape merge into one another as their characteristics gradually charge. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

$I01Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable than to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics **with** precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

$I01While a soil **survey** is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled fran farm records and from field or plot experiments on the same kinds of soil.

$I01Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. Fbr example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

$I01After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

$I05Map Unit Composition

$I01A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of' the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

$I01Most inclusions have properties and behavioral patterns similar to those of the dominant soil. or soils in the map unit, and thus they do not affect use and management . These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed, and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

$I01The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but ratter to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

$I01The section, "Survey Procedures," explains specific procedures used to make this survey. (Optional in published soil surveys.)

(x) Formation of the soils.

(xi) Survey procedures. This section is optional at the discretion of the State Soils Staff. The purpose of this section is to describe and document the specific procedures used to make the soil survey. Authors are encouraged to include this section, especially if a survey has been made at two levels of refinement or if transect data are available. See Exhibit 603.1(a)(2)(xi) for an example of some of the kinds of information that can be written about. Transect data in narrative or tabular formats and statistical reliability statements may be published in this section.

(xii.) References and footnotes.

Survey procedures. (Optional in published surveys. The following is an example of some of the kinds of information that can be written about in this section.)

The general procedures followed in making this survey are described in the National Soils Handbook of the Soil Conservation Service. The Soil Survey of Alpha Survey Area (1), published in 1928, and the Geology of Southwestern Betaland (2) were among the references used.

Before the actual fieldwork began, preliminary boundaries of slopes and landforms were plotted stereoscopically on quad-centered aerial photographs flown In 1976 at a scale of 1:80,000 and enlarged to a scale of 1:24,000. USGS topographic maps at a scale of 1:24,000 and photographs were studied to relate land and image features. An aerial reconnaissance was then made by helicopter or fixed-wing aircraft prior to traversing the surface.

Traverses were made on foot in Gamma Valley. In the rest of the survey area, they were made by truck and trail bike on the existing network of roads and trails. Where there were no roads or trails, traverses were made on foot. In the Alpha Lake Preserve, which was inaccessible by foot, they were made by helicopter. Because of limited landing areas, however, in some places in the preserve complete traverses were not possible.

Most of the traverses were made at intervals of about one-fourth mile. Traverses at closer intervals were made in areas of high variability and in Gamma Valley. Some areas of high variability are in the Delta-Zeta-Roe Association and in the Roe-Delta Association.

Soil examinations along the traverses were made 100 to 800 yards apart, depending on the landscape and soil pattern (4). Observations of such items as landforms, trees blown down, vegetation, roadbanks, and animal burrows were made continuously without regard to spacing. Soil boundaries were determined on the basis of soil examinations, observations, and photo interpretation. The soil material was examined with the aid of a hand auger or a spade to a depth of about 6 feet or to bedrock if the bedrock was at a depth of less than 6 feet. The pedons described as typical were observed and studied in pits that were dug with a backhoe.

Three delineations of each map unit were chosen to be representative of the map unit and were transected to determine the composition of the map unit and to record the kind of vegetation. The point-intercept method of transecting (3) was used in open areas. A random transect method (5) was used in forested areas and in areas of limited accessibility.

Samples for chemical and physical analyses were taken from the site of the typical pedon of the major soils In the survey area. The analyses were made by the National Soil Survey Laboratory, Lincoln, Nebraska. The results of the analyses are stored in a computerized data file at the laboratory. The results and the laboratory procedures can be obtained by request from the laboratory.

After completion of the soil mapping on quad-centered aerial photographs, map unit delineations were transferred by hand to orthophotographs at a scale of 1:24,000. Surface drainage was mapped in the field. Cultural features were transferred from U.S. Geological Survey 7 1/2-minute topographic maps and were recorded from visual observations.

References. (References are to be shown in the reference section only.)

(1) For illustration only

(2) For illustration only

(3) Johnson, William M. 1961. Transect methods for determination of composition of soil mapping units. Soil Surv. Tech. Notes. Soil Conserv. Serv., U.S. Dep. Agric., pp. Y-11, illus.

(4) Miller, Fred P., D. E. McCormack, and J. R. Talbot. 1979. Soil surveys: Review of data collection methodologies, confidence limits, and uses. Natl. Acad. Sci., Transp. Res. Board, Transp. Res. Rec. 733, pp. 57-65, illus.

(5) Steers, C. A. and B. F. Hajek. 1979. Determination of map unit composition by a random selection of transects. Soil Sci. Soc. Am. J., vol. 43, no. 1, pp. 156-160.

APPENDIX C

Soil Property Variability

The scientific basis of a soil survey is that soils and their location on the landscape are predictable to an experienced soil scientist who has a knowledge of the geology, climate, and landform patterns of the area. The soil scientist is not able to observe or sample the soil at every point on the landscape. Only enough observations are made during mapping to determine the dominant soil landscape relationships and confirm predictions of soil models established from these relationships. Thus, individual. areas of named soils bounded by lines (mapping unit delineations) are derived, to a great extent, from inferences gained from a small sampling of the landscape. This is possible because soil properties change systematically with landscape position; visible changes in vegetation, surface color, drainage pattern and slope permit a soil scientist to locally extrapolate, with confidence , soil property-landscape relationships to areas yet unmapped.

One of the common properties of soils as a natural landscape body is variability. The natural scatter and range of values between soil properties varies systematically, as observed above, but also some variability occurs in an undefined (random) manner, Soil scientists are aware of this natural scatter or variability in soil properties. They make every attempt to design mapping units and map soils that restrict property variability to limits that permit meaningful interpretations of soil use, management, and behavior. In spite of this effort, soil properties are not homogeneous within mapped soil areas. They often have ranges that exceed the dominant soil conditions of the area because of inclusions of other soils in the mapped area. Sources responsible for such property variability and those properties expected to be most variable are discussed below.

The magnitude of soil property variability depends on the nature of geologic parent materials, the intensity of soil weathering and leaching processes, topographic position, soil water movement, degree of erosion, and biological factors. It also depends on the properties under consideration. In general, igneous and folded-metamorphic bedrock and water-laid sedimentary deposits are most variable while loess, eolian sands, and glacial till deposits are most uniform. Nearly level broad uplands and terraces are more uniform than narrow sloping summits, shoulders, and side slope positions that are subject to surface water runoff, erosion, and differential sediment transport. Likewise, depressions, foot slopes, fans, deltas, and flood plains are likely to be highly variable over short distances because of differential sediment transport. and deposition. Areas subject to high physical and biological disturbance, such as frost heaving, slump, landslides, surface mining, tree-throw, and crayfish, ant, termite, worm, and rodent activities, are likely to have marked changes in soil properties over short distances. Development of subsurface physical and chemical pans or restrictive layers and depth to bedrock may also vary over short distances as a consequence of differential intensity of soil weathering processes acting on variable parent materials.

Coefficient of variation is a measure of the relative magnitude of soil property variability. It represents the degree of dispersion of property values about the mean value. Coefficients of variation of 15 to 25 percent are generally considered relatively low. However, values exceeding 35 to 40 percent and especially those of 100 percent or more are high and Indicate extreme soil property variability. In areas of soil disturbance from surface mining, soil properties such as sulfur content, soluble salts, and pH may have CV's of several hundred percent within local areas. High coefficients of variation decrease the confidence with which soil scientists may accurately predict the range of soil properties within a given area.

Properties that reflect the water status of soils such as soil moisture retention, rate of water movement, infiltration, soluble salt content, organic matter content, fine clay content, depth of carbonate leaching, depth of mottling, and solum thickness are most variable and will likely have CV's greater than 35 percent up to 100 percent. or more within natural. landscape units. In contrast;, soil properties such as dominant. soil color, pH, texture (total sand, silt, and clay content), calcium carbonate content, mineralogy, cation exchange capacity, and soil structure are less variable and will likely have CV's between 15 and 35 percent within map units.

Soil property variability may increase with depth; soil scientists make few observations below 2 meters. As a general rule, the confidence in predicting soil property variability from soil survey mapping procedures decreases with depth. This is because soil scientists make more observations near the surface, and subsurface variability may not be evident from surficial expression of soil color, topography, vegetation, and other landform conditions.

Estimating the ease of soils to compaction from soil survey data base

S. C. Gupta and W.E. Larson

a. To describe the compression behavior of soils in the temperate and tropical regions.

Confined compression tests were run on several soils from the United States, Brazil, Venezuela, Nigeria, Israel, Sweden, Morocco, and India. From the compression test data, ease of soils to compaction either due to applied load or change In moisture content is estimated. The parameters that describe the ease of compaction are (i) the slope of bulk density vs. log of the applied stress (compression index, C) and (ii) the slope of bulk density at 1 kg cm-2 applied stress vs. degree of water saturation (Δ_T). Compression test data show that C and Δ_T are dependent on the clay and organic matter content of the soil. The compression parameters can be separated into two groups, depending on the type of clay. Other parameters estimated (from the compression test data) are the bulk density at 1 kg cm-2 applied stress (p^1) and the stress above which soil aggregates shear and lose their initial identity.

b. To predict compression behavior of soils from particle-size distribution and organic matter content.

The soil survey data base generally contains the detailed particle-size distribution and the estimated percentage of organic matter content. This is also the information needed in the packing model to estimate the minimum, random, and maximum bulk densities of soils. The ratio of maximum to random densities is an index that could be used to describe the susceptibility of soil to compaction. Tests are being made to define the relationships between compression parameters (C, AT) and the packing index. These relationships will be useful In delineating soils according to their susceptibility to compression for a given set of local conditions, i.e., (a) the size of farm machinery and (b) the climatic conditions (precipitation distribution at the time of tillage). Relationships could also be developed to estimate the range of moisture content and of applied stress which is not conducive to excessive compaction near the soil surface.

Plans are also being made by Bob Grossman of SCS to test. the usefulness of the packing model in predicting field bulk density from particle-size distribution and organic matter content. If the tests prove successful, predicted bulk density from the packing model could replace the field measurements for soil survey reports. This work will be done in cooperation with the SCS group at Amarillo, Texas, and with ARS groups at Rushland, Texas, and Lincoln, Nebraska.

c. To develop and test a soil compaction model.

Relationships are also being developed to estimate Other parameters of the compression test from particle-size distribution or predictions of the packing model, or both. These relationships, along with the relationships developed in objective (b), will be used in our soil compaction model to delineate zones of limiting plant and soil conditions in the soil profile. An experiment has been initiated by Ward Voorhees of ARS to test the usefulness of the predictions of the compaction model in the field.

Some Soil Studies by the Land Hesources Development Centre

By A. J. Smyth, Land Resources Development Centre,
Tolworth, U.K.

Aspects of the work of the Land Resources Development Centre (LRDC), an organisation funded within the British Overseas Aid Programme, have been described in several previous biannual Work Planning Conferences of the U.S. Soil Conservation Service (1975; 1979; 1981). Currently, staff of LRDC are working in seventeen countries in the Third World (Bangladesh, Belize, Indonesia, Kenya, Malagasy Republic, Malawi, Montserrat, Nepal, Oman, St. Helena, Somalia, Sri Lanka, Sudan, Tanzania, Yemen Arab Republic, Zambia, and Zimbabwe). Future plans foresee a continuation of the Centre's soil survey work as an important part of Its general land development activities.

The immediate objectives and the circumstances under which LRDC soil studies are undertaken continue to be extremely diverse. It may be of interest to illustrate this diversity by reference to three specific projects, in Tanzania, Nepal, and Cyprus, respectively. The soil studies in both Tanzania and Nepal are carried out in support of integrated rural development projects, but the contrast in their settings is considerable; between the gentle topography and environmental stability of the African shield in Tanzania and the rapid environmental change, in space and time, of mountainous Nepal. The scale and relative sophistication of studies in Cyprus are different again.

In Tanzania, the studies were designed to obtain an understanding of the soils sufficient to allow reliable land-use planning at village level and to train Tanzanian staff in the techniques involved. The work extended to the whole of the Tabora Region covering 73,500 km^2 and commenced with a reconnaissance soils and land-use survey with associated agronomic, forestry and socio-economic studies (Mitchell, et al, 1980, 1983). It was early appreciated that the human population of the Tabora Region was very unevenly distributed; whilst there were few people in most of the Region some areas were seriously overcrowded. A method of assessing the human carrying capacity of different lands was devised to determine the seriousness of the problem in crowded villages and to plan solutions, particularly to plan new villages for people who would have to leave the overcrowded areas (Corker, 1983).

Although there are many other factors to be considered In deciding how much land a family needs to achieve an acceptable living, differences in soil productivity are clearly important. Thus a major contribution of the soil and agronomic studies in this project has been the assessment of productivity of each of the main soils for each of the main crops in the various farming systems. The assessment is necessarily tentative and recognizes only four classes of potential for each crop expressed as a percentage of the standard yield expected on the best, Class 1, soils (Class 2 gives 80 percent; Class 3 50 percent; Class 4 gives no effective yield). The LHDC team sought the assistance of local farmers in assessing the yield potential of the different soils in an average year, and, to this end, the team was careful to relate its own system of soil classification closely to traditional systems of distinguishing soils understood by the farmers.

In Nepal, soil studies formed part of the rural development activities financed by the United Kingdom in the Kosi Hill area (Goldsmith, 1981). This mountainous tract in the east of the country covers 5,000 km2 extending from the edge of the flat Terai plains to the Himalayan border of Tibet. The area is characterised by extremely steep topography. Nevertheless, population pressure is generally great and most sites on which agriculture is possible are already terraced. Thus, nearly all soils of any significant depth are collutival and/or anthropomorphic and their texture, colour, stone content, etc. change over very short distances. Early in the field work it was apparent that conventional soil mapping would be very difficult and probably not very meaningful.

Climate almost always defines the possibilities of agricultural land use, but in the Kosi Hills change in altitude and aspect, and therefore climate, is so significant within short distances that climate is the dominant distinguishing factor even in fairly detailed land suitability mapping. Seven categories of climate were recognised, and experience showed that the lands so distinguished could be usefully subdivided in terms of soil depth and slope angle. Using these criteria 56 kinds of land were recognised, mapped and evaluated in terms of their suitability for six defined land uses, Very little can be said, as yet, about the soil properties or productivity of any particular site but the maps are expected to be valuable in planning agricultural extension work in the area and, in particular, in identifying those few areas of flat or terraced land to which irrigation might be extended.

The role of LHDC soil studies in Cyprus has been very different from that in Tanzania or Nepal. In Cyprus the work is associated with a feasibility study for the construction of a modern pipeline to convey water from the Troodos mountains of western Cyprus to areas along the southern coast and eastern end of the Island, a distance of about one hundred kilometres. The water is needed for both domestic and irrigation usage. Crucial to a decision on the best distribution of available water, and, thus, on the design of the dams and pipeline was an understanding of the nature of the irrigable areas and of their water requirement along the planned length of the pipeline. To obtain this information, land in these areas was mapped at a scale of 1:25,000 (Makin, 1982). The maps show land units classified in terms of irrigation suitability, but distinctions are carefully drawn between soils that differ in characteristics important to crops of the immediate locality. Quantitative measurements and assessment of crop rooting volume and soil water holding capacity were made for the major land units. Forty-year historical records of rainfall, taken together with levels of evapotranspiration computed separately for each crop in each area, have then been used to predict the pattern of irrigation requirements under the widely varying Cyprus climate and a computer simulation model used in conjuction with the soil mapping has assisted the team In examining and optimising alternative possibilities of water distribution (Eavis, et al, 1980).

These brief comparisons of soil survey objectives and achievements serve to underline how differing environmental conditions and development priorities can influence what is feasible at acceptable cost, suggesting a need for flexibility and imagination in devising the approach to be used in each new situation.

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Status of the Soil Survey and Related Activities of the Soil, Survey Division (Mexico)

By Gaudencio Flores Mata, Secretariat of Agriculture
and Hydraulic Resources, Soil Survey Division

OBJECTIVE

The Soil Survey Division was established in 1967. Its principal objective is the preparation of taxonomic and interpretative soil surveys of those areas that are suitable for irrigation and rainfed projects.

ORGANIZATION

The Soil Survey Division includes 6 offices, 17 regional head offices, and 15 laboratories for physical and chemical analysis of soils and water. It employs 489 technical people (89 in Mexico City and 400 in other parts of the country).

KINDS OF SOIL SURVEYS

The kinds of soil surveys prepared by this Division are as follows : Reconnaissance, Semidetailed, Detailed, and Special. Each kind has its own objectlves, mapping scale, map units, specific information, and kind and intensity of field procedures.

Reconnaissance. This kind of soil survey is intended for very broad, general land use planning at the regional level, usually to determine the potential of soils for cropland, pastureland, woodland, etc., and to identify areas having potential for more intensive development.

Mapping scales range from 1:200,000 to 1:50,000. The scale must be large enough, however, to represent great groups, families, and associations of soils.

The soils of representative landscapes and their pattern of occurrence on the landscape are Identified by direct observation. Channels, drains, roadcuts, holes, and other land features are used in plotting soil boundaries on maps.

The information is presented in a relatively brief report, which describes the more important characteristics of the map units as well as possible uses. This kind of survey includes a soil map showing the principal map units.

Semidetailed. This kind of soil survey provides enough information for decisionmakers to determine irrigation needs and to establish crop programs. The information is adequate to project profitability (cost/profit).

The information consists of: land characteristics (topography, susceptibility to erosion, natural drainage, etc.), characteristics of soil hydrodynamics (infiltration rate, permeability, hydraulic conductivity, etc.), physical and chemical properties of the soils (texture, structure, depth, pH, salinity, water-holding capacity, etc.), and recommendations on soil use, management, and conservation.

During the fieldwork, soils are plotted according to their similarity in texture, structure, stoniness, number and kinds of horizons, etc. Also, soils are mapped according to their soil group (vertisol, andosol, etc.). In this kind of soil survey, the physical and chemical analyses of soil samples are given.

All this information is represented in several maps (taxonomic and interpretative) at a scale of 1:20,000.

Detailed. This kind of soil survey is an intensive soil resource inventory carried out to facilitate the final planning of irrigation or rainfed agricultural development.

More soil properties are considered in a detailed survey than in other kinds. Hydrodynamics tests and complex physical and chemical analysis of soil and water samples are a significant part of these intensive inventories, as are maximum or near-maximum refinement of soil and land differences, both categorically and cartographically. All information is obtained by intensive sampling.

The survey contains detailed information on soil characteristics and qualities. Soil series and phases of soil series are described. The Land Capability Classification or USBR Land Classification for Irrigation are given. The mapping scale ranges from 1:20,000 to 1:5,000.

Special. This kind of soil survey is designed for detailed planning for small areas (a hundred to a few thousand hectares), for example, irrigation systems, intensive farm and plantation management, drainage, salinity or alkali problems, erosion control, and others, especially in the context of problem solving.

The survey contains information on specific problems. Taxonomic map units used are mainly phases of soil series. The mapping scale generally is less than 1:10,000.

SOIL SURVEYS

From 1976 to 1982, the Soil Survey Division completed about 2,000 soil surveys in large or small scale projects, covering about 16 million hectares.

YEAR	SOIL SURVEYS	AREA (hectares)
1976	265	761,254
1977	231	1,733,693
1978	357	2,696,061
1979	386	3,049,341
1980	249	2,130,372
1981	283	4,073,609
1982	198	1,741,601
TOTAL	1,969	16,185,931

Methodologies. The Land Capability Classification, USBR Land Classification for Irrigation, USDA Soil Taxonomy, FAO Land Evaluation, FAO/UNESCO Soil Units, etc. have been adapted for the ecological conditions of Mexico without a change in fundamental principles.

Within taxonomic classifications, the Soil Survey Division uses soil series and phases of soil series; also, if the purpose requires it, soil associations, families, subgroups, and great groups are used.

The Division has completed several studies in which the 7th Approximation was applied, for example, in the states of Chihuahua and Tamaulipas.

PHYSICAL AND CHEMICAL ANALYSIS OF SOIL, WATER, AND PLANT SAMPLES

This analysis is a necessary component of a soil survey report and is employed to confirm the soil scientists' criteria about the land classifications and to identify some soil problems, estimating the degree of severity in the limitations of crop productions.

The Soil Survey Division's 15 laboratories in the last 7 years processed 154,231 samples of soil, water, and plants, and 2,240,745 determinations were completed.

In making their determinations, in addition to their own techniques, the laboratories often utilize the resources of learning institutions in Mexico and in the United States.

AGRICULTURAL EXPERIMENTATION

The Soil Survey Division oversees seven experimental plots in which the response of crops in different kinds of soil are analyzed. The crops are rice, wheat, beans, corn, sorghum, barley, and alfalfa and some fruit trees in thin, rocky soils that have a strong slope. Also, the Division is testing methods for controlling erosion and is conducting tests on saline and sodic soils.

Furthermore, an experiment involving 40 field trials is being conducted by the Division in collaboration with the Micronutrient Assessment Project, which was started in 1974 by FAO in cooperation with the government of Finland. The objective is to determine the micronutrient level of soils and plants in Mexico.

THEMATIC MAPS

To carry out the objectives mentioned, it is necessary to consider all the ecological factors that are involved in soil formation; thus the Soil Surver Division has prepared several thematic maps that are used-as background for-the taxonomic and interpretative classifications of soils and lands. Some of these maps are:

General Map of the Mexican Republic at a scale of 1:2,000,000.

Soil Units Maps of the Mexican Republic according to the FAO/UNESCO System of Classification at a scale of 1:2,000,000 (4th edition in process of preparation).

Vegetation Map of the Mexican Republic at a scale of 1:2,000,000 (2nd edition in process of' preparation).

Land Capability Map of the Mexican Republic at a scale of 1:2,000,000 (in process of preparation).

Geomorphological Map of the Mexican Republic at a scale of 1:2,000,000 (in process of preparation).

Photographic mosaics of Mexico State, Baja California, Veracruz, Puebla, and Hidalgo.

Geology, Present Use, Climatology, and Soil Erosion of Tlaxcala State at a scale of 1:200,000.

Geology, Hydrology , Land Capability, Climatology, Soil units, Soil Taxonomy, and Topography of Tamaulipas State at a scale of 1:1,000,000.

Land Capability and 7th Approximation of Chihuahua State at a scale of 1:1,000,000.

Satellite Images Mosaic of Mexican Republic at a scale of 1:1,000,000 obtained from 139 images of EARTS 1 and 2.

Business Meeting

Bob Swenson, SCS State Conservationist in South Dakota, spoke to the participants. His remarks are included in the proceedings.

Old Business

The chairman reported that most recommendations from the previous conference were considered by the steering committee. As far as possible those ideas were incorporated in the schedule and operation of this conference. There were no other old items brought to the attention of the participants.

New Business

Based on a proposal by Bob Grossman and discussion by the participants, the conference agreed-to have a report at the next conference on the results of integrating resource information on three or four pilot areas. The selected areas should include digitized soil maps, fertility classification, moisture information and so forth.

Do” McCormack reminded us that the National Conservation Program would soon be released and he encouraged the steering committee to consider those priorities in their deliberations. This will place emphasis on activities that are supportive of resource conservation.

There being no further items, the chairman offered some concluding remarks.

Concluding Remarks

As chairman of the conference, I will be writing letters of thanks to the lead speakers who shared their viewpoints with us. They helped set the stage for spirited discussion.

Our thanks to all representatives of other national/international soil survey organizations that shared in our deliberations and informed us of some of their activities. We appreciate having them with us.

Our thanks to all the invited participants for their interest and their helpful comments. You help us maintain the depth and breadth of what we do and need to do in NCSS.

A pat on the back to all the permanent members for once-again showing that we are a National Cooperative Soil Survey. Individually and as representatives of institutions and agencies, you demonstrate so well the relevance of pedology as a discipline. Our standards are high, we expect good quality, and we work together for common goals. I hope we never lose this capacity and desire to provide strong technical and professional leadership in soil survey and related activities.

Special thanks to the committee chairman who, with their committee members, presented well prepared materials for consideration by the conference and arrived at many recommendations for the steering committee to act upon. It shows to me that we want changes to occur.

The committees and their chairmen were:

Standing
1. Moisture in Soils - Bob Grossman
2. Confidence Limits - Larry Wilding

National Issues
1. National Geographic Data Bases - Bill Reybold
2. NCSS Image - Billy Harris and Ed Ciolkosz
3. Update Strategy - Ted Miller
4. Soil Taxonomy-Soil Fertility - Dick Rust

Technical Committees
1. Soil Taxonomy - Richard Guthrie
2. Land Capability - Dick Johnson
3. Soil Interpretations - Joe Nichols
4. Soils-S's - Dick Kover
5. Horizon Designations - Richard Fenwick

A very special thanks to Mrs. Sarah Epps, who worried about the arrangements of this conference. She so capably handled the details that most of us were unaware of the changing situations. She made it possible for us to concentrate on technical aspects and we all appreciate her efforts.

The SCS NHQ staff is responsible for the conference operations. We recognize their fine contributions and thank them.

We've all noted that the committees looked in depth at the charges and have provided recommendations. I think the success of the conference will be measured, in large part, by how well the steering committee functions. By that I mean--we must take action--positive action on your recommendations--if we are to keep moving ahead. No action is a poor management response--and we cannot afford to be unresponsive.

I look at this conference as a bright spot in our progress. We do look at our history, we do care about what each of us are doing, and we are looking to the future.

The NCSS is strong because you are strong--because you care--because you're darned good pedologists.

Thanks again. Conference is closed.

☆U.S. Government Printing Office : 1983 [illegible]

NATIONAL COOPERATIVE SOIL SURVEY

Soil Survey Conference Proceedings

Washington, D.C
April 6-10, 1981

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United States
Department of
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**Soil
Conservation
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Proceedings of the National Technical Work-Planning Conference of the Cooperative Soil Survey

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April 6-10, 1981

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SUMMARY OF CONFERENCE

BY DR. KLAUS W. FLACH

Ralph McCracken started out the conference with 14 points and I would like to mention a few of them again.

We need a better structure for the National Cooperative Soil Survey and I think what Dick Arnold presented earlier today is a good step towards that better structure; we need to work on Soil Taxonomy and the Soil Survey Manual. We have to completely update the National Soils Handbook and get it out to a broad range of users. We have to work hard on new technology, such as remote sensing and radar; we have to get a handle on spatial variability and, in general, on our technical credibility. We need better ways of handling soil information. We have to interact better with our user agencies, and again I believe we have come a long way in this direction during this conference. We need a new emphasis on international soil geography; we have to work with modelers, and on education and training, and above all, we have to chart a soil survey program that will eventually lead to less emphasis on mapping and more emphasis on soil resource information.

I am planning to go through the program point by point and try to summarize and identify major recommendations. I would like to go a step farther than that and suggest people who will take responsibility and a general time frame for implementation. Obviously, we are very much aware of the criticism that, in the past, we passed nice resolutions and then appeared to do nothing about them. We will try to improve our image.

Reports of standing committees: First, I would say I was very much impressed by the reports of the three standing committees. They have come a long way since the last conference. The first committee report was by Dr. Larson on surface soil characteristics. He described his packing models and said that the best measurements and the best observations are made in the field. It seems now that we need to get out tentative instructions on how to obtain this information in the field and start pilot projects--perhaps one in each of the regions to test procedures. Hopefully, by the next work planning conference we will come up with a testing procedure for general acceptance. I would suggest that Dr. Holzhey of the National Soil Survey Laboratory take the major lead in working with Dr. Larson on transforming his ideas into National Cooperative Soil Survey working instructions. Is this accepted?

The second report by Dr. Wilding and Dr. Miller dealt with confidence limits and variability. Their long-range objective indeed deals with confidence limits and variability. I believe, Dr. Wilding, you people have made great progress and I presume that at the next conference you will have rather specific recommendations. I would like to point out that this issue was raised by some of our users, especially the consulting engineers. I have a personal suggestion. We should define the minimum area to which the variability applies to which has been defined in the mapping unit description? For a very detailed survey this may be a few acres; for a order-3 survey it may be a few hundred acres. The short-range objectives have come a long way. Unfortunately I have not seen your drafts for sections of soil survey reports, but what Dr. Miller talked about looked very good. I hope that we will get this material soon. Obviously, Don McCormack and his staff would have major responsibility with Pat Looper to implement this recommendation. Something that came out of that recommendation and also, again, from the user groups is that the need for something like professional paper 950 of the U.S. Geological Survey. I would like some indication on whether we should look for this kind of a publication or whether we should put all of these ideas into the introduction of soil survey reports. My own feeling is that we badly need a vehicle with which we can communicate to the technical people outside the soil survey field.

No voice here; I assume that we are looking for two things--improving the manuscripts and getting out a publication about how we make soil surveys that addresses largely a technical audience.

The third committee report was presented by Dr. Grossman on a scheme for an intergrated soil moisture classification which intergrates soil characteristics and the climatic environment. Again this looks very good; we should try to implement this report and get out pilots in each of our four regions. I would recommend one county in each of the four regions, As you know, we have a soil moisture initiative. We are hoping to strengthen our soil moisture work and there is an obvious tie between the work of this committee and the soil moisture initiative.

Updating Soil Taxonomy: We then had a discussion on strategy for updating Soil Taxonomy. Ten years ago Soil Taxonomy was in a great state of flux and we looked forward to a period of stability. Right now it almost looks as if stability has turned into rigor mortis. We certainly need to get moving again. There were several recommendations. One was to get started on a bookkeeping system to keep track of the recommendations as they come in. There was a suggestion of revising our updating procedure and a very good recommendation that we handle updates in the same way that scientific journals handle the review of papers. That for each topic somebody be appointed as an editor who canvasses reviewers and comes up with a final recommendation. I guess, Dr. Arnold, that we should rewrite our procedures. Dr. Cuthrie should be responsible for that. Can we do that by July 1 or so?

Something occurred to me while putting these notes together. Do we need to designate individuals who are responsible for specific parts of Soil Taxonomy, like orders or family criter [illegible] Updating Soil Taxonomy is a big job, really too big for one person. [illegible] have any comments on that? We would make somebody responsible for Mo[illegible]s who would review proposals that impact on Mollisols.

Obviously we have not done a very good job in moving things along in the past and these ideas will help.

When Dr. Arnold first came to SCS we had an idea that we did not want to implement in small increments because it is very difficult for the users to keep track of small changes. At that time we talked about setting a target date for a new edition of Soil Taxonomy. In the meantime, at the session on Monday, we talked about breaking Soil Taxonomy into a loose leaf format perhaps by orders, and we might do the updating more by parts than on the whole. Can I get any expression on this idea? Well, get back to Dr. Arnold if you have any comments so that he can incorporate them into the proposed updating procedure. Presumably, we will circulate the updating procedures to national and international cooperators.

Monday afternoon and Tuesday morning we had two sessions that dealt with the international application of Soil Taxonomy, and we were fortunate enough to have excellent presentations by the chairmen of the international committees, ICOMORT, ICOMLAC, and ICOMAND. I hope to speak for this conference if I extend an appreciation and gratitude to the chairmen and their committees for the excellent work they have done. Since we decided not to vote, we do not have to vote, but I trust that this is a consensus. I certainly have been very much impressed by the quality, quantity, and the dedication of the committees, especially of the committee chairmen. On some of these committees the US participation may not have been as strong as we may have liked. I would like to encourage both government and university people to take the work of these committees seriously; to make recommendations and make themselves heard because the committees will come up with solutions with which you will have to live.

On Tuesday we had a very good round table discussion on international work, on Soil Management Support Services. Some very good points were made. I think the most important one was that more emphasis in this kind of work should be on soil survey and soil survey procedures, that we need the new edition of the Soil Survey Manual and parts of the Soils Handbook to assist people in running a sound soil survey program with adequate quality control and with emphasis on interpretations. A lot of people make soil surveys but soil surveys in many parts of the world have a reputation of being an academic exercise because there has not been equal attention on developing appropriate soil survey interpretations. I like Dr. Smyth's comment that we have to help those people identify and formulize purposes of surveys and then help them execute the survey so it will indeed meet its objectives. There have been standard soil surveys that may or may not have met the needs of a individual country at that point in time. Do we have any more comments on this? I do not really know at this point whether any implementation is particularly necessary. I would like to accept the recommendation on the internationally testing of the draft of the manual.

One thing that occurred to me in working on this material was that many individuals and experiment stations have individual agreements or contracts with AID and other international organizations to conduct soil surveys and to assist in soil surveys in individual countries. Somehow we do not get much feedback from these efforts. There must be a lot of information around that is being lost to the scientific community; for example: the testing of soil taxonomy. So I wonder whether we, as part of NCSS or the Soil Society of America, could perhaps set up some kind of a mechanism, (a) that we know when somebody is going where? and (b) arrange for a debriefing or report **when** that person comes back, We might be able to pick up some funding for that from **SMSS. Any comments** on this point?

Dr. Eswaran, will you work on this? I guess we will have to write to all the experiment stations and get some kind of a mechanism started.

Heetings with User Croup: I think I will turn to the Tuesday afternoon session with the Federal agencies and the related Wednesday session witb users. Like the rest of you I was dissappointed with the turnout on Wednesday. We sent out 150 invitations; some people came and a lot of people did not come, and some people who came left as soon as they could. I think we ought to consider this in the context of the current scene in Washington. These people are representatives of interest groups, that are staking out their turf with the new administration. Probably, the timing for the session could have been better. I believe nevertheless that the poor turnout reflects the fact that we are not as well known as we ought to be and are not as appreciated as we agree we should be. We will have to strengthen our efforts to work with tbe public and their understanding of soil survey and what soil survey can do. I suggest, Dr. **McCormack,** that we soon have a post mortem on this session at least here in the SCS National Office and discuss the next steps to be taken. Some items came across very clearly. One of them was that our soil survey reports have got to be more a document of the soil resource and what is known about the soil resources of the individual survey area. Our “literature cited” section has to be expanded to a bibliography. We have to tell people about the National Cooperative Soil Survey. We have to tell them about other sources of data, especially point data. We have to tell them about our computer systems, about **SOILS-5's,** the soil survey investigation reports, the experiment station publications and this kind of thing. A complaint that we have bad repeatedly from our friends in USGS is that we have all this information and we bury it in our files. We need, again, a technical document that explains to people how we map.

Our technical users have to understand that the soil scientist maps by projecting what be knows about tbe relationships between landscape and soil. Tbey, particularly engineers, have to understand tbat our “estimates of soil properties” for a taxonomic unit are better numbers than the “bard data” for a few pedons. Engineers map by projecting from many sample units that are a more or less statistical sample of the landscape; the soil scientist projects a model and his sample sites are quite likely to be the places where the validity of the model is suspect. This is the approach the mapper uses in selecting sites for **augering;** it is also quite commonly the approach for selecting the **taxon** that is to be sampled for laboratory characterization. I believe that very few people outside our faternity understand this.

Many of our users called for more information about the properties of materials that underlie the soil. We have been reluctant to do this **in** our publication because we had been accused of exceeding the limits of our professional competence and because we wanted to maintain the conceptual priority of soil surveys. I believe we should become more flexible. There are some map units where we can speak with authority about likely proporties of underlying materials, and we should. There are others where we cannot and we should say so. It bothers me, however, if we have apparent inconsistencies in our maps and we do not explain them for our users. In our reports we must explain, for example, why certain arbitrary, if necessary, conventions cause us to map Quartzipsamments in association with gross arenic Palendults. If we do not, we lose credibility. This ought to be taken up by a committee for the next vork-planning conference.

I am uneasy about making interpretations on toxic waste material which again, may exceed our competence. Groundwater movement and all kinds of things that are outside our competence become very important. Yet, we need to make more of an effort to lead people to data on cation exchange capacity and other information we have that will help them to make the appropriate judgments. We certainly know so much more than we tell people in our reports, and that knowledge should get to people who could use it.

We have a very strong call from people outside the agricultural community for a standard scale of 1:24,000 and I guess implicitly a cartographically correct map base. Now, our soil conservationists in many parts of the country feel very strongly that they need a larger scale than 1:24,000. At this point I do not know which direction we should move on this question. Do 1 have any comments on this? Should we set up a committee on it again?

To summarize the high points, better soil survey publications, better means for distributing technical information that is not in soil survey reports; reexamine our policies on reporting on materials below the soil and reexamine our policies on mapping scale.

Dr. McCracken raised the question of a soil survey interpretation manual. I am not sure whether this should be a manual or a chapter on soil survey interpretation in the Soil Survey Manual. My preference would be for the Soil Survey Manual. But again, if there are strong opinions in other directions, please let us know. Some people, Dr. Swindale for example, is very impressed with the draft of the chapter that we have for the Manual. He says, get it out. As a matter of fact he has distributed xeroxed copies widely in developing countries. Certainly, internationally very much needs to be done in the general area of the soil survey interpretations.

Operating procedures for the National Cooperative Soil Survey:

We had a very lively session yesterday morning on regional **comments.** Directly or indirectly we were told all the things that we did wrong or did not do quite right or should do differently, and I very **much** enjoyed this. I am not particularly masochistic but we need this kind of feedback. In SCS, under Hr. Berg's direction, we have a very open process of policy making and we spend considerable time in meetings of the top staff where people are being heard and where a very honest attempt is being made to come up with equitable solutions. In order to speak there with conviction we need the feedback from you. We need to know what works, **what** does not work, **what** needs to be done, and what needs to be changed. So please keep this line of communication open. Call us, write to us. We appreciate most any comment we get from you in the field. The purpose of us here is to help you. This seems like an awfully trite phrase. Perhaps we need to be reminded periodically to live up to it. You brought up many problems: among others, travel and personnel ceilings. Let us talk about overhead. SCS as an organization concerned about overhead. We are reminded of Parkinson's law. Parkinson's example was the British navy which doubled it's administrative overhead when the size of the fleet was cut in half. We had somewhat a similar tendency in SCS. We have less total staff but we have more total people in the State offices and in the National Office. These kind of things are of concern especially as they are being recognized by our traditional supports. You know the situation on travel. Every once in a **while** there are headlines in the paper indicating that half the airline seats to Denver are occupied by civil servants; presumably on unnecessary pleasure trips. Travel ceilings are certainly going to stay with us. The major concerns in the session yesterday, dealt with problems of quality control in a time of limitations on staffing and travel. The only suggestions I have are to strengthen the role of the nonfederal cooperators in quality control and to be very careful in our priority setting. For the **TSC's,** this means responding to a larger extent to specific requests for assistance and to deemphasize routine coverage of field reviews and correlations. One thing the **TSC's** can do is to review carefully the memorandums of understanding for each soil survey. These come for review to the **TSC's.** You may have to go back to the States and tell them that what they propose is more than we can do with the available resources.

The session on training and the ideas on level 1-5 technical training looked very good to me. These concepts are ready to be implemented. I would suggest that Hr. Hinkley be given the charge to implement this part of the recommendations. We discussed possibilities of the training of students in field work, particularly mapping. A summer camp as part of requirements for the BS degree was mentioned. I wonder whether we can have a recommendation as to how we can implement something like this. I am addressing the experiment stations' professors. What can and should be done? Now about the role of the Soil Science Society? Dr. Arnold, would you take the lead on following up on this?

Completion of soil mapping "once-over".

There was quite a bit of concern about soil survey completion; the kind of language that implies that the soil survey can be completed. I would like to make a few comments and I may have a few suggestions. We are under great pressure to get national coverage of soil maps. We have gone through the RCA process and it is quite possible that some kind of an incentive program will become part of the RCA implementation. Farmers that have eroding soils will get some kind of help. This requires that we can identify the farms and the fields that are requiring assistance. For that we need soil surveys. The Agriculutural Stabilization and Conservation Service (ASCS) just completed a study on their program. They concluded that much of the financial assistance through ACP went to land that really did not need it. Hence, there is a great pressure for national soil map coverage and I expect that this pressure will increase rather than decrease--a matter of sematics. We should be very careful talking about once-over mapping, or perhaps better, the once-over completion of the mapping phase of the soil survey. Somehow we have to get across the point that mapping is not identical with soil survey. We should improve our reporting system. We are reporting acres mapped which is a very convenient measure.

In a bureaucracy there is a tendency to measure success, be it for a party leader, an area conservationist, a State Conservationist, or even Director of Soils, in terms of the one thing that is being reported. This is similar to counting published papers as a measure of success in the academic community. Somehow, we have to come up with a more equitable measure that emphasizes equally all components of soil surveys. Again, we would appreciate having suggestions.

Another issue is what to do in States that are approaching completion of the mapping phase of the soil survey. We need long-range plans for post-mapping activities that become triggered a couple of years before the completion of mapping or in an administrative area or a State. I would suggest, Hr. Hinkley, that we get out a draft for consideration of the regional conferences next year.

We talked about communications both up and down. We have the suggestion of a NCSS newsletter. This is something that we would like to promote. But this is yet another job. We would have to find someone to write and edit the newsletter and this would mean to stop doing something else. In any case Hr. Hinkley should explore this matter and report back to the coference. The last point that I would like bring up is strengthening the National Cooperative Soil Survey as a truly cooperative venture. Dr. McCracken and Dr. Arnold have addressed this point before. This would mean for SCS as the lead agency to relinquish some authority to the experiment stations and especially the other cooperators to take on more responsibility for the soil survey program. It has been my observation that the best State soil survey programs are the ones where we have the greatest input and the greatest contribution by the experiment stations' representatives.

Soil Resource Informations System: We had a series of very interesting sessions on information systems yesterday. Obviously the sky is the limit, all we need is money. Finally, after years of struggle, we have succeeded in setting up an Integrated Resources Information Systems staff here in SCS. I wonder, as an action item, whether this conference should have a standing committee on resource information systems? And should there be a newsletter. There was concern about insufficient communications. Colorado may be doing something that is very similar to what Pennsylvania is doing; both could save resources and get ideas if they cooperated. I suggest that we set up a standing committee of this conference and either incorporate information systems as a major item in a NCSS newsletter, or establish a committee newsletter to improve communications. This committee should establish communications with the vorking group of International Soil Science Society. In general, we have not been overly active in this working group. The Canadians have made systematic efforts towards the establishment of a soil information system much longer than we have. Communications with the Canadians would seem to he a very important part this effort.

Looking back over my notes I discovered one item I missed in relation to communications. During the last few years we have had evening sessions of Division 5 at the annual meetings of the Soil Science Society. These sessions should be made a formal feature of annual meetings, as a means primarily of communications between the Federal establishment and experiment stations. Dr. Arnold, as chairman of this conference, please pass this on to the chairman of Division 5 of SSSA.

This completes my impressions and summary of the Conference. I am now turning the meeting back to Dr. Arnold for his concluding remarks. Thank you for listening.

WELCOME BY DR. McCRACKEN

14 Points Stressed

1. Better Working Relationships
2. Updating Soil Taxonomy
3. National Soil Survey Manual
4. National Soil Interpretations Manual
5. National Soils Handbook
6. Better Interpretation Tables
7. Thematic Maps
8. New Technology for Soil Scientists

   Better imagery, ground penetrating radar, transects, spacial variability, and digitizing maps

9. Outgoing - Work With Other Disciplines
10. Improvements in Laboratory Technology

    What are we measuring and do we need it.

11. Work With Modelers
12. Renewal of Soil Geography
13. After Once-Over--What Then?
14. Education and Training.

National Technical Work-Planning Conference
of the Cooperative Soil Survey

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Washington, D. C.

Report of Committee Number 3 - Surface Horizon Characteristics Under Different Conditions

The physical properties of the surface horizon of soils are dynamic, particularly under tilled conditions. Because of tillage and vehicular traffic, and weathering. changes in physical properties occur almost daily. In addition, the physical properties of surface horizons usually have large spacial variability.

Because of time and spacial variability, it is desirable to characterize these horizons on key soils with measurements carefully timed. Physical characteristics at other times and for other locations can be estimated with suitable models.

Recommendations are:

1) Bulk Density

a) A packing model for estimation of minimum, equilibrium, and maximum bulk densities needs further development and checking for use on a Major Land Resource Area basis.

b) A compression model for estimating bulk density where applied forces are known (tractor wheel pressures) needs application on a Major Land Resource Area.

c) The excavation procedure (developed by Grossman) for measuring bulk density in loose cultivated soils is recommended.

d) A regression equation which considers particle size distribution, organic matter. and calcium carbonate can be used to estimate "average" bulk densities.

2) Soil Water

a) The water content of a soil at a specific matrix potential can be estimated from a regression equation which consider6 sand, silt. and clay content; organic matter content; and bulk density. The coefficient6 for the regression need development on a Major Land Resource Area basis.

b) In estimating water intake into surface horizons, four parameters are particularly important. They are: surface roughness, residue cover, susceptibility ro sealing, and cracking.

(1) Surface roughness can be measured with a pinboard device, or estimated by comparison with pictures of known roughness. Grossman has developed a simplified pinboard technique.

(2) Percent surface cover can be measured by a line transect method or computed from weight measurements.

(3) Slaking (or sealing) can best be estimated in the field. We suggest slaked, partly slaked, or unslaked.

(4) We suggest Grossman's method for measuring and expressing surface connected cracks.

3) Soil Temperature

We suggest that the reflection coefficient of a wide range of soils be related to the Munsell color in both the wet and dry state. The reflection coefficient can then be used for soil temperature modeling.

4) Annual Use Sequence

Notation of the annual use sequence as proposed by Grossman is recommended so that models requiring input such as crop, rotation, and tillage practice can be used.

COMMITTEE 5: CONFIDENCE LIMITS FOR SOIL SURVEY INFORMATION

COMMITTEE MEMBERSHIP .

Co-Chairmen: L. P. Wilding and F. P. Miller

- Dr. R. W. Arnold
- Mr. William J. Edmunds
- Hr. Frederick E. Gilbert
- Dr. R. L. Handy
- Dr. B. L. Harris
- Ms. Heleanine Harkowick
- Dr. E. M. Rutledge
- Mr. Charles Thompson
- Dr. Goro Uehara
- Mr. E. E. Voss

SHORT-RANGE SUBCOMMITTEE

Chairman: Dr. F. P. Miller, University of Maryland

- Dr. B. L. Harris, Texas A & M University
- Mr. R. L. Shields, State Soil Scientist, Nd-Del, SCS,Retired
- Dr. M. J. Singer, University of California, Davis
- Mr. C. M. Thompson, State Soil Scientiest, Texas,SCS
- Dr. L. P. Wilding, Texas A & M University

LONG-RANGE SUBCOMMITTEE

Chairman: Dr. R. W. Arnold, SCS, Washington, D.C.

- Dr. R. Cline, U. S. Forest Service, Montana
- Dr. J. P. Campbell, VPI, Blacksburg, VA
- Dr. W. J. Edmunds, VPI. Blacksburg, VA
- Ms. H. Markowlck, USGS, Reston, VA
- Dr. L. Nelson. North Carolina State University
- Dr. W. M. Schafer. Montana State University

COMMITTEE 5: CONFIDENCE LIMITS FOR SOIL SURVEY INFORMATION

At the 1979 National Technical Work Planning Conference of the National Cooperative Soil Survey, it was recommended that this committee be subdivided into two subcommittees; one to deal with long-range objectives and the second to address short-range objectives. This recommendation and the long - and short-range charges are reproduced in Appendix I.

SHORT RANGE OBJECTIVES

In essence, the basic short-range objectives of this subcommittee are to develop ways to describe and communicate more effectively within soil surveys the variability of soil properties and map units and the confidence limits of the soil survey itself.

A BASIC QUESTION

In surveying the subcommittee members for a consensus on our charges, a basic question was raised that needed to be addressed. This question was: Should the soil survey report be 1) a technical document; 2) a general soil report designed for layman's use, or 3) an expanded document designed to serve both needs?

There were arguments for each of these options submitted by members of the committee. More often than not, the committee felt that the current format needed "jazzing up" by including more diagrams, figures, interpretive maps, and better narrative explanations for the soil survey users. There was also a general expression that there should be an introductory section explaining the scientific premise on which the soil survey is based and how variability is accommodated and what the confidence limits of the soil survey are.

Several committee members argued for the need to incorporate more data into the report rather than generalizing or watering down what is currently published. A strong plea was made to define more precisely the map unit descriptions and, where possible, indicate approximations of their composition, although there was not unanimous agreement on this point.

POINTS OF CONSENSUS

In responding to the aforementioned basic question, the following points were made and agreed to by a majority of the committee members:

1. The soil survey is and should be a technical document containing as much information as we know about the area or that can be feasibly accommodated in a single report.

2. The soil survey format should be expanded to accommodate more interpretive maps, graphs, figures, diagrams, photographs, and narrative material to aid the user in understanding the soil survey as well as the particular interpretations he or she is after.

3. The sections on "How the Soil Survey was Made" and how to use the engineering sections and behavioral interpretations should be rewritten or amended to explain the premise on which soil surveys and/or their interpretations are based and the confidence limits of the information and interpretation.

4. Consideration should be given a supplemental publication that would be designed for the laymen that would provide an Illustrated narrative on how soil surveys are made, their scientific basis, the recognition of variability, and an explanation of the of the confidence limits and bounds of the information. Such a publication might be patterned after the USGS Professional Paper No, 950 which is an excellent color bulletin on the use of geologic Information containing exploded block diagrams, cross sections, pictures, and tabular data for the layman.

SHORT-RANGE RECOMMENDATIONS

Charge 1. Model Draft of Confidence Statement:

Model statements of confidence limits will depend, in large part, on the type and amount of data obtained to assess taxonomic composition of map units and soil property variation.

a. Statements on the confidence limits of map unit composition should be included where possible. Data are relatively easy to obtain and are often available for many surveys, especially those currently in progress, A suggested statement of probability or confidence limit might be expressed thusly:

> "In 90 percent or more of the units mapped as Soil 'A', Soil 'A' makes up 60 to 80 percent of the map unit. The remaining 40 to 20 percent of the map unit is made up of small areas of Soil 'B' intermingled with Soil 'A' and areas of Soil 'C' along small drains which dissect some map units."

b. Where detailed or even sparse field data on map unit composition and property variation are lacking, the soil scientist can convey such information to the soil survey user in 1) a subjective manner in a narrative section of the report, and 2) by more detailed map unit descriptions. This should be the minimum standard for all soil surveys, regardless of scale and order.

Charge 2. Narrative Section on Soil Survey Objectives, Statistical Validity and Soil Property Variability.

Appendix No. II (HOW THIS SURVEY WAS MADE AND IT'S STATISTICAL VALIDITY) is a suggested narrative section that could be adapted to all soil survey reports.

Appendix III contains an example of a supplemental narrative statement developed for regulatory agencies using soil surveys as a tool in Maryland.

Where transects and other field investigations of map unit composition and soil property variation have been done, examples or excerpts from research reports, thesis, and published papers should be included in the soil survey report.' Often, the detail and length of such studies and reports preclude their incorporation into a soil survey report. Nevertheless, the soil scientist is obligated to relay the conclusions of such studies in a succinct manner within the soil survey report - selecting sample data and/or summary material for inclusion in the soil survey report. Editorial policy should encourage the inclusion of such information. Such information can and should be incorporated into map unit descriptions where appropriate and a narrative section identifying this subject.

Charge 3. Map Unit Description of Composition:

Many soil survey users require more detailed map unit information than is portrayed in the general and abbreviated descriptions now published. The committee recommends that map unit descriptions be given more emphasis in the report with respect to being more specific and quantitative.

There are various transect techniques that quantitatively provide at least estimates of map unit composition and soil property variation. Confidence levels can be determined with many of these techniques. It would be helpful to some soil survey users to include an example of actual data obtained from such transects so that the standard deviation, sample numbers and other statistical parameters are available for discussion. Confidence statements, such as that in Charge 1.a could then be synthesized from the data.

Data can be presented in a variety of formats. At least six methods of conveying variability of soils and soil interpretations have been identified:

Methods	Examples
1. Tabular	Paper by Lietzke, D. A., R. S. Weber, and D. F. Amos. Use'of. mapping unit variability as a criterion in making interpretations. Proc. So. Regional Work Planning Conf. of the Soil Survey Okla, City, Okla., March 20, 1980.

Methods	Examples
2. Narrative	Description of single and multi-taxa units using appropriate statistical Information,
3. Cross-Sections	Conventional hand drawn
4. Block Diagrams	Computer net In 3 dimensions
5. Photographs	Pictures of variability In a particular series.
6. Graphic Displays	Scattergrams histograms, schematic illustrations.

Appendix IV contains examples of several of these formats.

For some soil properties and other types of data, confidence statements are not easily developed, Tabular or graphic presentations may be necessary. For example, hydraulic conductivity data are usually an extremely variable soil property, Regression analysis of such data lends Itself to the construction of prediction intervals with specific confidence limits. Such data generated by an Experiment Station could be Incorporated In one or two small graphs with limited narrative description. Figure 4 In Appendix IV from Baker (Water Resources Research, Vol. 15(1):103-108, 1978) is an example of a graphic display of a prediction Interval for hydraulic conductivity (k) of the Piano series In Wisconsin.

NOTE: The variety of statistical parameters and techniques used to express variability, confidence limits, and other measures of natural scatter are beyond the training and background of most field soil scientists. Therefore, it Is necessary for those scientists trained and experienced in statistical methods to aid field soil scientists and soil survey report. writers In Incorporating varience and probability statements Into the soil survey reports where appropriate, And the editorial policy should be flexible enough to accommodate such contributions.

Charge 4. Generalized Aspects of Soil Water Movement:

One of the most Important elements in soil behavior and land use constraints. as well as one of the least understood, is water disposition within and on the soil medium.

A section within the soil survey should be devoted to the components of the hydrologic cycle within the survey area. Total precipitation, potential CT, and annual runoff should be discussed in general terms as a moisture budget. The modifications to the budget, such as land use (e.g. vegetative cover and duration), slope, map unit, etc. should be discussed. A schematic diagram illustrating the magnitude of the water pathway vectors should be incorporated as a model for discussion. Downslope water movement must be portrayed in its components of both surface and subsurface flow.

The dynamic aspects of water table fluctuations should be discussed. (See example, Appendix III). Graphic displays of water table measurements in the survey area should be included in the report where appropriate.

Charge 5. Soil-Geology-Hydrology Relationships:

Each soil survey report should have several generalized cross-sections or a block diagram of the major geologic features, showing their relationship to geomorphology and soils. This effort should be the responsibility of the state SCS geologist. The U.S.G.S. Professional Paper 950 provides excellent examples of such illustrations.

Charge 6. Crop Yield and Climatic Data:

The State Soil Scientist should seek the cooperation of the State Agricultural Experiment Station Director And/or Extension Service Director so that the latter could appoint a staff member (either the Experiment Station Soil Survey Representative or Soil Management Specialist) to coordinate yield and climatic data acquisition. Extension agents, ESCS and ASCS personnel, Crop Reporting Service personnel, thesis research and other sources should be consulted for data and information.

GENERAL RECOMMENDATION:

The variety of conditions and different levels of data acquisition in each state and area preclude the possibility of drafting model narrative sections for each topic addressed in the charges to the committee. Each survey is unique and should reflect the state of knowledge at the time of its development,

To carry this philosophy even further, the committee favors more local input and originality in soil survey reports while maintaining most, if not all, of the current “standardized” data, This recommendation stems from the concern over the "standarized format” of the narrative section of the survey report, This policy results in survey reports of the same length, format, style, and writing level. This situation is further entrenched by the use of computerized sections which are merely a "fill in the blanks" approach to writing. The committee suggests that, not only should more originality be accommodated, but different sections of the survey report could be written for different audiences.

To address the general condition and provide the layman and general soil survey user with conceptual information and interpretive guidance, including confidence limits and degrees of variability, this subcommittee recommends the development of a general soil bulletin to supplement the soil survey nation-wide, This publication should be patterned in part after the U.S.G.S. Professional Paper 950, 1978. Many of the concepts and subject areas identified in the short-range charges could be discussed in this medium, allowing only specific points and data to be used in soil surveys themselves,

LONG RANGE OBJECTIVES

The subcommittee on long-range objectives has no report at this time.

COMMITTEE 5 RECOMMENDATION

It is recommended that this committee be continued.

NATIONAL TECHNICAL WORK-PLANNING CONFERENCE
OF THE COOPERATIVE SOIL SURVEY

April 6-10, 1981

Report of Committee - Water Supplying Capacity Of Soils for Different Plants

Charge

Th. amount of water available to plants depends on climatic factor., physiographic position, and waterholding capacity of soil including th. effective depth of storage. What data are available and what are needed to better evaluate water storage and supply capacity of soils.

MEMBERSHIP

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P. I.. M. Veneman	University of Massachusetts
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I I. B. Grossman, Chairman	SCS, Lincoln, NE
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INTRODUCTION

We think that resolution of the charge requires establishment of national guidelines for recording water-related information. Therefore, th. charge was addressed by designing a water-related information record Lo supplement and extend soil series and soil phase documentation. The record is technical and is not directly useable by our general public. It contains information for soil behavior prediction but does not supply interpretations. Parts may b. directly applicable to nonpoint hydrologic models. The portions that document field experience could b. incorporated into state and regional soil survey quality control.

The report consists of . commentary, . single recommendation, an explanation of rh. record, and examples of records. Large blank worksheets sr. available from the chairman for rho.. who would lik. to try th. record format.

The assistance of J. A. Thompson in assembling the water balance diagrams is very much appreciated.

COMMENTARY

Annual Use Sequences

Subdivision of th. soil phase is necessary to identify usefully information about the pattern of water states, plant available water, and infiltration rate. The record format therefore separates information about the series and phase from that which pertains to subdivisions of phases referred to . annual us. sequences, based on plants, tillage practice and position in ch. rotation. (See Item 6 of format explanation.)

Adoption of th. annual us. sequence concept in th. NCSS would provide a category for ordering information with . potential for cl..... very similar to tho.. employed by the Service and other agencies that plan and install conservation practices on sm.11 parcels of land. Water-related information for th. annual use sequence would have nearly direct application to aspects of conservation planning as well as to yield prediction and would b. applicable to th. hydrology portion of models such as CREAMS designed to . ssist in conservation planning.

Curve Number and Runoff

The proposed record format (Item 8) links th. Curve Number and th. runoff class to th. monthly pattern of soil water states (monthly assessments whether dry, moist. wet, frozen for standard depths). The Curve Number is the proportion of the total daily rainfall that occurs as runoff. Tabled values are given for combinations of soil hydrologic group, the soil surface condition including canopy, and the antecedent moisture condition. Curve Numbers are widely used for conservation planning and are used in the CREAMS nonpoint pollution model. Making th. Curve Number dependent on the monthly water state would closely interrelate soil survey information with engineering design. Such linking would require changes in current practices. On. change is that th. hydrologic group would not b. constant for soil' that are wet seasonally; rather, the hydrologic group would be assigned monthly and be dependent on the depth to fr.. water. Another change is that occurrence of a frozen state at shallow depth would become . necessary soil survey observation because of Its importance in determining Lb' Curve Number.

The current runoff concept may require re-evaluation and perhaps it should b. dro9p.d. Runoff is not commonly used; instead, the Curve Number is employed. Another weakness is that runoff class placement cannot be evaluated on the basis of the qualitative definitions in Soil Survey Staff (1975). Finally, there is an inherent difference between the runoff concept and the Curve Number. It rests on th. fact that peak rates for short time periods are slope dependent, whereas daily rates are only weakly dependent on slop.. Runoff class placement is 'lop, dependent, whereas Curve Number is not. Hence, by inference, tb. runoff concept apparently pertains to peak rates for short time durations rather than th. daily rates to which the Curve Number refers.

"by are th.'. considerations *of* runoff snd Curve Number important to the charge of th. committee? The answer is that shortly we likely will b. calculating soil water state using hydrologic models that estimate the proportion of tb. precipitation that do.' not infiltrate. Our present soil taxonomy model does not consider runoff. We have th. potential to "s. more soil survey information for the estimation of the amount of water that runs off than is current practice.

Plant-Available Water

Rooting depths and laboratory water retention values have been combined to calculate what are called water retention difference sums (see Item 7 of explanation). The calculation rests on dividing the range of energetically available water at 200 kPa (2 bar) and on the assumption that only . portion of rhs water retained at tension below 1500 kPa (15 bar) is available within the zone of few roots, whereas for Lb. zone of common (or many) roots all *of* th. water retained is available. In turn, the proportion *of* th. water that is available in the ro". *of* few roots depends on soil 9r09.rti.s that control how easily roots in that zone can grow towards water. The specifics of tb. calculation are not very important; they undoubtedly would change. Rather, what seems important in . management sense is that '"ch conversions require root depth generalizations which we lack . program to obtain.

The CREAMS Hydrologic Model[a]/

A format for water-related information should both provide information for and receive inputs from . major hydrologic model. CREAMS[a]/ seems an appropriate model. It has had . broad base of development with input by . large number of SEA-AR scientists and is receiving much attention within the Service as a vehicle for conservation planning. Internal water state is evaluated on . running basis using leaf 'I.. index, radiant energy and assumptions 'bout evaporation *from* bare ground . . well as water retention characteristics. The water state is then used to adjust the Curve Number. Estimates of runoff and percolation ST' obtained.

The proposed water *information forma:* right provide the following input for CREAMS:

A.) Curve numbers for periods outside the growing season when rh. soil may bs frozen and/or depth to fr.' water is shallow. These are the periods when the antecedent water condition is less well calculated by the current model. Also, default Curve Numbers could b. su9pli.d where calculation by the mod.1 is not desirable.

B) Root-depth information and tbs depth pattern of maximum water removal by plants.

C) Estimates of maximum water retention (satiation) and of water retention at several tensions.

D) Compilation of infiltration rate and hydraulic conductivity data.

E) Measured and estimated patterns of water state against which patterns calculated by the mod.1 *could* be ca.9.r.d.

Output from CREAMS might be used *for* calculation *of* the taxonomic water regime statement and water balance diagrams and to describe portions of rhs monthly 9.tt.m of water states for standard depths.

RECOMMENDATION

The Problem: The proposed water information record format involves these departures from *current soil survey* documentation:

A.) Definition of . category below the ph... that incorporates plant, cultural practice, etc.

B) *Incorporation* of *root depths into evaluation* of *available water and* the *generation* of *additional water* retention points.

[a]/Knisel, W. G. ed. 1980 CREAMS: A Field-scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems USDA Cons. Rept. 26.

C) Assembly of water movement information for surface and near surface.

D) A more detailed description of the yearly pattern of water states beyond what is currently proposed.

E) Association of Curve Numbers with the monthly water state and a redefinition of Hydrologic Groups.

Departure A is a major change which has the potential of providing direct soil survey input into conservation planning on the field scale. Departure B requires action nationally to obtain root depth records. Departure E would result in appreciable change in current Curve Numbers.

Relatedly, the record format is far from settled. We probably should shortly explore how to design a format to service CREAMS and how to incorporate its output. But more generally, the format proposed is only to make concrete certain ideas which otherwise could not be explored. Not only the format but these ideas require consideration.

With these considerations in mind, it would seem that simple acceptance or nonacceptance of the format is probably inappropriate which leads to the recommendation that follows.

RECOMMENDATION:

Establish a small group of people, advisory to the National Office, to explore the proposed water information format with emphasis on 1) the features that would require appreciable changes in soil survey practice and 2) on integration of the format with CREAMS.

IMPLEMENTATION:

The advisory group might include representatives from the four regional soils staffs, the chairman of the current committee, a National Office staff member, and one or more University people active in soil water work. If the present committee and its charge is continued for the next conference, integration with CREAMS probably should be a major activity.

Explanation of "Soil Survey Water-Related Information"

The record consists of NO or more pages. Items 2 and 3 on the first page pertain to the series and Item 4 to both series and a phase or ph"... The second and/or additional pages pertain to plant-soil us. concepts, referred to as annual use sequences. The initial entry under each item is referred to as Entry A. Updates till become a, C, etc.

ITEM 1

The number of records refers to the additional sheets beyond the series sheet as of the date indicated.

ITEM 2

The graph is for , station near the center of occurrence of the soil series. The discussion to follow is from . paper in publication by J. A. Thompson, et al., entitled "Computer Program for Obtaining Diagrams of Climatic Data and Soil and Water Balance."

The diagrams are obtained with a computer and a Calcomp plotter using the Fortran program CLIPLOT (available from the National Soil Survey Laboratory).

These diagrams give . simplified graphic picture of the soil moisture regime of ● whole soil. They are based on average monthly values from long-term records for precipitation and temperature. The diagrams include potential evapotranspiration (PE) calculated from air temperature and from the available water capacity WC).

PE is calculated according to the Thornthwaite formulation and is adjusted for yearly temperature regime and day-length. Available water capacity is taken as the water retention difference to 2 meters or to the first impervious layer, whichever is shallower. An approximation may be obtained from the AWC for the correlated soil series. Utilization is defined as the PE needed to remove water retained in the soil at a tension of less than [illegible] kPa. Deficit is the PE occurring while the soil is at or below 1500 kPa moisture. The calendar date when deficit begins is given.

Recharge begins when precipitation exceeds PE and continues until the available water capacity is filled or PE again exceeds precipitation. Surplus exists when precipitation satisfies available water capacity and continues to exceed PE. The period of surplus can be interpreted as the time when runoff from the soil is most likely, or for pervious soils, through-flow is the greatest.

Equal area projection is used to determine the location of vertical lines separating utilization from deficit in the diagram area UD or recharge from surplus in the diagram area RS. your conditions are tested: 1. if AWC and RS exceed UD; 2, if AWC and UD exceed RS; 3, if RS and UD exceed AWC; or 4, if none of these conditions exist.

ITEM 3

The table gives the calculated soil moisture regime for the taxonomic moisture control section based on monthly precipitation and PE normals. The climate station I. near the center of occurrence of the soil series. The calculation scheme was developed by Franklin Newhall (retired), climatologist, Soil Conservation Service. The table may be obtained at either the Washington Computer Center or at the University of Nebraska, Lincoln. The computer program, MREG, for this purpose addresses . tape file of climate data with one control card.

The explanation to follow is taken from an unpublished paper by Newhall, "Calculations Of Soil Moisture Regimes from the Climatic Record":

The soil moisture profile: Extends from the surface down to . depth such that the available water capacity (AWC) between the surface and that depth is 200 mm.

The soil moisture control section (MCS): The upper boundary is the lowermost depth that dry (tension >1500 kPa but not air dry) soil till be brought to field capacity by 25 mm of water. The lower boundary is the depth to which the available water capacity of ● soil is filled by 75 mm of water moving downward from the surface.

Movement of moisture into the soil: The model assumes that moisture enters the soil from the top and fill each increment of soil to field capacity before entering the next increment. When the wetting front reaches the bottom of the soil moisture profile, excess ☐ oi'tut. is . ssumed to be lost by deep percolation or by runoff.

Movement of moisture out of the soil: Except for excess moisture, removal is only by evapotranspiration. It is assumed that in the early phases of the depletion process, one unit of Pi removes one unit of moisture. In later ph..,., one unit of PE removes less than one unit of moisture; less and less is removed . less and less water remains in the soil moisture profile.

Climatological factors: These are the year-by-year record of monthly total precipitation (MP) and of the normal monthly potential evapotranspiration (PE). Monthly precipitation, MP, is . ssumed to be distributed within the month according to the following rules: a) one-half of MP, called "HP," (for "heavy precipitation") occurs during the principal storm of that particular month. ml. moisture is assumed to enter the soil instantaneously at the middle of the month and to be added. without lo". to any moisture already in the soil except when AWC is xceeded. mi. moisture is dissipated at a rate proportional to the available water in the soil; b) the other half of MP, called "LP," (for "light precipitation") occur. in several light falls and is dissipated at the full rate of PE for this month. None of the light precipitation enters the soil except when LP is greater than potential evapotranspiration and AWC is not exceeded. The amount actually that enters the soil, or, if LP <PE, is lost from the soil, is called net moisture activity (NMA).

The second climatological factor, potential evapotranspiration, PE, is estimated from Thornthwaite's formula. Where available, the published monthly average PE values are used. For other stations, long-term averages are calculated. PE is assumed to be distributed uniformly over all days of the month. The PE available to remove moisture from the soil moisture profile is reduced by the PE required to dissipate LP.

<u>The Soil Moisture Diagram</u>. The conceptual diagram used in the computer mod.1 consists of 200 individual 1 mm increments of th. . . sumed available water capacity of 200 mm. Each of the.. increments or layers is divided into 200 segments to cover the range from 1500 kPa retention to field capacity. These segments, each 1/200 of 1 mm, are the units that are manipulated by the computer. During accretion, moisture is added first to fill the top increment from left to right and then to fill successively lower increments. By convention, the lowest increment to undergo accretion during the HP or LP event is filled completely at the end of the event.

The model for depletion is quite different. It is assumed that more energy or more units of potential evapotranspiration are needed to remove moisture as the soil dries and . the drying layer occurs deeper in the soil. This concept is applied in the calculation through the . sumption that along any diagonal (referred to as . "slant") of the soil moisture diagram, moisture I. . ssumed to be removed with equal ease. It is assumed that for the first few slants, one unit of potential evapotranspiration removes one segment of moisture and that for subsequent slants progressively more unit' of potential evapotransporation are needed to remove one unit of moisture until in the driest condition and fat the last increments of the diagram as many as five units of PE are needed to remove one unit of moisture.

ITEM 4

<u>Column A</u>

These are the depth limit' on the 'oil property table of the S-5 form with subdivisions within these depths. Depths for analyzed pedons may be adjusted to depths determined by the S-5 form.

<u>Column B</u>

This is the lower water content limit of the <u>wet</u> water state C1." (Item 8). It is not commonly run in the laboratory. Measurements can be made in the field with tensiometers. We use approximations made by adding to the measured retention at 33 or 10 kPa an amount of water equal to. portion of the calculated air-filled porosity for that tension:

	Portion of Air-filled Porosity	
<u>Particle Size</u>[a/]	<u>33 kPa</u>	<u>10 k?.</u>
Smdy. Coarse-loamy[b/]	0.50	0.05
Other	0.40	0.35

The value calculated for the measured 10 kPa retention is used if available.

[a/] >2 mm excluded; otherwise family particle sir. rules apply.

[b/] Air-filled porosity must ● rc..d 2:. Within this restriction, add 3 volume percent units of water.

Column B my be useful as an estimate of maximum water holding capacity. The difference between cols. B and F may be used . the maximum water retention energetically available to plants.

<u>Column. C through G</u>

These entries are based on laboratory determinations. Retention at 33 kPa may be available but not at 10 kPa. A rough estimate of the retention at 10 kPa may be obtained by adding one-fourth of the calculated air-filled porosity at 33 kPa to the retention at 33 kPa. Retention at 200 kPa is assumed to separate the water considered readily plant available in an energetic sense from that which is difficultly available. Most of the common field crops adapted to usually moist soil. or intergrades thereto do not undergo economically important stress if the tension is below 200 kPa in the major part of the depth of common or many roots. The separation at 200 kPa may h.". little application for plants adapted to the natural water regime of soil. drier than the intergrades to usually moist. Selection of 200 kPa was based on the *fact* that this is about the lowest tension at which retention measurements can be run on sieved samples thereby reducing the cost.

<u>Columns H and I</u>

Hydraulic Conductivity is recorded for the saturated condition and at 5 kPa tension. Both pertain to vertical inplace orientation. Vertical saturated hydraulic conductivity is the same as the permeability of the S-5 soil property table. The estimates on the S-5 property table are based on guidelines relating morphology and on measurements on cores 8 x 8 cm (O'Neil, 1952. SSSAP 10:312). Macroscopic features (structural planar voids, animal burrows, etc.) commonly determine the saturated hydraulic conductivity. These features usually are widely spaced. Hence, the specimen on which measurements usually are made may not contain representatively the controlling features. Resultingly, the reported values may be too low.

Unsaturated hydraulic conductivity commonly is measured for several tensions and so-called K-curves are obtained. The 5 kPa value was selected because many of the field determinations currently are by the instantaneous profile method and at appreciably lower tension than 5 kPa they may not yield data for shallow horizons. Similarly, some laboratory methods also fail at appreciably lower tensions. For many purposes, values at tensions near 1 kPa would be useful. In the future, cl.,,., of K curves may be specified.

Columns J-L

These are standard laboratory determinations. The >2 mm includes up to 25 cm diameter material.

Columns J and K permit conversion changing of volume percent water (Cols. B-G) to weight percentage on a <2 mm basis. Multiply by the quantity

$$\frac{1}{J-\frac{J \times K}{100}}$$

where the letters refer to column designations. Modifications are needed if the >2 mm contains appreciable water.

ITEM 5

This is reference information and explanation for Items 1-6. The positional order of the sequence numbers parallels the positional order of the entries under the Item part.

ITEM 6

Annual Use Sequences: These are January to January segments of the soil-use continuum that b'c."" of kind of plants or type of management including tillage practices are expected to have a pattern of water states and/or surface or near-surface water movement differing appreciably from other annual use sequences of the same soil ph.,.. The sequences selected should involve major plants and rotations. Actual sequences would be grouped if no useful purpose would be served by separation. Large physical differences in the tillage-affected zone, as well as water-related properties, would be differentiating criteria. But here the focus is on water.

Typifying Surveys: These are published soil surveys in which the annual use sequence under consideration is well exemplified.

ITEM 7

Part A

Major plants are listed for the annual use sequence in Item 6. It is suggested that index plants be established by Major Land Resource Area and applied to the various annual soil use sequences. Maximum depth of occurrence is assigned for the common and few abundance classes of fine and/or very fine roots. If the plants are annuals, the depths are for near physiological maturity. Depths under irrigation may be given. The cl."" follow rho,. in "Soil Taxonomy" (Soil Survey Staff, 1975. USDA Handbook 436). For future application, it is suggested we implement the suggestions of Harold Taylor presented in the 1979 report of this committee and reduce the abundance cl.,, limits for dicots relative to monocots. To the depth of few roots an increment is added to account for upward water movement to the lowermost roots. This adjustment is only made for soils that are usually very moist or wet below the depth of few roots. The depth increments to follow are determined by properties immediately below the lower boundary of few roots:

Depth Increment cm	Soil Properties
30	Coarse-silty (>2 mm excluded) or very fine sand; and very friable or friable.
0	≥35% clay, loose, or very firm or stronger
15	Other

Part B

These water retention sums use the root depth. in Part A and the water retention values of Item 4 with adjustments if necessary in the water retention for the tillage-affected zone . . given in Item 9. After adjustment for electrical conductivity (Col. L of Item 4 and Fox, 1957. Soil Sci. 83:449), these water retention sums may be employed as available water capacity estimates. The values for the adjusted base of few roots for 10-1500 kPa may be particularly useful . an ● .tlma* of available water capacity.

For depths to the base of co-n roots, the calculation is straight forward. The calculation is somewhat more complex for the zone from the surface to the adjusted lower limit of few roots. It is assumed that in the zone of few roots, mly part of the water retained between 10 and 1500 kPa is utilized. The rationale is that water movement at tensions above 10 kPa is slow and that utilization by plants depends importantly on root extension. Therefore, properties indicative of high soil strength and hence difficulty of root extension, would indicate . reduced utilization of water. Presumedly water in the 10-200 kPa range would move more readily to root. than that in the 200-1500 kPa range. Furthermore, it is assumed that . the proportion of the water held above 1500 kPa increases relative to the water in the 200-1500 kPa range that the average tension of the 200-1500 kPa water rises and movement to roots is slower. Guidelines follow based on th.'. generalizations for the percent of laboratory retention that is included. The soil property statements ● pplP to half or ☐ 01'(of the zone in question. The adjustments are only made if the annual use sequence is for annual plants or perennials that are not adapted to 'oil' drier than usually moist. For perennials adapted to soils drier than usually moist, the full 10 to 1500 kPa retention is employed.

Soil Properties	10-200 kPa	200-1500 kPa Ratio of Water Retained: 200-1500/1500 kPa ≥0.5	<0.5
	----------------------------	Pct ----------------------------	
Very friable or friable, and <35% clay; or, one of the following: strong granular of my size; strong fine blocky or subangular blocky, or strong very fine prismatic	50	70	50
Not above and >35% clay, or firm or stronger	50	30	10
Other	70	50	30

An attractive alternative is to obtain field-determined plant available water through direct measurement. Water content with depth is determined at or near physiological maturity for years where there has been strong water deficiency during the major part of the growing . eason following wetting to field capacity or above appreciably below the depth of water extraction. Water desorption measurements are made . deemed useful (commonly at least 1500 kPa retention). The 10 kPa water retention estimate is used as the upper limit. The volume percent differences between 10 kPa and the field-determined minimum values are reported for Ch. depth zones of Item 4. The depth of appreciable water extraction by roots is taken as where the water content exceeds the . an of the 10 and 200 kPa retention estimates from Item 4; or, if desorption data are unavailable or at variance with the field water measurements, it is the depth where over the underlying 50 cm there is little or no change in water content. Place the information on field-determined plant available water in . footnote. Finally, the method may be inappropriate in most years for 'oil' drier than ustic or xeric because wetting below the depth of rooting does not occur. In unusually wet years, however, it may be appropriate.

Part C

Infiltration Rate is the flux passing across the soil surface into the soil. The further restriction is made that the measurement employs . sprinkling infiltrometer. Infiltration decreases with time . . the soil wets. Hence, time in the wetting process must be specified and antecedent water content is also useful. Usually values for relatively wet conditions are given.

Intake Rate is . concept used to make recommendations on furrow irrigation (SCS Staff, National Engineering Handbook, section 15). It pertains to the CUM on . log-log scale of cumulative infiltration versus time. Values are obtained by furrow irrigation tests.

Hydraulic Conductivity i' discussed under Item 4. Surficial hydraulic conductivity pertains to the depth affected by tillage, tree harvest and the like, including compaction.

ITEM 8

Part A

This is an estimate by month of the annual water state ● equence. It pertains to the nonirrigated condition unless otherwise indicated. A 3 or 5 cl... set of water states is provided. The second row is used to indicate . frozen condition. The moisture cl... selected should describe the wetter 1/2 of the depth interval for one-half or more of the month. The water state cl..... and symbol. follow:

Class Name	Symbol	Tension kPa
Dry	D	>1500
Moist	M	1500-1
Slightly moist	MS	1500-200
Very moist	MV	200-1
Wet	W	<1
Satiated	WA	Free water present
Not satiated	WN	no free water
Frozen	F	

The wet cl... has been subdivided based on whether free water is present. The water content where free water first appears is referred to . satiation (Miller and Bresler, 1978. SSSAJ 41:1020). This water content is calculated in the same fashion as the values for the wet state (Col. B, Item 4) except the factors are increased by .05.

Flooding and Ponding (PND-FLD) follow definitions in the National Soil. Handbook. Entries are only made for average years. I! Ponded, . P is shown. I! flooded, a two-letter designation 1. used. The first letter is the frequency cl... and th. second, th. duration Cl....

The table may be used in several ways: 1) to record field experience gained in soil mapping and its quality control, 2) to abstract and generalize from specific measurement data sets, 3) to record specific data sets, and 4) . combination of 2) and 3). For u s. 3), it is suggested that the months b. deleted from the heading and the specific dates inserted. If feasible and in keeping with the kind of information, make generalizations for average (6 years in 10) conditions and for the 2 years in 10 most dry and most wet.

Part B

Rows have been allotted for monthly runoff cl... and for Curve Number (CN), It is suggested that more effort be put on Curve Number assignments than on runoff.

Either the runoff cl..... current in th. N.tim.l tolls Handbook or ● q.loy the cl..... to follow which of!.? the advantage of being more subject to verification. In either case, complete only for average and wet years.

The concept of runoff here involves the ratio of runoff to the total water received by the soil (rain and melted snow) exclusive of rainstorms that exceed the 10-year, l-hour intensity for the area (USDC Tech. paper LO or other publications).

Cl...	Water Received That Runs Off Pct	Guidelines
Very High (VH)	>80	Mainly steep soils with very low infiltration rates such . . wet swelling clays.
High (H)	50-80	Mainly moderately ● t*.* soils with low infiltration rates.
Moderate (M)	30-50	Gently sloping soils with ☐ 0d.r.t. infiltration rates, or steeper soils with high infiltration rates.
Slight (S)	10-30	Nearly level or very gently sloping soils, or steep soil. with very high infiltration rates.
Very Slight (VS)	<10	Level or nearly level ● ll#, or soils with extremely high infiltration rates.

Curve Numbers are the proportion of the total daily rainfall that occurs as runoff. The concept has been thoroughly developed by Service hydrologists for planning design of mechanical structures (for example, pond size versus watershed area). The concept of land unit is very similar to the annual use sequence (SCS Staff, National Engineering Handbook, section 4). Assignment of Curve Numbers should follow Service guidelines with certain modifications to account for the effects of a frozen condition or shallow depths to free water, as follows:

Assume Hydrologic Group D if water state WA above 50 cm, or if WA above 100 cm and Wet (WA or WN) above 50 cm. Otherwise, use the assigned Hydrologic Group.

For months that 0-25 cm is both Wet and Frozen and adjacent months 0-25 cm is Frozen, the CN is 98. If Frozen, but other conditions are not met, the CN is the higher two values: 96 or the CN based on considerations other than whether frozen or not. Do not consider the frozen state as a factor if the soil lacks cementation due to ice in the upper 25 cm. Provisionally, assign antecedent moisture class II while Frozen to soils with aridic or torric moisture regimes and to soils that are Dry 0-25 cm.

Otherwise, assign based on the antecedent moisture (classes I, II, or III) equated with the monthly water state as follows:

I - Dry 0-25 cm; or Slightly Moist 0-25 cm,
and Slightly Moist or dry 25-50 cm

III - Wet 0-25 cm

II - Other

Part C

Indicate the months for the annual use sequence in which the soil water state most critically determines erosion and plant growth. Do for 6 years in 10 only.

ITEM 9

This follows Item 5. It is important that the user be able to evaluate the origin of the information in the sense of whether it rests on certain specific data sets, on generalizations from data sets, or is a generalization from field experience with little or no specific quantitative information.

COMMENT BY CHAIRMAN

In use of the information sheet, these considerations have surfaced:

A. A correction for salts should be considered in the calculation of the root-related water retention differences (Item 7, part B).

B. The adjustment of the lower depth of few roots probably should be dropped (Item 7, part A).

C. The tension for the separation of very moist and slightly moist should be dependent on particle size. For sandy materials, the tension might be lowered to 10 kPa. For coarse-loamy materials with a bulk density <1.60, the separation might be at a water content halfway between the retention at 200 and 10 kPa.

EXAMPLES OF WATER-RELATED INFORMATION SHEETS

Brief descriptions follow of the series for which water-related information sheets have been prepared.

AIKEN: Clayey, kaolinitic, mesic Xeric Haplohumults

These deep, well drained soils are on broad gently sloping tabular ridges with moderately steep to steep side slopes at elevations of about 1,200 to 1,500. They are formed in residuum from basic volcanic rocks, principally tuff breccia. The climate is subhumid mesothermal with warm dry summers and cool moist winters. Mean annual precipitation is 750 to 2650 mm, some of which is snow. Mean annual temperature is about 50° to 60°F, average January temperature about 40°F, and average July temperature about 72°F.

BOWIE: Fine-loamy, siliceous, thermic Plinthic Paleudults

Deep, moderately well drained, moderately slowly permeable soils formed in loamy Coastal Plain sediments. On broad nearly level to sloping uplands. Runoff is slow or medium. Slopes are dominantly 1 to 5 percent but range from 0 to 8 percent. Mean annual precipitation ranges from 1000 to 1250 mm. Mean annual temperature is 64° to 69°F. The PE index exceeds 64.

CROSBY: Fine, mixed, mesic family of Aeric Ochraqualfs

The soils have dark grayish brown silt loam Ap horizons, yellowish brown mottled silty clay loam and clay loam B horizons and yellowish brown mottled loam C horizons. They occur on nearly level to gently sloping topography on moraines, drumlins, and till plains. Slopes are 1 to 3 percent. They are formed in loam, heavy sandy loam or light clay loam calcareous till of Wisconsin age. In places, there is a thin silt cap ranging up to 18 inches in thickness. Mean annual temperature is 48° to 55°F. Mean annual precipitation is 900 to 1100 mm.

IDA: Fine-silty, mixed (calcareous), mesic Typic Udorthents

The soils are deep, well drained, and moderately permeable. They are formed in loess and occur on the summits of unstable narrow interfluves and saddles of inr.rfluv.8 that are sharply convex and on steep and very c.*P convex shoulders of side slopes. Slopes r. 2 to 60 percent. Mean annual temperature ranges from 47° to 54°F and mean annual precipitation is 700 to 800 mm.

KYLE: Very-fine, montmorillonitic, mesic Ustertic Camborthids

The soil is deep and well drained, occurring on nearly level to moderately sloping uplands and colluvial fans and is formed in clay sediments weathered from calcareous clay shale. Slopes are plane to convex, and slope gradient is 0 to 9 percent. Mean annual air temperature is 45° to 53°F, and mean annual precipitation is 300 to 430 mm.

LARKIN: Fine-silty, mixed, mesic Ultic Argixerolls

These deep well drained soils, are on undulating to steep uplands covered with deep loess. Slopes range up to 55 percent. Elevation ranges from about 2,300 to 3,700. The mean annual precipitation is 560 to 610 mm and includes about 4 feet of snowfall. December and adjoining months have the maximum precipitation; July and August are the driest. The mean annual temperature ranges from 45° to 50°F.

PAWNEE: Fine, montmorillonitic, mesic Aquic Argiudolls

These soils are deep and moderately well drained. They are formed in glacial till on uplands. Slopes range from 0 to 12 percent. Mean annual precipitation is 650 to 850 mm, and the mean annual temperature is about 54°F

PERU: Coarse-loamy, mixed, frigid Aquic Fragiorthods

The series consists of deep, moderately well drained soils that formed in compact acid stony glacial till of Wisconsin age. They occupy the nearly level to sloping positions on drumlins and sloping areas of uplands. Slopes generally range from 0 to 15 percent but also include slopes up to 25 percent. Typically, the soils have very dark iron-fine sandy loam A horizons, yellowish red and olive brown fine sandy loam i-horizon, mottled in the lower part, underlain by an olive gray, gravelly fine sandy loam fragipan at depths of 30 to 90 cm.

PULLMAN: Fine, mixed, thermic Torrertic Paleustolls

The series consists of deep, well drained, very slowly permeable soils that formed in calcareous clayey materials on broad upland plains. Slope is 0.5 to 0.8 percent but ranges to 3 percent. The soil is presumed to have formed in eolian materials which have been deposited in successive layers with intervening periods long enough for soil forming processes to operate. Annual precipitation is 450 to 550 mm, mean annual temperature is 57° to 62°F, and the Thornthwaite PE index is 25 to 32.

RIVERTON: Fine-loamy, mixed, mesic Aridic Argiustolls

The series consists of deep, well drained, moderately permeable soils that formed in old alluvium from sedimentary and igneous rocks. The soils occur on concave side slopes and broad swales of the upper, more stable surfaces. Slopes range from 0 to 5 percent. Mean annual precipitation is about 15 inches and mean annual air temperature is about 51°F.

ULY: Fine-silty, mixed, mesic Typic Haplustolls

The series includes deep, well drained and somewhat excessively drained moderately permeable soils formed in loess. Slope is dominantly 7 to 15 percent and ranges from 0 to 30 percent. Mean annual precipitation is 450 to 600 mm, and mean annual temperature is 45° to 55°F.

WALKNOLLS: Loamy-skeletal, mixed (calcareous), mesic Lithic Torriorthents

The series consists of shallow, well drained soils that formed in residuum from sandstone and marlstone. The soils are on gently sloping to very steep hills, ridges, and side slopes with slopes of 2 to 50 percent. The mean annual precipitation is about 200 mm, and the mean annual temperature is 48°F.

WELLS: Fine-loamy, mixed, mesic Udic Argiustolls

The series consists of deep, well drained, moderately permeable soils formed in residuum from noncalcareous sandstones and sandy shales modified by thin deposits of colluvium from sandstone and loess. The soils are on uplands. Slopes are 2 to 8 percent. Mean annual temperature is about 54°F, and mean annual precipitation is about 650 mm. The Thornthwaite PE index is 44 to 54.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2

ITEM 1

Series:

Aiken

No. Records:
1

ITEM 3

```
PERCENT PROBABILITY  - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - -
1       100     DRY SOME/ALL PARTS MCS  90 OR MORE DAYS CUMULATIVELY    WHEN SOIL TEMP 5 DEG C OR HIGHER
2         0     DRY SOME/ALL PARTS MCS  6/10 OR MORE OF DAYS CUMULATIVELY WHEN SOIL TEMP 5 DEG C OR HIGHER
3         0     DRY ALL PARTS MCS       1/2 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
4         0     DRY ALL PARTS MCS       3/4 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
5       100     MOIST SOME/ALL PARTS MCS 90 OR MORE DAYS CONSECUTIVELY    WHEN SOIL TEMP 8 DEG C OR HIGHER
6       100     DRY ALL PARTS MCS       45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER SUMMER SOLSTICE
7       100     MOIST ALL PARTS MCS     45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME:  MESIC   ESTIMATED FROM NORMAL AIR TEMPERATURES
SOIL MOISTURE REGIME:  XERIC      ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 2, 5, 6, 7
AND MOISTURE REQUIREMENT IS "NORMATIVE" FOR:
 DURARGIDS, HAPLARGIDS, PALEARGIDS, CALCIORTHIDS, CAMBORTHIDS, DURORTHIDS, PALEORTHIDS, TORRIFLUVENTS, TORRIORTHENTS, TORRIPSAMMENTS
 ARGIALBOLLS
```

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	100	1500	10-1500	Saturated	33kPa			
	<-------- kPa --------					-------->					
cm	<-------- Vol. Pct --------					-------->	<---- cm/day ----	---->	g/cc	Pct	mmhos/cm
0-50					27				0.95	5	
50-100					19				1.00	5	
100-225					27				1.35	10	
225-250					26				1.25	20	

ITEM 5

Ref. Nos.

Item 1: Explanation A

Item 2: Explanation A

Item 3: Explanation A

Item 4: Explanation A 1

1. Pedon S59CA-3-12. Soil Survey Staff, 1973. Soil Survey Invest. Rept. 24.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Ponderosa Pine, Douglas Fir, Sugar Pine, White Fir, Incense Cedar, Black Oak Base Common: 100 Adjusted Base Few: 250
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 10-1500 kPa: Adjusted Base Few 10-200 kPa: 10-1500 kPa:
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):
Aiken Loam, 2-15%
Mixed Conifers

Typifying Survey(s):
Amador County, CA

Compiler(s):

E. B. Alexander

ITEM 8

Part A

Depth cm	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M	M	M	M	M	MS	D	D	D	MS	M	M																								
25- 50	M	M	M	M	M	M	D	D	D	D	M	M																								
50-100	M	M	M	M	M	M	M	MS	D	D	MS	M																								
100-150	M	M	M	M	M	M	M	M	MS	D	D	M																								
150-200																																				
PND-FLD																																				

Part B

	J	F	M	A	M	J	J	A	S	O	N	D
Runoff												
CN	60	60	60	60	60	60	40	40	40	40	40	60

Part C

	J	F	M	A	M	J	J	A	S	O	N	D
Erosion												
Growth												

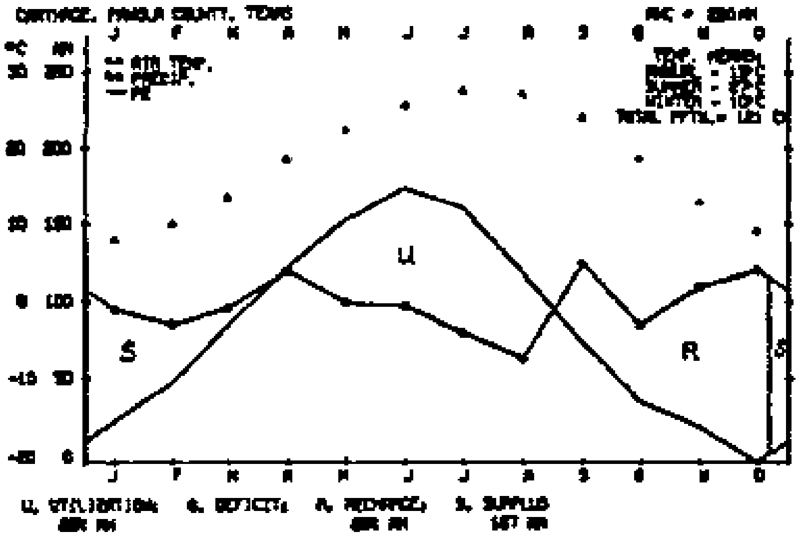
ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Based on field experience
2. Curve number of 60 for Roman II antecedent moisture from SCS California State Office

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Bowie

No. Records:

1

ITEM 3

```
       PERCENT PROBABILITY     - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - -
1              45              DRY SOME/ALL PARTS MCS   45 OR MORE DAYS CUMULATIVELY       WHEN SOIL TEMP 5 DEG C OR HIGHER
2               [illegible]    DRY SOME/ALL PARTS MCS   1/2 OR MORE OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER
3               [illegible]    DRY ALL PARTS MCS        1/2 OR MORE OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER
4               [illegible]    DRY ALL PARTS MCS        3/4 OR MORE OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER
5             100              MOIST SOME/ALL PARTS MCS 90 OR MORE DAYS CONSECUTIVELY      WHEN SOIL TEMP 8 DEG C OR HIGHER
6              10              DRY ALL PARTS MCS        45 OR MORE DAYS CONSECUTIVELY      DURING 120 DAYS AFTER SUMMER SOLSTICE
7             100              MOIST ALL PARTS MCS      45 OR MORE DAYS CONSECUTIVELY      DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME:   THERMIC                     ESTIMATED FROM NORMAL AIR TEMPERATURES
SOIL  MOISTURE   REGIME    UDIC                        ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 5, and 7
AND MOISTURE REQUIREMENT IS "TYPIC" FOR:
 [illegible]
```

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	3kPa			
	<--------kPa-------->										
cm	<--------Vol. Pct-------->						<--------cm/day-------->		g/cc	Pct	mmhos/cm
0-13				13	8		60		1.24	0	
15-30				13	8		23		1.43	0	
30-43				19	12		4		1.54	0	
43-91				22	15		30		1.49	0	
91-107				19	13				1.50	0	

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	

1. Profile 39 in USDA-ARS 41-33-1. 1961. Not using 10 and 33kPa retention because on sieved samples.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Loblolly, Shortleaf Pine, Sweetgum Base Common: 75 Adjusted Base Few: 200(?)
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 10-1500 kPa: Adjusted Base Few 10-200 kPa: 10-1500 kPa:
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 60 5kPa:

ITEM 6

Annual Use Sequence(s)

Bowie fine Sandy Loam, 1-3%
Mixed Conifers and Deciduous

Typifying Survey(s):

Panola County, TX

Compiler(s):

E. R. Finney

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	MV	MS	MS	MS	MS	D	MS	MV	MV	MV
25- 50	MV	MV	MV	MS	MS	D	D	D	MS	MS	MV	MV
50-100	MV	MV	MV	MV	MV	MS	D	D	MS	MS	MS	MV
100-150	MV	MV	MV	MV	MV	MS	MS	D	D	MS	MS	MV
150-200	MV	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS	MV
PND-FLD												
Part B												
Runoff	S	S	S	M	S	S	S	VS	S	VS	S	S
CN	55	55	55	55	55	55	55	55	55	55	55	55
Part C												
Erosion												
Growth			X	X	X	X	X	X	X	X		

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MS	MV	MV	MS	MS	D	D	D	D	MS	MS	MS
25- 50	MS	MV	MV	MV	MS	D	D	D	D	D	MS	MS
50-100	MS	MS	MV	MV	MV	MS	D	D	D	D	D	MS
100-150	MS	MS	MS	MV	MV	MS	D	D	D	D	D	D
150-200	D	D	D	MS	MS	MS	MS	D	D	D	D	D
PND-FLD												
Part B												
Runoff												
CN	55	55	55	55	55	55	55	55	55	55	55	55
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	MV	MV	MV	MS	MS	MS	MV	MV	MV	MV
25- 50	MV	MV	MV	MV	MV	MV	MS	MS	MV	MV	MV	MV
50-100	MV	MV	MV	MV	MV	MV	MV	MS	MS	MV	MV	MV
100-150	MV	MV	MV	MV	MV	MV	MV	MS	MS	MS	MV	MV
150-200	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV
PND-FLD												
Part B												
Runoff	M	S	M	M	S	S	S	S	S	M	M	M
CN	55	55	55	55	55	55	55	55	55	55	55	55
Part C												
Erosion												
Growth												

ITEM 9

Item 7:	Ref. Nos.
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	1
Item 8:	
Part A - Explanation A	2
Part B - Explanation A	2
Part C - Explanation A	2

1. Core method
2. Based on general field observations only.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 1

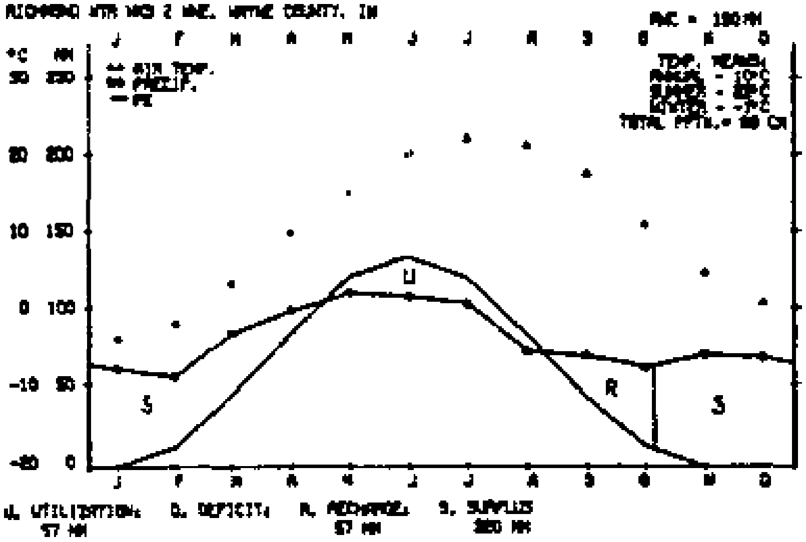
Series:

Crosby

No. Records:

1

ITEM 2



ITEM 3

	PERCENT PROBABILITY	- - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - -		
1	30	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: MESIC   ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME UDIC   ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 5, 6, 7

AND MOISTURE REQUIREMENT IS "TYPIC" FOR:
ARGIALBOLLS

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 5 DEG C AND ABOVE. BEGINS APR 11 ENDS NOV 25 DURATION 228 DAYS.

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 8 DEG C AND ABOVE. BEGINS APR 24 ENDS NOV 6 DURATION 196 DAYS.

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<------------------kPa------------------>										
cm	<------------Vol. Pct------------>						<------cm/day------>		g/cc	Pct	mmhos/cm
0-27	42	40	35	17	8	32			1.45	0	
27-55	42	41	38	37	26	15	80		1.45	0	
55-75	41	40	37	31	25	15	50		1.50	0	
75-150	24	23		15	9	14	1		1.85	tr	

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3 Explanation A	
Item 4: Explanation A	1

1. Franzmeier, D. P. Personal communication and reference 1 in Item 9.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Corn, Soybeans Base Common: 30 Adjusted Base Few: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 7 10-1500 kPa: 12 Adjusted Base Few 10-200 kPa: 9 10-1500 kPa: 12
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 20 5kPa:

ITEM 6

Annual Use Sequence(s):
Crosby Silt Loam, 0-2%
Corn-Soybeans, Conventional
Typifying Survey(s):
Boone County, IN

Compiler(s):

D. P. Franzmeier

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	WN	WN	WN	WN	MV	MV	MS	MS	MS	MS	MV	WN
	F	F	F	F								F
25- 50	WA	WA	WA	WN	WN	MV	MS	MS	MS	MS	MV	WA
	F	F	F									
50-100	WA	WA	WA	WA	WA	WN	MV	MS	MS	MV	WN	WA
	F	F										
100-150	WA	WA	WA	WA	WA	WA	WN	MV	MV	WN	WA	WA
150-200												
PND-FLD												
Part B												
Runoff												
CN	98	98	98	98	86	88	85	85	85	85	88	96
Part C												
Erosion			X	X	X							
Growth						X	X					

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	WN	WN	MV	MV	MS	MS	D	D	MS	MS	MS	MV
25- 50	WN	WN	MV	MV	MV	MS	MS	MS	MS	MS	MV	MV
50-100	WN	WN	MV	MV	MV	MV	MS	MS	MS	MS	MV	MV
100-150	WA	WA	WA	WA	WN	WN	MV	MS	MS	MS	MV	MS
150-200												
PND-FLD												
Part B												
Runoff												
CN	98	98	88	86	86	75	75	75	75	75	88	96
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	WA	WA	WA	WN	WN	MV	MV	MV	MV	MV	MV	MV
25- 50	WA	WA	WA	WA	WN	MV	MV	MV	MV	MV	WN	WA
50-100	WA	WA	WA	WA	WA	WA	WN	MV	MV	WN	WA	WA
100-150	WA	WA	WA	WA	WA	WA	WA	WA	WA	WA	WA	WA
150-200												
PND-FLD												
Part B												
Runoff												
CN	98	98	98	97	97	86	85	85	85	85	88	81
Part C												
Erosion												
Growth												

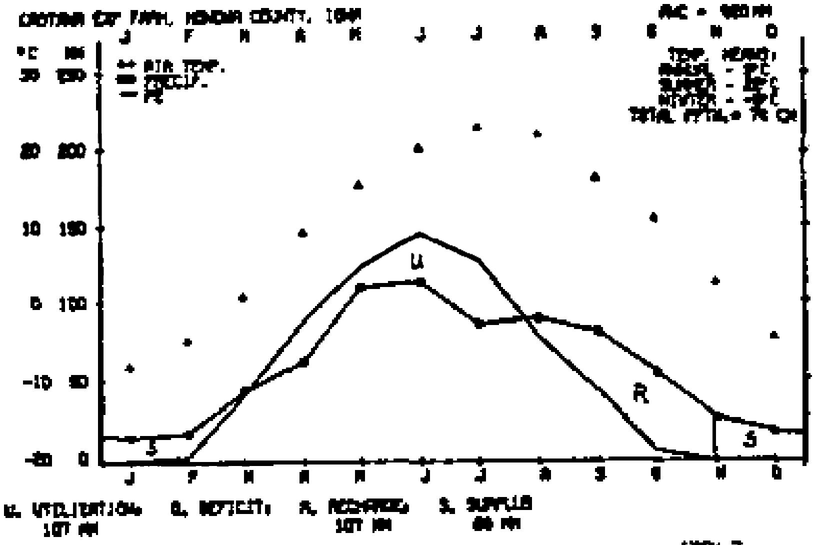
ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	1
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Harlan, P. W. and Franzmeier, D. P. 1974. Soil-Water Regimes in Brookston and Crosby Soils. Soil Sci. Soc. Am. Proc. 38:638
2. CN for corn

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Ida

No. Records:

1

ITEM 3

	PERCENT PROBABILITY	- - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - -		
1	13	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	1	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	3	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	90	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: MESIC ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME UDIC ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 2, 3, 4, 7

AND MOISTURE REQUIREMENT IS "TYPIC" FOR:
ARGIALBOLLS

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 5 DEG C AND ABOVE. BEGINS APR 10 ENDS NOV 11 DURATION 214 DAYS.

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 8 DEG C AND ABOVE. BEGINS APR 29 ENDS NOV 2 DURATION 187 DAYS.

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<-----kPa----->										
cm	<-----Vol. Pct----->						<-----cm/day----->		g/cc	Pct	mmhos/cm
0-30	44	41	29	19	14	27			1.29	0	
30-90	44	38	24	14	11	27		1	1.22	0	
90-150	46	41	29	16	12	29		1	1.23	0	
150-200	47	44	29	15	11	33		1	1.25	3	

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1, Item 9

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Soybeans Base Common: 135 Adjusted Base Fav. 190
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 32 10-1500 kPa: 37 Adjusted Base Fav 10-200 kPa: 45 10-1500 kPa: 47
C	Water Movement, cm/day Infiltration Rate: 30 Intake Rate: NA Surficial Hydraulic Conductivity Saturated: 15 5kPa: 0.7

ITEM 6

Annual Use Sequence(s):

Ida Silt Loam, 9-15%, Severely eroded
Soybeans, Conventional

Sampling Survey:

Monona County, IA
Woodbury County, IA

Compiler(s):

R. B. Grossman

ITEM 8

Part A

Depth cm	6-12	6-19	6-26	7-3	7-[illegible]	7-[illegible]	7-17	7-[illegible]	7-[illegible]	8-[illegible]	8-[illegible]	8-16	8-20	8-24	8-29	9-[illegible]						Driest 2 years in 10									
0-25	MV	MV	MS	MS	MS	D	D	MS	MS	MS	D	D	D	MV	MV	MV										MV	MS	D			
25-50	MV	MV	MV	MV	MV	MV	MS	MV	MS	MS	D	MS	D	MS	MV	MV										MV	MV	MS			
50-100	MV	MV	MV	MV	MV	MV	MV	MV	MS	MS	MS	MS	D	MS	MS	MV										MV	MV	MS			
100-150	MV	MV	MV	MV	MV	MV	MV	MV	MS	MS	MS	MS	D	D	D	D										MV	MV	MS			
150-200	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV	MV										MV	MV	MV			
ND-FLD																															

Part B

Runoff																															
CN																															

Part C

Erosion,																															
Sdtain																															

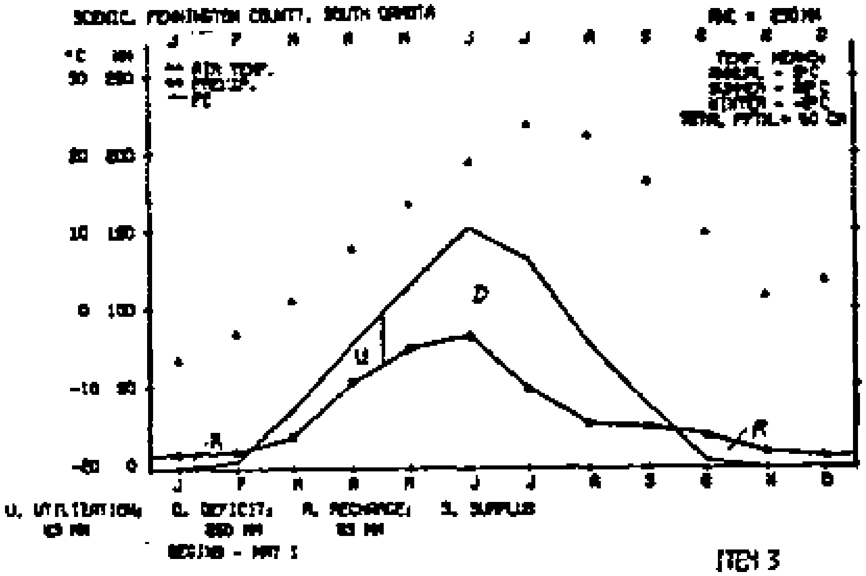
ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	1
Part B - Explanation A	
Part C - Explanation A	2, 4, 1
Item 8:	
Part A - Explanation A	3
Part B - Explanation A	
Part C - Explanation A	

1. Mason, et al., 1980. Soybean Row Spacing and Soil Water Supply. SEA-AR AAT-NC-5. Base of few roots established from water distribution.
2. North Central Regional Committee 40. 1979. Water Infiltration into Representative Soils of the North Central Region. Univ. Ill. Agr. Exp. Sta. Bul. 760. Second run 24 hours after first. Corn seedbed.
3. Reference 1. For 1979 only. 1 m spacing; not irrigated. Precipitation May-September 6.3 inches below average of 15.8 inches. Consulted Annual Progress Report - 1979, Western Research Center, Castana, Iowa.
4. Edwards, W. M., 1976. Infiltration of water into soils as influenced by surface conditions. Ph D Thesis Iowa State University, Ames.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Kyle

No. Records:

1

ITEM 3

PERCENT PROBABILITY		CRITERIA FOR MOISTURE CONTROL SECTION (MCS)		
1	95	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	60	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	40	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	5	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
5	96	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	75	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	5	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: MESIC ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME USTIC ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 2, 3, 4, 7

ARID MOISTURE REQUIREMENT IS "NON-ARIDIC" FOR:
HAPLUSTALFS, PALEUSTALFS, USTOCHREPTS, ARGIUSTOLLS, CALCIUSTOLLS, HAPLUSTOLLS, [illegible], PALEUSTOLLS
[illegible], HAPLARGIDS, PALEARGIDS, CALCIORTHIDS, CAMBORTHIDS, DURORTHIDS, PALEORTHIDS, TORRIFLUVENTS, TORRIORTHENTS, TORRIPSAMMENTS
ARGIALBOLLS

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 5 DEG C AND ABOVE. BEGINS APR 20 ENDS NOV 14 DURATION 208 DAYS.

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 8 DEG C AND ABOVE. BEGINS MAY 4 ENDS OCT 29 DURATION 178 DAYS.

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	(<-- kPa -->)										
cm	(<-- Pct w/w -->)						(<-- cm/day -->)		g/cc	Pct	mmhos/cm
0-5	45	41	36	27	20	21			1.12	0	1.5
5-10	45	43	40	32	26	17			1.26	0	0.7
10-70	44	44	42	35	27	17			1.37		0.6
70-150	44	43	41	36	27	16			1.16	a	3.5

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1

1. Pedon 79SD-071-1. In a fine family and hence taxadjunct to series. 1 and 10 kPa retention calculated.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants. Buffalograss, Blue Grama, Western Wheatgrass Base Common: 30 Adjusted Base Few: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 3 10-1500 kPa: 5 Adjusted Base Few 10-200 kPa: 9 10-1500 kPa: 17
C	Water Movement, cm/day Infiltration Rate: 40 Intake Rate: NA Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):
Kyle Silty Clay, 2-6% slopes
Range, fair, cool and warm season

Typifying Survey(s)

Mead County, Southern Part

Compiler(s):

M. W. Smalley
R. B. Grossman

ITEM 8

Part A

Depth cm	Average - 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0-25	D	D	MS	MV	MV	MV	D	D	D	D	D	D																								
	F	F	F									F																								
25-50	D	D	D	MS	MS	MS	D	D	D	D	D	D																								
	F	F																																		
50-100	D	D	D	D	D	D	D	D	D	D	D	D																								
		F																																		
100-150	D	D	D	D	D	D	D	D	D	D	D	D																								
		F																																		
150-200																																				
PND-FLD																																				
Part B																																				
Runoff																																				
CN	86	86	86	86	86	86	72	72	72	72	72	86																								
Part C																																				
Erosion																																				
Growth																																				

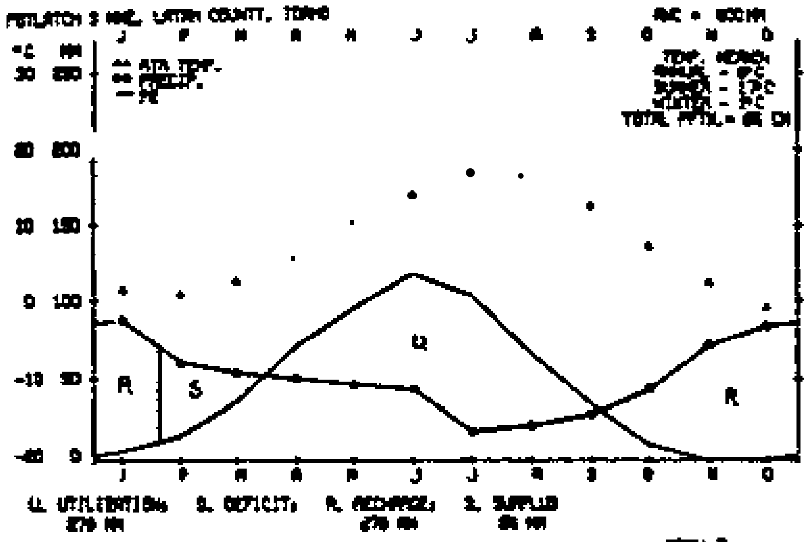
ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	1
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Hanson, C. L., Kuhlman, A. R., and Lewis, J. K., 1978. Effect of Grazing Intensity and Range Condition on Hydrology of Western South Dakota Ranges. South Dakota State Agr. Exp. Sta. Bul. 647. Water content measurements with neutron probe twice a month through the growing season 1963-1973. Used only data for moderate grazing intensity. During this period, precipitation exceeded the long term average by 2.1 inches. The 1963-72 pattern of water states is considered average, but is on the wet side and is close to being for the wettest 2 years in 10. Two of the six access tubes in Pierre soil and four in Kyle. The water retention values employed to place the field moisture in classes were calculated by weighting Kyle 79SD-071-1 twice that of Pierre 79SD-071-2.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Latahco

No. Records:

1

ITEM 3

```
PERCENT PROBABILITY      - - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - -
1          [illegible]    DRY SOME/ALL PARTS MCS   90 OR MORE DAYS CUMULATIVELY       WHEN SOIL TEMP 5 DEG C OR HIGHER
2          10             DRY SOME/ALL PARTS MCS   6/10 OR MORE OF DAYS CUMULATIVELY  WHEN SOIL TEMP 5 DEG C OR HIGHER
3          0              DRY ALL PARTS MCS        1/2 OR MORE OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER
4          0              DRY ALL PARTS MCS        3/4 OR MORE OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER
5          100            MOIST SOME/ALL PARTS MCS 90 OR MORE DAYS CONSECUTIVELY      WHEN SOIL TEMP 8 DEG C OR HIGHER
6          45             DRY ALL PARTS MCS        45 OR MORE DAYS CONSECUTIVELY      DURING 120 DAYS AFTER SUMMER SOLSTICE
7          100            MOIST ALL PARTS MCS      45 OR MORE DAYS CONSECUTIVELY      DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME:   MESIC               ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL  MOISTURE   REGIME    USTIC               ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 5, 6, 7

AND MOISTURE REQUIREMENT IS TYPICAL FOR:
 HAPLUSTALFS, PALEUSTALFS, USTOCHREPTS, ARGIUSTOLLS, CALCIUSTOLLS, HAPLUSTOLLS, NATRUSTOLLS, PALEUSTOLLS
 ARGIALBOLLS

AND MOISTURE REQUIREMENT IS NON-TYPICAL FOR:
 DURARGIDS, HAPLARGIDS, PALEARGIDS, CALCIORTHIDS, CAMBORTHIDS, DURORTHIDS, PALEORTHIDS, TORRIFLUVENTS, TORRIORTHENTS, TORRIPSAMMENTS
```

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<--------kPa-------->										
cm	<--------Vol. %cc-------->						<----cm/day---->		g/cc	%cc	mmhos/cm
0- 10					16				1.39	0	.5
10- 23					17				1.48	0	.3
23- 38					18				1.54	0	.3
38- 53					23				1.74	0	.2
53- 89					23				1.72	0	.2
89-124					24				1.81	0	.2
124-157					21				1.76	0	.2

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1

1. 77102974 Univ. Idaho data.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Ponderosa Pine, Oceanspray, Ninebark Base Common: 70 Adjusted Base Few: 115
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 10-1500 kPa: Adjusted Base Few 10-200 kPa: 10-1500 kPa:
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):
Larkin silt loam, 12-35% slope
Native Forest

Typifying Survey(s):

Benewah County, Idaho

Compiler(s):

S. R. Base

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M	M	M	WN	WN	M	D	D	D	M	M	M
25- 50	M	M	M	WN	WN	M	M	D	D	D	M	M
50-100	M	M	M	M	M	M	M	D	D	D	D	M
100-150	M	M	M	M	M	M	M	M	D	D	D	D
150-200	M	M	M	M	M	M	M	M	D	D	D	D
200-FLD												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M	M	M	M	M	D	D	D	D	D	M	M
25- 50	M	M	M	M	M	M	D	D	D	D	D	M
50-100	M	M	M	M	M	M	D	D	D	D	D	M
100-150	M	M	M	M	M	M	M	D	D	D	D	D
150-200	M	M	M	M	M	M	M	D	D	D	D	D
200-FLD												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M	M	WN	WN	WN	WN	M	D	D	M	M	M
25- 50	M	M	WN	WN	WN	WN	M	M	D	D	M	M
50-100	M	M	M	WN	WN	M	M	M	D	D	M	M
100-150	M	M	M	M	WN	M	M	M	M	D	D	M
150-200	M	M	M	M	M	M	M	M	M	D	D	M
200-FLD												

Part B

		J	F	M	A	M	J	J	A	S	O	N	D
Average	Runoff	S	S	S	M	M	M	S	S	S	S	S	S
	CN	63	63	63	63	63	63	63	63	63	63	63	63
Driest	Runoff												
	CN	63	63	63	63	63	63	63	63	63	63	63	63
Wettest	Runoff												
	CN	63	63	63	63	63	63	63	63	63	63	63	63

Part C

		J	F	M	A	M	J	J	A	S	O	N	D
Average	Erosion				X	X							
	Growth				X								
Driest	Erosion												
	Growth												
Wettest	Erosion												
	Growth												

ITEM 9

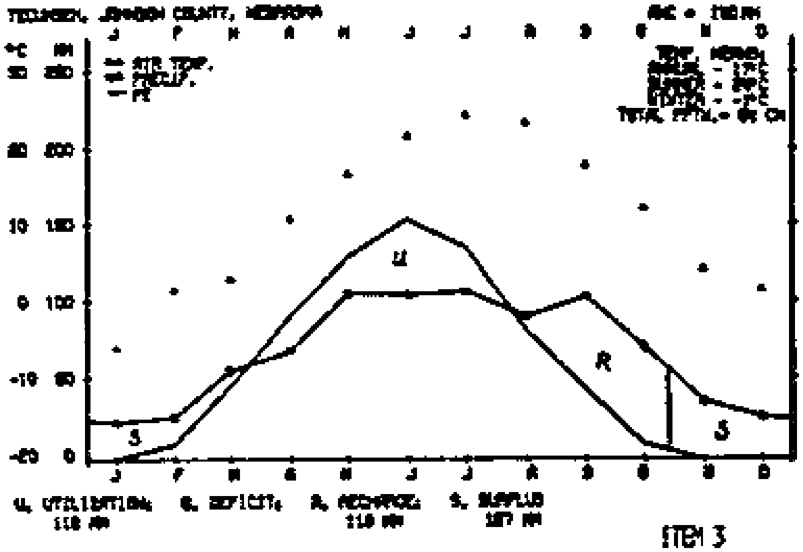
	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Input based on unpublished study by S. R. Base "Soil Moisture and Classification of Selected Soils, Latah County, Idaho." Field water content compared to 15 bar at 10 and 30 cm for 1968 and 1969. Measurements every 2 weeks—6/15 to 10/15.

2. Roman II CN from Idaho State Office.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Pawnee

No. Records:
1

ITEM 3

	PERCENT PROBABILITY	---------------- CRITERIA FOR MOISTURE CONTROL SECTION (MCS) ----------------		
1	63	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: MESIC ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME UDIC ESTIMATED FROM PROBABILITY VALUES IN LINES 2, 3, 5, 6, 7

AND MOISTURE REQUIREMENT IS "TYPIC" FOR: ARGIUDOLLS

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 5 DEG C AND ABOVE. BEGINS APR 10 ENDS NOV 23 DURATION 227 DAYS.

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 8 DEG C AND ABOVE. BEGINS APR 22 ENDS NOV 7 DURATION 199 DAYS.

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<------------------kPa------------------>										
cm	<------------Vol. Pct------------>						<------cm/day------>		g/cc	Pct	mmhos/cm
0-25	46	41	30	26	17	24			1.27	1	
25-35	46	40	36	27	23	17			1.33	1	
35-90	41	40	39	33	27	13	0.04	<0.0001	1.31	1	
90-135	36	35	34	29	25	10			1.47	1	2
135-150	36	34	32	28	25	9			1.44	2	
150-190	36	35	34	28	24	11			1.47	2	

ITEM 5

Ref. Nos.

Item 1: Explanation A

Item 2: Explanation A

Item 3: Explanation A

Item 4: Explanation A Col. H, I, 2; other Cols., 1

1. Pedon 73NE-55-1. Bromegrass meadow. Measured 60kPa retention and estimated 200kPa as sum of 1500 plus 2/3 of difference between 1500 and 30. Not in study area of reference 1, Item 9.
2. Pedon within meters of 73-55-1. Saturated value by double tube method and unsaturated by crust test. Using latter measured 0.0001 cm/day at 4kPa.

ITEM 7

Part **Quantity**

A Rooting Depth, cm
  Plants: Little, Big Bluestem
  Base Common: 30
  Adjusted Base Few: 100

B Root-related Retention Difference Sums, cm
  Base Common
    10-200 kPa: 4
    10-1500 kPa: 7
  Adjusted Base Few
    10-200 kPa: 10
    10-1500 kPa: 16

C Water Movement, cm/day
  Infiltration Rate:
  Intake Rate:
  Surficial Hydraulic Conductivity
    Saturated:
    5kPa: .02

ITEM 6

Annual Use Sequence(s):
Pawnee Clay Loam 3-7%, eroded.
Range, fair, warm season
Typifying Survey(s):
Seward County, NE

Compiler(s):
R. B. Grossman

ITEM 8

Part A

Depth	Average – 6 years in 10												Driest 2 years in 10												Wettest 2 years in 10											
cm	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	MV	MV	MS	MS	MS	MS	MS	MS	MV	MV																								
	F	F	F									F																								
25- 50	MV	MV	MV	MV	MV	MV	MS	MS	MS	MV	MV	MV																								
	F	F																																		
50-100	MS	MV	MV	MV	MV	MV	MS	MS	MS	MS	MS	MS																								
100-150																																				
150-200																																				
PAN-FLD																																				
Part B																																				
Runoff																																				
CN	98	98	84	84	84	84	68	68	68	84	84	84																								
Part C																																				
Erosion																																				
Growth																																				

ITEM 9

	Ref. Nos.
Item 7:	
Part A – Explanation A	1
Part B – Explanation A	
Part C – Explanation A	2
Item 8:	
Part A – Explanation A	1
Part B – Explanation A	
Part C – Explanation A	

1. Quandt, L. A. 1971. Soil Moisture Regimes Near the Udoll-Ustoll Boundary in Eastern Nebraska. MS Thesis. University of Nebraska, Lincoln. Pattern water states for calendar 1969, 1970. Annual precipitation in 1969 was 88 mm below and in 1970 25 mm below the long term average for Seward, Nebraska located 20 km to the west. The study area is on the western and drier edge of occurrence of the series. Assumed 2-bar retention is equal to the measured 5-bar retention plus half the difference between 6 and 15-bar retention. Two access tubes about 1 mile apart. Class recorded for each month is the most frequent class for the two sites in the two calendar years. The drier class is recorded if the above criterion does not provide a basis for decision. Key cut between 8/15 and 9/15.
2. See footnote 2, Item 5.
3. Roman II value from R. Kluth.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 1

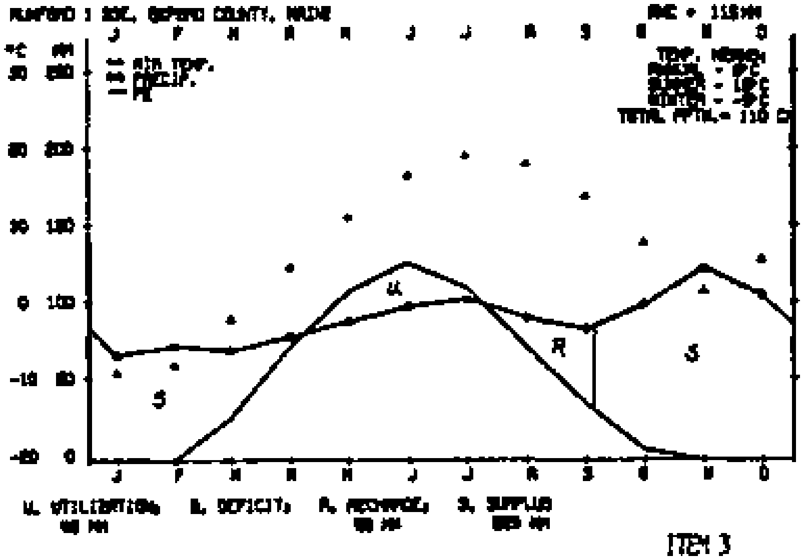
Series:

Peru

No. Records:

1

ITEM 2



ITEM 3

PERCENT PROBABILITY ---------------- CRITERIA FOR MOISTURE CONTROL SECTION (MCS) ----------------

1	0	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	0	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	0	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	100	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: FRIGID OR CRYIC ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME UDIC ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 2, 5, & 7

AND MOISTURE REQUIREMENT IS SATISFIED FOR:
[illegible]
[illegible]

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk	Volume	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa	Density	>2mm	
	<------------------kPa------------------>										
cm	<---------------Vol. Pct--------------->						<--------cm/day-------->		g/cc	Pct	mmhos/cm
0-13	49	23	20	17	10	13			0.51	33	
13-25	49	36	30	17	10	26			0.93	17	
25-53	32	40	30	17	10	30			0.90	7	
53-75	31	22	17	15	13	9			1.56	28	
75-105	24	20	17	13	6	14			1.91	8	

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1

1. Rourke, R. V., Beek, C. 1968. Soil water, chemical, and physical characteristics of 8 soil series in Maine. Maine Agr. Exp. Sta. Tech. Bul. 29. Site 2 of Peru. 200 kPa retention by interpolation between 100 and 300.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Maple, Birch, White Pine, Spruce, Fir Base Common: 30 Adjusted Base Few: 75
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 4 10-1500 kPa: 6 Adjusted Base Few 10-200 kPa: 11 10-1500 kPa: 12
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):
Peru fine sandy loam, 3-8%
Northern Hardwoods, conifers

Typifying Survey(s):
Somerset County, ME

Compiler(s):
R. V. Rourke

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M F	M F	M F	WA	WN	MV	MV	MV	MV	MV	WN	M F
25- 50	M	M	M	M	M	M	M	M	M	M	M	M
50-100	M	M	M	M	M	M	M	M	M	M	M	M
100-150	M	M	M	M	M	M	M	M	M	M	M	M
150-200												
PND-FLD												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M	M	M	M	WN	M	MS	MS	MS	M	M	M
25- 50	M	M	M	M	M	MS	MS	MS	MS	MS	M	M
50-100	M	M	M	M	M	M	M	M	M	M	M	M
100-150	M	M	M	M	M	M	M	M	M	M	M	M
150-200												
PND-FLD												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M	M	M	WA	WA	WA	WN	WN	WN	WA	WA	M
25- 50	M	M	M	M	WN	WN	WN	WN	WN	WN	WN	M
50-100	M	M	M	M	M	M	M	M	M	M	M	M
100-150	M	M	M	M	M	M	M	M	M	M	M	M
150-200												
PND-FLD												

Part B

Runoff CN	J	F	M	A	M	J	J	A	S	O	N	D
Average - 6 years in 10	98	98	96	92	86	71	71	71	71	71	92	96
Driest 2 years in 10	98	98	96	86	86	71	52	52	52	71	71	96
Wettest 2 years in 10	98	98	96	92	92	92	86	86	86	92	92	96

Part C

	J	F	M	A	M	J	J	A	S	O	N	D
Erosion (Average)				X							X	
Growth (Average)					X	X						
Erosion (Driest)												
Growth (Driest)												
Erosion (Wettest)												
Growth (Wettest)												

ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	3
Part B - Explanation A	
Part C - Explanation A	
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

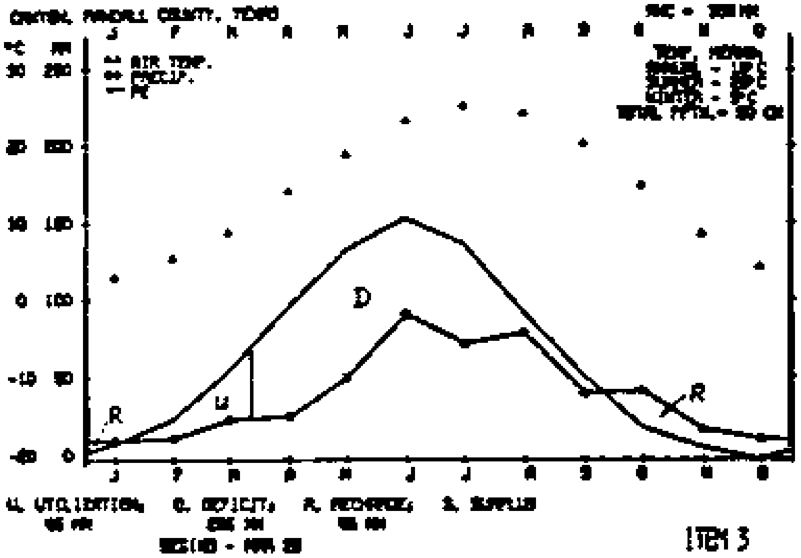
1. Based on field experience.

2. CN for Roman II antecedent moisture of 71 from Maine State Office.

3. Few roots to top of fragipan. For typifying pedon of series the top of fragipan is 75 cm. The range for the series is 30 to 90 cm.

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Pullman

No. Records:
1

ITEM 3

PERCENT PROBABILITY - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - -

1	[illegible]	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	[illegible]	DRY SOME/ALL PARTS MCS	OVER ONE HALF OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	[illegible]	DRY ALL PARTS MCS	[illegible] OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	[illegible]	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	[illegible]	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP > 8 DEG C OR HIGHER
6	[illegible]	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	[illegible]	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: THERMIC ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME USTIC ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 2, 5, 6, 7

AND MOISTURE REQUIREMENT IS [illegible] FOR:
[illegible]

AND MOISTURE REQUIREMENT IS [illegible] FOR:
[illegible]
[illegible]

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	3kPa			
	<------------kPa------------>										
cm	<------------Vol. Pct------------>						<--------cm/day-------->		g/cc	Pct	mmhos/cm
0-15			33	28	18				1.40	0	
15-41			37	33	26				1.47	0	
41-74			36	32	25				1.53	0	
74-96			34	31	24				1.56	0	
96-147			35	32	27				1.56	0	
147-198			33	28	17				1.57	0	
198-234					21				1.60	0	

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1

1. Pullman 79TX-381-003 supplemented by 200 kPa retention data from pedons 80TX-371-1,3. Assumed that retention at 200 kPa equal to retention at 1500 kPa plus 2/3 of difference between 200 and 1500 kPa retention. Retention at 33 kPa estimated for surface horizon from AWC on 5-5 form and 1500 kPa retention. Bulk density estimated for surface horizon.

ITEM 7

Part	Quantity
A	Rooting Depth, cm
	Plants:
	Base Common:
	Adjusted Base Few:
B	Root-related Retention Difference Sums, cm
	Base Common
	10-200 kPa:
	10-1500 kPa:
	Adjusted Base Few
	10-200 kPa:
	10-1500 kPa:
C	Water Movement, cm/day
	Infiltration Rate:
	Intake Rate:
	Surficial Hydraulic Conductivity
	Saturated:
	5kPa:

ITEM 5

Annual Use Sequence(s):
Pullman clay loam, 0-1%
Wheat-fallow; variable tillage frequency
Typifying Survey(s):
Potter County, Texas

Compiler(s):
R. B. Grossman

ITEM 8

Part A

Depth	1	3	4	5	6	8	9	10	12	1	2	3	3	3	4	4	4	4	5	5	5	6	6	6	7	8	9	11	12				
cm	28	8	14	25	22	2	7	27	13	18	26	7	14	23	5	13	21	28	4	15	23	1	12	23	24	21	22	6	22				
0- 25	D	MS	MS	MS	MS	MS	MS	MV	MV	MS	MS	MS	MS	D	D	D	D	D	D	MS	D	D	D	D	MV	MV	MS	MV	MV				
25- 50	D	MS	MS	MS	MS	MS	MV	MV	MV	MV	MV	MS	MS	MS	D	D	D	D	D	D	D	D	D	D	MV	MS	MV	MV	MV				
50-100	D	MS	MS	MS	MS	MS	MS	MV	MV	MV	MS	MS	MS	MS	MS	D	D	D	D	D	D	D	D	D	D	D	MS	MS	MS				
100-150	D	D	D	D	D	D	D	D	MS	MS	MS	MS	MS	MS	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D				
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS				
PND-FLD																																	

Part B

Runoff																																	
CN	64	64	64	64	64	64	81	81	81	81	81	64	64	64	64	64	64	64	64	64	64	64	64	64	81	81	81	81	81				

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	D	M	M	M	M	M	M	M	M	M	M	M	M	M	MS	D	D	D	M	M	M	M	M	M												
25- 50	D	MS	MS	MS	MS	MS	MS	MS	MV	MV	MV	MV	MV	MV	MS	D	D	D	MV	MS	MV	MV	MV	MV												
50-100	D	MS	MS	MS	MS	MS	MS	MS	MS	MV	MV	MV	MV	MS	MS	D	D	D	D	D	MS	MS	MS	MS												
100-150	D	D	D	D	D	D	D	D	D	D	D	MS	MS	MS	MS	D	D	D	D	D	D	D	D	D												
150-200	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS												

ITEM 9

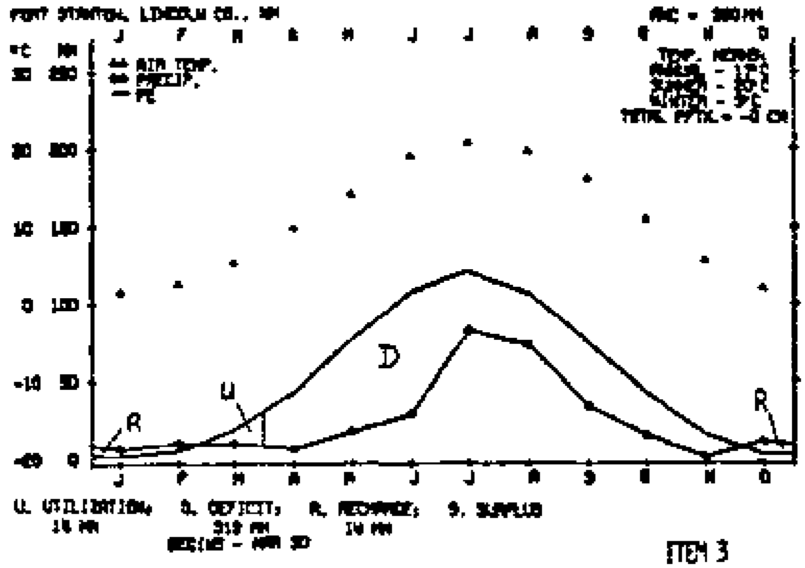
	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	
Item 8.	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Johnson, W. C. and Davis, R. G., 1980. Yield-water Relationships of Summer-fallowed winter wheat. ARR-S-5. January 1971 to December 1972 data. Block 1 minus plots 5, 6, 7. Upper record for dates of moisture observations. Lower record a monthly generalization for the period of measurement. Accumulation precipitation curve 1971-72 similar to long term average (see figure 19 of reference). Harvest late June 1971 and plant September 1972.

2. CN for Roman II from Texas State Office

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Ravanton

No. Records:

1

ITEM 3

```
PERCENT PROBABILITY      - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - -

1        100             DRY SOME/ALL PARTS MCS   90 OR MORE DAYS CUMULATIVELY        WHEN SOIL TEMP 5 DEG C OR HIGHER

2         99             DRY SOME/ALL PARTS MCS   6/10 OR MORE OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER

3         60             DRY ALL PARTS MCS        1/2 OR MORE OF DAYS CUMULATIVELY    WHEN SOIL TEMP 5 DEG C OR HIGHER

4         15             DRY ALL PARTS MCS        3/4 OR MORE OF DAYS CUMULATIVELY    WHEN SOIL TEMP 5 DEG C OR HIGHER

5         10             MOIST SOME/ALL PARTS MCS 90 OR MORE DAYS CONSECUTIVELY       WHEN SOIL TEMP 8 DEG C OR HIGHER

6         35             DRY ALL PARTS MCS        45 OR MORE DAYS CONSECUTIVELY       DURING 120 DAYS AFTER SUMMER SOLSTICE

7          5             MOIST ALL PARTS MCS      45 OR MORE DAYS CONSECUTIVELY       DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME:   MESIC                      ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL  MOISTURE   REGIME:   ARIDIC OR TORRIC           ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 5, 6, 7

AND MOISTURE REQUIREMENT IS "TYPIC" FOR:
 ARGIALBOLLS

AND MOISTURE REQUIREMENT IS "NON-TYPIC" FOR:
 DURARGIDS, HAPLARGIDS, PALEARGIDS, CALCIORTHIDS, CAMBORTHIDS, DURORTHIDS, PALEORTHIDS, TORRIFLUVENTS, TORRIORTHENTS, TORRIPSAMMENTS
```

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<----------kPa---------->										
cm	<----------Vol. Pct---------->						<----cm/day---->		g/cc	Pct	mmhos/cm
0-17		31	20		12	19			1.5	3	0.5
17-100		28	24		17	11			1.6		
100-140		27	22		16	11			1.6	10	11
140-160		26	20		14	12			1.5	5	7

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1

1. New Mexico State University pedon 78NM-27-2. Bulk densities adjusted to moist basis and 333 kPa retention replaced by measurements on cores supplied by T. M. Zobeck. 10 kPa water retention calculated as per Explanation A.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: One Seed Juniper, Pinyon Pine, Blue Grama Base Common: 20 Adjusted Base Few: 150
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 10-1500 kPa: 4 Adjusted Base Few 10-200 kPa: 10-1500 kPa: 18
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):

Reventon Loam, 3-8%
Juniper - Pinyon

Typifying Survey(s):

Lincoln County, NM

Compiler(s):

T. M. Zobeck

ITEM 8

Part A

Depth cm	Average - 6 Years in 10												Driest 2 years in 10												Wettest 2 years in 10											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MS F	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	D	D	D	MS	MS	MS	MS	MV	MV	MS	MS	MS	MS	MS	MS	MS	MS	MS	MV
25- 50	MS	MS	MS	MS	MS	MS	D	D	MS	MS	MS	MS	MS	MS	MS	D	D	D	D	D	D	MS	MS	MS	MV	MV	MS	MS	MS	MS	MS	MS	MS	MS	MS	MV
50-100	MS	MS	MS	MS	MS	D	D	D	D	MS	MS	MS	MS	D	D	D	D	D	D	D	D	D	MS	MS	MV	MV	MS	MS	MS	MS	MS	MS	MS	MS	MV	MV
100-150	MS	MS	MS	MS	MS	D	D	D	D	D	MS	MS	MS	D	D	D	D	D	D	D	D	D	MS	MS	MV	MV	MV	MS	MS	MS	MS	MS	MS	MS	MV	MV
150-200	MS	MS	MS	MS	D	D	D	D	D	D	MS	MS	MS	D	D	D	D	D	D	D	D	D	D	MS	MV	MV	MV	MS	MS	MS	MS	MS	MS	MS	MV	MV
PND-FLD																																				

Part B

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Runoff	M	M	M	M	M	H	H	H	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H	H	H	M	M	M
CN	65	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	65	65	45	45	45	45	45	45	45	65	45	65

Part C

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Erosion	S	S	S	S	S	M	M	M	S	S	S	S																								
Growth				X	X	X	X																													

ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Generalized from measurements made in 1978 and 79. Zobeck, T. M. 1980. Soil Moisture Regimes along a Vegetative Transect in Central New Mexico. PhD Thesis New Mexico State University, University Park. Microfilm Abst. No. 8017072. Water state pattern for open areas between trees.
2. CN assumes 35% cover. Initialized with New Mexico State Office estimate.

ITEM 1

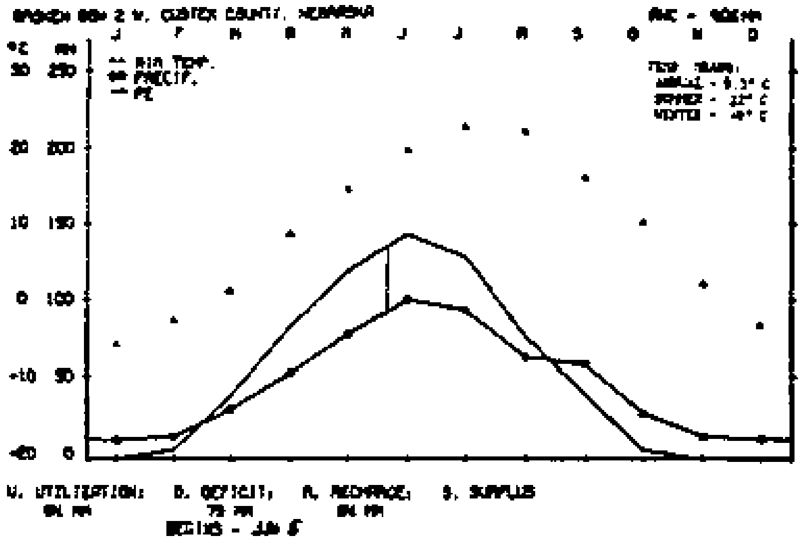
Series:

Oly

No. Records:

1

ITEM 2



ITEM 3

SOIL MOISTURE PROBABILITIES TO DETERMINE SOIL MOISTURE REGIME FOR SOIL TAXONOMY

	PERCENT PROBABILITY	- - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - -		
1	40	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	5	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	6	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	100	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	9	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	70	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: MESIC ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME USTIC ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 5, 6, 7

AND MOISTURE REQUIREMENT IS "TYPIC" FOR:
ARGIUSTOLLS

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 5 DEG C AND ABOVE. BEGINS APR 14 ENDS NOV 16 DURATION 216 DAYS.

ESTIMATED DATES AND DURATION WHEN SOIL TEMPERATURE IS 8 DEG C AND ABOVE. BEGINS APR 30 ENDS OCT 31 DURATION 184 DAYS.

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<--------kPa-------->										
cm	<--------Vol. Pct-------->						<------cm/day------>		g/cc	Pct	mmhos/cm
0-25	45	40	31	23	14	26			1.25	0	
25-60	42	37	26	25	16	22	140		1.29	0	
60-150	46	44	33	23	13	31	140		1.33	0	0.6

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1

1. Pedon 79NE-063-001. Only 1 kPa retention calculated.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Big and Little Bluestem; others Base Common: 45 Adjusted Base Few: 105
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 7 10-1500 kPa: 11 Adjusted Base Few 10-200 kPa: 18 10-1500 kPa: 28
C	Water Movement, cm/day Infiltration Rate: 80 Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):

Oly Silt Loam, 11-15% slope
Native range, fair

Typifying Survey(s):

Dawson County, MT
Morton County, ND

Compiler(s):

J. T. Brubacher
R. B. Grossman

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M F	M F	MW	MW	M	M	M	D	MS	M	M	M F
25- 50	M F	M F	M F	M	M	M	D	D	MS	M	M	M
50-100	M	M F	MS	M	M	M	D	D	D	D	M	M
100-150	M	M	MS	M	M	M	D	D	D	D	M	M
150-200												
PND-FLD												
Part B												
Runoff												
CN	98	96	71	71	71	71	71	52	52	71	71	96
Part C												
Erosion						x						
Growth				x								

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	D	D	D	D	D	D	D	D	D	D	D	D
25- 50	M	M	MS	MS	MS	MS	D	D	D	D	D	D
50-100	MS	MS	D	D	D	D	D	D	D	D	D	D
100-150	D	D	D	D	D	D	D	D	D	D	D	D
150-200												
PND-FLD												
Part B												
Runoff												
CN	71	71	52	52	52	52	52	52	52	52	52	71
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	M	MV	MV	MV	MV	MV	MV	MS	MS	M	M	M
25- 50	M	MV	MV	MV	MV	M	M	M	M	M	M	M
50-100	M	M	M	M	M	M	MS	MS	MS	MS	M	M
100-150	M	M	M	M	M	M	M	M	M	M	M	M
150-200												
PND-FLD												
Part B												
Runoff												
CN	98	96	71	71	71	71	71	71	71	71	71	96
Part C												
Erosion												
Growth												

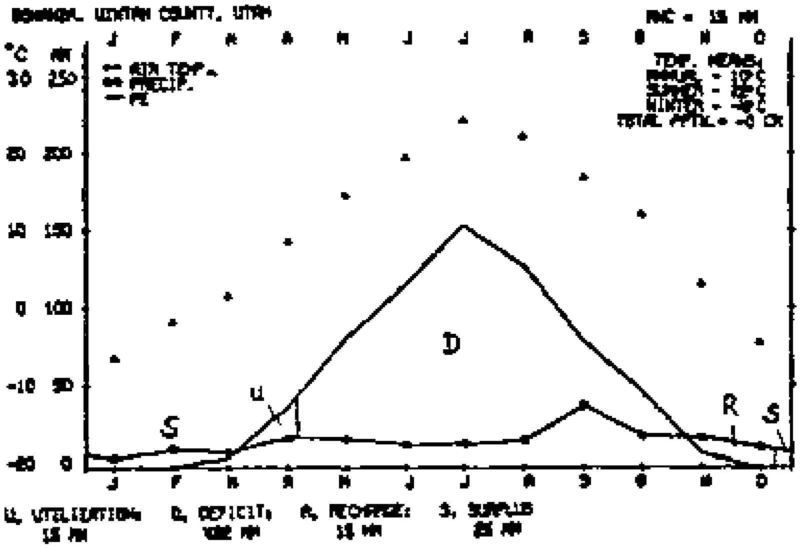
ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Based on field experience, not measurements
2. Roman II CN of 71 supplied by R. Kluth

SOIL SURVEY WATER RELATED INFORMATION

ITEM 2



ITEM 1

Series:

Walknolls

No. Records:
1

ITEM 3

```
     PERCENT PROBABILITY     - - - - - - - - - - - - - - - CRITERIA FOR MOISTURE CONTROL SECTION (MCS) - - - - - - - - - - - - - - -
1         100           DRY SOMEWHERE PARTS MCS   90 OR MORE DAYS CUMULATIVELY      WHEN SOIL TEMP 5 DEG C OR HIGHER
2         100           DRY SOMEWHERE PARTS MCS   [illegible] OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER
3         100           DRY ALL PARTS MCS         1/2 OR MORE OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER
4         [illegible]   DRY ALL PARTS MCS         [illegible] OR MORE OF DAYS CUMULATIVELY   WHEN SOIL TEMP 5 DEG C OR HIGHER
5           0           MOIST SOMEWHERE PARTS MCS 90 OR MORE DAYS CONSECUTIVELY     WHEN SOIL TEMP 8 DEG C OR HIGHER
6         100           DRY ALL PARTS MCS         45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER SUMMER SOLSTICE
7         [illegible]   MOIST ALL PARTS MCS       45 OR MORE DAYS CONSECUTIVELY     DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME:   MESIC                  ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL  MOISTURE   REGIME    ARIDIC OR TORRIC       ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 6, & 7

AND MOISTURE REQUIREMENT IS TYPIC FOR:
 [illegible]

AND MOISTURE REQUIREMENT IS [illegible] FOR:
 [illegible]
```

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	33kPa			
	<---------------kPa--------------->										
cm	<------------Vol. Pct------------>						<-------cm/day------->		g/cc	Pct	mmhos/cm

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1

1. Samples collected. Pedon S80UT-47-10

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Wyoming Big Sage, Spiny Hopsage, grasses Base Common: 20 Adjusted Base Few: 30
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 10-1500 kPa: Adjusted Base Few 10-200 kPa: 10-1500 kPa:
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):
Walknolls very channery loam, high rainfall, 4-25% slopes; low sagebrush and grass, fair.

Typifying Survey(s):

Compiler(s):
T. B. Hutchings
J. M. Downs
G. W. Leishman
R. G. Greenman

ITEM 8

Part A

Average + 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MS	MS	MV	MS	MS	D	D	MS	MS	MS	MS	MS
	F	F										F
25- 50	MS	MS	MV	MV	MS	D	D	D	MS	MS	MS	MS
	F	F										
50-100												
100-150												
150-200												
2ND-FLD												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25												
25- 50												
50-100												
100-150												
150-200												
2ND-FLD												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25												
25- 50												
50-100												
100-150												
150-200												
2ND-FLD												

Part B

	J	F	M	A	M	J	J	A	S	O	N	D
Runoff	VS	VS-S		S	VS	VS	VS	S	M	VS	VS	VS
CN	98	96	86	86	72	72	72	72	72	72	72	96

Driest and Wettest 2 years in 10: Runoff and CN blank.

Part C

	J	F	M	A	M	J	J	A	S	O	N	D
Erosion			X	X					X			
Growth				X	X			X	X	X		

Driest and Wettest 2 years in 10: Erosion and Growth blank.

ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Field evaluation; no measurements
2. Roman II CN from Utah State Office

SOIL SURVEY WATER RELATED INFORMATION

ITEM 1

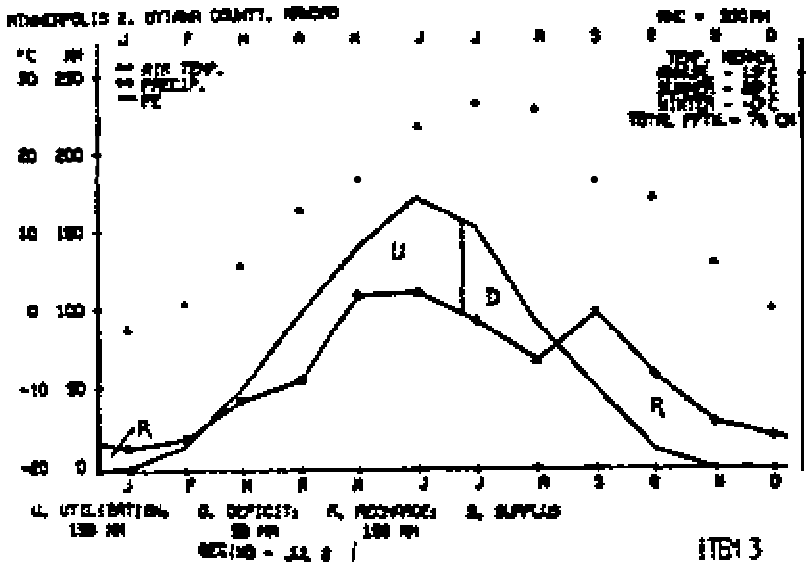
Series:

Wells

No. Records:

1

ITEM 2



ITEM 3

	PERCENT PROBABILITY	CRITERIA FOR MOISTURE CONTROL SECTION (MCS)		
1	55	DRY SOME/ALL PARTS MCS	90 OR MORE DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
2	10	DRY SOME/ALL PARTS MCS	6/10 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
3	0	DRY ALL PARTS MCS	1/2 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
4	0	DRY ALL PARTS MCS	3/4 OR MORE OF DAYS CUMULATIVELY	WHEN SOIL TEMP 5 DEG C OR HIGHER
5	95	MOIST SOME/ALL PARTS MCS	90 OR MORE DAYS CONSECUTIVELY	WHEN SOIL TEMP 8 DEG C OR HIGHER
6	20	DRY ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER SUMMER SOLSTICE
7	60	MOIST ALL PARTS MCS	45 OR MORE DAYS CONSECUTIVELY	DURING 120 DAYS AFTER WINTER SOLSTICE

SOIL TEMPERATURE REGIME: MESIC — ESTIMATED FROM NORMAL AIR TEMPERATURES

SOIL MOISTURE REGIME: USTIC — ESTIMATED FROM PROBABILITY VALUES IN LINES 1, 3, 5, 6, 7

AND MOISTURE REQUIREMENT IS "TYPIC" FOR:
HAPLUSTALFS, PALEUSTALFS, USTOCHREPTS, ARGIUSTOLLS, CALCIUSTOLLS, HAPLUSTOLLS, NATRUSTOLLS, PALEUSTOLLS
ARGIALBOLLS

AND MOISTURE REQUIREMENT IS "NON-TYPIC" FOR:
DURARGIDS, HAPLARGIDS, PALEARGIDS, CALCIORTHIDS, CAMBORTHIDS, DURORTHIDS, PALEORTHIDS, TORRIFLUVENTS, TORRIORTHENTS, TORRIPSAMMENTS

ITEM 4

A	B	C	D	E	F	G	H	I	J	K	L
Depth	Water Retention						Hydraulic Conductivity		Bulk Density	Volume >2mm	EC
	1	10	33	200	1500	10-1500	Saturated	5kPa			
	<------kPa------>										
cm	<------Vol. Pct------>						<------cm/day------>		g/cc	Pct	mmhos/cm
0-25	31	27	21	16	11	16			1.46	2	0.2
25-100	29	27	22	18	14	13			1.59	1	<0.1
100-125	26	22	16	14	11	11			1.6	1	0.1
125-150	26	22	16	14	11	11			1.4	5	0.1

ITEM 5

	Ref. Nos.
Item 1: Explanation A	
Item 2: Explanation A	
Item 3: Explanation A	
Item 4: Explanation A	1

1. Pedon 79KS-143-001. 10 and 200 kPa retention values estimated. Lower two bulk densities estimated.

ITEM 7

Part	Quantity
A	Rooting Depth, cm Plants: Big, Little Bluestem Base Common: 65 Adjusted Base Fev: 100
B	Root-related Retention Difference Sums, cm Base Common 10-200 kPa: 6 10-1500 kPa: 9 Adjusted Base Fev 10-200 kPa: 10 10-1500 kPa: 14
C	Water Movement, cm/day Infiltration Rate: Intake Rate: Surficial Hydraulic Conductivity Saturated: 5kPa:

ITEM 6

Annual Use Sequence(s):
Wells loam 3-7%
Range, good, warm season

Typifying Survey(s):
Ottawa County, KS

Compiler(s):
L. E. Brown
V. Hamilton
R. B. Grossman

ITEM 8

Part A

Average - 6 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MS F	MS	MV	MV	MS	D	D	D	MS	MS	MS	MS
25- 50	MV F	MV F	MV	MV	MV	MS	MS	D	MS	MS	MS	MS
50-100	D	MS	MS	MV	MV	MV	MS	MS	D	D	D	D
100-150	D	M	M	M	M	M	M	D	D	D	D	D
150-200												
PND-FLD												
Part B												
Runoff												
CN	61	61	61	61	61	41	41	41	41	41	61	41
Part C												
Erosion												
Growth												

Driest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MS	MS	MS	MS	MS	D	D	D	D	D	MS	MS
25- 50	MS	MS	MS	MS	MS	MS	D	D	D	MS	MS	MS
50-100	D	D	D	MS	MS	MS	D	D	D	D	D	D
100-150	D	D	D	M	M	D	D	D	D	D	D	D
150-200												
PND-FLD												
Part B												
Runoff												
CN	61	41	41	41	41	41	41	41	41	41	41	41
Part C												
Erosion												
Growth												

Wettest 2 years in 10

Depth cm	J	F	M	A	M	J	J	A	S	O	N	D
0- 25	MV	MV	W	W	MV	MS	D	D	MS	MS	MV	MV
25- 50	W	W	W	W	MV	MV	MS	MS	MS	MS	MV	MV
50-100	MS	MV	MV	W	W	W	MV	MS	MS	MS	MS	MS
100-150	M	M	M	M	M	M	M	M	M	M	M	M
150-200												
PND-FLD												
Part B												
Runoff												
CN	61	61	78	78	61	61	41	41	41	41	61	61
Part C												
Erosion												
Growth												

ITEM 9

	Ref. Nos.
Item 7:	
Part A - Explanation A	
Part B - Explanation A	
Part C - Explanation A	
Item 8:	
Part A - Explanation A	1
Part B - Explanation A	2
Part C - Explanation A	

1. Field experience; no measurements
2. Range II CN obtained from Kansas State Office

Strategy for Updating Soil Taxonomy

To keep things in perspective, I plan to briefly discuss the history of Soil Taxonomy, then discuss what we are now doing, followed by statements on future plans.

In 1951, the Soil Conservation Service made the decision to develop a new soil classification scheme which was finally published in 1975 as Soil Taxonomy. This was a lapse time of nearly 25 years. The main reason it took so long to develop and publish was because of all the information that had to be assimilated and the rapidity new information accumulated. Probably by design the rate of accumulation of new information did slow down enough so concentrated effort could be put on publishing the system rather than all the effort being concentrated on improving it.

Once Soil Taxonomy was published, suggestions for changes such as additional classes, redefinition of existing classes, clarification, etc., started pouring in. An elaborate review process was set up to review suggestions to ensure any approved changes would really result in an improvement to Soil Taxonomy. As a result of the review process being too cumbersome and also understaffing, the review process failed, resulting in no officially approved or rejected suggestions. People who had made suggestions were not sure of the status of their suggestions and for various reasons the number of new suggestions being submitted greatly diminished. In the meantime several International Soil Taxonomy Committees were established.

The current lull of receiving few proposals is going to be short-lived because the International Committees will start submitting their recommendations in the near future.

At this time, I estimate that we have nearly 1 man-year of work to process our backlog. The work involves: (1) reviewing each proposal, (2) requesting additional information where documentation is inadequate, (3) writing the necessary documents for approving or rejecting them, and (4) making proper record on the status of each proposal. We desperately need to clear up this backlog if we are ever to handle the International Committees recommendations. Since the International Committees will start submitting their recommendations by the end of 1981 or early 1982, we should plan to have our backlog substantially reduced by them.

Our current procedure is as follows:

1. We act on new proposals first and those for which we receive a followup letter requesting early acceptance.

2. We evaluate the proposal and determine the amount of review it has received.

3. If the amount of prior review is minimal but we believe the proposal should be accepted, we send it out to the **Head, NSSL,** and the Heads, Soils Staffs, at the four **TSC's** for their **recommendations.** The four Heads, Soils Staffs, are chairmen of the respective Regional Soil Taxonomy Committees and as chairmen they have the option to send the proposal to committee members for their review. If we receive no objections, the amendment is approved by the Director, Soils. The Head, NSSL, and the four TSC Soil Staff Heads are notified with a request they notify soil scientists within their area and the cooperators.

4. If the amount of prior review appears adequate and no objections were received, the amendment is approved by **the Director** of Soils. Again the approval notice is sent to the NSSL and **TSC's.**

5. A few months after an amendment has been approved, a notice is prepared. Each notice will include: (a) a brief statement describing the amendment and date approved, **(b)** justification for the amendment, and (c) required changes in Soil Taxonomy to accommodate the amendment. The main reason for not publishing immediately is to give a few others a limited amount of time to evaluate all the changes required.

6. We believe the document title "Soil Taxonomy--Approved Amendments and Clarification of Definitions" dated **May** 5, 1978, should receive special attention. Even though the document, which received wide distribution, was labeled "approved" it never really received official sanction. We are reviewing this document. Those proposals ("approved amendments") that we can identify as not being too controversial and that are adequately documented and justified will be published first. Most of these have been identified and a few have been written up as a notice in draft form. The notice will be referenced back to the 1978 document.

The "approved amendments" that were controversial will require additional research before a decision is made as to which **onces** should be approved and published. Others that includes subject matter that involves international committees will be deferred until we receive the **committees** recommendations.

7. Host other proposals that we have on hand were published in the document "Proposed Amendments to Soil Taxonomy" dated **May** 1978. During the last **1-1/2** years very little time has been spent reviewing these proposals.

Other Plans:

1. A computer program for recording the status of Soil Taxonomy proposals have been developed. So far, however, we have not **inputed** any of the proposals and a real plan for doing the inputting has not been developed. At this time we do not have a good record **of** the status of proposals and if somebody inquires about a particular proposal it takes some searching to determine its status.

2. We hope to computerize Soil Taxonomy to assist in keeping track of changes required in ST as a result of approving amendments and to test proposed amendments. Such a computerized system is needed because changing one part often has implications in many other places. It is very easy to overlook a needed change if the operation is done manually. At this time, we have approval to develop a contract with New Zealand and we believe the contract will be approved for funding mostly through SMSS. New Zealand has already done considerable amount of work needed for a program as a result of their flow diagnosis.

3. Sometime in the late 1980's we plan to produce an updated edition of Soil Taxonomy that incorporates all the changes that we expect to be making within the next few years. There will be numerous changes and some of them will be major, especially as a result of incorporating recommendations from the International Soil Taxonomy Committees. We expect, however, that within the U.S. the impact of these major changes will be relatively small in that probably only a few families and no series will be split. In other words the classification of a series may change but *its ranges* in characterization will be unchanged.

Use and Application of NCSS Standards in International Activities

I want to discuss briefly what we are doing now and some of our future plans concerning the use-and application of NCSS standards in international activities. I would then like to hear your comments if you think we could be more effective by using other approaches.

I think I can safely say that we have not tried to force our NCSS standards on other countries and are reluctant to even distribute our standards unless specific request for them is made. Most of our standards are contained in Soil Taxonomy Soil Survey Manual, National Soils Handbook, and Soil Survey Investigations Report Number 1. We do not have the resources to make wholesale distribution of these documents, unless, of course, the requesting country pays printing and shipping costs.

At the same time, we have distributed a lot of free copies of Soil Taxonomy, for example, but most of these were given out as a result of personal contacts or letter requests and then generally only to soil survey leaders in a country.

Probably the most systematic application of NCSS standards in international activities is made when a requesting country asks for in-country assistance. In these instances, we transfer, as applicable, our NCSS standards to the host country.

In the future, we plan to be more systematic in letting other countries know of new developments or improvements in our standards. Hari Eswaran is developing an address list of people we know or believe are interested in our standards. There are about 250 names on this list. As new chapters of the Soil Survey Manual or amendments to Soil Taxonomy are printed for publication in the National Soils Handbook or other items of interest comes up, we will send copies to these people. Hari plans to manage the list so names self destruct if we do not receive acknowledgments at set periods of time. We do not plan to make distribution of our standards to disinterested people.

Also, plans are being made to develop a set of monographs on such subjects as soil resource inventories, use of soil phases, and soil chemical analyses for Soil Taxonomy. These will be written with an internatinal flavor.

International Efforts in the Use and Application of Soil Taxonomy

The Soil Management Support Services

Hari Eswaran*

Introduction

Agricultural development efforts throughout the world, especially in the less developed countries (LDC's), call for more and accurate information on soils and land use. The urgency for such information is highlighted by various scenarios for global food supplies and population in the next few decades. Economic inflation, arising in large part from oil price hikes, is a major stimulus to efforts of LDC governments to seek self-sufficiency in food and fiber production at a rate faster than in previous decades. Many LDC's realize that they cannot wait for local research efforts to provide answers. Their immediate and urgent requirement is for technology transfer from other LDC's with similar agro-ecological conditions or from other sources.

Two Federal agencies--the Soil Conservation Service (SCS) of the United States Department of Agricultue and the State Department's Agency for International Development (AID)--have played a small but significant role in projects for agricultural technical assistance to LDC's. In September 1979, SCS and AID entered into a participating agency service agreement (PASA) to coordinate their assistance efforts, particularly in soil survey, classification, and management. The PASA complements other efforts of each agency. The assistance project is called the Soil Management Support Services (SMSS).

The Purpose of SMSS

Agro-technology transfer should be site specific and even soil specific. Consequently, the purpose of SMSS is to develop the prerequisites for soil-based agrotechnology transfer. Effective international transfer of technology requires a common language, and SMSS uses Soil Taxonomy (Soil Survey Staff, 1975) as the vehicle for this international transfer.

Soil Taxonomy presents a soil classification system that was designed specifically for making and interpreting soil surveys. As the system was being developed, the all-important question was continually asked: "Do these groupings permit us to make precise predictions of soil behavior?" Extensive testing in the United States and in some foreign countries has shown that, by and large, they do permit such predictions. As a vehicle for technology transfer, however, the system has some inherent weaknesses. For example, because it was developed with data from the United States, it presents some problems in classification of soils of the intertropical

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areas where many LDC's are located. This is not to imply that tropical soils cannot be classified with the Soil Taxonomy system, but questions frequently arise about the appropriateness of the classification in terms of the kinds of interpretations that can or should be made.

Besides a common language, an effective transfer requires a pool of information. A recent evaluation (Beinroth et al., 1980) indicates that, in general, enough information is available but that it is unequally distributed among LDC's and is often lacking where it is most needed. Furthermore, experience with particular kinds of soil is also unequally distributed. Beinroth et al. (1980) note that it is often difficult or impossible to extrapolate experimental results to other sites, because the experiemental sites are located on atypical soils or because the soils are inadequately characterized and classified. They conclude that the USDA soil classification system in Soil Taxonomy is essential for the effective transfer of agronomic research.

General Objectives of SMSS

Keeping in mind the overall goal of increased food production leading to self-sufficiency in the LDC's, the two general objectives of SMSS are (1) to provide technical assistance in soil survey and interpretation and (2) to assist in technology transfer by refining the classification system of Soil Taxonomy for more effective use in the intertropical countries and by encouraging its greater use in these countries.

SMSS technical assistance is provided at no cost to the recipient countries and is normally for a period not exceeding 6 weeks. This assistance includes:

a. Helping the countries establish policies and programs for solving problems in land use and food and fiber production;

b. Helping plan, carry out, and evaluate soil surveys and soil conservation programs;

c. Providing laboratory and field testing services;

d. Publishing soil management information that is needed in land use planning and for food and fiber production;

e. Conducting seminars and other training sessions on improving soil management and on classifying soils;

f. Interpreting soil properties to determine the potential of the soils for agriculture and predict their response to management; and

g. Disseminating new ideas for increasing soil fertility, improving plant nutrition, and controlling soil erosion and sedimentation.

Requests for technical assistance originate from the countries, and are transmitted by the AID country missions through AID headquarters in Washington, D.C., to SMSS. A technical specialist is nominated for the task according to the nature of the request. The search for the specialist is conducted in SCS, universities in the United States, or from other U.S. agencies or abroad. A file of interested individuals is maintained by the SMSS staff for this purpose. On completion of the assignment, the specialist prepares a report that is transmitted to the country through AID. Any recommended follow-up activities are coordinated by AID or SMSS.

In its first year of operation, SMSS responded to 18 requests from LDC's. Some of these, such as the fuelwood project in Senegal, required detailed soil surveys of experimental areas. Others, such as a request from Sudan, called for an assessment of the requirements for a national soil survey laboratory. Assistance was also provided for developing soil survey programs (Rwanda), or evaluating ongoing programs (Ecuador).

The technology transfer objective of SMSS requires a different approach. Soil classification and soil survey interpretation are emphasized. The premise is that Soil Taxonomy can be used to further horizontal transfer of technology, that is, transfer between countries. Vertical transfer is the delivery of technology from the specialist to the farmer. Our strategy for horizontal transfer is to assist agricultural technicians by making them aware of available technologies. The countries are encouraged to use a common system to develop their data bases so that they can benefit from experience elsewhere.

To enable the technology transfer, Soil Taxonomy is being modified to take into account new information from the intertropical areas where it is used and tested. To assist in this task, several international committees have been created and the work of these committees will be reported later.

Compared to the global magnitude of food and population problems, the contribution of SMSS is very small. It nevertheless is mutually rewarding project both for the recipient country and for us. It has been said that the greatest advances in soil science came about as a result of developing Soil Taxonomy, and it appears that many of the expected modifications of Soil Taxonomy will come through this project. With the experience and expertise gained as a result of SMSS, Soil Taxonomy will truly become one of the most effective vehicles for agro-technology transfer.

References cited

Beinroth, F. H.; G. Uehara; J. A. Silva; R. W. Arnold, and F. B. Cady. 1980. Agrotechnology transfer in the tropics based on Soil Taxonomy. Advances in Agron. Vol. 33: Academic Press. New York. p 303-339.

Soil Survey Staff. 1975. Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys. U.S. Dep. Agric. Soil Conserv. Serv. Agric. Handb. 436. U.S. Gov. Print. Off., Washington, D.C. 754 p.

ICOMLAC

Summary review, for biannual National Work Planning Conference

The mandate of ICOMLAC is to upgrade the level of taxonomic classification of Alfisols and Ultisols, dominated by low activity clays, i.e., 1:2 layered clay minerals, mainly kaolinite, and/or oxy-hydroxides of iron with common occurrance of gibbsite. At present, the only levels available to distinguish these highly weathered soils are the subgroup and the family (mineraology class). Because these soils are widespread and because they have a number of management-related properties in common which distinguish them from related taxa with high activity clays, it seems necessary to distinguish them at a higher level of generalization.

The category choosen to distinguish the LAC Alfisols and Ultisols is that of the Great Group. Short of creating a new order of LAC soils (or of thoroughly changing the concept of Oxisols), the Great Group is taxonomically the most appropriate level for reclassification of these soils.

The formative elements, proposed for use in the nomenclature of LAC Alifsols and Ultisols at the Great Group level are "Kandi" and "Kanhapl". The former indicate deep profiles, with a textural profile similar to the "Pale groups" of e.g., Udalfs. The latter, though having LAC properties,, do have textural profiles related to those of the "Hapl" groups of e.g., Ustults.

Discussions on the diagnostic criteria, to be used for defining LAC taxa of Alfisols and Ultisols have not yet led to complete concensus.

Recognition of an argillic horizon is often difficult so that the distinction between Kandi taxa and Oxisols/LAC Inceptisols frequently is controversial. For this reason, a new diagnostic subsurface horizon has been proposed, the ksndic horizon. Recognition of a kandic horizon is based on clay increase with depth, but excepted are cases where young sediments have been deposited over a more clayey substratum. The increase in clay is the same as defined for an srgillic horizon, but is reached within a vertical distance of 15 cm or less. The kandic horizon is exclusive for LAC taxa of Alfisols and Ultisols; moreover the argillic horizon, if present, has priority as a diagnostic property.

Charge properties of LAC soils are difficult to determine; CEC values often lack reproducibility. For want of better, and in order to be able to use the most commonly available CEC data, the LAC property is determined by measuring the CEC/NH$_4$OAc at pH and/or the ECEC^), both expressed per 100 g clay. In LAC Alifsols and altisols, the CED/NH$_4$OAc is less than 24 meg and/or the ECEC is less than 16 meg in the major part of the argillic or the kandic horizon.

No agreement has been reached on the classification of LAC Alfisols and Ultisols in which a major part of the clay-fraction is formed by iron oxy-hydroxides and gibbsite (oxidic families?); it is felt that such soils should possibly be separated at the Great Group level.

Ranking of the LAC Alfisols and Ultisols in the keys of Soil Taxonomy varies with the suborder, but in principle they should have a higher ranking than the existing "Trop", "Pale", "Rhod", "Hapl(o)", "Ochr", and "Umbri" Great Groups. In the higher ranking group grous, the LAC properties, when occurring, are to be distinguished at the subgroup level.

Subgroups of the various LAC great grous follow, where possible, the definition proposed for existing subgroup of Alfisols and Ultisols. The necessity of some, but by no means all, new subgroups specifically required for LAC taxa was discussed. Subgroups, based on a very low ECEC (acric) and on iron segregation without a concommitant aquic moisture regime (vadic) are proposed. A differentiation between soils with less and with more than a defined amount of weatherable minerals (10 percent) would be desirable. Contrary to general assumptions, the content of weatherable minerals is not nearly always linked with the low activity character of the clay fraction.

Largely unfinished are the detailed descriptions of the impacts that the proposed amendments and changes will have on all taxa that will be affected.

x) ECEC = sum of bases + Al extractable in 1 NKCI at the pH of the soil.

SHORT REPORT ON ICOMERT

The first circular letter was just finished in the month of February and sent to the first group of possible interested members in this order of Soils. It included soil scientists from Australia, New Zealand, India, USSR, Syria, Yugoslavia, Belgium, France, Spain, Sudan, Nederlands, USA, Puerto Rico, Venezuela, and FAO.

The main problems which vere presented in this first letter vere:
(1) the fact that in some countries and conditions, the Chrom and Pell criteria is not working well in establishing a clear separation betveen better and poorer drainage conditions. In countries like Venezuela, the Pell is grouping the poorly drained, but the Chrom also groups, in about half of its members, poorly drained together vith better drained. The proposed criteria of "slope" apparently is not improving much the separations because we could end up with almost all Vertisols grouped vith Pell when we add "or have slopes less than 1 percent", as most of them are in flat surfaces. An improvement in the definition of drainage classes in Vertisols is another need. A possibility is presented based on Venezuelan conditions. Three or more months vith water stagnant on the surface could be the basis to group poorly and very poorly drained, and separate them from the better drained. On this basis the presence of "Chromas of 2 or less on the surface of ped dominanting in the upper 50 cms", groups Vertisols very well in respect to drainage condition. This could be criteria to define a Suborder Aquert, but an agreement for an operational definition on aquic moisture regime would have to be reached.

2. Acid and nonacid families in Vertisols was proposed, and is reminded here based on a lower pH than the one required for other mineral soils. The proposition is for acid families "pH less than 4.5 in 0.01 M $CaCl_2$ or 5 in 1.1 water".

3. Calcareous families can be better defined for Vertisols based on the definition as follow "the major part of the pedon effervesces while the rest may not be calcareous".

REPORT ON ACTIVITIES OF THE INTERNATIONAL COMMITTEE ON SOIL MOISTURE REGIMES IN THE TROPICS (ICOMMORT)

(April 1981)

A. Van Wambeke

The Committee acts as an informal clearinghouse for suggestions made abroad to make changes to "Soil Taxonomy". These suggestions are discussed and submitted as a package to the Soil Conservation Service.

The Committee is only expected to consider changes in the definitions of moisture regimes in tropical areas. The ustic moisture regime was the central topic of the discussions, although criteria for subdividing other regimes were also considered.

The intent is not to develop a pedoclimatology, but to have temperature or moisture constraints implied in the definition of taxa when they seriously restrict root growth. The level at which the climatic criteria are to be introduced, and the precision required for use in the definitions is also a matter of concern.

A. Subdivision of the Ustic Regime in Tropical Areas

Dr. Guy Smith has made suggestions for the subdivision of soils with ustic moisture regime in areas with iso-temperature. They are based on the number of consecutive days that the moisture control section is moist in some or all parts during one year. The critical limits are six months and nine months. Those with less than six months would be aridic ustic. Those between six months and nine months would be typic ustic. The soils with more than nine months would belong to udic subdivisions.

Other proposals considered a "dry contact" or a flushing moisture condition at some period of the year.

B. Temperature Regimes

It is difficult to define moisture regimes without considering at the same time the criteria used for the temperature regimes. The following points were of interest.

1. It was felt that the present definitions of temperature regimes which are now only based on mean annual soil temperatures and the iso-criterion can be improved. FAO recommends developing a system which takes into account the duration and the intensity of cold and warm seasons.

2. The usefulness of the iso-temperature criterion is still debated, and some suggest eliminating it completely or only using it at the family level. A complete elimination at all levels and in all definitions, including the definition of Xeric, would produce groupings of winter rainfall and summer rainfall soils into one taxon of high category.

FAO suggests to replace the criterion of 5° difference between winter and summer by one where all months are warmer than 18°C. The rationale is that the 18°C limit would match the intertropical belt better than the actual 5°C difference limit. Testing of these boundaries is needed to allow more precise selection of criteria.

3. There is a proposal to create an isomegathermic and a megathermic temperature regime in which the mean annual temperature would be higher than 28°C.

C. Difficulties in the determination of the moisture regime.

1. The moisture control section. Soil Taxonomy states that the intent of the HCS is to facilitate the estimation of moisture regimes from climatic data. It is that part of the profile in vhich changes in moisture during one year would be diagnostic of the moisture regime according to a preconceived classification,

In this perspective the moisture control section is not limited exclusively to the part of the profile from which plsnts extract water. Neither does it represent exclusively the major rooting zone of crops. It is actually an artifact which serves the purpose of a classificaton system which uses properties of a part of the profile to evaluate the impact of climate on soil genesis and on the growth of roots.

This definition may of course be broadened to include available water present in the rooting zone, for example in a section of a soil between fixed boundaries.

2. The soil temperature measurements. Several members comment that the soil temperature at 50 cm depth changes markedly when the soil cover is modified by cropping.

These observations have been confirmed in several parts of the world, particularly in tropical and in dry areas. An agreement is needed on the kind of soil *temperature to* be used in Soil Taxonomy and on the conditions under which it should be recorded. As in all other observations related to climate, measurements will be comparable only when obtained under standardized conditions. The soil temperatures to be taken Into account are probably those for soils under natural vegetation or growing crops. There is little practical value in using the temperatures observed in bare soils as requested by the World Meteorological Organization; these data may be useful for airfields or for road construction, but do not serve agronomic purposes adequately, except for seed emergence.

It would seem appropriate that Soil Taxonomy specifies the conditions under which the temperatures in the soil should be measured. The use of shelters to protect instruments and soils from direct radiation may be needed.

3. The estimation of soil temperature from air temperature. There have been a number of attempts to relate air temperature with soil temperature in many parts of the world. Several members have been working on this particular subject. There is apparently no universal method which

would be valid in all parts of the world and regional solutions may have to be sought.

4. Calculation of potential evapotraospiration. This is also a frequent subject of discussion and regional solutions probably are the best for the time being.

5. Computer Models. There are several computer models available in the literature which help to identify moisture regimes on the basis of atmospheric data. The degree of detail and the factors to be taken into account depend on the uniformity expected in each taxonomic subdivision. There is not much to be gained subdividing the soil continuum into segments which are narrower than the confidence limits attached to the measurements. Some climatic classes will remain broad for considerable time in the future.

Soil Information to Serve Forest Service Requirements

The Forest Service uses NCSS soils data extensively for land and resource management planning and project design purposes. These uses can be described in four general categories:

1. Classification--identification of biophysical land units.

2. Productivity--determination of potential production and yield.

3. Suitability--for management practices or resource uses.

4. Hazards--sensitivity of the land, including soil, to use or management practices.

Land management planning is primarily concerned with long-range future management; therefore, the accuracy, level of detail, and intensity of soils data must be designed to support prescriptive decisionmaking. It must also aid in identifying problem areas and limitations to be considered in the development of land management plans.

One of the problems in using NCSS soils data is the lack of complete coverage on national forest lands. Some national forests are not scheduled for completion until 1995-2000. Associated with this problem is the lack of correlation between soils on national forest lands and adjacent lands.

The "information revolution" is bringing about major advances in the handling and communication of information. Terminals, video conferencing, projected multicolor graphics, and massive information systems are here or on the horizon. The NCSS procedures must be adapted to this new technology. An efficient mechanism is needed for storing soils data directly from the field, and also for retrieving and communicating this data and interpretive information.

The Five Agency Policy Committee (BLM, FS, USGS, FWS, SCS) is coordinating the establishment of uniform interagency inventory procedures, definitions, and joint data bases. This effort applies to soil information as well as vegetation, landform, aquatic habitat, and other components of the land. The objective is to provide consistent interpretations along with a reliable data base that each of the agencies can use.

To meet the needs of the Renewable Resources Planning Act, additional emphasis should be placed on research related to forest soils. Improved procedures for monitoring the effects of management practices on soil productivity are needed. Additional research should also be directed toward predicting and measuring erosion and sedimentation.

SOIL INFORMATION TO SERVE FEDERAL AGENCY REQUIREMENTS

By: D. G. Fohs, Federal Highway Administration.

Rather than addressing the topic of thls session as a representative of a Federal agency I have chosen to assume the role of a geotechnical or materials engineer of a State Transportation Agency In describing soil information requirements. I felt it was most appropriate to speak from their position because under the Federal-Aid to Highways Programs the State Transportation Agencies are responsible for the planning, design, construction, operation and maintenance of the Interstate, Primary and Secondary Systems and are in reality the users of the soil information provided in soil survey reports.

State Transportation Agencies use soil survey reports to varying degrees; however, mostly in the early phases of project development. It is generally accepted that transportation projects are developed through the following stages: (1) corridor study, (2) route selection, (3) preliminary design, (4) final design, (5) advertising and bidding, and (6) constructton. To develop information for planning a major transportation facility between points A and B one or more corridors perhaps up to five miles wide are defined. The corridor study is the stage of project development during which the choice of best sites can be encouraged and poor sites discouraged, County soil survey reports containing engineering chapters, are among the resources the geotechnical engineer uses to provide Input to corridor studies. Topographic, drainage and geological maps, aerial photographs, geological literature, USGS water resource reports, test borings and soil test data from adjacent or local projects and review of known problem geological or soils and foundation conditions are other sources which are reviewed with respect to the corridor under study. During the corridor study an assessment should be provlded of critical right-of-way requirements, areas of potential instability, bearing capacity or consolidation considerations, considerations for pavement design, need for special construction sequences and techniques and anticipated maintenance problems. In part. soil survey reports provide the basis for these assessments.

Geotechnical investigations for the route selection stage of project development vary from nonexistent to fatrly comprehensive programs. The general tendency is to perform only the geotechnlcal investigations required for adequate evaluation of potential problem areas. It Is the belief of several agencies that route selection is often predicted on considerations other than geotechnlcal (i.e., geometrics, economics. traffic patterns, politics, and local concerns), and, therefore, only limlted investigations are required.

However, the information gathered during the corridor study can be supplemented with additional fieldwork where necessary to help tie down the final alignment. This stage is also crucial with respect to right-of-way and cost estimates; failure to consider all geotechnlcal factors can be costly In terms of funds and timely project completion.

During route selection, some attention is given to maximum heights for cuts and fills, subsurface drainage, and potential slide areas. Small changes in alignment often reduce the problem potential for little or no increase in cost.

The geotechnical investigation may also supply adequate information so that the designer can establish grades, right-of-way widths, special cut sections, and other considerations. This information is also used to estimate earthwork quantities, write special provisions, and prepare plan notes.

Engineering information from soil survey reports influence the preliminary design developed. Landslide potential, type of subsurface drainage structures (steel or concrete), means to protect against erosion during and after construction are inferred or obtained from published sources such as soil survey reports to provide the basis for route selection.

Soil survey reports are frequently used to develop boring, sampling and testing programs to be conducted to provide subsurface data for pavement and foundation design.

In a soon to be published National Cooperative Highway Research Program (NCHRP) report it was indicated that "soil survey data are most useful in the preliminary planning stages of the project. The data should be used to consider the relative cost, suitability and impacts of alternative routes and to plan the general nature of the subsurface explorations that will follow. The following general estimates of conditions in the various soil parcels of mapped areas are as follows:

- general suitability/unsuitability
- depth range to bedrock
- groundwater conditions
- general slope stability
- erosion susceptability
- excavation characteristics
- frost susceptability
- heave or collapse potential
- potential borrow areas
- degree of uniformity or complexity of soil conditions

Soil survey maps are also excellent sources of projecting data beyond the normally-mapped right-of-way, especially in locating borrow materials and estimating environmental impact such as surface and culvert erosion and related sedimentation."

Once the location of a facility is established the geotechnical engineer will conduct a detailed subsurface investigation to measure the soil parameters necessary for the structural design of pavement or foundation structures. It does not appear to be cost effective to map the parameters necessary for design for large areas; consequently, most States obtain engineering soils data on a project by project basis, Soil survey reports are frequently used to develop boring, sampling, and testing programs to provide subsurface data for pavement, slope, and foundation designs.

The foregoing is offered in response to Bill Reybold's question, "How does your agency use soil survey information?"

Heretofore the most significant shortcoming relative to soil survey reports was the lack of coverage and that many of the available reports did not contain engineering chapters.

The legislative package recently sent to Congress by the Department of Transportation calls for completion of the Interstate System by 1990 and that the management of the Federal-aid highway program will protect the investment of the American people in our highway network.

The proposed legislation stresses completion of the Interstate System by 1990, and preservation of the system as the highest Federal priority. The bill further emphasized the importance of both the rimary ystem and the bridge repair and replacement programs. Each would continue to receive high levels of Federal funding.

Federal-aid for secondary and urban systems would be phased out after fiscal year 1983, and the States would then be expected to assume full funding responsibility for those programs. A number of existing categorical highway and safety programs also would be eliminated under the proposed legislation.

The current 3-R program (resurfacing, restoration, and rehabilitation) would be expanded to a 4-R program by adding reconstruction. Effective October 1, 1981, the Federal share for Interstate 4-R projects would rise from 75 to 90 percent, and 4-R funds could not be used for toll roads. For the first apportionment under the legislation for fiscal year 1983, no State, except Alaska, will receive a combined total of Interstate and 4-R funds which is less than the combined Interstate and 3-R apportionment would have been under existing law for fiscal 1983.

The shift in the highway program administered by the Federal Highway Administration (FHWA) from providing new routes to maintaining those already constructed indicates that the early stages of project development, for which soil survey data provides valuable input, will not be conducted because few, if any. new highways will be built in the next 10 years. However, roadbuilding in this Nation will not end with the completion of the Interstate. The current transporation legislation calls for transfer of the Appalachian Highway Development System to the Department of Transportation to be funded from the Highway Trust Fund. The Territorial Highway Program would be transferred to the Department of Interior.

With the major network of roads completed attention will be turned toward providing improved access to high type transportation facilities. Many of these feeder roads will be on new alignments. The new legislation infers that development of these facilities will be the responsibility of local officials who are not presently equipped technologically to do the engineering. The FHWA presently has a research program that is developing tools for the relative layman to design, construct and maintain his local road network. Some States are already using soil survey data as a basis for pavement and drainage design for low volume roads. Soil survey data is particularly useful for this level of facility because they must be provided at relatively low cost. Alignments tend to follow existing terrain so that little cutting or filling is done; consequently the pavement for low volume roads will lie in a relatively shallow zone whose characteristics are documented in soil survey reports. Construction of the

Interstate and other development has depleted the source of aggregates for roadbuilding; consequently, fine-grained soils stabilized by chemicals such as portland cement and hydrated lime are being seriously considered as the principle pavement construction material for low volw roads. Stabilizer requirement is primarily dictated by grain size and clay mineralogy. Consequently, clay mineral type by series would be a useful piece of data for future soil survey reports. Also, research has shown that pedological soil series is an excellent tool for predicting the stabilizer requirements, This research was completed in the late 1950's or early 1960's; however, the geotechnical and materials engineer has not used it extensively because he was afforded the opportunity to sample and test the soils to establish the stabilizer requirement. Local road officials, responsible for the major portion of new roadbuilding, will probably not have the technical or financial resources to do similar sampling and testing, thus, I believe it would be worthwhile for soil survey reports to suggest stabilizer recommendations.

In conclusion It appears as though the use of soil surveys by State transportation agencies will decrease significantly because those phases of highway project development, corridor studies,and route selection, for which survey reports were most used will not be conducted. However, a significant amount of roadbuilding will continue on secondary and local low volume facilities. It is recommended that the NCSS regard these agencies as their new highway customer. As 1 Indicated above, I believe that modern soil survey reports fulfill local roadbuilders needs but SCS should establish contact with representatives of local roadbuilders such as the National Association of County Engineers (NACE) and the National Association of County Officials (NACO) to obtain their inputs for planning soil surveys.

National Cooperative Soil Survey: Status Within the National Park Service

James C. Patterson

The National Park Service (NPS) has a standing need for soils information to ascertain the status of the existing soil resource, to evaluate present use requirements, to assess the appropriateness of existing uses, and most importantly, to suggest methods of improved soil-land use in the future. It is to this end that the National Park Service was pleased to participate in the Soil Survey.

Soil resources of NPS lands are about 30 % mapped. Some parks were mapped during the early phases of the National Cooperative Soil Survey while others are of recent vintage. A second problem is that the mapping scales are varied, fmn 1:400 to 4:5,280. The most commonly used scale was 1:24,000. (This scale was used within one-third of the parks which have been mapped). Obviously, the detail of mapping within my National Park boundary varies as do the interpretations. For example, a few parks whose boundaries lie within the jurisdictions of several counties have completed soil surveys at different mapping scales. Cur statistics indicate that at least 66% of cur park areas need to be mapped and/or have their maps updated, In some select and intensely used locations mapping detail should be enhanced. Sane areas, due to their small or impervious coverings, may not need to be mapped. Some specific soil information needs of the NPS include the following:

1- Some consideration needs to be given to the 4 ft to bedrock zone. obviously, if bedrock is at considerable depth, specific &tails would be out of the question. Some knowledge does exist for the zone 6 ft to perhaps 15 ft or more. Presentation of existing knowledge would significantly enhance interpretations and appropriate land use to say nothing of avoiding sane serious land developnent mistakes.

2- Include a geologic interpretative section. In many areas substantial geologic data exists and presentation of at least significant summary information is highly appropriate. These data may earmark certain potential problem situations.

3- Inclusion of sane hydrologic data such as flooding frequencies and extent of 10, 25 and perhaps 100 year storm frequency would be valuable.

4- Interpretations. We would like to see inclusion of more specialized interpretations. For example, recreation potentials, soil compaction potentials, significant zones for specialized wildlife habitat, etc.

5- Disturbed soils. There is severe need to begin considering these soils and to map their extent. In many instances, these soils can be mapped to reflect predominate soil series. Specifically, some effort is required to further advance classification of these soils and to provide management and intepretations for these soils.

6- Stream management. Much effort is required to provide guidance with regard to management of surge flows, stream bank vegetation and rehabilitation (emphasis must be placed on non-exotic plants), sediment control and utilization there of, and methods to encourage infiltration of water which tends to pass over impacted soil surfaces.

7- Water tables which exist within soils present complex problems to the park manager. Further refinement of existing knowledge is required as well as further characterization of water tables and their effects upon management.

Although this listing is rot mutuallv exclusive of other important considerations, it does provide an overall review of sane of the soil problems with which the NPS must deal.

Specific research needs which we foresee with regard to better management of our soil resource can be summarized within the following three categories:

1- Compiling and addressing the myriad of problems which are existent just below the defined soil profile but encountered prior to bedrock. In most oases, these data as well as information exist and merely need to be published with the text along with their respective interpretations.

2- Disturbed soils must be recognized and further defined within soil surveys. When one considers that the principal users of soil survey information are the urban, urban-fringe fraction of our societv, the need is apparent.

3- There is a severe need to complete the mapping of the park system in a timely fashion. Once again, the need is vivid when consideration is given to the numbers of people visiting and ultimately creating the often irreversible, deleterious effects upon the resources, particularlv soil and water resources.

THE BUREAU OF LAND MANAGEMENT REQUIREMENTS FOR SOIL INFOWTION

The Bureau of Land Management (BLM) has a need for soil information to meet the requirements of the Federal Land Policy Management Act, 1976 (FLPMA) and in the Public Eangeland Improvement Acts of 1978 (PRIA). The Secretary of the Interior is directed to prepare and maintain on 'a continuous basis a current inventory of all Public Lands, their resources and other values. The policy will be to systematically prepare and maintain an inventory of the soil, vegetation, watershed and water resource values, including their conditions and trends. These Acts go on to say that there inventories shall be kept current on a regular basis to reflect changes in conditions and to identify new resource and other values. The inventories shall be coordinated vith other BLM programs as wall as with appropriate Federal, State, and other local agencies and groups. The information will be made available to the public as well as state and local governments.

These acts and others have caused the Bureau to undertake an accelerated inventory program for soil, vegetation, and other resources to meet the requirements stated in the Legislative Acts. In 1970, the Bureau entered into a Memorandum of Understanding for Soil Surveys on the Public Lands with the Soil Conservation Service (SCS) and Forest Service (FS). At that time, the Bureau's need for soil information was paramount to meet the requirements for sound multiple-land-use decisions.

The Bureau was faced in 1978 with the preparation of 144 Crazing Environmental Impact Statements (EIS's) by 1989 on 170 million acres in the Western United States. Also in 1978 the Bureau developed the Soil Vegetation Inventory Method (SVIM) for gathering the soil vegetation information necessary to implement the decisions identified in the multi-land-use plans and in the EIS's.

The SVIM procedures show that the coil inventory will be conducted et the standards of the National Cooperative Soil Survey and that the vegetation inventories will be conducted as specified in the BLM Manaual 4412 titled Physical Resource Studies, dated August 10, 1979. SVIM is essentially the mapping of soils at phases of series at a mapping scale of 1:24,000 with minimum rise area of 6 acres. The mapping units are generally associations vith some consociations and complexes. The soil map is converted to a range rite map upon which the present vegetation communities are identified and delineated. The range site condition class is estimated. These areas are called Site Write-up Areas (SWA's). Similar SWA's are grouped (stratum) together for sampling purposes. This stratum consists of similar soil-vegetation components having the same range site, or woodland ● ite, or forest type in the same condition class or seral stage. SWA's to be sampled • re

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[1] Presented by Jack C. Chugg. Soil Scientist, Bureau of Land Management, Division of Eangeland Management (222), Washington, D.C., April 7, 1981 at the National Cooperative Soil Survey Work Planning Conference, April 6-10, 1981.

randomly selected within each stratum. The selected SWA's are sampled, recording essentially the composition by weight and by plant ● peciea for the production data as well as for identification or conformation of the condition class (seral stage). The vegetation data is placed into • model for allocation. The vegetation allocation is made to ● atiafy the needs for watershed protection, livestock grazing, wild horses and burros, wildlife habitat and recreation.

The Bureau uses the soil survey primarily for project end activity planning and for monitoring. SVIM requires the productioo and composition information for the allocation of the vegetation. The soil end vegetation (potentiel) information assist the managers to make sound decisions in planning and management of there resources. The soil survey mill serve as bare-line date in the Bureau's monitoring program.

The Bureau conducted three regional soil, water, and air workshops in early FY '81. Soil information needed but not provided by the NCSS program was diocueeed. The conclusion was that the SCS Soils-5 was adequate and there was no need for • change in content. It was recognized, however, that there are local ● ituatione where special soil interpretations are needed. These local • rea problem areas could be identified in the soil mapping unit description and the interpretation would be made at the local level. The criteria for the interpretation would be developed and placed in the National Soil handbook (NSH) for credibility, i.e., illustrated in NSH, part II, Section 403.6. Other interpretations.

The different ways that soil information can be displayed is done beet in soil survey reports, in tables and as interpretive maps. The manner in which the date is displayed as a working document in the field offices is as varied as the individuals that put them together and for what purpose. One other way that needs full consideration is that the soil potentiala and limitationa (behavior) for major land uses in the survey area be described in the soil mapping unite, i.e.,Benewah County, Idaho, 1980. This is for use by the resource planners and managers.

The one and foremost means of sharing soil vegetation information among ● gcncie@ is for them to sdopt end follow the procedures of the Nations1 Cooperative Soil Survey. Also, there should be a Netionsl Depository for Natural &source date thst could be accessible to ● gcncier.

The major soil research needs • re thoee of soil climate. Namely, soil temperature and moisture relationships in the dldlend plant community areas of the Western United States. Range rite soil correlation supported by research or study of soil-vegetation-climate relationships is necessary to preserve the credibility of the wil snd vegetation inventories. The BLM and SCS are now conducting wil and vegetation inventories et an ● ccellerated rate end are neglecting the correlation of range sites. Many soil and range scientists within BLM and SCS support a wil vegetation climate study dth interagency support. The BLM, SCS, FS, snd SEA have been working on such a project. The BLM will propose the project for partial funding in FY'82. The quantification of soil interpretations, e.g., erosion, needs further study snd ● pplicstion.

Soil Information to Service Fish and Wildlife Service Requirements

Buck Reed, Wetlands Ecologist

National Cooperative Soil Survey Work Planning Conference

Soil Information to Serve Federal Agency Requirements

U.S. Fish and Wildlife Service Presentation

Usage

National Wildlife Refuge system has made use of or contracted for soil information in designing development plans (diking, buildings, recreational facilities) and in determining the capabilities of specific areas for farm crops, grazing, or timber management. The new master planning process uses soils information to determine the resource capability of particular parcels and this forms part of basis for early management decisions.

Ecological Services uses soil surveys to identify mitigation areas for habitat replacement as a part of civil works project reviews. Soil surveys are also used as a photo base to aid in vegetation and habitat assessment.

Needs

1. Training workshops at field or area office level. Field biologists do not know what the information means or how to use it. Federal job mobility results in many people working in sections of the country they are unfamiliar with. Intensive training in soils specific to their work area is essential for their fullest usage of soils information.

2. Display soil map units at 1:24,000 scale (standard 7.5 minute USGS topographic quadrangles). The minimum soils mapping unit of 2-3 acres can be protrayed at this scale. Many users of natural resource information, including FWS biologists, would find this portrayal more useful than the present 1:20,000 strips and this format would allow its comparison directly with other resource information. The most useful system would involve the inclusion of all map units in a digital geo-based data base so that the information (or portions of the data) could be displayed at any scale desired.

3. Correlation with vegetation. A more complete listing of native trees, shrubs, and herbaceous vegetation layers (community composition) characteristic of each soil series or group of series would be extremely useful in aiding biologists to better and more quickly relate to soils information. It is often confusing as to whether native or potential vegetation is being given in soil surveys or on Form SCS-SOILS-5. Range site information is given for Western States, but these often span a broad range of plant species and communities. Vegetative indicators are

commonly used in the actual mapping program, but this information is often not incorporated in the final manuscript. Many of older surveys have much more vegetative information which appears to have been deemphasixed in the newer progressive surveys.

4. National consistency of symbology and terminology. The individual county soil survey information could more easily be related to other counties where the same soils were found if a constant symbology was maintained for each soil series and if the range site names were consistent. The range site information needs to be entered into a computer data base so that we can efficiently begin to understand plant-soils relationships. The range sites of vegetative communities representing wetland should be related to the Fish and Wildlife Service's new wetland classification system which SCS has recently adopted. The definition and consistency of application of the drainage classes across the country appears to need upgrading. Additional terms, such as those dealing with tbe frequency of flooding (brief, short, long), growing and cool season, and drainage classes need to be defined in the appendix.

5. Identification of obligate and facultative wetland (hydric) soils in county reports and on Form SCS-SOILS-5. This will allow users concerned with wetland management to most efficiently identify those areas most likely to have wetland properties and values. The incorporation, at least for these wetland soils, of water table studies detailing the timing and duration of flooding and/or saturation (especially displayed in figures) would be extremely useful collateral information which could be added to the county soil surveys.

SOIL SURVEY USERS WORKSHOP
Holiday Inn
Crystal City, Virginia
April 8, 1981

Welcome and introductions - Donald E. McCormack

Soil surveys and resource planning - Ralph J. McCracken

Overview of uses of soil surveys - Donald E. McCormack

Presentations by representatives of Soil Survey User Croups -

Charles L. Bootbby - National Association of Conservation Districts
Sam Stenzel - National Vocational Agriculture Teachers Association
C. Page Fisher - American Consulting Engineers Council
Jorge A. Valladarea - The Maryland National Capital Park and Planning Commission
Anthony T. Stout - Tranaporation Research Board
Charles L. Frazier - National Farmers Organization

Small group discussions

Questions and comments - International visitors

Summary remarks - Richard W. Arnold

SOIL SURVEY AND RESOURCE PLANNING

Ralph J. McCracken

It is a pleasure to welcome you to this first-ever meeting of the major national organizations that use soil surveys and to tell you a little about the status of our soil survey activities. We have invited you here today so that you can help us make soil surveys most useful to you. We thank you in advance for the help you will be giving to us. We will try to provide maximum opportunity for each of you to tell us what you would like for us to do to make soil surveys more useful to you.

First, I will discuss the work of the Soil Conservation Service (SCS) and its use of soil surveys.

When the use and management of land is being planned or evaluated, it is vitally important for as much information as possible to be assembled so that we can understand the special hazards and suitabilities of the land for each alternative use. We also must know about the potential productivity or performance of the land for each use and the kind and measures or technologies that must be applied to get the best possible (or the most economic) performance. The soil is the most important deteminant of these aspects of land quality and value.

Therefore, SCS uses soil surveys as the basic background data for all resource planning. In fact, SCS is the biggest user of soil surveys. SCS uses soil surveys to:

determine best adapted crops or plants for farming, range management, wildlife habitats, and wind range of other land uses.

determine the kinds of practices required to minimize soil erosion and other forms of soil degradation.

develop standards and specifications for alternative treatments that may be needed.

- assist landowners to choose among alternative land uses that may create the need for preventive or corrective measures vith a better understanding of the probable costs and expected returns involved.

As implied in my earlier remarks, most soil surveys are made by SCS, although a total of about 20 percent are made by the Forest Service and cooperating State and local agencies. The first soil surveys were made by the Department of Agriculture in 1899.

Prior to 1950, most uses of soil surveys related to agriculture. There were notable exceptions, e.g., the Michigan Highway Department has used soil surveys for the planning and design of highways since the later 1920’6. Since 1950; however, not only has use by highway engineers increased sharply, but a wide range of uses by other disciplines has evolved.

I realize that I may have overlooked the particular use that is of most interest to some of you. In fact, a few years back a representative of a carpet manufacturer contacted ua for information about the dominant color of topsoils around the country. They had a theory that matching these to the carpet colors would be attractive to the lady of the house for obvious reasons. Assuredly, soil surveys have a very wide range of uses.

One particular concern of ours is that building codes sod subdivision regulations in most of the Nation do not take into account sufficiently the fact that soils differ. To have the same requirement for drainage of footings, footing widths, basement wall design, and other aspects of dwelling installation for all soils of a local is not very logical in many areas. Sump pumps that run 23 hours and 59 minutes every day have a tendency to break down, usually with disastrous results.

Yes, we in SCS would like for all land users to be cognizant of the soils they deal with and their particular capabilities and needs. We would like all people to recognize the unique value of our prime farmland and join with us in finding ways to keep it in farming. Some prime farmland has severe limitations for nonfarm developments. The logic of preventing such development is resounding. And, of the land that is not prime farmland, some is usually at least fairly well suited to urban development. Soil surveys help identify such land and also the kind of measures needed to assure satisfactory performance.

Modern soil surveys have now been made for nearly 70 percent or 1.5 billion acres of our land. As we proceed to complete the remaining 30 percent, we pledge that we will do all we can to conduct the soil surveys and present the data in such ways as to be of most value to you, the principal users. So again, welcome to this workshop and please make sure that you tell us what you would like for us to do to achieve this objective. The benefactors will be the land and those who depend on it both now and in the future.

In conclusion let me recall a statement from my introductory college course in soils. The kind of soil that occurred on a specific area was (a) due in part to the kind of vegetation that grew on it, and that the kind of vegetation was largely determined by the soil and the climate; (b) due in part to the kind of geologic formation on the earth’s surface; (c) due in part to the land form or relief at the site as it affected and interfaced with the vegetation and the precipitation, runoff, and soil temperature; and (d) due in part to the length of time the complex set of interactions had functioned. It is very clear to me now that the nature of the soil provides a portrayal of not only the current ecosystem, but also those that preceded it and more importantly permits valid inferences of the impacts of future land use and management changes. As resource managers, we need to understand as much as we can about such inferences.

OVERVIEW OF USES OF SOIL SURVEYS

D. E. McCORMACK

This summary is intended to provide a brief review of the scope of uses of soil surveys. All uses of land are influenced by tbe nature of the soil. For some land uses, especially these low intensity uses with little investment, the soil is the main determinant of the productivity or carrying capacity of the land. For more intensive land uses, the nature of the soil is among the major factors determing the cost of achieving the level of performance sought.

Let us envision, in lieu of slides, a whole set of scenes where the nature of the soil and its particular set of use restrictions or management needs were not properly understood or treated:

-- eroded cropland with poor crop

— potholes in a street or parking lot

-- wet cropland with poor crop

— septic tank absorption field with effluent on surface

-- cracked basement walls

-- damage to fragile lands by off-roda vehicles

-- wet basement

This list could be extended to great length. But we do not wish to imply that these failures are the dominant situation. We do wish to point out that they are much too common, and that we need to work together so that existing facts that might prevent such failures are not overlooked.

There are about 70,000 kinds of soil in the United States. Some are very cold, some hot; some are very wet, others dry; some are clayey, some are sandy, etc. There is a very wide range in the productivity and use potentials of these soils as a result of the wide range in soil properties. Estimated values for 15 to 30 or more of these properties are included in soil surveys.

Predictions of soil behavior are also included. They are based on soil properties and observations of actual soil performance in the field. For agricultural uses, adapted crops and estimated crop yields are included. In addition, ratings of the degree of restrictions in use based on limitations for field crops, risk of damage if cropped, and response to management are included. These are the familiar Land Capability Classification System. In addition, soils qualifying as prime farmland are designated, productivity and management hazards for woodland, pasture, rangeland, windbreaks, and other agricultural uses are provided as needed for the area.

For nonfarm land uses, predictions of soil behavior are also included. Ratings of the degree and kind of soil limitations for building sites, sanitary facilities, water management facilities, and recreation areas are included. These ratings are designed to call attention to soil problems that exist and the general severity of those problems. In addition, suitabilities for the various elements of wildlife habitats and for sand, gravel, topsoil, and roadfill sre indicated.

A new approach known as soil potentials is being used to an increasing extent to analyze relative soil quality in a positive sense. Not only does this approach identify soil limitations, it also utilizes local expertise to identify feasible corrective measure ans their costs and the severity of any continuing soil limitations that cannot be corrected by feasible modern technology. These ratings are prepared for use in making decisions required in land use planning. The understanding of the relative quality of soils gained through this approach is of clear value in land use planning.

PRESENTATIONS BY REPRESENTATIVES OF USER GROUPS

Charles L. Boothby, National Association of Conservation District (NACD), made general remarks concerning the many uses made of soil surveys, the need to complete this natural resource inventory for national coverage, and NACD's continued support of the required program activities.

Sam Stanzel, National Vocational Agriculture Teachers Association, remarked on the value of soil surveys as educational tools. He cited several examples of how he had used soil surveys and illustrated several additional potential uses. He emphasized the point that the Nation's youth are effective teachers as well as practioners of conservation and need to be made aware of the soil resource.

John W. Guinnee, Transportation Research Board, summarized his remarks as follows:

1. Soil survey reports and maps are most useful in the early stages of route selection so as to avoid problem areas if possible.

2. After corridor selection--the soils maps which are on air photos are most useful--the details aid the geotechnical engineers in planning and executing his corridor soil survey.

3. The surveys would be more useful if they included warning flags and information about unusual soil properties--volume-change, seasonal water tables, dispersive and collapsible soils, etc.

4. The current need relates to rehabilitation, realignment, restoration or reconstruction of existing highways; site specific information could be very useful. Readily available original data would also be useful.

Charles L. Frazier, Director, National Farmers Organization, made the following presentation.

THE FARMER'S INTERESTS IN SOIL SURVEYS

The value of the finished product may have escaped the attention of too many of our producers as we have moved farming into a world of advanced technology over the last 40 or 50 years. It is only natural that those individuals who are interested in community planning, farmland values, disposal of toxic wastes, and those with other commercial interests have the resources and the time to utilize soil surveys in an organized manner. This has led quite easily to responsive action on the part of the Service to meet these genuine and worthwhile requests for basic information on our soils.

It is quite possible; however, that the public clamor for protection of our environment, safeguarding our valuable soil resources for food production in the future and similar organized endeavors in behalf of the whole society, has relegated the interests of the farm owner-operator to a relatively low level of priority in disseminating survey results.

In an organization composed entirely of farmers and ranchers, one in which our basic thrust is to bargain for better prices for our commodities, we are kept constantly aware of the economic status of those who are first responsible for wise use of our soil end water resources. It should be kept in mind that the terrible increase in our costs of production over the last 10 years have placed an unprecedented pressure on our farmers to attain enough income on their production to maintain the family farming units, pay the bills, produce the food required for domestic and export purposes, and still be able to **commit** some of their income to soil and water conservation practices.

For example, total farm debt in 1970 amounted to $53 billion; today it is in excess of $157 billion. In 1980 farmers had a total interest bill of $16.2 billion and managed to take home only about $12 billion in net cash income from commodity sales.

It is suggested that the Service reexamine their working relationship with vocational school leaders, local bankers, PCA managers, **FmHA** directors, and ASC county committees in an effort to make the most usable soil survey materials freely available to the owner-operators and tenants whose principal income is derived from farming and ranching. It may be difficult to measure accomplishments or the influence of such educational efforts, but it is my plea that every step be taken to keep the man on the land aware of the valuable basic information that can make him more efficient in the use and protection of soil and water resources.

Page Fisher, American Consulting Engineers Council, summarized his presentation in the following four items:

1. Pointed out how very valuable the soil survey reports are to geotechnical engineers in the preparation of preliminary and/or feasibility studies and in the planning of exploration programs.

2. Criticized, rather severely, the practice of local Soil Conservation Service offices offering free engineering advice and service to governmental agencies at the local level, particularly in the area of building code development, building site selection, and waste disposal site selection.

3. Pointed out the difficulties that arose when nontechnical people used the ASCS published comments on the suitability of certain soils highway location, building sites, or waste disposal sites in public hearings.

4. Encouraged the Service to give serious consideration to expanding ***their*** mapping program ***to*** include information on more deeply buried soils and parent materials and/or to reporting information of this type that they presently collect during the course of a normal soil survey hut which is not included in the standard survey report.

Jorge A. Valladares, Maryland-National Capital Park and Planning Commission, made general comments about the use and availability of soil surveys in the area covered by his organization. He cited several examples of the benefits of having published soil surveys available to enable better structuring of site-specific studies.

Anthony T. Stout, Transportation Research Board, cited the following points as highlights of his presentation.

1. Availability of digital soil mapping:

There is a need for computer generated soil maps which can aggregate individual soil characteristics for engineering, productivity, and other soil survey uses. The State digitized maps available are not readily compatible, so a national program would be helpful.

2. Scope of soil surveys:

There are two distinct uses of the soil surveys--site specific and general planning. The published surveys might be split into two surveys to address these two different users. It also might be broken into soil engineering and agriculture. There was also concern for compatibility of the survey with other geologic or hydrologic surveys.

3. Availability of soil field data and other unpublished soil information:

The access to the original field notes used for the survey would be helpful in site specific interpretations of the soil survey. The major problem with data access is developing a uniform retrieval system.

4. Disclaimer of potential soil survey uses:

There is concern that the surveys are overused for site specific planning without adequate field checks, especially by laymen (i.e., local politicians). A better system for disclaiming improper uses is needed.

SMALL GROUP DISCUSSIONS

Workshop participants were requested to assemble into three small groups to consider and respond to the following list of questions.

1. Is there data, other than that now being collected, that should be obtained as soil surveys are being prepared?

2. Are currently used map scales of published soil surveys satisfactory? Do the surveys show too little detail? Too much?

3. How do you believe soil surveys should be used to assist site studies? Do soil scientists properly relate soil surveys to site-specific data needs? If not, how can we improve our explanations?

4. Do you suggest that data be collected at greater depths than currently done as soil surveys are made?

5. How frequently do you feel soil surveys need to be updated to be most useful to you?

6. Are members of your group who use soil surveys sufficiently informed about how they were made? If not, what can we do to help?

7. How could methods of presenting and displaying soils data be made more useful to you?

8. Would you be able to contact delivery points such as SCS State Offices to obtain printouts of computer-stored data or interpretations? To obtain unpublished soils data?

9. How useful to you are SCS predictions on the performance of individuals soils? What would make these predictions more useful?

10. How do you feel about using computer-generated maps for the interpretation of soils?

11. Would you be satisfield with soil surveys published in loose-leaf form to facilitate updating?

12. Would it be useful to you to have access to the actual field records of observations? How would you like to have these data displayed?

13. Are there important uses of soil surveys for which they are not now being used?

Each of the small groups selected a spokesperson who summarized the group response to the questions. The particularly salient points made in those responses were as follows:

1. It would not be reasonable to expect the soil survey to respond to the special needs of all users of soil information.

2. Many users express a desire that observation and sampling be extended to greater depths from the soil surface.

3. Several noted that soil scientist's field notes and other records of observations that may not be published should be made more readily available.

4. Questions and comments conccerning the quantity and quality of data collected to support interpretation of soil maps were numerous.

5. Many are concerned about the misuse of data, particularly the making of site-specific recommendations on the strength of generalized information.

6. Data collection, retrieval, manipulation and distribution by computer systems was discussed at considerable length.

QUESTIONS AND COMMENTS - International Visitors

Several of the international participants in the National Soil Survey Work Planning Conference posed some thought-provoking questions and shared their experiences that related to major points of general discussion.

Dr. Moormann, Univeristy of Utrecht, Netherlands, strongly supported the use of soil survey information in teaching youngsters of high school age, or even younger, since the soil is a most essential part of nature.

Dr. Leamy, New Zealand, related an experience with a soil survey that was needed to solve a sewage disposal problem for the city of Singapore. He noted that as in most instances where a serious resource problem exists, one of the first things done is to make a soil survey. He asked why we do not consider sewage sludge as a valuable resource rather than a disposal problem.

Dr. Tavernier, Belgium, offered the observation that his organization produces standard 1:20,000 scale quadrangle maps and reports that explain the map units. Most user-needed information is provided in separate soil monographs.

Dr. Kanter, Germany, expressed some surprise that the soil survey and geological survey are not accomplished simultaneously in the U.S. as they are in Germany.

Dr. Day, Canada, shared his experience with a very comprehensive data collection system needed develop soil interpretations and stressed the absolute need to plan for the investment of resources that will be required. Comprehensive systems are time consuming and expensive. Dr. Day inquired as the probability of user-group financial support for additional interactive data storage/retrieval systems. Dr. Fisher, American Consulting Engineers Council, expressed doubts that such support would be widely or readily available in the United States.

SUMMARY REMARKS

Richard W. Arnold

The explosion of soil-related information is upon us. Each of us is painfully aware of our own inability to comprehend the massive data sets that abound in all areas of endeavor.

This suggests that each of us has had to focus on our competencies, to hone in on aspects about which we can expect to provide reliable information in as timely a manner as possible.

Soil maps delineate “areas of expectation” and so we must learn how to better approach the expectations of individuals. We tend to talk about the confidence or confidence limits of soils information. How good is the information? What are the limitations or constraints of using the information? There are spatial attributes related mainly to maps showing location and extent of kinds of soils. There are point data on site-specified information that usually have laboratory measurements, it is easier to evaluate because of standard statistical procedures.

All of us must be concerned with conveying the reliability of information. Some decisions are made with generalized relatively nonprecise information, whereas other decisions require very precise and very accurate information. These latter decisions tend to be more site-specific and require methods and procedures that are not the normal situation for soil surveys. The point was made that we must consider how to handle information for a specific purpose or a specific use. I would think that is sound advice, whether the decision is for sites or for large areas or even regions. That is, guidelines for using and handling data would be beneficial for all of us. It is important for communicating with each other.

I hope each of us can recognize the individual responsibility for integrity in producing, evaluating, and presenting information. Earth sciences are just that--science. And science is an objective activity that must stand up to close scrutiny or else it must be subject to modification and change. We all like honesty, we all can live with the truth, we all are going to die.

There may be no absolute truth. In our experiences of daily living, events and phenomena are relative. Thus, there are various approaches and interpretations of what we measure, what we see, and how we use it.

Scientific decisions must be based on the available factual information. Those decisions must be objective. This contrasts sharply with many political management decisions which often one arrived at by consensus.

We in National Cooperative Soil Survey are listening to what you are saying. Some points touch vital nerves and we want to defend ourselves--because you often are asking for more--more data, more maps, more interpretations, more precision, higher accuracy, new and innovative approaches; for better systems to handle and share data.

You have cautioned us to be aware of the limitations of our products. That is like the Mennen Skin Bracer commercial, where you get a slap in the face and reply, “Thanks, I needed that!” Oversell is interesting.

Some years ago in upstate New York we struggled to get dairy farmers to increase alfalfa yields by improved surface drainage. These farmers resisted change for quite a long time. There was a tendency for us to tell them again and again, each time more evangelistically, close to oversell. But one day we went downstate near New York City to talk about ways to relate soil and climatic information to grape culture. For example, you can increase the rooting zone on soils shallow to fractured rock or those with fragipans by ridging. A man cornered me and we bad a brief discussion. He was ready to invest lots of dollars. Here was ready acceptance, too ready acceptance; a frightening experience. General statements were perceived as on-site recommendations. Conclusion: there are many audiences, we must speak clearly and correctly to each. Again a responsibility of each one of us.

We are honored to have had your thoughts--please do not ever stop. We need you--you represent large constituencies.

NCSS will endeavor to get to know of your people, not only here, but at all levels of your organizations--particularly in the States and local offices. We need your help as to how to better assist the people and interests you represent.

The challenges are here, we accept them and hope you do too.

SCS NEEDS FOR SOILS INFORMATION

Thomas N. Shiflet
Director of Ecological
Sciences, SCS

How SCS Makes Use of Soil Survey Information

SCS use soil survey information in many ways and in practically all programs and activities. Soil surveys are used to provide assistance in conservation planning and implementation on farms, ranches, woodland, and other lands of individual owners or operators. Other recipients of SCS assistance such as units of government also use soils information in a variety of ways.

In working with landowners and users, soils survey information may be used at the series and phase level of detail for irrigated land or by groupings of series or even higher categorical levels for extensive management of some rangelands and forest lands.

Soil information is also important and used for:

Engineering activities
Reclamation of disturbed lands
Plant materials plantings
Delineation of prime, unique, and important farmlands
Many nonagricultural applications

Soil Information Not Now Provided

Modern published soil surveys provide most of the required information. Some areas where additional data or interpretations would be helpful, include soil-vegetation correlations, toxic metals, and minor chemical elements.

We need to give attention, not only to the interpretation data in a published survey, but also to the format in which it is presented. The format should be designed to facilitate use of the information.

Ways to Provide Soil Survey Information

Soil survey information is provided in many different ways. The entire published survey is useful and needed in many situations, especially for planning at county and multicounty levels. A variety of interpretative maps or overlays are used depending on the situation, including prime farmland maps, soil association maps, and generalized soil maps.

With individual farm or ranch operators, several interpretative maps or overlaps may have utility. These include:

A sheet or sheets from the published survey that covers the particular farm or ranch.

Range site maps which may be interpreted directly from soils maps if proper correlations have been made.

- Woodland suitability maps that group soils with similar potential and similar problems relative to growing trees.

Land capability maps are often utilized for cropland.

Pasture and **hayland** suitability group maps.

How Soil Information Right Better Be Shared

Sharing of soils information between agencies can be enhanced by working together. Each needs to know what the other is doing and what their needs are for soils information. Collaboration between users during the initial stages of a soil survey is important. If potential users of the survey work together in selecting the level of detail mapping units, etc., the final production will be more useful to all concerned. Joint survey parties particularly in areas of mixed Federal-nonfederal land ownership would be helpful.

Major Soils Research Needs

Probably the first and foremost research need is that of determining soil loss tolerance **(T).** How much erosion can a particular soil (or group of similar soils) tolerate without degrading its productive capacity? **"T"** values needs to be related to specific soils and not to water quality, sedimentation, or others items.

Another research need closely related to **"T"** values is the effects of erosion on production. The need for this data is most urgent on **cropland** but applies also to forest and rangelands. There is likewise a need for more soils-vegetation correlation work.

We need more use of soil surveys on research **areas** particularly on “wild lands” (range and forest lands). There is the need for detailed soil surveys on many areas where research is being conducted to improve the interpolation and extrapolation of the research results. Soil delineations could he used more for stratification of research studies.

SOIL RESOURCE INFORMATION NEEDS

Jerry S. Lee
Director
Inventory and Monitoring, SCS

Today my subject deals with two areas of concern; Inventory and Monitoring (INM) and the Resource Conservation Act (RCA) as both pertain to soil oriented resource information needs. Let me begin by saying that both of these activities are distinct and specific, and yet at the same time are closely related. RCA deals with the status, condition, and trend of soil, water and related resources, and an analysis of those situations with substained productivity of the resource base in mind.

INM deals with the resource data collection process and the interpretation of that data used not only by RCA but a multitude of others as well.

During the 1980 RCA process, we found out a lot of things we did not know. To be specific, more than 100 data voids were identified, many of which, but not all, were soil related. In developing the subject today of resource information needs as it applys to RCA, let me very briefly reiterate the 1980 process because it more nearly set the stage for the National Resources Inventory (NRI)-82 than any other single factor.

In the 1980 RCA process, the NRI-77 served as a base data source. It was not designed to do this job, however, it performed well. It exceeded all expectation that we had for the inventory, and it enabled us to say something about: (1) land use and trends, (2) land capability and its limitations, (3) erosion rates (4) prime lands, (5) potential croplands, (6) wetlands and flood prone areas, and (7) other items.

We were able to analyze these elements singularly and in combination with each other and present what I consider to be a fairly comprehensive status, condition, and trend report on a State basis.

When we went beyond status, condition, and trend and got **into projecting resource supply versus demand, we ran into problems from both data availability and data completeness standpoints. We found that we could not adequately portray soil-plant relationships as was really needed. Some of the questions we could not answer with any degree of reliability included:**

1. **What is the long-term effect of erosion on yield?**

2. **Given the current mix of soil types being cropped, will current and potential rates of compaction influence long-term productivity?**

3. **What are the potential tilth problems associated with current and developing technology, i.e., the growing fasination with organic farming?**

4. Perhaps a more basic question, what are the potential yields **of** the resource base that can be cropped?

5. What can we expect the plant-crop response to various salinity levels to be?

6. What are yield levels on restored mind areas and on drained **adverses** undrained soils?

7. Erosion data on urbanizing areas?

8. We need to have adequate vegetative data base such as nonfederal forest stand size stocking levels, overstoring. canopy, forest forage potentials, plant community composition, riparian areas, grazing levels, range condition, and trend.

Quite obviously, many of these data voids will require significant research and the answers will be a long time coming. Remedial measures include a more intense sample scheme for the 1982 NRI, addition of many of the vegetative data elements. I mentioned a moment ago, and perhaps more significant at least as far as we are concerned, a merger of the soils interpretations and the NRI data files so that some things can be said about the resource base in a more definitive and thorough manner.

Summary of Comments by Howard C. Tankersley,
Director of Land Use, SCS

1. SCS Land Use Staff's Interest in the NCSS

The SCS Land Use staff is interested in the quality or accuracy of the data mapped in the NCSS. Interpretive maps, such as the important agricultural lands maps, produced using the NCSS data can be only as accurate as the survey map. Any agricultural lands evaluation or viability rating system must utilize the soils data expressed in the maps.

The SCS Land Use staff is interested in accelerating the completion of the survey. Though it is scheduled for completion in 1990, completion before that date would be most desirable from two points of view. First, the data would be available for land use planning in all areas of the Nation. Second, completion should make available more staff for work on interpretive functions--those-that serve land use planning activities. Attention might be given to ways of accelerating the survey without increasing expenditures, such as using USGS slope maps.

2. Information Needed by the SCS Land Use Staff

The Land Use staff needs information, by States and by sections of the country, that will show us:

a. The amount of important agricultural land under each definition in the USDA Land Use Policy Statement, Secretary's Memorandum No. 1827, Revised ;

b. The uses to which the above lands are not being put;

c. Potential uses to which the above lands might be put and any improvements needed; and

d. Rates of conversion of agricultural lands in each definition in Secretary's Memorandum No. 1827, Revised, by capability classes.

National Resource Information

Natural resource information is the basis for all decisions that affect the use of soil, water, and related resources.

As natural resource planners, we work with three basic categories of clientele:

Individuals - The person (or persons) that owns or uses a tract of land that makes decisions as to how the land and its related resources will be used.

Groups - Two or more land users or landowners that work together to solve a common natural resource problem on land which they control.

Units of Government - Governmental agencies or their representatives that exercise control over how land may be used but do not own or use the land themselves.

Natural resource information is needed to help the above clientele make sound decisions regarding the use and care of the land. To do so, the resource information must be:

Reliable - Soils Information should be technically sound with a high percentage of accuracy. It must be consistent in quality so the users; have confidence in the product. It must be in as much detail that is consistent with need. High intensity surveys are needed in some areas, while medium or low intensity are satisfactory in others. We need to contact and meet with the potential users prior to initiating the survey to determine its use.

Available - For people to use natural resource information, it must be readily available. Too many people are not aware that the soil survey information is available as mapping is completed. Some still feel they must wait for a published report. We also need to consider the priority for mapping. Traditionally. we viewed a county or a soil conservation district as a soil survey area. Depending upon land use within a county, that may not always be desirable.

Understandable - We need to publish soils information in a form that the user can understand and properly interpret. Too often, It appears the survey is being published for soil scientists. Most users are lay people. not scientists. Publish in layman terms.

Soils information is essential for sound decisions concerning the use of soil, water, and related resources. Decisionmakers need data that is reliable and understandable. It should be geared to the users' needs.

J. C. Hytry

KTAckerson

Digitizing Maps.

Much of the natural resource information presently in or being put into data bases is site specific. Little is readily available to provide apscisl relationships for the contents of our data banks. Creation of data bases with geographic orientation vould afford an opportunity not only to digitally map the occurrence of soils. soil characteristics. and pertinent elements of related disciplines but slao to show the relationships among them.

Uses to be made of a geographically oriented data base range from the simple portrayal of specific soil characteristics, such as the depth of soil. to analyses of soil survey progress and allotments of funds. They include studies showing the interrelationships of various elements of the physical environment, land use, and agricultural enterprise. Digitally generated interpretations can be displayed graphically. Many other uaea of data with geographic orientation would be feasible; they are limited mainly by the ingenuity of those using the data.

To date, digitization of soil maps and maps concerned with related subjects has been minimal. The recently published map, Land Resource Regions and Major Lend Resource Areas of the United States, 1:7,500,000, has been digitized. However, the tape needs to be edited before it csn be used for analysis and display. Detailed soil surveys of 12 survey areas were digitized during the last fiscal year; these data sre ready for use in compiling interpretive maps.

Maps presently exist which could be digitieed to initiate s geographically oriented data base for soils. The general soil map of the United States. scale 1:7,500,000, could be digitieed now. However, compilation of s new edition has begun and in about 1½ to 2 years, when the newer msp is expected to be finished. an updating of the data would be needed.

General soil maps of states could be digitized also. Compilation of these maps is not closely controlled. As a consequence. data about kinds of soils and their distribution is not consistent. On awe maps soils sre classified in taxa of Soil Taxonomy and on others they are in categories of the older soil classification system. The level of classification varies from great groups (or great soil groups) to soil series. Scales range from about 1:750,000 to 1:1,500,000 and commonly there is s corresponding difference in -cartographic detail. Matching at state boundaries is erratic. Digiticing these maps would provide the moat useful available information but use for regional or multistate areas would be difficult. New editions would involve interagency cooperation in many instances because SCS soil scientists are not necessarily the principal authors nor is SCS the publishing agency.

General soil maps of soil survey areas csn be expected to provide a better quality data base then the state maps, mainly because the rules for compilation are better stated and they are subject to a atandard editorial process.

Major lend resource area maps of states are available in manuscript form. They are matched at state boundaries and would meet needs for more detailed presentation of MLRA boundaries, if needed.

The Status of Soil Surveys map has just been published. Digitizing this map would make feasible analyses of survey progress and assist with matters pertaining to personnel, funding, etc. Furthermore, computer-aided publication of subsequent editions (possibly annually) would be facilitated.

Currently, interpretations of the National Resources Inventory 1977 are being presented graphically. Similar interpretations, new interpretations, and comparisons between data in NRI 77 and NRI 85 would be greatly enhanced by availability of the geographically oriented data base visualized in these discussions.

SOIL DATA BASES

Soil Series Descriptions

We have all recognized the need for ADP to handle the tremendous volume of data we have relative to soil series descriptions. In addition, I believe we all visualize the kind of ultimate data base we want. One that would provide rapid retrieval and permit manipulation, massaging, and reformating according to our wishes. We should be actively planning and formulating such a system. In the meantime, however, I suggest we explore the possibilities of storage and retrieval of data as it now exists.

Let us then look at what our possibilities are right now. Can we in fact do anything at the present time with the large number of series we now have stored on various kinds of word processing equipment (IBM - Mag Cards, Linolex, etc.)? Can we convert these descriptions electronically to a system whereby we can transmit, store, and retrieve from a central location? I suggest we try. We have thousands of soil series descriptions currently stored on IBM Mag cards and Linolex word processing equipment. There may be no need to key all of these descriptions into another system. The object here is to "capture key strokes." The following is suggested:

1. Dump all soil series descriptions currently stored on IBM Mag Cards and Linolex equipment on to g-track tapes for transmittal with SCS's Harris equipment.

2. Store at central computer facility for access by users (National, State and TSC) . Suggest Ames, Iowa facility, since all interpretations records are now stored there and complete soil series descriptions should include interpretations.

3. Retrieve data using existing Harris equipment. Retrieval would be similar to that now used for interpretation records. Users could call for listings of series in storage and retrieve specific descriptions as needed.

There are of course, disadvantages. We could not manipulate or reformat the data. In addition, transmitting via Harris equipment is slow although this may not be a significant problem as we would not be transmitting large volumes at any one time. I visualize most of the usefulness would be in our everyday correlation efforts.

This is not the ultimate system we all desire, but it could be very useful in filling our needs until the time such a system is formulated and in full operation. As we all know, that may be some time off unless we are willing to dedicate the necessary money and manpower to that effort now. With current money constraints, that does not look very encouraging at the moment.

F. Ted Miller

Digitizing Soil Survey
Gale TeSelle

Thank you for the invitation to participate on the map digitizing panel. As requested, I have written a brief summary of what I presented at the conference.

An automated mapping system is in operation at the four cartographic facilities. The equipment was accepted in July 1977 at a cost of $1.4 million.

We spent much of the first 2 years in staffing and training the AMS effort and working on trial projects. So far, 12 detailed soil survey counties (1,023 soil sheets) have been digitized as well as 89 county base and general soil maps, and the U.S. Major Land Resource Area map. Many interpretative maps have been made from the digitized soils data.

Since we know AMS cannot produce the digital data as fast as SCS needs, we are placing special emphasis in cooperative digitizing efforts with private firms, State, and local governments as well as other Federal agencies. To highlight a few, we are providing guidance to the North Carolina State Department of Natural Resources in digitizing Jones County, and we are analyzing data compatibility with USGS for Ocean County, New Jersey. We are working with SCS staff in New Jersey regarding their contract with Argon Labs for Cape May County and with the Pennsylvania staff who is working with Penn State for Mifflin County.

For the future in SCS digitizing, we see the following trends:

1. Increased assistance and cooperation with the States in getting digitizing accomplished at the State level.

2. Placing high priority on digitizing soils prepared on orthophoto gases.

3. Increased efforts in digitizing maps that assist the IRIS staff to prepare graphics for the RCA reports.

4. Digitizing U.S. status maps that are updated annually to simplify maps production.

5. Further down the road as the digital data base grows, we foresee the need for color graphic CRT’s and printers at the State Offices.

Pennsylvania Data Systems Report

by Edward J. Ciolkocz
Professor, Soil Genesis and Morphology
Agronomy Department
Pennsylvania State University

The data explosion is with us, and the only reasonable method of handling tbese data are with computerized systems. These systems will vary with the kinds and uses of the data. In soil survey and land use, data applications can take the form of analysis and display of tabular data and the interaction of these data with spatial data. Both of these modes of display can be interactive or batch outputs.

With this introduction in mind, the remaining part of my presentation will be a summary of what we at Penn State are doing and what we perceive as future needs in data handling in the National Cooperative Soil Survey.

Presently we have interactive computer models for corn and potato production. We also have an interactive model for determining the site suitability for on-site sewage effluent disposal according to Pennsylvania regulations.

We are developing a data base system for soils information in Pennsylvania. Presently we have the USDA Form SCS-SOILS-S, our soil characterization data, acreage, and other tabular data from published and unpublished Pennsylvania Soil Survey reports on file. We also have two small areas of digitized soil map data. These data have been merged and varying displays have been generated in a 1981 M.S. Thesis (S. Sykes, A Computerized Soil Information System for the Production of Interpretive Maps, Agronomy Dept., Pennsylvania State Univ.).

These soils data are projected as only one layer of a data base for Pennsylvania. Pennsylvania Power and Light Company of Southeastern Pennsylvania has developed a data base of varying kinds of data (power line location, property ownership, etc.) for 16 counties. The soils data for their data base was a 1:380,000 general soil association map. This data base is presently being traded to Penn State for other layers of data to be added to their data base.

The needs that we presently see in the development of our system are:

1. The digitization of our soil maps. Without this geographic information our data base has only limited usefulness.

2. Better communication between various people who are developing data systems. This could be a part of a national cooperative soil survey newsletter. This communication could be a major factor in more efficient development of a system, particularly for those who would want to take advantage of breakthroughs that others have made in system development.

One last item, we believe that data base systems should be a State based effort. The amount of data available is very great. Thus it would seem impossible for a national system to handle the needs of a State in a rapid, responsive manner.

SOIL RESOURCE INFORMATION SYSTEM (SRIS)

Thomas Priest
SCS-Colorado

The soils of the United States are an invaluable resource. Knowledge of our soils is critical if we are to effectively conserve and use them. Cognizant of this need, many diverse efforts have been undertaken to gather information about soils. Although a wealth of soils data has been collected, many problems exist inhibiting effective data use. These problems involve availability and access to existing data, knowledge of where data resides, and the dispersion of data collections throughout the United States.

In an effort to address soils information problems, the Colorado State University Department of Agronomy, the Laboratory for Information Science in Agriculture (LISA), and the College of Agriculture Sciences have initiated a joint project with the U.S. Department of Agriculture, Soil Conservation Service (SCS).

The goal of this project is to determine the necessary components, structure, and feasibilities of a Soil Resource Information Systems (SRIS). To achieve this goal, a project team was established consisting of a soil scientist (working closely with other agency and university soil scientists), an information system analyst and a computer programer. The following objectives were outlined by the project team.

1. Evaluate past soil information studies and carry out additional interviews with current and potential soil information users to ascertain their data needs.

2. Identify necessary features of a soils information system required by the community of current and potential users.

3. Identify and obtain soil, climatic, and other resource data from relevant sources.

4. Develop a demonstrable pilot segment of SRIS emphasizing required features,

5. Develop a workplan for the comprehensive implementation of SRIS.

Approach

The general approach to the development of a Soils Resource Information System involves four stages: (1) analysis, (2) pilot development, (3) prototype development, and (4) implementation.

Analysis

The analysis stage is directed at discovering user needs. To accomplish this, the user community was segmented into groups according to their general application of data.

A summary of interviews indicated the following data sources and the percentage of requests for interviewees: 53 percent of those questioned needed soils interpretive data obtained from SCS-SOILS-S; 50 percent needed information available from the National Pedon Data Soil Subsystem; 22 percent needed information on climatology; and 20 percent needed information from other sources. Fifty percent of those questioned needed information from two or more sources and various other information such as plant community information, satellite imagery, and census of agriculture.

Phase or Stage of Development	Description
PILOT	A pilot is a small scale working model of a system containing a limited amount of data. Its purpose is to investigate the structure, needed for, and feasibility of a fully operational system.
PROTOTYPE	A prototype system evolves from pilot system investigation. It is an operational model of a proposed system loaded with a data set needed by a selected user group. The user group is trained to access the prototype for information needs and to test and evaluate how well the prototype provides those needed. The prototype system provides necessary feedback, prior to full-scale implementation of the system.
IMPLEMENTATION	At this stage a permanent residence and data base administration is established. Data, not previously loaded, is loaded and correlation and data editing are completed. At this stage intensive user training is achieved.

DATA BASES **WHICH** PRESENTLY CONSTITUTE **(SRIS)**

HAP UNIT	Data Base now contains 59 data elements. After redesign, it will contain all data elements on the SS-6 and new data elements such as precipitation and growing season. The data off the SS-6 and the Form SCS-SOILS-5 can be mechanically loaded into the **Map** Unit Data Base and other data elements **will** have to be loaded mechanically.
SOILS-5	Data Base now contains "Estimated Soil Properties" and taxonomic classification portion of SOILS-S. This year will be expanded to include the entire Form SCS-SOILS-5. Form SCS-SOILS-5 Data Base is loaded mechanically for Form SCS-SOILS-5 tape from Ames.
PEDON	Data Base contains selected data from the National Pedon Data Subsystem. Work plan calls for expansion to include all information on National Pedon Data Subsystem. Data Base will be loaded mechanically.
CLIMATOLOGY	Now includes precipitation and temperature data from weather stations. Work plan calls for expansion of sources and data. Data will be loaded mechanically.
RANGE	Data Base contains 36 data elements from the SCS Range Site description and the Plant Information Network (PIN). The PIN information can be loaded mechanically. The Range Site data must be loaded manually. The Range Data Base contains 108 Range sites at the present time.

DATA BASES

MANAGEMENT	Data Base is in the early stage of planning and development. The concept includes management alternatives for various land uses. It will be developed cooperatively by the SCS, CSU, Department of Agronomy, and Extension Service.
GRAPHICS	Digital information including base map, soil survey maps, land use maps, and **Landsat** information. From the overlying of these data sources many interpretative maps can be made.
CORI	We are working with the Laboratory for Information Science in Agriculture (LISA) to develop a Data Base containing a catalog of sources of Natural Resources information.

This Data Base would contain data on the availability of all types of Natural Resource information. This includes information such as soil, geology, land use, topographical maps, vegetation maps, land form, climatic, and aerial photographs as well as other information.

This system would be an excellent place to store soil survey progress maps, geologic survey progress maps, topographical availability maps, ortho availability maps, and the map showing the availability of Prime Farmland.

EXAMPLE OF
CATALOG OF RESOURCE INFORMATION (CORI)
DATA BASE

#1 Let us assume we select Kiowa County, Colorado, as our study area.

The system responds:

RESOURCE INFORMATION AVAILABLE FOR KIOWA COUNTY, COLORADO

Soils
Geology
Land Use
Vegetation
Topography Maps
Prime Farmland
Agriculture Statistics
Ortho Photos
Landsat
Demographics

#2 Let us assume we are interested in soils data.

The system responds:

SOIL INFORMATION AVAILABLE FOR **KIOWA** COUNTY, COLORADO

State General Soil Map
Soil Resources of Colorado
Special Soil Studies
Soil Survey of Kiowa County, Colorado
Soil Resource Information System **(SRIS)**

#3 Let us assume we select to know more about the Kiowa County soil survey.

The system responds:

SOIL SURVEY OF KIOWA COUNTY, COLORADO

DESCRIPTION: The soil survey contains information useful in land-planning. It contains predictions of soil behavior for selected land uses, and limitations or hazards inherent in the soil.

SCALE: **1:24,000**

DATE: 1971

ORDER: 2

STATUS: **Manuscript** format, expected publishing date Nov. 1981

AVAILABILITY: Soil Conservation Service
P.O. Box 17107
Denver, Colorado 80217
ATTENTION: State Soil Scientist
Phone: (303) 837-5791

ADVANTAGES OF A SOIL RESOURCE INFORMATION SYSTEM

Easy integration between data sources.

Users vith little or no computer training can assess data.

Users can access information at remote locations where large computer facilities are unavailable.

Easy editing and updaying data.

Adhoc questions can be answered.

Correlation and data compatability is made much easier.

Increased data accessability.

Increased data standardization.

- Timeliness of reports.

Increased data editing potential.

- Increased uses of soil survey resource.

April 28, 1981

TOPIC: Digitizing Capabilities in the Forest Service - Present and Future

PRESENTED AT - National Soil Survey York-Planning Conference, April 9, 1981.

Why do we digitize resource information?

Multiple resource information is needed by the US Forest Service manager to satisfy the requirements of the Resource Planning Act (RPA) and the National Forest Management Act (NFMA). It is necessary that the managers have access to the geographical distribution of these resources. Each resource type contributes to one or more "resource layers" that are needed to evaluate various planning alternatives and make sound management decisions.

The collection of these data is accomplished either through line digitizing, automated scanning, or hand coding for entry into a geographic information system data base. The data is collected in either grid or polygon format. Resource layers such as Soils are collected at a higher resolution for detailed area planning whereas state or multi-county planning activities may use coarser resolution data.

The location of digitizing functions varies within the Forest. Service. The desired location is the Ranger District or Forest Supervisor's office, but in many cases, digitizing is done at the Regional Office or contractors facilities.

A major effort presently being undertaken In the Forest Service to increase the digitizing capabilities is a Service-wide procurement to standardize intelligent graphic hardware within the Forest Service. The Geometronics Development Group located here in the Washington area is developing the necessary software in cooperation with our field units for a Local Interactive Digitizing and Editing System (LIDES). The objective of LIDES is to furnish the Forest Service with a national software capability to interactively digitize, display and edit graphic data. It will also provide our Forest units a means of entering data into the nationally supported Resource Information Display System (RIDS). RIDS is a geographic information overlay processing system that accepts, processes and outputs either cellular or polygon digitized map data. It is being used by many of our national Forest units to assist them in the land management planning process.

In summary the geographic data type, accuracy and volume of information that must be collected for land management planning activities is a tremendous task. Efforts must be made to expedite the data collection and processing efforts to meet Forest Service goals and objectives.

Roger Pelletier

ROGER T. PELLETIER, Cartographer
RIDS Project Leader

Ted Miller: Northeast TSC

Major Concerns:

States such as Maryland, Delaware, Connecticut, New Jersey, and Pennsylvania have been completely mapped or close to completion. It is necessary to enlighten the State Conservationist, area conservationist, and other influential people that this is only one phase of the soil survey program. This can be illustrated by enumerating on many questions that arise concerning interpretations. A large amount of the workload in the initial phase will entail recorrelation, so that the correct interpretations can be provided to the various communities. There is need to give serious thought to the long-range program. One of the major items is to provide soil material or data in a more useful way. It may be necessary to provide soil data in various publications. Various States have different needs for soil data but provided in a way that it can be advantageous for that particular State, i.e., vater budget map or clay content map. It is important that we be innovative in presenting soil data because there is great demand for soil information. There is a demand for intermediate maps (1:50,000) for planners as well as for farmers.

An analysis of staff personnel is needed so that a comprehensive plan can be formulated to meet the demands for soil information with the restricted resources (personnel and funds).

Training: Users within our own discipline can benefit from short-training sessions. These training sessions can provide the district conservationists, technicians, and engineers with more ammunition to sell conservation practices. With an understanding and appreciation of soil survey an evaluation of its' potential and limitations can be readily determined.

Soil potential: This is another avenue that needs to be developed.

Funding: States should continue maintaining level of funding thet is compatible with needed assistance.

High altitude program: This needs to be reevaluated because it has not been able to do the job that was expected. The 6-year program will not satisfy the need for coverage (maps) at the present rate of mapping.

More attention or closer reviewing should be given to NCSS guide lines that are being routed for review. These policies determine the effective of the soil survey program. We should also be reminded that policies are based on input from the various levels.

ED **CIOLKOSZ -** Penn State Regional Project:

1. A regional soil association map and bulletin have been developed in (scale of the map **1:5** ☐ il.) draft form. The report is modeled after the southern region report. There is a chapter on Spodosols, Entisols, Histosols, and one more order.

2. Comparative laboratory studies will provide statistical analysis of laboratory data, so it can be quantified. Provide and assist the development for guidelines how to analyze laboratory data. Formulate guidelines how to collect laboratory data.

Improvement suggestions for NCSS

1. Need a systematic or better line of **communication** such as newsletter. (There was concern who would be responsible for the newsletter.) Since all Federal publications receive strict editing and take a great length of time to get the document circulated, it would be easier to do it at the university level.

2. The National Office should make sure that all the regional and national proceedings are distributed to all cooperators.

3. The NCSS conference should be a technical conference and workshop--a conference of this type, **(NCSS** National Work Planning Conference, 1981) should be held in regions or other various level.

4. The soil scientist should be provided with better tools to do his job. Innovative ways are **necessary.** so that soil scientists can do **their** work more efficiently. Technology is available but the allocation of resources is too restrictive.

Classification for disturbed lands (coal land) should be developed to meet the demands that would assist users. A decision should be made to interpretations on disturbed lands.

MIKE STOUT: **MIDWEST** TSC

Soil Survey has made great strides in mapping and interpretation to meet various demands of the soil survey; although, there is a lot of room for improvement and challenging tasks lies ahead, which makes soil survey a viable program.

Work planning conference has been ineffective because recommendations are made but no follow-up or correction aggressive action is taken. Soil Taxonomy should be our guideline for classifying soil and it can be **polished** as we go along.

Quality Control: The lack of travel is effecting quality control at the level that is responsible for maintaining this phase. The lack of funds to have a progress review annually and the lack of time to do a comprehensive review or evaluation of the on-going soil surveys has severely affected the quality control activities.

Staffing: Staffing at the State Office and TSC level is not adequate to maintain workloads that are being produced by the field staffs. The field level receives funds and assistance from other sources so it is imperative to increase funding and staffing to accommodate the workload.

Training: Extensive practical training is needed for young party leaders, for most part they are technically sound in theory. An intensification of training is needed at field level so quality control can be reduced at State and TSC level. It should emphasized that there is a great need for staffing after the States have been mapped.

JOE NICHOLS: SOUTH TSC

Eleven of the 12 States have characterization data. Seven States are receiving State funds for soil surveys. Thirty-five soil surveys are being completed annually. The lack of balance in the soil survey program may mean redirection of the program. A factor that may have induced the problem is the reporting system. For the most part, acres have been the measure for success of the soil survey.

Equipment that aids the soil scientist in his work is power probes, remote sensing, ground penetrating radar, off road vehicles, etc.

Memorandum 66 (new Chapter 5) needs to be rewritten because it is a useful tool for young soil scientists to understand the concept of a map unit. Also this memo can be utilized to educate the users.

Soil investigation

For soil information to be accessible it is important to make utilization of computers,

Manuscript

Explicit policy is needed, what information should be published in the manuscript. There may be a need for two manuscripts with one being interpretive phase and a technical data phase.

Quality control: Invitations should be sent earlier so that travel can be reflected in cooperators budget and representation will be more representative.

Technology

False colored map can be utilized to separate various parent ma
Remote sensing has potential that can be utilized in soil survey.
(GPR) has the capability of recognizing or indicating an argillic horizon and otber diagnostic characteristics. The GPR can be adapted to pick out depth to bedrock.

DICK KOVER: WEST TSC

The West region has a large acreage that needs to be mapped. Many soil series are being developed in the new area at a rate of 20-30 series a month. This development precipitates updating parts of the taxonomy. Also the development of series have created a built-in high cost for making distribution of the soil series.

There is a need to understand other disciplines.

Cartography is a major problem in lack of coverage for areas that are projected to be map.

University staff is providing various maps on soil climate, vegetation, etc.

BLM/SCS joint project interstate soil sites study; i.e., duripan.

Chuck Cowdy is working with a SCAN system that has possibility or potential of entering soil series into computer data bank.

Modification of interpretative data to provide information on soil survey at various level; i.e., 1, 2, 3, and etc.

The use of off road vehicle has caused damage to much of the landscape. Meetings with administrators of various discipline to develop a dialogue.

Training is needed for new soil scientists and party leaders.

A follow-up program on soil surveys should be developed to evaluate how they are being used in the county once the report has been issued. There is a great need for developing soil potential.

A National State Soil Scientist conference is needed.

Training programs

TED MILLER: NORTHEAST TSC

There is a need to develop a systematic approach to technical training.

A model concept is a 5 level training plan

I Level - All Soil Scientist participation
II Level - A basic soil course (new S.S.)
III Level - Classification and correlation (new party leader)
IV Level - Advance correlation course or refresher
V Level - Advance training (Cornell and Iowa State)

FRED GILBERT

General : Provide training to people who need it.

Specific: Training done at the State level rather than TSC training in computer technology. Develop a national confidence level for soil survey. A national uniform guide should be utilized for soil survey. A standard acceptable level for soil maps should be developed. Educate the other disciplines on soil data (district conservationist, engineers, etc). Training in fiscal budget and operation management for State Soil Scientists.

Kermit Larson - Forest Service

There is great need in computer science for mapping operation, interpretation, and map unit design that can be interrelated to geology and geomorphology.

ED CIOLKOSZ

Graduate students need experience in soil mapping. Should mapping be requirement of graduate student? We need an agreement between SCS and universities for students to map during summer or have a summer workshop.

LARRY WILDING

Needs

1. Reading
2. Writing, more efficient
Encourage certification of soil scientist
2: Geomorphology at the TSC needs to provide leadership in this area.

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