United States
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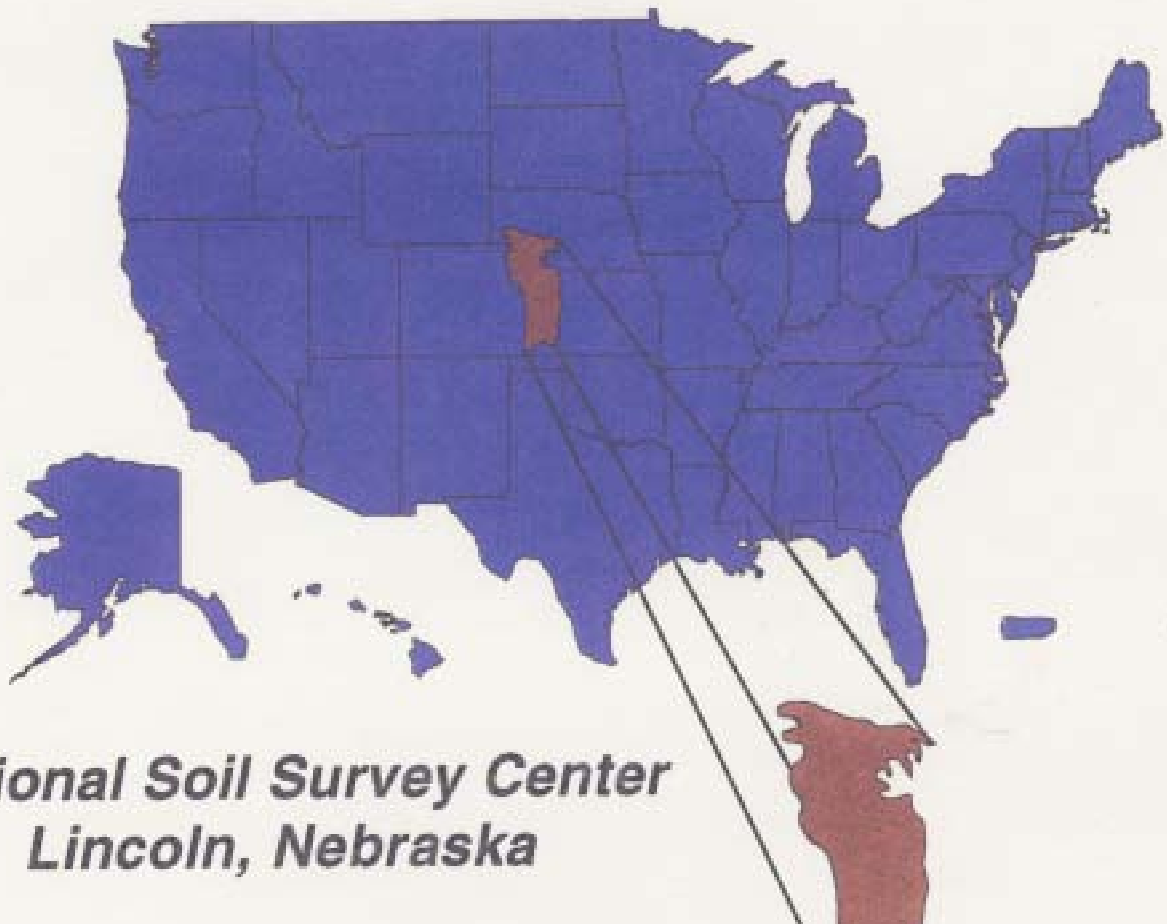
Soil
Conservation
Service

December 1993

Soil Survey by Geographic Area

Major Land Resource Area - MLRA



National Soil Survey Center
Lincoln, Nebraska

MLRA:
SOIL SURVEY BY GEOGRAPHIC AREA

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FIRST EDITION

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Preface

The National Soil Survey Center began to consider ways to maintain and improve soil survey maps, soil property records, and soil interpretations in the 1980s. The idea thought to be most promising was the creation of a single data base by modernizing the information for several existing soil survey areas contained within the same geographic area or Major Land Resource Area (MLRA) using one common standard. The theory was that the increasing demand for resource information and the advances in computer technologies heightened a need for a coordinated, joined data base which could be most effectively maintained and utilized by larger geographic areas (MLRAs). The concepts have been well received by the states and others involved in the national cooperative soil survey.

This document is an accumulation of the National Soil Survey Center's (NSSC) guidance and direction given for maintaining information by MLRA. It is intended to provide explanations and examples for many of the processes to be developed by state and project soil survey offices. As you will discover, the MLRA approach encourages the use of modern technologies, such as telecommunication for data transfer; computers for evaluating, reviewing, and editing information; and Geographic Informatin Systems to project information for areas of known coordinates. Improvements in communication, scale accurate maps, data collection, data evaluation, quality assurance, published formats, and electronic availability of the information will enhance soil survey.

The NSSC feels strongly that maintaining the information by geographic area will improve the soil survey's reliability because the same standards will be applied throughout. The major thrust of the MLRA project soil survey will be to bring maps, and interpretations, as well as, map unit and soil series composition to a common standard. Improvement of the soil information for analysis, program application, and automated geographic data bases is the goal for areas that have similar resources (land use, water, soils, and plants).

This is a new approach, and we are learning how to address the issues confronting us. We do not have all of the answers, however if we coordinate our efforts we can develop a quality product for future generations.

The sections that follow describe important activities involved in making and maintaining a soil survey for a Major Land Resource Area (MLRA). One section describes the process used to gain approval for a soil survey by MLRA. One section describes some of the procedures for making a soil survey by MLRA. The information in this guidebook is not intended to be static but is designed so that as we learn and expand our knowledge on modernizing soil survey by large geographic areas we will revise it. Updates to this information will be made annually.

The examples contained in this guidebook are compiled for illustration purposes. Many were developed with assistance from states. They have been edited. If you locate any inconsistencies between the information in this guidebook and the National Soil Survey Handbook please let us know. In any situation use the National Soil Survey Handbook as the correct information.

Jim Culver

James R. Culver
National Leader
Soil Survey Quality Assurance Staff

MLRA SOIL SURVEY: MAINTENANCE

The sections contained in this handbook are intended to provide guidance in the form of explanation and exhibit. The National Soil Survey Center is providing this information for beginning the maintenance of soil survey information by large geographic areas (MLRAs).

Considerations: Maintenance Needs

The maintenance of soil survey information is a continuing process to improve and expand technical knowledge for both present and future user needs. Some of the reasons why soil survey information needs to be maintained include:

1. **Classification.** Many of the older soil surveys are pre-taxonomy and the pedon descriptions are inadequate to determine the correct classification of soils.
2. **Interpretation.** Some of the soil interpretations are outdated or inaccurate. The need exists for new information for the many technical advances in agriculture and urban uses of soil survey. Changes in land use also require additional soil interpretations.
3. **Soil maps.** The detailed soil maps in the older soil surveys are outdated and in some cases inaccurate. The photo base is often of poor quality and not to the scale or control base acceptable for a Geographic Information System data base.
4. **User needs.** The increasing demand from users has made it necessary to maintain and organize soil survey information in order to meet the existing and future interpretive needs.
5. **NCSS Standards.** Many of the older soil surveys do not meet the present standards (new interpretive needs, inaccurate mapping, join inconsistencies, incomplete data, changes in land use/needs of users, etc.) of the National Cooperative Soil Survey Program. The Food Security Act and Water Quality initiatives have placed new emphasis for more specific soil information and related resource data.

Considerations: Data

1. **Fill gaps of existing data.** User needs may require collecting additional laboratory data, transect data, and special soil survey investigations or studies to improve the quality of the survey. The NSSC encourages the project soil surveys the collect as a minimum a comprehensive data set for the benchmark soils in the area.
2. **Variability determinations.** The spatial, temporal,

and drastically changed (management-altered) properties of soils should be determined in the survey area and be made a part of the data base system.

3. **Recognize agricultural concerns.** The maintenance project needs to recognize the soil properties relating to sustainability with regard to tillage operations and to applications of herbicides, pesticides, and waste materials to land and their effects on water quality.
4. **Models.** The collection of resource data used in prediction models should be included in the design of additional information to collect during the update.
5. **Uniformity in landscape terminology.** Consistent use of landscape terminology by soil scientists involved in project soil surveys with that of other disciplines in the natural resource field improves data use and accuracy.
6. **Surficial geology and geomorphology.** The surficial geology maps and information from geomorphic studies should be part of the resource data for updating the survey information.
7. **Specific data sources.** Additional resource data needs to be recognized and made a part of the data base.

Considerations: Planning

The following items should be considered in the planning for a MLRA Soil Survey Project.

1. Existing information:
   a. Major land use changes;
   b. Soil-related problems, such as erosion;
   c. Needs of users;
   d. Maps;
   e. Taxonomic and map unit descriptions;
   f. Soil interpretations;
   g. Specific needs for technical advances.
2. Update must be an improvement.
3. Flexibility:
   a. Remap only where needed;
   b. Reclassify, correlate, and revise interpretations as needed;
   c. Storage of data in electronic data base;
   d. Be oriented to needs of users.
4. Size of soil survey project area:
   a. One or more MLRA's or other physiographic, hydrologic, or other resource-based area larger than previous detailed soil survey areas defined without regard to county or state lines.

5. Financial support. Organize local, state, and federal funding to support regional effort. The intensity of maintenance should be based on the needs of users.
6. Quality control and assurance. The quality control and assurance for the maintenance of soil survey information should continue to be a function of the USDA, Soil Conservation Service.

MLRA APPROVAL PROCEDURES

Background

In the past, most soil surveys have been prepared and published by county, parish, parts of counties, or small groups of counties. An attempt to coordinate the soil surveys of these political entities was made but there was a difference in the kind and intensity of information provided. For some soil surveys, these differences reflect a greater knowledge of soils, and information in other surveys has become outdated because of advances in technologies and changes in user needs. Recently a greater effort has been directed toward updating and maintaining the data. The initial update efforts were again mainly along political boundaries, usually by county. To better coordinate our soil data and to increase efficiency, all future updates of existing soil survey information will be part of a maintenance project for a MLRA or other physiographic region.

The concept is that the MLRA, or other selected region, is the survey area and the county or other political entity within the MLRA are subsets. It is anticipated that the correlation procedures historically employed will be applicable to the MLRA survey but will be adapted to accommodate a larger geographic area. To implement and carry out a successful MLRA maintenance project requires careful planning. The project must be coordinated with all states that share part of the MLRA.

Actions Needed

Seven actions are needed to obtain approval for implementing a MLRA maintenance project:

1) The states and cooperating agencies must define and agree on the area and the product expected of the update.

2) The states and cooperating agencies agree on the framework and responsibilities for participating in the MLRA project. Political boundaries will be minimized.

3) The specifications of the soil survey product desired of the update and the agreement to cooperate are outlined in a draft Memorandum of Understanding for the MLRA.

4) A schedule for evaluating the published surveys in the MLRA being considered for maintenance and completing Soil Survey Evaluation Worksheets within the MLRA is developed and agreed on.

5) A Project Plan for conducting the MLRA maintenance project and an initial Soil Identification Legend are prepared;

6) (1) the Project Plan, (2) the draft Memorandum of Understanding, (3) the individual Soil Survey Evaluation Worksheets, and a request for approval are submitted to the NSSC;

7) The NSSC makes recommendation for approval or disapproval to the Director, Soil Survey Division.

After these actions are taken the director will approve or disapprove.

Approval Procedures

The State Conservationist is responsible for maintaining accurate and current information for all soil surveys of state and private lands. This is done in consultation with the National Cooperative Soil Survey representatives and local users.

Action to develop a project plan is initiated by the state soil scientist or other agency representative after the need to update an individual county or other subset soil survey within the MLRA has been determined. An organizational meeting with the states that share the MLRA is scheduled in consultation with the National Leader, Soil Survey Quality Assurance Staff. As a general rule this meeting is coordinated by the initiating state if the MLRA is within one National Technical Center area. If more than one NTC is involved the NSSC will assist in coordinating the session.

The makeup of participants at the organizational meeting varies but is generally those people having knowledge of data needs of the MLRA and in a position to decide the effort each state can expend in the maintenance project. Normally included are the state soil scientists and cooperators from each state sharing the MLRA, representatives of the NSSC and NTC, as well as selected area representatives and other disciplines. EXHIBIT 1 gives an example of an organization meeting announcement.

The main purposes of the organization meeting are: to discuss the rationale of MLRA maintenance projects; to determine each States' interest in the project; to collectively define the product believed to be needed to meet user needs; to establish a schedule for evaluating each county or other subset soil survey in the MLRA; and to establish leadership responsibility for progressing the project plan or the project after approval is obtained. The ideal situation is where all of the involved states can participate in the project at about the same level and time. This is not always possible but it is critical that all states take part in the planning and agree to work toward a common product. They must agree to coordinate the mapping legend and agree to participate in correlation activities, particularly those along state lines. The impact of political boundaries must be minimized to achieve a join in map lines, map unit names, and interpretations. Leadership responsibility for coordinating and progressing development of the project plan should be agreed upon. This responsibility is often assigned to the state soil scientist or another designated representative of the state having the major part of the MLRA, or to a steering committee. The steering committee is made up of representatives of each state (SCS and other cooperators), the NSSC, and the NTC. EXHIBIT 2 is an example of a trip report of an organizational meeting. EXHIBIT 3 is an example of a steering committee report.

A draft copy of the MLRA memorandum of understanding is prepared and routed for comment following the organization meeting. The draft may be prepared by a state, a cooperating agency, or by the NSSC representative. The specifications of the soil survey product desired and the agreement to cooperate are identified. Special data needs, new interpretations, along with other items which will improve the opportunity to obtain a coordinated and accurate soil survey should be briefly outlined. All cooperating agencies and their cooperative agreements for progressing the maintenance project are identified and certified within the Memorandum of Understanding (MOU). Refer to MLRA-MOU, EXHIBIT 7.

The definition of the product desired of the maintenance project as shown in the MOU provides a standard to compare or evaluate against for the information to be updated. It also provides a basis for estimating the resources needed for each subset survey to meet the standard.

It is important to understand that the evaluation and the maintenance of the information are separate, yet related, processes. The evaluation needs to determine what must be done in each subset survey area to meet the standard. The maintenance is the progressive survey activities designed for updating the existing information. The evaluation of each county or other subset soil survey will determine if current user needs are met. Many of the existing surveys were probably prepared at different times by different people, which will require different items needing to be updated. Some adjoining subset surveys, however, may have been prepared at about the same time. These surveys probably have similar maintenance needs; thus, the evaluation findings for one would apply to the others.

There are several possible approaches for evaluating a subset soil survey area. These range from a very detailed field investigation to a very cursory office review. Recent experience has suggested that a "subjective" or "expert" evaluation coupled with some field documentation of identified problem areas provides most of the required information. The "subjective" approach assumes that the original maps are correct unless they have proven to be in error. Most of our predecessors were conscientious and had reason for their line placement. The evaluator must build on what are known or suspected deficiencies in the subset survey area to determine maintenance needs. This can be done by assembly and review of existing data, the map unit use files, previously gathered but unpublished data, correlation documents, the official file copy of the original report, records of appeals from landowners and users, laboratory data, research data, and geologic and topographic materials. This information will help identify map units that are so similar they should be combined; map units that were dropped in previous correlations; soils that were considered taxadjuncts or variants, or were slightly different than named; map units that have been challenged and required an onsite determination; and map units that no longer fit the present needs of users.

Consult with district conservationists, resource soil scientists, and other major users of the soil survey. Road check to see if soil boundaries separate landform segments and if phase criteria and interpretations are appropriate. Key in on the major areas needing maintenance and document their nature and extent by transect, traverse, check plot mapping, or other appropriate field investigation techniques.

EXHIBIT 4 is a completed Soil Survey Evaluation Worksheet for one subset soil survey. Other subset surveys could show similar kinds of needs or completely different needs. This worksheet requires some general information about the subset soil survey being evaluated but its design is to identify those map units requiring extensive investigation, those needing correlation, and those needing additional data to provide updated interpretations. This information, along with estimates of time required for map digitizing, manuscript development, and special studies, is used to project the staffing and budget needed to complete the maintenance effort for the subset surveys. The evaluation worksheets from all the subset surveys in the MLRA are used to develop the MLRA project plan.

The MLRA project plan is a long-range plan. The plan details how long the project is expected to complete the update. It outlines the procedures, standards, and schedules that will be used to gather, evaluate, organize, and disseminate the soil survey and related resource information specified in the memorandum of understanding for the MLRA. The content and detail of the project plan will vary but may include:

a. a summary of the county or other subset soil survey evaluations with estimates of staff and budget needs;

b. a schedule for updating that identifies imagery needs and priority;

c. a plan providing for special investigations and laboratory data as required to fill data voids or provide for interpretation;

d. a plan for obtaining consistency in official series descriptions and interpretations;

e. a plan for consistent description of landforms and landform segments;

f. a plan to gather and evaluate all existing research data and field studies by university, Federal, State and private groups that have followed NCSS standards;

g. a plan for quality control/quality assurance functions, including legend control and kind and amount of documentation, as well as use of standard techniques and guides to be used for development of and verification for the quality of the MLRA survey's data;

h. a plan for interdisciplinary participation to coordinate resource groupings such as range site, capability subclass, and erosion factors K and T;

i. a plan for MLRA data base development;

j. a plan for publication.

A detailed listing and brief discussion of items to consider when developing a MLRA project plan are discussed in the section titled "MLRA PROJECT PLAN." EXHIBIT 10 is an example of a completed project plan.

1) the MLRA project plan, 2) the draft memorandum of understanding, and 3) the county or other subset soil survey evaluations are transmitted to the National Leader, Soil Survey Quality Assurance Staff, National Soil Survey Center. The materials are reviewed and a recommendation is made to the Director, Soil Survey Division, for approval or disapproval of the plan. The director approves or disapproves and informs state.

Once approval is obtained, the state person or steering committee having leadership responsibility initiates action to obtain signing of the memorandum of understanding and begins coordination of the maintenance project.

EXHIBIT 1: Organizational Meeting

Subject: SOI - Operations-Major Land Resource Area 99, Erie-Huron Lake Plain, Soil Survey Evaluation and Planning

To: State Conservationists - OH, IN, MI

The National Soil Survey Center and states are advocating that soil surveys be maintained or modernized using a MLRA or other physiographic region approach. Ohio has begun two modernization projects in MLRA 99 and is planning two others. These plans were briefly discussed by members of our staff and representatives of the states which share MLRA 99 at the North Central Work Planning Conference in June. We were asked to coordinate a meeting to explore the possibility of updating the soil surveys in MLRA 99 as a regional project.

MLRA 99 includes all or parts of about 33 counties, 17 of which are in Michigan, 15 in Ohio, and part of 1 county in Indiana. A list of counties is enclosed.

The goal of the maintenance effort is to develop a current, coordinated, joined soil survey data base for the MLRA in a format suitable for use in a geographic information system. To accomplish this will require very careful planning and the willingness to minimize political boundaries. The involved states and counties must agree on the product expected of the maintenance project and develop a plan of action to bring the individual soil surveys to a common defined standard. Specifically, they must agree on the map scale, the map unit design, and the soil data elements required to best meet the future needs of users in MLRA 99.

Larry F. Ratliff of the National Soil Survey Quality Assurance staff will be our contact person. Arrangements have been made for representatives of the SCS and major cooperators from Ohio, Michigan, and Indiana to meet November 13-14, 1990, at Perrysburg, Ohio, to discuss and begin planning this project. The meeting will begin at 1 p.m. on November 13 and adjourn the afternoon of November 14. A suggested list of agenda items is attached for your consideration.

A block of rooms has been set aside at the Holiday Inn, 10621 Fremont Pike (just off Interstate 75 and U.S. 20 at exit 193), Perrysburg, Ohio 43551 (phone 419-874-3101). The meeting room is at the motel. Each person must confirm their own reservation by 6 p.m. November 9 if lodging is required. We hope your state soil scientists and representatives of cooperating agencies can attend.

Attachment: 1: AGENDA

MLRA-99 Update Meeting
Perrysburg, Ohio
November 13-14, 1990

1. Welcome and Purpose
2. Review of update status by each state.
3. General review of update procedure.
   a. Steering committee, and AD HOC committees.
   b. Chairperson of the steering committee.
   c. Roles and responsibilities of participants.
4. Determine if update is for entire MLRA or selected parts.
5. Define the product expected of the update.
   a. Map unit design and map scale.
   b. Minimum size delineation.
   c. Coordinated MLRA legend.
   d. New uses and/or data needs.
   e. Method of delivery (publications, GIS, both)
6. Discuss development of project plans, survey evaluations, and a draft of the MLRA-99, Memorandum of Understanding.
   a. Discuss who will develop a draft of the MLRA-99, MOU by the next meeting.
7. Schedule the next MLRA-99 meeting. Who will make the arrangements, and where the meeting will be held.

EXHIBIT 2: MLRA Meeting

Subject: SOI-Operations-MLRA 99, Erie-Huron Lake Plain, Soil Survey Evaluation and Planning Session, November 13-14, 1990

To: State Conservationists - IN, MI, OH

Participants: Representatives of the soil staffs of the Soil Conservation Service, the State Experiment Stations, the State Department of Natural Resources or the Department of Agriculture from Indiana, Michigan and Ohio. Soil scientists from the Midwest National Technical Center and the National Soil Survey Center were in attendance. Also participating were two area conservationists, one from Michigan and one from Ohio. Attachment 1 gives a detailed list by name.

Background: MLRA 99 includes all or parts of about 33 counties in Indiana, Michigan, and Ohio (Attachment 2). About half of the county soil survey reports were published before 1975 and the field work was done 5 to 10 years earlier. Ohio is updating some of their surveys or plans to update them soon. The National Soil Survey Center is recommending that, wherever possible, maintenance of soil survey information be done on a MLRA or other physiographic region basis. This meeting was held at the request of the involved State Soil Scientists to provide a forum for discussion of the feasibility of a MLRA-Soil Survey Maintenance Project.

Activities: Each state reported on the status of their soil survey program with emphasis on plans for completing and/or updating the soil surveys in MLRA-99. There seemed to be unanimous agreement to the logic of updating and maintaining soil surveys by MLRA, although many participants had questions or suggestions about how such a project should proceed. Most of the session was spent discussing these general concerns and examining procedures for completing such a project. A detailed set of notes of the activities are attached for your reference (Attachment 1).

Findings and Recommendations:

1. It was agreed that the soil surveys in MLRA-99 should be updated to a common standard using a common legend. All states desire a coordinated, joined, digitized soil survey of the MLRA on 1:12,000 orthophoto quarter quads. Map units are to be consociations or complexes with a minimum size delineation of about 3 acres. Individual or multi-county soil survey reports can be published as subsets of the MLRA survey. A two or three part publication format is preferred.

2. It is anticipated that the update will involve an effort at least ten years. Michigan has about 8 million acres of new soil surveys to complete before they can direct much of their resources to modernizing existing reports. They are willing to assist in developing the project plan and to cooperate as needed to ensure a improved, coordinated product. Indiana has only part of one county in the MLRA.

3. The project activities, standards, and coordination will be directed by a steering committee chaired by the State Soil Scientist of Ohio. The committee will be composed of one representative from the National Soil Survey Center, one Soil Conservation Service representative from each state, and one representative of other cooperating agencies from each state. (As an alternative, a state may elect to have only one representative.) The resource soil scientists responsible for MLRA 99 will serve as ad hoc members. This committee will be formed by May 1, 1991, and meet at the discretion of the committee chairperson.

4. The states agreed to provide C. L. Girdner, Midwest National Technical Center, a listing of map units within SSSD for the MLRA as soon as possible but no later than February 1, 1991. C. L. will consolidate all individual county soil survey legends into one initial MLRA legend and send to the committee chair-person.

5. Benny Brasher represented the National Soil Survey Laboratory and indicated the laboratory has compiled all the NSSL data for the counties in MLRA 99 into one report and will make it available to the states. The NSSL will also assemble data from the state or other laboratories into the report if the states will provide their data. March 1, 1991 was selected as a date for getting all data (characterization and engineering) to the NSSL. The suggested format of the report was to list data by series by state.

6. One of the first activities to be performed by the states will be to evaluate the existing soil surveys and document the action needed to bring each to the common standard defined for the MLRA survey. Preliminary evaluations are to be completed by each state by November 15, 1991 and provided to the steering committee. These evaluations will assist the committee to develop a project plan outlining a schedule of activities and resources needed to complete the update.

7. Thomas E. Reedy will develop a draft memorandum of understanding for the MLRA by May 1, 1991. The draft MOU will be revised by the steering committee and concurred in by all involved states and cooperating agencies before formalizing a request to National Headquarters for updating. Plans are that the individual soil survey evaluations, the project plan, and the project memorandum of understanding will form the documentation needed for approval by the Director, Soil Survey Division of the

request to update the surveys. The materials will also form the basis for the states and national headquarters to budget and staff for completion of the project. Upon approval of the project then individual memorandum of understanding may be developed by the states with counties or groups of counties as needed to identify special needs or clarify reimbursable, cost-share, or cooperative agreements.

It is important to note that this and other modernization projects do not impugn the existing soil surveys. They remain excellent sources of data and are some of the most comprehensive resource data available. However, the data were gathered by many hands over a period of about 25 to 30 years and reflect what was known about soils at the time of survey. They have become outdated to varying degrees as new information became available and as technologies, environmental questions, and intensities of land use change. There is an opportunity to bring the soil surveys to a common standard and build on existing information to develop a more coordinated data base that will better address regional and national concerns.

The success of this project will depend on the approval and support of state conservationists, cooperating agencies and national headquarters. Much up-front planning and help from other disciplines and cooperators will be needed to augment the existing information and to carry the project to a successful conclusion. We will try to do our part to help coordinate and provide quality assurance for the maintenance project.

I am asking that the State Soil Scientists provide copies of this report and attachments to the participants from their state.

Larry F. Ratliff
Supervisory Soil Scientist
NSSQA

cc. State Soil Scientists in IN, MI, OH, Culver, Knox, Mausbach, Holzhey, Dornbusch, Arnold, Reedy

EXHIBIT 3: Steering Committee Report

Subject: SOI - MLRA-77 Soil Survey Update, Steering Committee Report

To: Steve Holzhey
Assistant Director
NSSC, SCS, Lincoln, NE

The MLRA-77 Steering Committee met October 27-28, 1992 at Elkhart, Kansas. A list of those in attendance is attached. The minutes of that meeting follows:

OPENING REMARKS: Dick Babcock, Chairman
Three items were put forth for the group's consideration.

1. Dick proposed and asked for comments on the idea that "work groups" be set up to accomplish the tasks of:
   - updating series needed in the MLRA update.
   - updating soil interpretations for these series.
   - developing a sampling plan for the update effort.
2. Dick suggested steering committee meetings be reduced from a quarterly to a semiannual or annual basis. It was agreed that the next meeting be held in Clovis, New Mexico in October 1993.

STATUS REPORTS:

TEXAS: An 8-person soil survey detail completed update mapping and checking of 787,336 acres in Hockley County and the northern part of Terry County this past spring. This and the 958,253 acres previously updated in Deaf Smith County brings the total in Texas to 1,745,589 acres, or approximately 6 percent of the Texas portion of MLRA-77. A minimal amount of documentation was collected and more is needed to meet the requirements established by the MLRA-77 steering committee.

A study of playa lake-vegetation relationships was conducted by a team of range conservationists, biologists, and soil scientists. Agreement was reached on criteria to ensure proper designation of wetlands.

(Other STATE progress comments followed but are not included with EXHIBIT 3.

MASTER LEGEND: This discussion resulted in agreement to develop a numerical master legend for MLRA-77. It will be a local option to use an alphabetic legend when publishing subset or county level legends. The numeric and alphabetic legends will be tied together. Chuck will continue to develop the master legend with a 5-digit code for all map units.

MLRA DATA BASE: Texas has agreed to be the host repository for the MLRA-77 data base. The data base will be a copy of appropriate SSSD data base information from each state, with an extra column for MLRA-id "mlramusym." This will require two sets of Soils-6s be maintained, one in the STATE SSSD and one in the MLRA SSSD. Also two "schedules" will need to be maintained: one for the STATE and one for MLRA-77.

It was agreed to assign stssaid as a "700" series with alphabetically sequential county numbers to replace the FIPS code for each county in the MLRA data base.

Each state agreed to send Soil-6s for the map units on their approved legends to TX to process and send out for review. A Soils-6 will be developed and forwarded to TX for inclusion in the MLRA SSSD for each new map unit approved and added as the county legends are developed. This MLRA SSSD will be accessible to all MLRA-77 states.

The steering committee recognizes a need for computer communications between soil survey staffs. It was agreed to pursue the option of installing Soilnet in the survey offices.

CRITERIA FOR K VALUES: The committee agreed to use the criteria in the NSSH when lab data is available (K Value nomograph or DOS program). A minimum of three sets of lab data will be required when using the nomograph or program. When adequate lab data is not available the SNTC guidelines will be used.

CRITERIA FOR T VALUES: The National Criteria for T Values will be used.

CAPABILITY UNIT AND SUBCLASS: It was agreed to utilize the guidance in Ag Handbook 210 and supplement it with the system developed by D. Williams and L. Carron. Copies of this system were provided to all states with the last steering committee minutes and additional copies were handed out at this meeting.

MANUSCRIPT FORMAT: It was agreed at the last meeting to use the template provided by C. Sample. He provided a computer disk of the latest version of the template and a Soil Survey Map Unit template and guide and requested comments be sent to Chuck.

EXISTING LAB DATA: P. Finnell discussed shell programs he has developed to obtain lab data from the Soils-8 data base. The data that includes lat and long can be used to plot locations of sample sites. Bill Waltman, NSSC has a GRASS shell, which will plot locations of sample sites from the Soils-8 data base.

COMMENTS by Larry Ratliff, NSSQA Staff: The lack of documentation and new data seems to be a common thread in the work completed at this point. You, as a committee, adopted documentation and quality standards for the update, now you must decide how to apply the standards that were adopted. We need to recognize the importance of documentation and schedule time during the survey to ensure it is collected. Documentation is necessary to write the correlation document and improve or add new interpretations for subsets before they are made available to the public. We must collect the documentation in conjunction with the mapping to ensure the integrity of the surveys.

There appears to be a need to know what GIS layers and shells are available at Lincoln for use by the states. Larry will pursue this item.

Steering Committee Chairperson

EXHIBIT 4: Completed Evaluation Worksheet

Soil Survey Evaluation Work Sheet

for

Noname County, WI Subset Survey Area,
MLRA 105M

I. General Information

Acreage:	Private 352,784	Public	____________
		State	____________
		USFS	____________
		BLM	NONE
		BIA	NONE
		NPS	NONE
		Other	____________

Date: Survey -- Published 1961, Correlated 1960.
Fieldwork -- Began 1940s, Completed 1950s.

Base map: Scale - 1:20,000; Kind - low altitude; Type - black and white.

Land Uses (in acres) (from NRI)	Cropland	116,000
	Pastureland	54,600
	Rangeland	
	Forestland	116,200
	Urbanland	2,700
	Other:	
	Orchards	48,284.

List the extent in acres of important land use changes since the existing soil survey was mapped:

A substantial acreage has been covered to rural homesites and other non-agricultural uses, especially near existing urban centers. Gently sloping forestland has been converted to cropland, some of which is used for cash cropping. Marginal cropland and pastureland has been planted to trees and is used as recreational properties by owners who live outside the county. Minor acreage has been converted to mined lands and quarries.

II. Quality of Existing Soil Survey

A. Soil Maps

Attachment **A** is a list of symbols and acreages of map units that require remapping. Map unit delineation problems are expressed on this attachment.

An explanation of why remapping and what corrective actions are needed is shown on the attachment. Corrective action and remapping needs for map units fell into one or more of the following categories:

1. Soil lines do not delineate landform segments which can be identified on the ground and on the maps.
2. Delineations of the same map unit do not consistently identify the same landform segment.
3. Additional delineation of landform segments can be made within the map unit and are needed by users; i.e. inadequate map unit design for current needs.

B. Map Unit Names and Descriptions

Attachment **B** is a list of those map units and acreages that do not need remapping but will require correlation to meet the standards for naming and interpretation.

A description of how the determinations were made and the corrective actions needed is shown. These map units usually fell into one or more of the following categories:

1. Inadequate information about map unit composition and/or soil patterns.
2. Map units that are improperly named at the series or higher category of Soil Taxonomy.
3. Map units with incorrect phase criteria.

C. Interpretations

Attachment **C** is a list those of map units that do not need remapping or correlation but require additional data to provide for revised or new interpretations. A description of how the determinations were made and the corrective actions needed is included.

III. Plans to Improve the Soil Survey

A. Products

Is this maintenance project a part of a Multi-county or regional project? Yes **X** No

Will the soil maps be digitized as part of map finishing? Yes **X** No

What is the new base map? Kind - Ortho photography,
Scale - 1:12,000.

B. New soil information

1. What additional soil data are needed by users?

   Water quality information pertaining to movement of pesticides and nutrients through soils, including attenuation qualities of soils. Information on variability and composition of mapping units, particularly with GIS application. Need characterization data for all soils to support interpretations.

2. What additional interpretations are needed by users?

   Expanded forestry interpretations as related to site habitat management. Modern interpretations on septic systems and land spreading of municipal and farm waste, especially as it relates to water quality and runoff. Interpretive criteria needs to be made compatible with state codes. Micronutrient, chemical and physical soil properties as they relate to speciality crops and sustainable agriculture.

C. Support needed

1. Briefly describe the investigative and laboratory support needed to provide the new data and interpretations.

   Studies on water table depths and movement in soils.

Sampling studies to include characterization support work and transecting which would include extensive use of backhoe pits to depths of 10 feet. Along with the transect work and mapping we would need to involve geologists and geomorphologists for their expertise. Statistical analysis of data collected will be used to determine map unit composition.

D. Maintenance improvement

1. Briefly describe how this survey will be improved by the maintenance project.

   Newer base maps will be a big improvement. Uniformity in mapping and map unit legends between counties. Accurate landscape delineations and knowledge of geological variability within map units will increase interpretation accuracy and usability. Soil lines conforming to landscape breaks will increase the creditability of the map and confidence to the user. New information will be in a more usable format and computer compatible. Additional characterization data will refine and expand the soil data base to better support all interpretation and computer models.

2. Briefly describe the publication plans.

   Soil information will be digitized using GRASS software and will be available at state and local offices. A two part publication that contains maps and text in one part and interpretations in the other will be developed. Maps and text will conform to current standards specified in the National Soil Survey Handbook for both tabular and spatial information.

IV. Staffing and Budgeting Needs

Estimate the staff years to complete:

Item II.A.	Soil Map-------	2.5	staff years
Item II.B.	Map Unit Names--	.5	staff years
Item II.C.	Interpretations-	.5	staff years
	Map Digitizing--	.5	staff years
	Other (soils)---	.5	staff years
	Total (soils)--	4.5	staff years

Estimate the kind and amount of support needed from other disciplines.

Geomorphologist and geographer: deposition, sedimentation and land form evolution; development of hierarchical terminology for landforms and segments.
Geologist: bedrock stratigraphy and composition.
Cartographers: digitizing support, imagery identification (remote sensing).
Research work from universities: monitoring and evaluation of ground water movement.
Forester: habitat study and management considerations.

Estimate the kind and amount of additional support available for the maintenance project (subset survey).

Federal -- USGS: bedrock stratigraphy; MNTC: NSSL - soil characterization, NSSL - landform evolution and composition and MLRA hierarchy of landscape/landform terms.

State ---- University: Soils, Geology and Geography and Institute of Environmental Studies - field and lab support.

Local ---- Set of low altitude color photographs, monetary assistance for digitizing maps, backhoe work and secretary and data entry staff.

Completed by: ________________________ Date: _______________

Attachment A: Soil map delineations

Quality statements (QA Stat)

1. Soil lines do not delineate landform segments which can be identified on the ground and on the maps.
2. Units are mapped inconsistently and are not tied to a unique landscape. Remapping is needed in all areas and boundary adjustments are needed for interpretations.
3. Additional delineation of landform segments can be made within the existing unit and is needed by users. A drainage component that may include hydric soils has caused problems with wetland identification and FSA.
4. Additional delineations can be made within the map unit that separate surface textural phases at the series level are needed to join with adjacent states and/or county surveys.
5. Additional delineations can be made within the map unit, particularly in colluvial areas that are deep to bedrock.

Attachment A:
TABLE A. Reference complete statement above from column QA Stat. for each map unit. Note that map units are grouped into physiographic areas (STATSGO Unit).

MUID	Map Sym	Map unit name	STATSGO Unit	Comp Acres	QA Stat
023GoB	GoB	Gotham loamy fine sand, 2 to 6 percent slopes	087	150	1,2
023GoB2	GoB2	Gotham loamy fine sand, 2 to 6 percent slopes, eroded	087	160	1,2
023GoC	GoC	Gotham loamy fine sand, 6 to 12 percent slopes	087	260	1,2
023GoC2	GoC2	Gotham loamy fine sand, 6 to 12 percent slopes, eroded	087	310	1,2
		Total component acres		880	1,2
023Or	Or	Orion silt loam	057	4720	3
023Ar	Ar	Arenzville silt loam	057	3470	3
		Total component acres		8190	3
023Aa	Aa	Alluvial land, poorly drained	044	32270	4
023Ab	Ab	Alluvial land	044	950	4
		Total component acres		33220	4

023DuB2	DuB2	Dubuque silt loam, 2 to 6 percent slopes, eroded	103	70	5
023DuC2	DuC2	Dubuque silt loam, 6 to 12 percent slopes, eroded	103	740	5
023DuD	DuD	Dubuque silt loam, 12 to 20 percent slopes	103	7500	5
		Total component acres		8310	5

Attachment B: Correlation of map units (COR Stat)

1. Inadequate information about map unit composition needed to refine interpretations for water/soil relationships and water quality.
2. Map units that are improperly named at the series or higher category of Soil Taxonomy that should be correlated to fit concepts in similar landscapes in adjacent counties.
3. Map units with incorrect phase criteria due to deeper soil depth and coarser textures. Impacts agronomic and tree planting recommendations and interpretations.

Attachment B:
TABLE B. Reference complete correlation statement above from column COR Stat in table B.

MUID	Map Sym	Map Unit Name	STATSGO Unit	Comp Acres	COR Stat
023DaA	DaA	Dakota loam, 0 to 3 percent slopes	087	530	1
023MdA	MdA	Medary silt loam, 0 to 2 percent slopes	057	380	1
023Wa	Wa	Waukegan loam	087	280	1
		Total component acres		1290	1
023Gu	Gu	Gullied land	097	140	2
023JcB	JcB	Judson cherty silt loam, 2 to 6 percent slopes	104	450	2
023Su	Su	Stony colluvial land	097	700	2
		Total component acres		1190	2
023HuB	HuB	Hixton sandy loam, 2 to 6 percent slopes	097	100	3
023HsD2	HsD2	Hesch sandy loam, 12 to 20 percent slopes, eroded	097	50	3
023NoD	NoD	Norden fine sandy loam, 12 to 20 percent slopes	097	500	3
		Total component acres		650	3

Attachment C: Data base/Interpretation needs (IT Stat)

The following are statements (IT Stat) relevant to maintenance of the interpretive data base, improving the existing, and developing new:

1. Characterize official series for data base improvement. Depths to 2 or more meters are desired where possible.

2. Develop modern interpretation ratings for each existing and new map unit in the identification legend (spot check for accuracy and develop protocols for an interdisciplinary quality review).

3. Reference samples to be tested for organic carbon, cation exchange and particle size to 2 meters or more (where feasible) to improve the data base for sustainability and water quality concerns (all dominant crop land soils).

4. Expand forestry interpretations related to habitat management for each forested soil in the identification legend.

Attachment C:
Table C. Reference complete statement above from the column IT Stat.

MUID	Map Sym	Soil Name	STATSGO Unit	Comp Acres	IT Stat
------	All	All	----	----	2,3,4
023MmA	MmA	Meridian	087	1500	1
023CaB	CaB	Chaseburg	057	2020	1

ITEMS REQUIRED FOR MLRA APPROVAL

1. EVALUATION REPORTS

Evaluation reports for the subset soil surveys are the first of three items that are required for project soil survey maintenance approval.

All of the maintenance projects will be required to have a quality evaluation (EXHIBIT 4) made for the areas to determine the overall needs. This quality evaluation will be completed before the projects are approved. The items that should be evaluated include attribute data, soil lab data, map unit line placement, map unit composition, and soil interpretations. They are discussed in the following sections:

Soil Data

During the evaluation of the adequacy of the subset survey, the soil data in MUIR and the lab data need to be evaluated. A few basic questions should be answered.

- Do the amount and accuracy of data support the correct interpretation and classification of the soils of the area?
- Are the data concentrated on a few major soils and landform positions, or is it well distributed?
- Do the data support the estimated soil properties reported on the SIRs and in the MUIR databases?
- Are there concerns that some data are lacking or are in error in some areas?
- Do the users need additional data or interpretations need?

Existing Laboratory Data

To answer the evaluation questions the steering committee for the MLRA soil survey must first assemble all the available data applicable to the area. The compiled information should be filed in a MLRA library by the lead state. Data to be evaluated includes all National Soil Survey Laboratory data, including data from the former Riverside, Lincoln, and Beltsville regional labs; SCS State laboratory data; State University data; SCS soil mechanics lab data; and State Department of Transportation engineering test data.

SCS Soil Characterization data from 1978 or later can be obtained through the use of the INTERACT program by selecting the soil survey sample numbers, or by inputting the state and county codes. An alternate and probably more desirable method is to request that the NSSL staff assemble copies of the data sheets and pedon descriptions of all the data available in the counties involved. A data tape can also be obtained in data base format from the National Soil Survey Laboratory, Soil Conservation Service, Lincoln, Nebraska.

The National Soil Characterization Database (NSCDB) is at the State of Nebraska mainframe computer in Lincoln, Nebraska. Nearly all NSSL data is available in a prototype National Soil Characterization Data Base (NSCDB) on a CD ROM disc. The information included in the NSCDB is the SOIL-8 data, characterization data, and pedon description data. The supplementary data reports can also be retrieved as a flat aschii file and built into a table. Soil survey lab data of NCSS cooperators will also be able to be included in the data base. This disc is updated periodically to include new data and can be obtained for a state or geographic area by request from NSSL, Lincoln, Nebraska. The NSSL staff can also download the requested data into a DOS flat file. These tables can then be moved to UNIX using conversion programs. In the UNIX format, the tables can be queried using Prelude commands. Soil survey lab data of NCSS cooperators will also be able to be included in the data base.

Development of a long-range investigation plan for MLRAs must begin with the compilation of soils data. The first step in the plan is compiling the existing pedon data and pedon descriptions. This information must be carefully analyzed before completing the SOIL-8 form. Once this step has been completed, the SOIL-8 data base can be updated and data can be obtained for the specific characterization data base and is entered into the NSCDB.

With an updated SOIL-8 data base, shell scripts (refer to Appendix 5) using UNIX and Prelude commands can be used to:

- select the series by correlated name and pull the data (from NSCDB) useful for testing the data against the Soil Interpretations Record;
- add and complete columns in the Characterization data base for base saturation, texture, organic matter, sand and silt for K factor determination;
- determine the number of pedons sampled for each series;
- determine the usefulness of sampled pedons based on classification or series criteria;
- locate and plot (using a GIS) the sampled pedons based on classification or series criteria;
- provide the total of mapped acres for each series sampled.

Other sources of data should also be considered, including thesis, dissertations, journal publications, field studies such as water table monitoring or yield studies, and state and national geologic survey reports and maps. This information needs to be in the same place as the coordinator for the MLRA. An index of the reference material needs to be assembled and made available for field soil scientists so they can request data as needed or routinely routed to all participants.

Also needed are copies of the latest Soil Interpretation Records (SIRs) and Official Series Descriptions (OSEDs) used in the MLRA. A list of these can be obtained from the Map Unit Interpretations Record (MUIR) data for the MLRA. A tape of the MUIR data can be obtained from Iowa State Statistical Laboratory, Ames, Iowa.

Once all available laboratory data are assembled, it should be evaluated in some orderly and systematic fashion against the MUIR data and the OSEDs and SIRs. Items to consider include:

- Do the data fit within the range of the series sampled, or within the range of another known series? If not, what are the differences and does the data fit the current requirements within the soil's soil classification? This information can be obtained from the SOIL-8 data base using the TAXCD column.

- Do the values reported on the laboratory data sheets (including the supplemental data sheets) fall within the estimated ranges on the Soil Interpretation Record? If not, should the ranges on the SIR be expanded, or another SIR phase be made, or is the data considered an anomaly?

- From what landform, geographic location, topographic location, and slope position was the sample taken? Does the position cause any unusual interpretive effect?

- Is the lab data sufficient to adjust data ranges in MUIR, develop a new soil interpretation record, or develop a new series?

Any discrepancies should be documented. Using the TAXCD, the SOIL-8 data base can be queried for those samples within the series ranges. The results of this query can be compiled along with the NOTES column to evaluate any discrepancies noted in the data. Using the SOIL-8 data base, evaluations can be grouped by series, taxonomic unit, or map unit to assist in the development of an MLRA sampling plan.

Once this evaluation using the SOIL-8 data base is completed, a determination of which series have been adequately sampled can be made. The data in the CNAME, SITE, LONGITUD, and LATITUD columns can be used in a GIS to plot sample sites. It will also be evident whether or not the data collected for each series covers the geographic and topographic extent of the series, or whether it is concentrated in one area and on only a segment of the landform, such as ridgetops, covered by that soil series. However, this will not be evident unless the geographic information is available and displayed in a readable format.

The evaluation will indicate gaps or weaknesses in data. These need to be noted and a plan developed to collect the additional information. Data needs should be included in the Project Plan for the MLRA survey. Site selection is very important. A preliminary study utilizing a statistically based transect method (see section on statistical methods) can be very useful to determine the variation in major soil properties and to identify representative pedons for laboratory analysis.

The importance of a well designed sampling strategy cannot be overemphasized. It is very important that the problem be stated clearly and a plan be developed to lead to results from which conclusions can be drawn. Once the steering committee or work group has identified a problem for which a special research project is warranted, we strongly suggest that research soil scientists at the NSSL and/or local university be consulted as needed to assist in the plan development. Such consultations will assure that the types of analysis, number of samples, location of sites, kinds of instruments used, etc. will adequately answer the original research question.

Laboratory Research Sampling Plan Development

Every effort needs to be made to develop an overall research and/or characterization plan for the MLRA project area. Subset soil survey areas need to be coordinated with a sampling plan projected for the MLRA. Previous sampling and analysis needs to be reviewed by the MLRA Steering Committee or work group to identify where information is needed. EXHIBITS 5 and 6 are examples of these plans. The following is a general outline to follow in development of a research/sampling work plan:

Research Work Plan Check List

1. Statement of problem:
   - concise summary;
   - questions that illustrate the problem that will be answered by the study;
   - operational, i.e., "need to know in order to" rather than just "need to know."

2. Justification:
   - local importance, i.e. county;
   - implications for wider application, i.e. landforms within and adjacent the project MLRA soil survey;
   - benefit(s) to the soil survey program, i.e. needs to fill data gaps, improve data reliability and

consistency.

3. Background:
   - setting, i.e. climate, geology, landscape, soils, etc.;
   - soil series and their classifications;
   - persons familiar with the problem, i.e. SCS, university, other;
   - specific background work pertaining to the problem, such as fieldwork, reviews, preliminary data.

4. Information needed:
   - geomorphic assistance;
   - literature review;
   - evaluation of existing data;
   - information to be gathered in present study.

5. Actions and Assignments:
   - project time table;
   - project coordinators, i.e. who in the MLRA (State) should the Soil Survey Laboratory staff contact;
   - Soil Survey Laboratory assistance needed:
      a. analyses suggested, i.e. state specific questions to be answered for each soil and/or horizon (complete analyses are not necessarily needed for limited, specific problems);
      b. persons involved, i.e. when, for what, travel involved, etc.
   - report responsibility;
   - report review responsibility;
   - distribution and application of data, i.e. within state, other states, etc..

6. Illustrations:
   - include diagrams and illustrations that define study area location, soil-landscape, stratigraphic relationships, etc.
   - emphasis needs to be placed here, i.e. need more to document soil model and theories.

EXHIBIT 5: Research Work Plan

INVESTIGATION OF THE SOILS IN THE REGION OF GLACIAL LAKE KASKASKIA IN MLRAs 113, 114, and 115

Sam J. Jones
MLRA Project Leader
Belleville, IL

PROBLEM

a. A significant part of St. Clair County, and parts of Randolph, Monroe, Washington, Clinton, Bond, Fayette, and Marion Counties (Figure 1) are underlain by glaciofluvial and lacustrine deposits which can range in age from pre-Illinoian (formerly designated as Kansan or Nebraskan, now grouped together as middle-Pleistocene to youngest of these deposits related to glacial activity is correlated with the Equality Formation (described by Willman and Frye, 1970). The fluvial deposits in the present flood plain area are correlated with the Cahokia Alluvium.

b. The younger deposits in Glacial Lake Kaskaskia are part of the Equality formation. Most of these areas are covered by Peoria Loess, except for the lowermost Woodfordian and possibly the early Holocene terrace level which appears to have little or no loess cover (Figure 2). Extensive areas of Iva, Weir, Piasa, Herrick, Virden soils, and other soils formed in materials considered to be associated with upland positions.

c. The original field sheets for the St. Clair County Soil Survey showed mapping units represented by tentative symbols, such as V308 (Alford), V453 (Muren), T16 (Rushville), V47 (Virden), T453 (Muren), and T454A (Iva). V was used for variant and T traditionally used in these upland soils. Documentation and correspondence during the survey also supported differences in stratigraphy. These differences were included in the "Formation of the Soils" section of the St. Clair County Soil Survey (Figure 3) (Wallace, 1978) but were not included in the mapping and classification of the soils in the county. One of the main reasons for this exclusion was the emphasis in the 1978 survey on the description and classification of the soils to a depth of only 60 inches.

d. More recently, the terrace/upland problem has been recognized in adjacent counties. During the recently completed Clinton County Soil Survey, soils formed in lacustrine deposits were mapped as T46 (Herrick), T47 (Virden), and 474 (Piasa). Soils mapped in map units T47 and 474 were eventually classified as a Montgomery taxadjunct (a soil developed in lacustrine material), and a new soil series was developed instead of on terraced positioned Herrick soil mapped in map unit T46 to recognize the importance of the lacustrine parent material.

e. Questions have arisen on the impact of these terrace soils and underlying materials on water availability for crops, yields of corn, and water quality. The Iva (86 bu/ac), Herrick (89 bu/ac), and Virden (91 bu/ac) upland soils have relatively high corn yields listed in University of Illinois Circular 1156 compared to the listed yields of the traditional terrace soils, which include Okaw (47 bu/ac) and Hurst (52 bu/ac), which is traditionally mapped as an upland soil. These discrepancies have been revealed in recent tax appeals to the State Board of Review. Differences in observed yields suggests differences in soils and available moisture for crop growth. These differences also suggest that the clayey substratum of the soils on terraces influences available water and movement of the water through the soil.

f. The problem is to not only accurately map and classify the surface soils but to also accurately identify and map the underlying materials, which influence the genesis, classification, and management of these soils. The objective of this study is to accurately identify soils, parent materials, and stratigraphy in the Glacial Lake Kaskaskia area. The hypothesis is that soils in the Glacial Lake Kaskaskia area differ from the upland soil, and that this difference is reflected in stratigraphy, soil physical and chemical properties, water status, and crop yields. Studying these soils in detail will provide more accurate interpretations for agricultural and urban uses in the Glacial Lake Kaskaskia area and the adjoining upland areas.

JUSTIFICATION

The Kaskaskia River glaciofluvial and lacustrine deposits occur in eight counties and the drainage basin of the Kaskaskia River covers 3,712,640 acres. The importance of the surficial and subsurficial materials in the Kaskaskia River Basin to agriculture and to the ground water quality of the area is evident. Rapid urban growth is occurring in St. Clair, Randolph, and Monroe Counties, and in turn, more urban and agricultural demands are being made on water that is supplied by the Kaskaskia River Basin. St. Clair County is currently being updated as part of the MLRA Soil Survey program in Illinois. Not only will the update in St. Clair County benefit from this study, but all of the other counties within MLRAs 113, 114, and 115 updates that have glaciofluvial and lacustrine deposits will also benefit. The information gained in this study will improve the credibility of the soil survey by supplying the survey users with more accurate and precise soil maps and interpretations. We will also be gathering soil and geology information at greater depths.

BACKGROUND

a. Most of the soils in the study area are the types that occur on uplands. The uplands consist mainly of the Illinoian glacial till plain or glacial outwash plain that is covered by loess. The total thickness of the Peoria Loess and Roxana Silt ranges from 100 feet in the western part of the area to 4 to 5 feet in the eastern part. Soils on the terraces formed in loess less than 60 inches thick overlying clayey material, or in the clayey material. There are also extensive areas of alluvial lands and bottomlands, that drain to the Kaskaskia River, which, in turn, drains to the Mississippi River.

b. The focus of this study is the determination of the boundary between the upland areas, represented primarily by soils formed in loess over glacial till, and the areas represented primarily by soils formed in glaciofluvial and lacustrine deposits. The difficulty in determining this boundary was well documented by the former Soil Survey Leader of the 1978 St. Clair County Soil Survey and his primary survey members. Historical correspondence between the soil survey party, the Illinois State Geological Survey, and the State Soils Staff discussed the difficulty and importance of making this determination. Unfortunately, the separations made by the soil survey party were dropped during correlation and final publication. They were dropped because of the emphasis on studying the soil to a depth of only 60 inches and the emphasis on the taxonomic placement of pedons. The MLRA update surveys will include more detailed descriptions to greater depths in order to meet the demands of modern agriculture and urbanization.

INFORMATION NEEDED

A soil-geomorphic / soil-stratigraphy study would be appropriate to determine the characteristics and extent of the glacial lake, and examine the relationship of these deposits to the distribution of soils across the landscape. From this study we can expand our knowledge of geomorphology and pedogenesis and gain a greater understanding of the geologic history of the Kaskaskia River Basin.

ACTION AND ASSIGNMENTS

a. The MLRA Update office requests the assistance of the Soil Survey Laboratory staff at the NSSC in Lincoln, NE. The Illinois Soil Survey Laboratory liaison is familiar with the area. He has expressed interest in working on this problem, and would be of great assistance in determining the soil-geomorphic/soil-stratigraphy relationships.

b. The coordinators for the study will be the MLRA project leader, the area soil scientist, Carbondale, IL, and Illinois State Soil Scientist. I will be the contact person. Other participants will be Illinois State University and soil scientists in MLRAs 113, 114, and 115.

c. Deep cores taken with a hydraulic probe and pits will be used to describe soils and sediments and collect samples for appropriate chemical, physical, and mineralogical analyses.

d. The study will be carried out in stages. The first stage will begin in November in St. Clair County. Transects will be made across three major valleys in St. Clair County - the Kaskaskia, Silver Creek, and Richland Creek valleys. Deep cores (depths > 20 feet) will be taken in transects perpendicular to each valley. A minimum of four cores will be taken in each transect, and each transect will begin in the upland, continue down an interfluve to the predicted terrace level, across the river channel to the terrace level on the other side, and again up an interfluve to the upland. Transect and core locations will be determined from topographic data and existing core data. We will determine the geomorphic and stratigraphic relationships, with emphasis on identifying the presence or absence of the Sangamon Geosol. The Sangamon Geosol is a key marker in identifying upland positions.

e. Tracing the Sangamon Geosol towards the streams will reveal where it has been eroded out of the valley. At the erosional boundary we expect the surface to be covered by Wisconsin deposits, and in places it can be lacustrine (slackwater deposits). Therefore, we need to examine the water regime characteristics at this geologic boundary to determine its influence on the distribution of modern soils (especially "problem" soils, such as Natraqualfs).

f. In places the development of the present soils in loess over the Pearl Formation with a Sangamon Geosol is different than the soils in loess over the Sangamon Geosol in till. The soils in the Pearl Formation are commonly developed to a greater depth and in places are better agronomic soils. This relationship may, in part, explain the higher yields of the Piasa mapped on the terrace compared to the yields for the Piasa mapped on the upland.

g. The results from the first stage of this study, will be used to guide the investigations in other counties that contain Kaskaskia glaciofluvial and lacustrine sediments. After determining the soil geomorphic and soil stratigraphic relationships in St. Clair County, the next phases of the study will take place downstream in Monroe and Randolph Counties, and upstream in Washington, Clinton, Fayette, Bond, and Marion

Counties. We hope to begin these parts of the study in the spring of 1992. The goal is to map the areal distribution of glaciofluvial and lacustrine sediments in the eight county study area, and eventually throughout southern Illinois and to determine the influence of these sediments on the genesis, morphology, classification, and management of the modern soils. The results of this study will be published and distributed to states with extensive glaciofluvial and lacustrine sediments.

SUMMARY OF PLAN OF ACTION

a. A literature review will be performed by the MLRA Project Leader in conjunction with the Illinois State Geological Survey (ISGS), completed 11/91.

b. The details of the experimental design and laboratory needs will be determined by the MLRA Project Leader, Area Soil Scientist, Soil Survey Laboratory liaison, and the Illinois State Geological Survey. At this time we will determine what water table, hydraulic conductivity, and yield data is needed for the study, completed 11/91.

c. The field work for the study will begin with one or two weeks of field work in 11/91 with cooperation between Illinois SCS, ISGS, and SCS NSSC.

d. Information gathered from the first three steps will guide the direction of the next portion of the field work to be carried out in 3/92.

e. It is envisioned that the study will take three to four years, to ensure sufficient collection of soils, yield and water table data.

EXHIBIT 6: Soil Characterization Plan

SOIL CHARACTERIZATION WORK PLAN

Identification:
State: Kansas
Investigation Project: Brown County study
County(ies): Brown
MLRA(s):
Plan prepared by: Jim Jones
In-state Contact(s): Jim Jones
Actively cooperating agencies:
Kansas Agricultural Exp. Station
Area or region of sampling, or soil survey area(s), if different from above:

Reasons for Investigations Project:
underscore the number of the primary reasons

<u>1</u>. Needs of current project soil survey.
2. Survey update or modernization.
3. Interpretation problem.
4. Regional correlation, definition of series, etc.
5. Study of genetic factors, processes, relationships.
6. Support of other activity (i.e. agronomic study).
7. Other - specify:

Intended use of Project Information:
underscore the number of primary uses

<u>1</u>. Characterize series or phase.
2. Document experimental or study site(s).
<u>3</u>. Determine classification.
<u>4</u>. Support correlation.
5. Test Soil Taxonomy.
6. Study soil relationships.
7. Other - specify:

For intended use 4,5,6, or 7, list questions to be answered here.

Assistance Requested:

Which year(s): 1990
Lab analyses from: SSL only
If data needed in less than one year, when?
Consultation before sampling? NO
Field study before sampling? NO
Reference samples to guide site selection? YES
Help with sampling? YES
Sampling equipment from SSL? YES
Number of pedons: 5 to 7.
Approx. number of samples: 50 to 55.
Ship to: Name
Soil Conservation Service
Address
Town, State, Zip
Proposed date for sampling: May 7 to 11, 1990.
Alternate date(s):

Status of Site Selection:
1. Sample sites have been identified:
   a. specific pedons? YES
   b. specific area (within 500 ft.)? NO
   c. general area (within a mile or two)? YES
2. Transect information available? NO
3. If 1a. is NO, when will pedons be selected? NO

Persons or Agencies Responsible:
Site Selection: Project Leader
Excavation of pits: Local SCS
Tools, equipment, materials: NSSL
Descriptions and classification: SCS State Office
Sample shipment: SCS - Kansas State Office
Analyses, other than SSL: NONE
Other:

Other Pertinent Information:
(may be supplied by attachments, e.g., official series descriptions, if applicable)

Pedon 5: Amego does not have free carbonates in the solum. The soils mapped in Brown County do.

Complete Table 1 for all projects; list alternatives if purpose is to check classification. Complete other tables insofar as information is readily available.

Table 1. Classification of Pedons to be Sampled.

pedon number	Classification to Family	Series and phase if important
1	Typic Hapludoll or Argiudoll fine-silty, mixed, mesic	Marshall *
2	Aquic Argiudoll, fine-loamy or fine, montmorillonitic, mesic	Mayberry
3	Aquic Argiudoll, fine, montmorillonitic, mesic	Chase
4	Typic Hapludoll, loamy mixed, mesic, shallow	Vinland
5	Typic Argiudoll, fine, mixed mesic	Wamego *

* Pedons to be sampled may not be representative of the named series, but may become new series.

Table 2. Extent of Series or Other Class Represented.

pedon number	Estimated Extent, acres this subset	area	MLRA	total
1	173,000			1,600,000
2	2,000			111,000
3	97,000			97,000
4	132,000			132,000
5	39,000			39,000

Table 3. Genetic Factors of Soils
attach block diagrams, geologic cross section, etc.

pedon number	Parent Material	Hillslope Position	Drainage Class	Vegetation (site)	Other
1	loess	convex ridge	W	corn	
2	till	convex summit	MW	wheat	
3	alluvium	low terrace	SP	soybeans	
4	shale	upland backslope	E	pasture	
5	shale / sandstone	convex ridge	W	native grass	

Table 4. Useful Data Available for These or Similar Soils (use lines as needed for each pedon to be sampled)

pedon number	Similar Pedons Previously Analyzed year/ state	County	SCS Lab or other	Series/ Family	Other Similar
3	KS1983	Morris	SSL	series	
5	KS1987	Wabaunsee	SSL	series	

New Laboratory Data

When the NSSL or any other lab produce new data it must be evaluated by selected members of the MLRA steering committee to determine its applicability to the project. Questions to be answered include:

-- Does the data fall within the range of the sampled series or higher level taxonomic unit?
-- Does the data fall within another established series or taxonomic unit?
-- How does it differ?
-- Does it classify differently?
-- Are the data internally consistent?
-- Do the results from one analysis agree with those of another?

In an effort to answer these and other questions, the project leader or liaison from NSSL and the representative steering committee member or the NSSC representative responsible for the area should review the data before it is returned to the state. States should compare the data with the applicable OSED and SIR and note any discrepancies. A consolidated list of comments from these staff members should be sent along with the final data to the states that use the series within the MLRA. A similar type of review should be made on all data, including university and special studies by the state.

As states receive the data, they should review it along with the comments from the NSSL and steering committee member. They can then determine applicability and complete the SCS-SOIL-8 form. If the lab data is acceptable the states should use the data to:

- check for inconsistencies on the SIR;
- check for additional data gaps or weaknesses;
- ensure that taxonomic questions are resolved;
- ensure that interpretive concerns are satisfied.

Any major revisions to the national data records or remaining concerns about the adequacy of the data should be brought to the attention of the steering committee and resolved on an MLRA basis.

The Lab Data Use course guide entitled "Principles and Procedures for Using Soil Survey Laboratory Data" provides an explanation of the data sheets and several cross checks that help determine the integrity of the data. Copies of this document are available from the NSSL.

SIR and MUIR Data Attributes

During the MLRA planning or early in the MLRA maintenance, the data in the MUIR database, SIRs, and OSEDs need to be evaluated for consistency and accuracy. As stated earlier, a data tape for the MLRA can be obtained from Ames. A data tape of the up-to-date Soil Interpretation Record data is also very useful and is available from Ames.

Some basic shell scripts have been written to help in this evaluation (Appendix 5). They can be used to compare all phases of a series or any other taxonomic level. These shells compare soil property and interpretive data between the different phases. Other shells can be written to compare the properties important to your specific area.

The completion of the evaluation of the laboratory data described above may indicate that the SIRs and OSEDs of some series need to be revised or perhaps new ones need to be established. These revisions should also be completed early in the maintenance process so that all field personnel are using the most up-to-date information. This should result in a much more uniform product.

Many of our soil series have been extended beyond the geographic area that best fits the central concept of the series. Also the range in characteristics (RIC) of many series has been expanded to include characteristics that are just outside the normal series RIC.

Many of these series need to have the RIC narrowed to more closely fit their intent. This narrowing is becoming more important as computer modelers use our data for water quality predictions, leaching potentials, and erosion and productivity prediction's.

Soil properties must be stated in quantitative terms for proper definition of the soil. New series may need to established for a part of the old RIC. As these refinements are made, the accompanying SIRs also need revision.

Another area of the OSED that needs attention is the "competing series" section. The competing series must be adequately differentiated based on soil properties of the series control section. These properties should be quantitatively stated in the range in characteristics.

Interpretations

A review of the laboratory characterization data against the soil series phase data contained within the estimated properties on the Soil Interpretation Record (SIR) should be made as well as a review of the assigned soil interpretation ratings. Several questions should be addressed during this interpretation check.

- -- Do the interpretations properly represent the soil behavior for the areas mapped?
- -- What questions are being raised by the users about the soil's behavior or interpretation?
- -- Are any interpretations outdated because of technology changes, local needs, or improvements in rating criteria?
- -- Do soil map unit delineations provide sufficient detail for the interpretations users need?

Discussions with the main users of the data base should point out the major interpretive weaknesses. A soil interpretation field review with land users should be conducted to evaluate the interpretations.

Review of Interpretation Overrides

An evaluation of the existing interpretations should be made with a query of the subset survey data bases (MUIR files). These interpretations should be pulled along with the codes that indicate those interpretations which were overwritten (hand entered) by the states. Each interpretation that was changed needs to be reviewed. Either the interpretive rating criteria was not generating the proper interpretation or the soil properties listed on the SIR created a rating that was disagreed with. For either situation, the inconsistency needs to be resolved. Do not assume that by overwriting the generated interpretation you have solved the problem - you have only created an interpretation that may not be joined by someone else.

For those overwritten interpretations, review the data elements associated with the rating criteria against your data. Perhaps the interpretive record was expanded to the point that it no longer creates the interpretive ratings originally intended. If this is true, then phases or new series may need to be considered. Contact the NSSC, Soil Survey Interpretation Staff for assistance in generating a printout of the interpretations and soil properties that were adjusted in MUIR.

Map Unit Components and Boundaries

The following sections describe the evaluation of soil map units and boundaries (tabular and spatial information) through transect methods. Information on transecting and statistical analysis is included here to improve documentation procedures.

Background

Why do we need transect information?

To understand the need for transect information it is necessary to consider how this information differs from observations a soil scientist makes during normal mapping operations. When making a soil map, a soil scientist utilizes a landscape model to determine where observations are to be made on the landscape. This model is used to predict the kind of soil that will be identified in a given area based on knowledge about the local effects of parent material, relief, vegetation, climate, and time (the soil forming factors). An underlying assumption exists that soils do not occur randomly on the landscape. The distribution of soils is a function of the interaction of the soil-forming factors.

When mapping, a soil scientist predicts where soils are likely to change on the landscape and makes observations to test the prediction. The better the landscape model, the more accurate the predictions about changes in soil types across the landscape. As a result, fewer observations are required to make an accurate map.

Landscape models are powerful tools that make it possible to make soil maps accurately and quickly. We must keep in mind, however, that the observations are heavily biased by the landscape model. For example, small areas that are inclusions in the map unit are purposely avoided.

In transecting, observations are made based on a predetermined spacing - for example, every 100 feet. A larger number of observations are made in a delineation as compared to mapping. The observations include the major soil making up the delineation and included soils. No sites are ignored as being "unrepresentative."

In mapping, the goal is to make observations which reflect the dominant soil condition and then to place lines on the map separating areas representing different soil types. In transecting, the goal is to document what is inside the lines drawn on the map as well as determining the accuracy of line placement in all areas.

Information gathered from transecting can be used to:

1) Determine the composition of map units, including estimating the amount of named and similar soils and contrasting soils. In addition, where in the landscape that common inclusions occur can be documented.
2) Aid in the selection of "Typical Pedons."
3) Determine the range in characteristics for a soil.
4) Provide data to support correlation decisions.
5) Estimate the variability of properties within a map unit.
6) Evaluate the quality of existing soil surveys.

Sampling by Transect

This section describes basic concepts of sampling as it relates to selection of delineations for transecting.

A map unit is made up of all of the delineations which are identified by a particular symbol on the soil map. We can think of the map unit as a population made up of many individuals (delineations).

The goal in gathering transect information is to be able to make estimates about the map unit as a whole. Ideally, we would like to know exactly what is inside the lines indicated as a particular soil type on the map. Of course, it is impossible to observe all of the pedons within each delineation that makes up a map unit. Instead, we rely on sampling a few delineations (individuals) to make estimates about the entire map unit (population).

Since only a few delineations are transected, the method of selecting delineations for transecting is very important. To be confident that the transects are representative of the entire map unit, delineations must be chosen at random.

The natural inclination often is to select areas because they are "good examples" of the soil in question. In effect, the criterion is that they support the conceptual model used in mapping. Site selection to verify landscape models is done when mapping. However, the goal in transecting is to determine what is inside the lines that have been drawn. In effect, we assume that our models were as good as was possible to develop for mapping purposes. Now we want to document what is inside the delineations and "let the chips fall where they may."

To think of it another way, consider the sampling of 250 people to determine the outcome of a local election. Interviewing people with bumper stickers in support of your candidate may support your idea of who you think should win but may not predict very well who will win. Selecting 250 people from a list of registered voters will likely result in the best estimate of the winner, even though you may not like that candidate.

The test for proper sample selection is simple. Every individual making up your target population must have an equal chance of being selected. In other words, each delineation making up the map unit must have an equal chance of being transected. There are many possible ways of designing a method of selecting delineations that will meet this criterion. The best methods are those which are quick and easy. We recommend the following procedure:

Random Selection of Delineations For Transecting

1. The first step is to stratify the survey area because we want the transects to be spread over the geographic distribution of the soil. For example, if the soil occurs over the whole survey area, split the survey area into four roughly equal areas (using match lines of field sheets as the boundaries). For area 1, put the numbers of all the field sheets in a "hat." Assume we want a total of eight transects for the survey area. In order to get a sample that represents the entire soil survey, we want to get 2 transects from each area, so pull two numbers from the hat. These are the two sheets to be used in this area. Repeat for the other areas so that we have a total of eight. If it turns out that any of the sheets selected don't have the soil you want, pull a new number.

It may be that a soil only occurs in one part of the survey area. For example, it may occur only in the northwest corner of the soil survey area on four field sheets. Since you want eight transects, you could select two sites on each of the four sheets by following steps 2 to 4 below. There are several possible variations.

2. The next step is to select a delineation on each sheet. To do this, first measure the match lines corresponding to the "X" and "Y" axis of your field sheet (we suggest you use centimeters). There are three lists of random numbers in Appendix 2. The first list is numbers from 1 to 25, the second is numbers from 1 to 50, and the third is numbers from 1 to 75. Use the list that is closest to the dimension you measured but is not smaller than the dimension.

For this example let's assume that the X axis match line is 38 cm and the Y axis match line is 22 cm. To select a point along the X axis, use the list of random numbers from 1 to 50. Select a number at random, and measure along the match line from the left hand corner that number of centimeters. (If the number selected is more than 38, go down the list until you come to a number between 1 and 38). Next, use the 1 to 25 list to select a number between 1 and 22. Measure up from the X axis point that distance.

3. Once you have a point located on the map, simply find the nearest delineation of the soil you are interested in. That will be the unit to transect. When you get to the field, try to do your transect as close to the general area selected as possible,

but judgment will be needed to accommodate such factors as obtaining permission from landowners to gain access, avoiding cemeteries, etc.

4. Repeat the procedure until all of the transects are located.

Orientation of Transects

Once an area has been selected, the next step is to lay out the transect. Ideally, the direction selected should be one that will cross the sources of variability in the most efficient manner.

For studies involving map unit composition, we generally are interested in changes in major morphological properties that are great enough to result in identification of different series. Since soils vary as a function of the interaction of the soil-forming factors, selecting a direction that will cross these sources of variation should give the best results. In most cases, transecting perpendicular to drainageways will achieve this.

Perpendicular transects, by nature, will run from high to low elevations in the delineation. This direction is likely to cross changes in parent material (particularly in stratified materials), and relief. If the elevation differences are great enough, local climate changes and vegetation differences will also be crossed. In addition, this direction is likely to encounter changes in geomorphic surfaces through time (if different surfaces are included in the map unit).

There are some possible exceptions to this situation. For example, in some karst areas soils are distributed in apparently random fashion as a result of the soil disturbance from "sink hole" activity. The distribution of soils has little relation to the present topography of the area. In addition, these areas may have no apparent drainage pattern. Other exceptions may include landscapes where depth to bedrock is highly variable with no discernible pattern.

If the variation in soil types is truly associated with no particular direction, selecting a direction at random to orient the transect (as by dropping a pencil and using whatever direction it points) would be fine. However, if there is a pattern which we simply do not discern, transecting in a straight line may fail to cross the variation effectively and could result in inaccurate data. Techniques involving geostatistics are available to determine which, if any, direction is associated with variability for given properties, but these procedures are beyond the scope of normal soil survey operations.

For those situations where straight line transects oriented perpendicular to streams may not be appropriate, some other strategy must be employed, including selecting points randomly for the observations (by using random numbers in a procedure similar to that which was done to select areas to transect) or by transecting in a zigzag pattern across the delineation.

Data Collection: Kind and Amount

Two main kinds of map unit composition transect data are collected during the course of a soil survey. One kind is soil taxonomic data. This information is gathered in the following way: at each point in a transect, the taxonomic class of the soil is identified, usually by specifying the soil series. Transecting a map unit only to determine soil series alone is not very useful. The other kind of data gathered consists of measurements of soil and site properties. These include such data as percentage of slope, position on landform, depth to bedrock, depth to gray mottles, thickness of mollic epipedon, depth to base of argillic horizon, or percent clay in Bt horizons, etc. Data collection during the soil transecting process must include the same basic soil properties for each series and map unit so that all transects represent an accumulation of the same data.

Some kinds of data will be collected at all points in every transect in a soil survey area (MLRA). The steering committee for the MLRA needs to decide on the data to be collected and put this criteria in the "MLRA Standards Handbook." These so-called "standard" measurements might include such things as soil name, percentage of slope, and position on landform. To assure that the statistical measures are accurate, the subset soil surveys contained within the MLRA must coordinate and use the predetermined standard measurements and make sure that all project members collect the same information at each point examined in a transect.

Some additional measurements may be desired. These should be decided early in the project survey. These measurements can vary with different kinds of map units. For example, the kinds of data gathered on a steep, stony unit normally will be different from data gathered on a level, frequently flooded, poorly drained unit. Additional data could include such things as thickness of the A horizon, texture of the B horizon, depth to bedrock, etc. It is critical to decide IN ADVANCE what data will be gathered in a transect because this will minimize the chances of conducting many transects, then realizing that some important information had not been gathered.

Balance in data collection is important. For example, transects should be run in all map units. If care is not taken, the easily accessible map units with soils that are easy to describe will be transected extensively, while the more difficult map units (wet, rocky, steep, thick vegetation, etc.) will not be properly evaluated. In addition to balance among map units, it is important to have a proper balance between complete pedon descriptions and brief descriptions of "important" information.

It is not always practical or useful to completely describe the pedon at each point in transects, although this may be appropriate in some situations. Transect data are used to answer correlation, interpretation, and mapping questions. In answering such questions, six transects with just the "important" information often will be more useful than three transects with complete descriptions at each point. One must always keep the purpose of the transects in mind.

A standard data form should be used to collect transect data. This form should have headings filled out for all required data and also blank headings so that any optional data can be identified and entered. A standard data form helps ensure that all the necessary data will be gathered at each point in a systematic manner.

Analysis of Transect Data: Statistics

Once transect data has been gathered, what is done with it? An important step in evaluating transect data is to summarize it. For example, assume you have run ten transects in a map unit to determine taxonomic composition. Simply counting the total number of transect stops at which the named soil or a similar soil was encountered can be very informative. It also is important to visually inspect your transect data and look for patterns or trends. For example, assume you have run a number of transects to determine, among other things, depth to bedrock in a map unit. By simply looking at the data it may become apparent that soils tend to be uniformly shallower in some delineations than in others. On the other hand, it may be apparent that there is not much difference among delineations, but there is a lot of variation within delineations. A relationship between depth to bedrock and landscape position within the delineations might also be noted. This kind of inspection is very important in determining how map units are to be named and interpreted.

Sometimes trends and patterns cannot be discerned simply by visual inspection. In these cases it is necessary to calculate and use statistics. The purpose of statistics is to "boil our information down" so we can understand it better. Statistics has been formally defined as a set of procedures to reduce large masses of data to a few meaningful values.

We generally use statistics to tell us two things. First, we are interested in "central tendency," the average or middle value. For example, what is the average salary paid to soil scientists? What is the average depth to bedrock in a soil map unit? What is the average slope? The arithmetic average, or mean, is a very important piece of information. If certain statistical criteria (beyond the scope of this discussion) are met, the mean is the best single value that characterizes a group of numbers.

However, simply knowing the central tendency (or mean) is not enough. We also must know how variable the data are. Assume you ran a 5-point transect, measured depth to bedrock, and this depth at each point was exactly 35 inches. The mean would be 35 inches, and you would appear to be sampling a very uniform delineation. Now assume you ran a 5-point transect in another delineation, also measuring depth to bedrock. However, in this case, the values obtained in inches were 15, 5, 65, 55, and 35. Again, the mean depth to bedrock is 35 inches; however, the population appears to be much more variable. Assume additional transects showed similar trends. Would these two groups of delineations be placed in the same map unit simply because, on the average, they are the same? In most cases, no.

To use statistics in evaluating soil map units, one must consider the average value. We most commonly use the mean. We also must consider how variable the individual observations are. Statistics commonly used to estimate variability include the standard deviation and range. The standard deviation is a useful statistic. In addition to describing a population, it can be used to conduct statistical tests on the population. For example, is the mean of the population (map unit) significantly different from the mean of another population (map unit)? The illustration (Figure 1) helps picture the variability within a map unit in randomly selected sample areas.

The standard deviation can be used to place a confidence interval around a mean. This allows us to make statistically reliable statements about the taxonomic makeup of a map unit. Confidence intervals around measured soil or site properties allow us to make statistically reliable statements about the occurrence of the property in the map unit. Statements, such as the following, can be made:

> "The true percentage of Alpha soil in this map unit lies between 70 and 90 percent at the 90 percent level of confidence," or

> "The mean depth to bedrock in this map unit lies between 32 and 45 inches at the 90 percent level of confidence."

It must be stressed that such statements as those above can be made only about the entire map unit. We cannot make such statements about individual delineations.

More complicated statistics, such as the standard deviation, have a definite use in the soil survey. However, most decisions needed to map, correlate, and interpret soil map units can be made by using simpler statistics. Most soil survey decisions can be made by using the mean and the range, if the transect data also are inspected closely to look for obvious trends. The mean gives us an estimate of the central tendency of the population, while the range gives us a rough idea of how variable the population is.

The range is calculated by subtracting the smallest value from the largest value. In the example involving depth to bedrock given above, the first population has a range of (35 - 35) = 0. The second population has a range of (65 - 5) = 60. (To be exactly correct, the statisticians would require us to calculate ranges according to the following formula: (Largest value - smallest value) + 1. The 1 is added because, using the sample above, the range theoretically should be calculated as follows: 65.5 - 4.5 = 61. For ease of computation and understanding, we will calculate the range as largest value - smallest value in the Soil Survey.

In analyzing transect data a number of things need to be kept in mind. When dealing with taxonomic data, a decision must be made about "similar" soils. Are they going to be combined with the named soil for the analysis or analyzed separately? A decision must be made about how to handle inclusions in map units. The decision made usually depends on your objectives: that is, are you trying to make inferences about a taxonomic unit, or are you trying to estimate soil properties within delineations, regardless of taxonomic class?

Gathering and analyzing soil transect data lends itself well to a "system." Within a soil survey, the way you gather and analyze data will be about the same from map unit to map unit. Therefore, as stated previously, a standard form is needed to enter the data. Normally, the data will be summarized and statistics calculated the same way regardless of the map unit transected or soil property measured. A form to systematize the calculation of means, ranges, and even standard deviations will increase efficiency. Computer programs and UNIX shell scripts also have been developed to calculate simple statistics from transect data. The use of such a program is highly encouraged.

One important point needs to be repeated. Estimates of the taxonomic composition, mean depth to bedrock, thickness of the surface layer, etc. apply to the entire map unit. We cannot use statistics to go further and say that these values will hold true for any single delineation. To illustrate this, consider a soil that has bedrock between 20 and 40 inches. Five transects in the northern part of the survey area each have a mean depth to bedrock (average for all points on each transects) of 20, 22, 25, 24, and 26 inches. Five transects in the same map unit in the southern part of the survey area have mean depths to bedrock of 28, 39, 30, 37, and 38 inches. The estimated depth to bedrock for the entire map unit based on all ten transects is 29 inches. The data from the individual transects clearly show that the likelihood of any one delineation having a mean depth to bedrock of 29 inches is not very great.

To avoid misleading users of soil survey information, care must be taken to report statistical information for the map unit as a whole. For the example given, the following statement is appropriate:

> *Based on ten transects, the best estimate of overall mean depth to bedrock is 29 inches. Individual areas of Alpha soil will vary from this estimate. Transect data suggest that the soil in this map unit may be shallower in the northern part of the survey area than in the southern part.*

It is important to identify procedures for conducting transects and analyzing data early in a MLRA project soil survey. Steering committees need to coordinate with State Office and National Soil Survey Center specialists in developing a strategy that is efficient and technically sound.

EXAMPLE: Analyzing Transect Data

In the soil survey, we deal with two main kinds of data. These are continuous data that are assumed to be normally distributed and discrete variables that have a binomial distribution.

Normal Distribution: A variable is normally distributed if it follows a distribution based on the normal curve. Although this is a circular definition, it probably is best since everyone has seen and can visualize the normal curve. Examples in the soil survey include measurements of depth to bedrock, thickness of the A horizon, etc.

Binomial Distribution: A variable has a binomial distribution if it has two possible outcomes, only one of which can occur. Examples include tossing a coin (head or tail), determining whether an animal is male or female, etc. In soil survey, deciding whether a given soil is present (yes) or absent (no) at a given point is an example.

A. Calculation of statistics for continuous variables that are normally distributed:

Hypothetical data are shown in Table 1. The data consist of a value representing the average depth to bedrock for each of five 10-point transects, i.e. each transect depth is the average of ten points.

Table 1: Transect Data

Transect Number	Average depth to Bedrock (in)
1	20
2	15
3	22
4	28
5	25
--------	----------------
n = 5	Total = 110 inches

Calculation of statistics from data, Table 1. The overall mean depth to bedrock in five transects is calculated as follows:

$$\text{overall mean or } \bar{\bar{x}} = (20+15+22+28+25) \;/\; 5 = 110/5 = 22 \text{ inches}$$

The mean is a measure of central tendency. In order to test a hypothesis about a mean or place a confinence interval around it, it is necessary to calculate a statistic that reflects how variable the population is. One such statistic, called the variance, is calculated as follows:

$$\text{Variance or } s^2 = \sum(\bar{x} - \bar{\bar{x}})^2 \;/\; (n - 1)$$

where in this case

$\bar{x}$ = average depth to bedrock in each transect

$\bar{\bar{x}}$ = overall mean depth to bedrock for all transects

n = number of transects run

$\sum$ = the sum of

Calculation of the variance for the data in Table 1 is illustrated in Table 2.

Table 2: Calculation of Variance

Transect Number	$\bar{x}$ Transect mean (in)	$\bar{\bar{x}}$ overall mean (in)	$(\bar{x} - \bar{\bar{x}})$ (in)	$(\bar{x} - \bar{\bar{x}})^2$
1	20	22	-2	4
2	15	22	-7	49
3	22	22	0	0
4	28	22	6	36
5	25	22	3	9
------	------	-------	------	-------
n = 5			Total = 98 inches	

$$\text{Variance or } s^2 = \sum(\bar{x}-\bar{\bar{x}})^2 \;/\; (n-1) = 98/4 = 24.5 \text{ in}$$

In order to put a confidence interval on the mean, one must use the variance computed above to calculate a statistic called the standard error of the mean, or $s\bar{\bar{x}}$. The standard error of the mean is calculated as follows:

Standard error of the mean or

$$s\bar{\bar{x}} = \sqrt{s^2 / n} = \sqrt{24.5 / 5} = \sqrt{4.9} = 2.2 \text{ in}$$

The standard error of the mean is 2.2 inches. After calculating the mean and its standard error, one can use the t distribution to put a confidence interval on the mean, as follows:

$$\text{Confidence interval or CI} = \bar{\bar{x}} \text{ +or- } (t)\ s\bar{\bar{x}}$$

The value of t depends upon the degrees of freedom, which is n-1 and the level of confidence, which is arbitrarily chosen. The most common are the 95 and 99 percent confidence levels. The meaning of this confidence level will be made clear as the example is continued.

The mean (22 in) and its standard error (2.2 in) have been calculated. From Table 3, a t value with n-1 = 4 degrees of freedom at the 95 percent level is chosen. Refer to Appendix 2 table 4 to find value of t. The t value is 2.776. The confidence interval is then calculated as follows:

Confidence Interval or

$$CI = \bar{\bar{x}} + (t)(s\bar{\bar{x}}) = 22 + (2.776)\ (2.2) = 22 + 6.1 = 28.1 \text{ in.}$$
$$CI = \bar{\bar{x}} - (t)(s\bar{\bar{x}}) = 22 - (2.776)\ (2.2) = 22 - 6.1 = 15.9 \text{ in.}$$
$$CI = 16 \text{ to } 28 \text{ inches}$$

Based on this analysis, the following kind of statement is appropriate concerning the mean depth to bedrock in the map unit being evaluated:

> *The best estimate of the mean depth to bedrock for this map unit is 22 in. There is a 95 percent probability that the mean depth to bedrock in this map unit lies somewhere between 16 and 28 inches.*

Since the 95 percent confidence level was chosen, there is a 5 percent probability that, as a result of getting an unrepresentative sample of transects by pure chance, we have completely missed the true mean.

Statements must be carefully written. This kind of sampling allows one to estimate a mean only for the <u>entire</u> map unit. It does not enable one to make any inferences about individual delineations. Being distributed on the landscape in discrete delineations is simply a characteristic of the populations being sampled. Therefore, in making inferences from this kind of sampling, mentally erasing delineations and visualizing the map unit as a single large area is helpful.

B. Calculation of statistics for data from a binomial population:

Much of the transect we gather in the soil survey is binomial. An important example is when delineations are transected to estimate the percentage of a soil component in the map unit. At each point on the transect, the observation consists of a judgment as to whether the soil occurs at that point or not. Since the variable can assume only two values, present or absent, the equivalent of 0 and 1, it is a discrete variable that follows the binomial distribution. There are specific statistical techniques for analyzing data from binomial populations. Although the same statistics (mean, variance, and standard error of the mean) are calculated, their manner of calculation differs.

Following is an example of how statistics are calculated when the sample data are from a binomial distribution. In this example, 10 transects of 10 observations each were run, a total of 100 observations. The observations consisted of whether a given soil (Alpha) was present or not. Since only two values are possible at each observation point, the variable clearly is binomial.

When assessing a binomial population, the statistics are calculated using the individual observations, even if those observations came from transect data. Therefore, one simply determines how many of the 100 observations were Alpha soil, assuming that Alpha soil was identified at 40 of the points. Assuming a representative sample, the best estimate is that Alpha soil makes up 40/100, or 40 percent of the map unit. In binomial statistics, 40 percent, the mean percentage of Alpha soil would be designated as $\hat{p}$. Using statistics applicable to binomial data, a confidence interval can be placed around this mean as follows (Steel and Torrie 1960):

Percent of Alpha soil ($\hat{p}$) is 40 percent.
Percent not Alpha soil ($\hat{q}$) is 100-40 or 60 percent.

For a binomial population, once the mean is known, the variance is simply equal to $\hat{p}$ times $\hat{q}$. The confidence interval on a mean of a binomial population can be computed as follows:

Confidence interval or $CI = p \pm (t)\sqrt{pq/n}$

$\hat{p}$ = 40 percent
$\hat{q}$ = 60 percent
n = 100, the total number of observations
t = 1.662, t value was interpolated from from Appendix 2, table 2 for n-1 or 99 degrees of freedom and a significance level of 90 percent.

$$CI = 40 + 1.662\sqrt{(40)(60)/100}$$
$$= 40 + 1.662\sqrt{24}$$
$$= 40 + 8$$
$$= 32 \text{ to } 48 \text{ percent}$$

The following statement can be made concerning the percentage of Alpha soil in the map unit:

> *The most likely estimate is that Alpha soil makes up 40 percent of the map unit. There is a 90 percent probability that the true percentage of Alpha soil in the map unit lies between 32 and 48 percent.*

We have included in Appendix 2 for your use lists of random numbers, and values of t. Binomial confidence limits have been calculated for samples of different size and are available in standard statistical texts.

Existing Soil Map Unit Quality

The first step in assessing the quality of existing soil mapping is to evaluate line placement. Specifically, do the lines conform to natural landscape breaks and are all important natural soil-landform units delineated? The following procedure is suggested to systematically evaluate line placement in a soil survey.

A) Select a general soil map association to work in.

B) Randomly select areas within the general soil map association for evaluation. In some parts of the country, sections may be selected for evaluation. In non-sectionalized parts of the United States, parts of map sheets may be selected randomly. Generally, these should be at least one square mile in size.

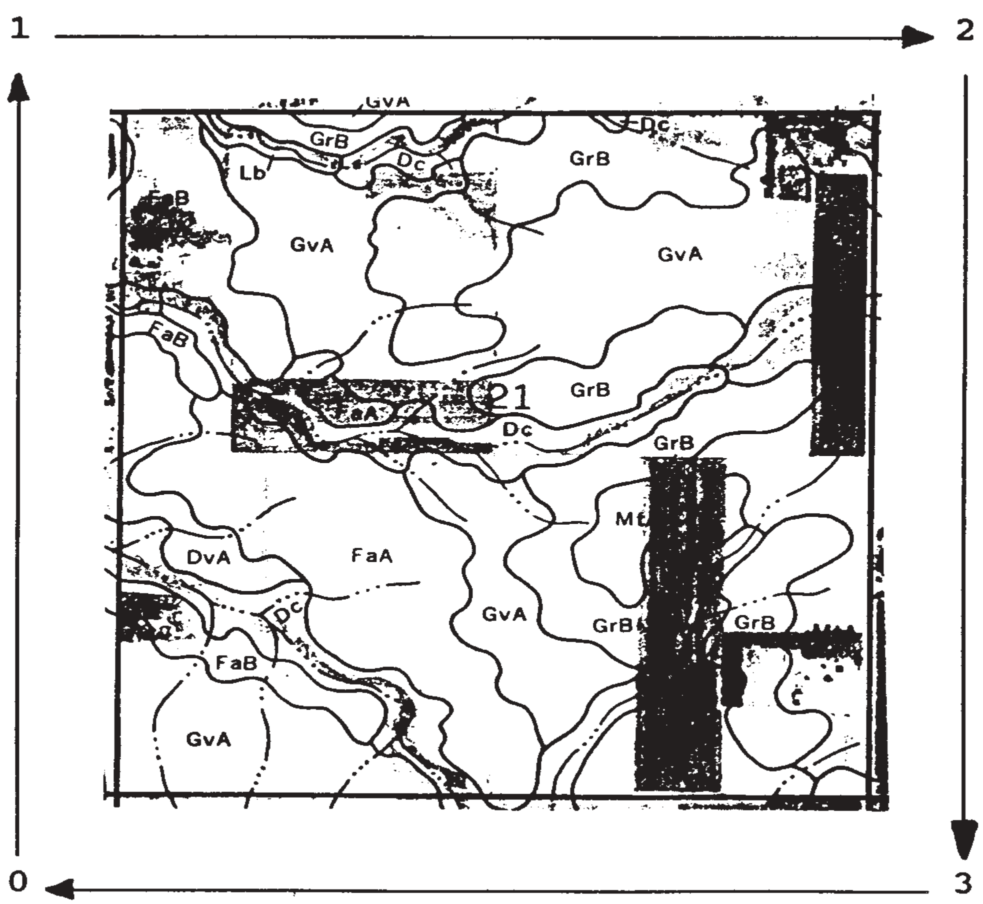


Figure 1. Evaluate soil lines by driving section boundaries.

C) Within each evaluation area, line placement is checked by driving available roads and checking each soil line that intercepts the road being traveled. In sectionalized country, it might be convenient to drive the section boundary (Figure 1). In other parts of the country, roads should be selected to transect the evaluation area in several directions. This procedure requires at least two people - one to drive and one to read the map and evaluate line placement. (Note: Many soil lines can be observed from a slowly moving vehicle. However, in some cases it will be necessary to get out of the vehicle and observe the landscape more closely. Observations should be made only near the road within a distance of less than 200 feet). Figure 1 illustrates steps B and C.

D) The following information is recorded for each soil line encountered.

1) The map unit symbol on each side of the line.

2) Comments on line placement. That is, is it properly placed on the landscape? If not, what is the problem?

3) Note any areas where a line should have been placed and was not. Identify the soil map units that should have been separated.

E) The information is summarized to indicate the following.

1) Identify those contiguous map units that are not separated correctly on the landscape. Record the number of times the boundary between two units was observed and the number (percentage) of times it was incorrect. Also identify those adjoining map units that are consistently separated accurately (no line changes needed). The assumption is that the lines between most map units will be correct, and that problems will tend to crop up again and again only in a relatively small number of units. This has been the experience thus far.

2) Identify those map units containing components that should have been delineated but were not. For example, areas of flood plain and colluvial soils might have been combined in the same delineations. However, it is now deemed necessary to delineate them separately. This will mean that each original delineation of the unit will need to be examined during the maintenance project.

3) Identify any "mystery lines" - that is, lines that have no apparent reason for being there. Determine if such lines are limited to certain map units. They will need to be evaluated during the update and either validated or removed.

F) Identify and clearly state the action needed to correct each line placement problem encountered. For example:

Alpha silt loam, 0 to 2 percent slopes (AaA) is not consistently separated from areas of Alpha silt loam, 2 to 6 percent slopes (AaB). All existing lines between these units need to be stereoscoped and/or field checked and corrected if necessary.

G) The evaluation of line placement is used by the field party to guide the maintenance activities. It should tell all project members which map units they need to target in correcting line placement.

Existing Map Unit Boundary Quality

Once the procedure of evaluating the overall quality of the line work is completed, the results must be evaluated with the following questions in mind:

1) For each general soil map unit: Which map units appear to have adequate line work and which do not?

At this stage of the evaluation you should attempt to identify the needs for each general soil map association and for specific map units contained within each association. This will give a clear picture of the workload required for total remapping, as opposed to documentation gathering.

In those rare cases in which nearly all of the line work in an association is inadequate, no further evaluation is necessary. That part of the survey area will need total remapping. In other associations, areas needing total remapping can be separated from those which do not. Some associations may not need any adjustments to the lines.

2) For those areas which are adequately mapped in terms of line work, the question now becomes: What is the composition of the existing map units?

To answer this question, we suggest the following procedure.

A) Select a general soil map association to work in.

B) List all of the map units in the association.

C) For each map unit, determine what information needs to be gathered. In addition to the identification of soil series, information for other properties, such as slope, stone cover, depth to redoximorphic features, surface texture, depth to bedrock, etc., may be needed. This list will vary for each map unit and should be decided before you go to the field.

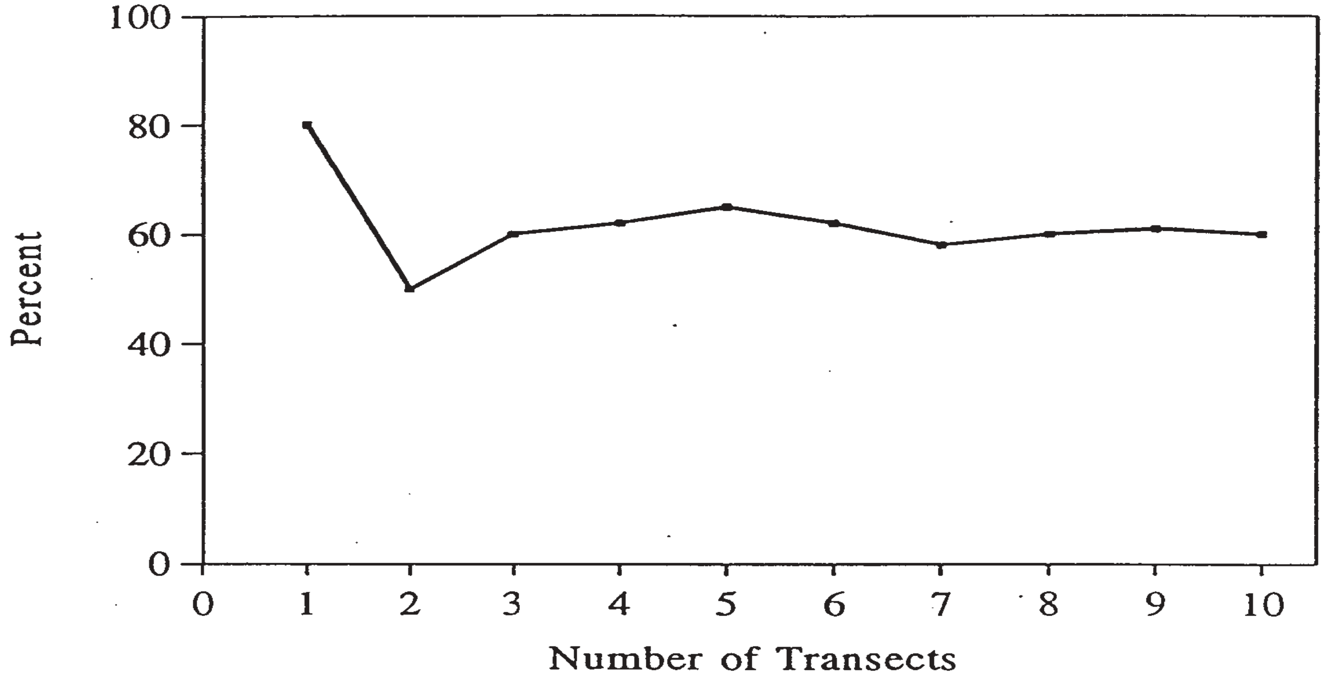
D) Using the procedure outlined in the section "Sampling by Transect," randomly select several delineations of each map unit.

The number of delineations that need to be visited will not necessarily be the same for each soil, and it is difficult to determine ahead of time how many are needed. However, in many cases, from 6 to 10 transects should be sufficient to determine the composition of a map unit within a general soil map association.

In practical terms, the number of transects needed can be thought of this way. At what point does gathering more transect information not affect the estimate of the composition of the map unit? Figure 2 helps to illustrate soil composition of map units in randomly selected areas.

The number of transects is shown on the X axis for each figure, while the estimated percent composition is shown on the Y axis. For the Alpha soil, it can be seen that the estimate for percent composition varies significantly until about three or four transects are included in the estimate. After this, adding more data affects the estimated composition little. In the second figure, the estimate varies significantly until about eight transects are included. Similar analysis could be made for estimates of such properties as depth to bedrock, percent stone cover, etc., by plotting these estimates against the number of transects. The important point is not just to gather transect information but to summarize it in stages. This will help you determine when data gathering for a soil should cease because adding more transects would not improve the estimate.

Estimated Percent Composition Alpha Silt Loam



Estimated Percent Composition Beta Sandy Loam

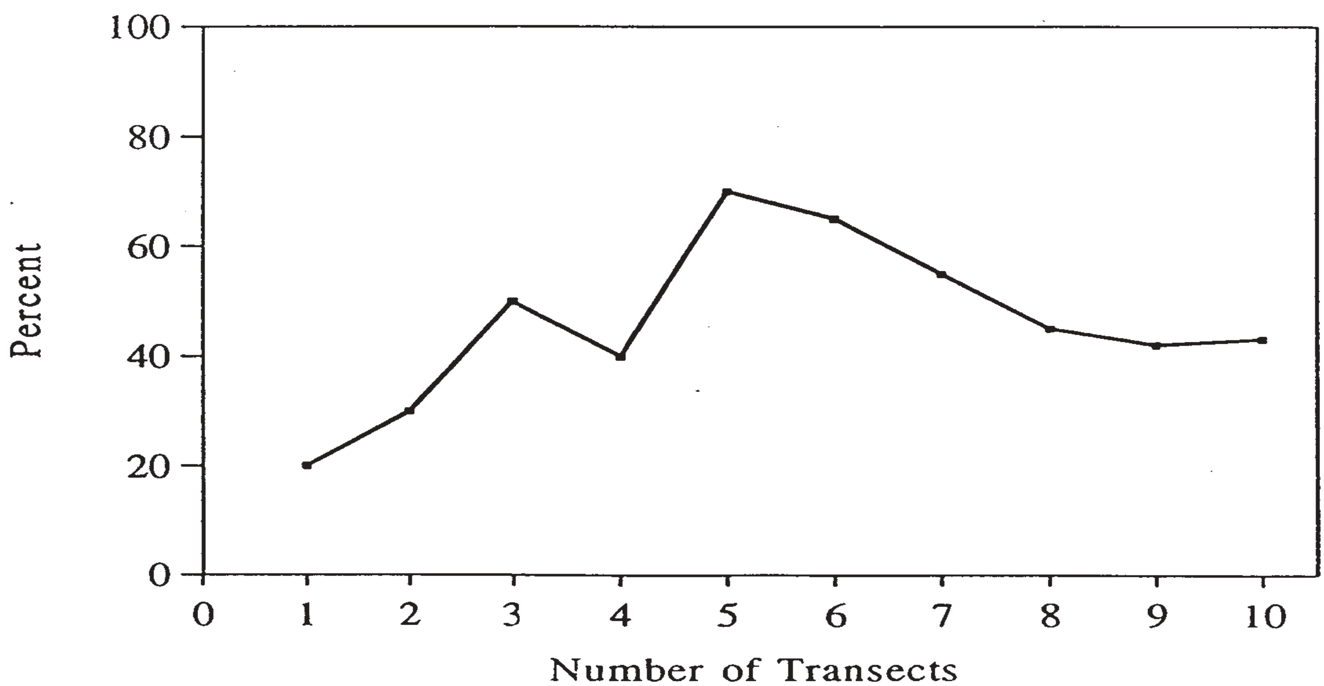


Figure 2

E) Once all of the soils in the association have been studied, repeat the process for the next general soil map association.

It should be noted that one of the benefits in analyzing by general soil map associations is that comparisons for soils that occur in more than one association can be made for the same soil from one area to another. For example, a soil defined as moderately deep may occur in two general soil map associations. Analysis for information on depth to bedrock may reveal that in one association the soil is moderately deep, while in another the analysis may indicate it is actually deep. If the transects were not grouped by general soil map association, these distinctions would be difficult to make and would probably be overlooked.

2. MEMORANDUM OF UNDERSTANDING

The second item that is required for soil survey project approval is the completion of a Memorandum of Understanding for the entire MLRA.

The Memorandum of Understanding (MOU) records the intent of SCS and one or more cooperators to join in making a soil survey of the MLRA or specific area or in performing related soil survey work. A Memorandum of Understanding may cover two or more MLRAs if they have essentially similar requirements.

A Memorandum of Understanding is not a contract, nor are the agreed-upon plans and specifications contained therein legally binding for the agencies that sign it. It may provide for entry into other working agreements for transfer of funds, services, office space, and the like at a later date. Cooperators operate within their own sphere of authority. Refer to subpart 104I-73.101 of the SCS Property Management Regulations for guidelines.

Responsibility

The State Conservationist is responsible for ensuring that a Memorandum of Understanding is prepared for all soil survey areas in which work is performed by the Soil Conservation Service (SCS) cooperatively with other public agencies and private organizations. Refer to Part 104I-73 of the SCS Property Management Regulations for specific instructions and authority. The State Conservationist is also responsible for ensuring that contribution agreements or trust fund agreements are prepared when outside funds, services, office space and the like are received by SCS.

First Draft

A draft Memorandum of Understanding is prepared as soon as possible after the first organizational meeting. During this meeting, representatives of the cooperating agencies define the product that is expected of a maintenance survey and agree to further evaluate the idea of a MLRA maintenance soil survey.

The State Conservationist conducts an evaluation and documents the deficiencies in the existing surveys. Refer to the section titled "Evaluate the MLRA Soil Surveys", for guidance in evaluating and documenting existing soil surveys. These evaluations will determine the specifications that are stated in the MOU in order to achieve a coordinated, joined, digitized soil survey for the entire MLRA at a common scale.

If a MLRA is entirely within one state, the State Soil Scientist is responsible for drafting the MOU. If one MLRA covers a part of two or more states, leadership for drafting the MOU may be designated to one SCS State Soil Scientist, to the chairperson or any member of the MLRA steering committee (see the section titled "MLRA Coordination" for a discussion of the role of the MLRA steering committee), experiment station or state agency representative, or appropriate federal agency representative. The National Soil Survey Center provides guidance and quality assurance.

Format and Content

The Memorandum of Understanding for the MLRA should include the information, format, review, and approval as given in section 606 of the National Soil Survey Handbook. Additional guidance for the preparation of the memorandum is also given in that section. Refer to Exhibit 5 for an example of a completed Memorandum of Understanding for a MLRA. The Memorandum of Understanding should contain the following major sections:

1. **Purpose for Doing the Work**

   The following items needs to be included:
   - statement of purpose;
   - summary of publication status;
   - summary of map scales.

The purpose of maintaining soil survey information is to ensure that our reports provide accurate soil maps, current and documented taxonomic and map unit descriptions, the latest soil property and quality information, and current and accurate interpretations in a data base that meets the majority of user needs. The purpose of the maintenance project is to coordinate and maintain the soil surveys in the MLRA and achieve an updated, joined digitized soil survey at a common scale in accordance with National Cooperative Soil Survey (NCSS) standards. Summarize the publication status of counties within the MLRA to inform the reader of the need to bring these published surveys to a common standard. Summarize map scales used in existing surveys and the time span between completed field work and publication dates.

Use the product definition to explain the purpose for doing the work. Specify how the information expected in the product definition will be an improvement over that in the existing soil surveys.

2. **Description of The Work Area**

The following items need to be included:
- ownership;
- MLRA map;
- acreage and map scale table.

Most of this information can be drafted from the publication AGRICULTURAL HANDBOOK 296, Land Resource Regions and Major Land Resource Areas of the United States. Provide a small tabular section to show the distribution of acres, by state, of private, State, and Federal land. Land acres should be the sum of land acres, plus water less than 40 acres. Also provide census acres, that is, areas of water bodies more than 40 acres in size. Use NATIONAL RESOURCE INVENTORY (NRI) figures to the extent possible. Count only those parts of counties that lie within the MLRA boundary.

Provide a map of the MLRA project survey and a table showing the names of counties associated with each state, acreages, map scales published, publication dates, final correlation dates, and other columns of information as needed.

3. Cooperating Agencies and Their Responsibility

Technical responsibilities are identified in this section. Administrative responsibilities for acquisition, such as money, personnel, equipment, office space, and other services, are also indicated. It may be necessary to specify that the acquisition of goods and services are contingent upon cooperative agreements and trust fund agreements developed by the states with local units of government.

Many agencies cooperate with SCS under a general State Memorandum of Understanding. These State MOUs should be acknowledged in the MLRA MOU with a statement, such as "Cooperating agencies will conduct the MLRA maintenance project in accordance with the Memoranda of Understanding governing soil surveys in the designated states."

Briefly state the role of the steering committee and the composition of the committee. Generally, the role is to develop a project plan, direct project activities and resources, build quality control standards, and coordinate the survey.

List each of the cooperating agencies. Be specific about their intended role in the maintenance project. It is essential that all agencies clearly understand their responsibilities. Do not use generalities here, as they often lead to misconceptions later on.

Specify how the correlation documents will be signed. State Soil Scientists from applicable states will sign the correlation documents for the MLRA survey area.

4. Specifications

The following items need to be included:

- expectations;
- digitized information;

- minimum standards;
- soil survey conduct;
- imagery;
- interpretations;
- map finishing;
- digitizing.

State the following:

The product expected of the project is a coordinated, joined, digitized soil survey at a common map scale of (1:24,000 or 1:12,000). Digitizing specifications will be in accordance with NCSS Map Digitizing Standards for SSURGO. Digitized data will not be copyrighted. Map units will be consociations and some complexes with a minimum size delineation of about ___ acres.

Make reference to the MLRA Project Plan for additional details of specific project assignments.

Specify the minimum standard of documentation to be used for quality control of the soil survey. These include checking map accuracy, documentation of taxonomic units and map units, testing of interpretations, and manuscript reviews. Also include plans to identify, measure, and describe soil properties and landscapes by map unit, including both spatial and temporal variability in detail sufficient to make needed interpretations. These survey area standards are specific as to numbers of transects, descriptions, laboratory analyses, yield data collection. etc.

If different levels of intensity of field investigations are to be used in various parts of the survey area, explain their use relative to field operations, map unit design, and interpretations.

Give general guidance on how the fieldwork will be conducted and specify the average size management area for the intended use and the maximum size of contrasting mapping inclusions that affect management decisions.

Give base imagery data. Who is the supplying agency? Provide the kind and format, e.g., full quad or quarter quad orthophoto, and scale to be used in making the soil survey. A scale is to be chosen that presents the map data legibly. The map scale must legibly accommodate the chosen minimum size delineation. Normally this scale is 1:12,000 or 1:24,000. The scale should be no larger than necessary to properly present the detail required to achieve the objectives of the survey. It is desirable to do the mapping on the same imagery and at the same scale and format as for publication.

Identify major soil interpretations for inclusion in the published survey and the agencies responsible for collections of support information, e.g. soil properties, soil qualities, and soil performance data. If new interpretations are to be included, then specify methods to be used to ensure technical accuracy, e.g. review by the Agricultural Experiment Station and the Soil Survey Interpretations and Geography Staff.

Identify the agency that is responsible for map compilation, digitizing, and map finishing and specify who will do the map compilation. Either those Soil Scientists who do the mapping or others, should do the map compilation. Give plans for map finishing, e.g. in-state contracting, by a cooperating agency, and digitizing plans for SSURGO.

5. **Information Necessary to Organize and Plan the Work**

State how existing resource data will be reviewed and incorporated in the maintenance project.

6. **Estimated staff years and dates**

Provide such estimates that each state will complete their portion of the project. (You may have chosen to enter this information in the section "Cooperating Agencies and Their Responsibilities." If so, just reference that section here).

7. **Publication Plans**

Provide the agencies responsible for preparing the manuscript and distributing the published report. They may also be stated in the section "Cooperating Agencies and Their Responsibilities."

Give the publication map scale and format of the soil survey map.

Indicate the scale of the general soil map (GSM) and that the GSM is to be published as a survey area subset of STATSGO. Recommended map scale for the GSM is 1:250,000.

Give plans for preparation of advance or interim information identifying who will prepare, review, and publish. Indicate plans for distribution. Refer to section 651 of the National Soil Survey Handbook. Describe the format for the manuscript. State the plans for publishing and distributing the soil survey.

8. **EEO Statement**

Provide the agencies policy toward equal opportunity and treatment of the work planned and documents published. A statement similar to the last paragraph of Exhibit 7 is recommended to be used.

Reviewing the Memorandum of Understanding

A draft of the Memorandum of Understanding is given an interdisciplinary review by the Steering Committee and State Staff. A copy of the draft is then sent for review and comment to each cooperator who will be signing it and the National Leader, Soil Survey Quality Assurance Staff (SSQA). The National Leader, SSQA, forwards a copy of the MOU to the National Cartographic Center and to the appropriate NTC Head, Soils Staff, for review. The National Leader, SSQA also ensures that the other national staffs review the draft MOU as needed. The draft MOU will be returned to the Steering Committee chairperson for resolution of the comments and final preparation for approval by the Director, Soil Survey Division.

Subset Survey Memorandum of Understanding

County, or multi-county subsets or other areas of the MLRA may require a separate MOU if local needs and agreements of the survey subset are not adequately addressed in the MOU of the MLRA. These subset MOUs clarify local cooperative activities, such as cost sharing, equipment, staff, office space, or specific schedules. EXHIBITS 6a and 6b illustrate two completed subset MOUs.

References:

Revised National Soil Survey Handbook, Parts 606, 610, 648, 649, and 651.

SCS Property Management Regulations, Part 1041-73.

EXHIBIT 7: MLRA MOU

UNITED STATES DEPARTMENT OF AGRICULTURE
NATIONAL COOPERATIVE SOIL SURVEY

MEMORANDUM OF UNDERSTANDING
between the
SOIL CONSERVATION SERVICE
in
NEBRASKA, KANSAS, AND COLORADO
and the
COOPERATIVE EXTENSION SERVICE
in
NEBRASKA, KANSAS AND COLORADO
and the
AGRICULTURAL EXPERIMENT STATION
KANSAS STATE UNIVERSITY
in
KANSAS
and
AGRICULTURAL EXPERIMENT STATION
COLORADO STATE UNIVERSITY
in
COLORADO
and the
CONSERVATION AND SURVEY DIVISION
UNIVERSITY OF NEBRASKA
in
Nebraska

TO ESTABLISH A PROJECT SOIL SURVEY FOR
MAJOR LAND RESOURCE AREA 72 - CENTRAL HIGH TABLELAND
(WHICH INCLUDES ALL OR PART OF THE COUNTIES LISTED IN
TABLE 1 AND SHOWN IN APPENDIX 1)

PURPOSE FOR DOING THE WORK: The purpose of this project is to improve and provide maintenance to the existing county soil surveys in MLRA 72 in accordance with National Cooperative Soil Survey (NCSS) standards. Most soil surveys were published in the 1960s and 1970s. Twelve soil surveys were published during the 1980s. About eighty percent of the surveys are at a map scale of 1:20,000, and the remainder are at a scale of 1:15,840, 1:24,000, and 1:31,680. The field work was generally completed about 2 to 14 years before the reports were published. Information provided in the reports reflect our knowledge of soil properties and soil behavior relative to the interpretation needs at the time of field mapping.

The published reports remain an excellent source of data. However, most of the published surveys need some updating in order to maintain a consistent data base that meets current NCSS standards. Updated soils information is needed because of the advancement in technologies, heightened environmental concerns, and changes in land use. The MLRA 72 update will build on the existing soil surveys and provide a coordinated and consistent data base that addresses local, regional, and national concerns. The project will develop a soil data base in both a digital format as well as published format that will be available to all users for better resource planning and environmental assessments.

The project will provide more comprehensive soil and site data for managing cropland, managing rangeland resources, conserving water and protecting water quality, improving and maintaining pasture, developing wildlife habitat, (developing soil-potential ratings), and preparing watershed, recreation, and urban plans.

DESCRIPTION OF THE WORK AREA: MLRA-72 is about 19 million acres and includes all or parts of 46 counties, 15 of which are in Nebraska, 22 are in Kansas, and parts of 9 counties in Colorado, (Table 1). The existing MLRA boundary will be studied during this project update and may be altered if a boundary revision is warranted. Currently seven county soil surveys are being conducted within MLRA 72 according to NCSS standards. These county surveys will become subsets of the MLRA and will meet the MLRA 72 update standards.

Nearly all of the MLRA area is in farms and ranches, and more than three-fifths is used as cropland. This is a major dryland farming area. Winter wheat is the main cash crop, but large acreages are planted to other small grains, grain sorghum, alfalfa, and other hay crops. Many crops are grown on the narrow bands of irrigated land along the Platte, Republican, and Arkansas Rivers. Corn, grain sorghum, and sugar beets are grown extensively on the nearly level uplands where ground water is used for irrigation. One-third or more of the area, consisting of hilly and steep slopes bordering drainageways, is in native grasses and shrubs used for grazing.

Elevation is about 2,600 to 3,900 feet (800 to 1,200 meters), increasing gradually from east to west. On the loess-mantled upland, slopes are mostly nearly level to gently rolling, but the major valleys are bordered by steep slopes. The Arkansas and Platte Rivers and a few of their larger tributaries have broad, level flood plains and terraces. The average annual precipitation ranges from about 15 to 21 inches (400 to 525 mm). The average annual air temperature ranges from about 50 to 58 degrees F (10 to 14 degrees C). The average freeze-free period is about 140 to 185 days, increasing from northwest to southeast.

The dominant soils are Ustolls. They are well drained and are medium textured and moderately fine textured. They have a mesic temperature regime, an ustic moisture regime, and mixed or montmorillonitic mineralogy. On loess-mantled uplands, well drained Argiustolls (Keith, Kuma, Rago, and Richfield series) dominate the gently sloping areas, whereas Haplustolls and Torriorthents are in steeper areas, and a mixture of Argiustolls, Haplustolls and Fluvents on flood plains and terraces.

Nearly all of the area is in private ownership.

MLRA ACREAGE TOTALS 1/

	KANSAS	NEBRASKA	COLORADO	TOTAL
LAND AREA Private				
State and Federal				
NON-CENSUS WATER water <40 acres 1982 NRI				
TOTAL REPORTABLE ACRES				
CENSUS WATER water >40 acres 1982 NRI				
TOTAL MLRA-72 ACREAGE				

1/ Acreage adjusted to coincide with MLRA boundary. Acreage values are close approximations.

COOPERATING AGENCIES AND THEIR RESPONSIBILITY: Technical responsibilities for the MLRA 72 update and coordination efforts are identified in this section. Administrative responsibilities that identify such items as cost sharing for personnel, equipment, office space, and other services will be developed by cost sharing agreements developed for soil survey subsets. Specific studies not considered a part of the whole MLRA update such as soil potentials or unique soil interpretive needs will be identified in Memoranda of Understanding developed for each soil survey subset.

Agencies listed in the title of this memorandum will cooperate in the conduct of this Project in accordance with the Memorandum of Understanding governing soil surveys in the designated states.

A Steering Committee will develop a project plan, direct project activities and resources, provide quality control standards, and coordinate the activities for the MLRA 72 update. The committee will be chaired by the State Soil Scientist of Nebraska. The committee will be composed of one representative from each cooperating agency within each state and one representative from the National Soil Survey Center. Ad hoc committee members assigned for specific tasks will include SCS area resource soil scientists and individuals from other disciplines or other agencies such as state or area resource conservationists and regional technical centers in the west and midwest.

A. The Kansas and Colorado Agricultural Experiment Stations and the Nebraska Conservation and Survey Division will cooperate in the conduct of the soil survey in accordance with the Memorandum of Understanding governing soil surveys in the designated states. These agencies will:

(1) assist the Steering Committee in developing and provide support for long-range soil characterization studies, or soil behavior studies.

B. The Cooperative Extesion Service will cooperate in the conduct of the MLRA 72 update. The Cooperative Extension Service will:

(1) have the leadership for information and education programs relating to use of soil surveys. This program will include the time beforeto initiation of the survey, during the field activity, and after the survey is completed;
(2) coordinate effective educational activities for the use of the soil survey in both agricultural and non-agricultural areas.

C. Soil Conservation Service. The Soil Conservation Service is the lead agency for the update of and providing maintenance to the existing soil surveys contained within MLRA 72. The Soil Conservation Service will:

(1) work with local and state units of government to develop cost-sharing agreements for project updates of soil survey subsets;
(2) lead the efforts to obtain cost sharing for and order the controlled base imagery and supporting cartographic materials for field mapping and publication;
(3) assist in characterizing major soils by laboratory analyses;
(4) assist the steering committee in developing a long range sampling plan and special studies for the MLRA and conduct soil investigations with assistance from cooperating agencies. Studies may include: water table depths and duration, water movement, temporal property changes, temperature and moisture regimes, landscape and landform terms, MLRA boundary, and productivity information;
(5) provide the necessary soil scientists to conduct progressive project soil survey activities, i.e. mapping, data evaluation and documentation, and

manuscript preparation;
(6) provide a consistent standard set of soil interpretations approved for use in the NCSS;
(7) use one soil identification legend in the preparation of soil survey manuscript(s) for county subsets within the MLRA and assemble a digital data base which will be available to all users;
(8) complete the map compilation and map finishing;
(9) ensure quality control coordination of progressive soil correlation through field reviews and technical checks of survey materials by State Staffs, including proper joining of soil lines, consistent interpretations, and data elements, and checks of statistical evaluations on soil mapping accuracy standards for meeting at least an 80 percent level of confidence. Regional and national staffs will provide quality assurance;
(10) cooperate with other agencies in public relations regarding progress of the survey, uses of soil survey information, and distribution of the published report(s);
(11) provide technical leadership in the development of digital soil survey. The digitized maps will be certified by the State Soil Scientists for their respective states that the accuracy standards specified in the NSSH has been met;
(12) study MLRA boundaries and make recommendations through the steering committee on revisions that are needed;
(13) assemble an MLRA 72 soil survey report that will be compiled from each of the subset surveys;
(14) develop correlation documents. The State Soil Scientists from the applicable states will sign the correlation documents for MLRA-72 and for county subsets along common state lines.

D. The Soil Conservation Service, in cooperation with the Kansas and Colorado State Experiment Stations and Nebraska Conservation and Soil Survey Division, will develop and implement laboratory and field investigative techniques and studies as required by the Steering Committee. Such studies could include analyzing surface horizons by land use, eroded soils, drainage classes, ground water quality, temperature and moisture regimes, water table depths and duration, the MLRA boundary, and productivity measurements, as well as special studies for a particular use, such as temporal properties of surface layers.

Estimated staff years and dates for each state to complete their portion of the project:

	*Staff Years	Starting Date	Completion Date	Project Life
Kansas -----				
Nebraska ---				

Colorado ---

* Resource soil scientists will assist as needed in special field studies, data collection, and project coordination.

SPECIFICATIONS: The product expected of the update is a coordinated, joined, digitized soil survey at 1:24,000 scale on full orthophoto quadrangles. Mapping will be on complete orthophoto quadrangles even though some of the area may be in the adjacent MLRA. The MLRA boundary line will be shown by a special symbol boundary line and labeled as "Limit of Soil Survey - MLRA 72 boundary," which will be digitized. Digitizing specifications will be in accordance with NCSS Map Digitizing Standards. Map units will be consociations (Order 2) and some complexes or undifferentiated units (Order 2) with a minimum size delineation of about 5 acres. On large, nearly level areas (terraces and flood, till, or lake plains) a minimum size of 3 acres will be used if coordinated and agreed to by the Steering Committee.

The project will provide a coordinated, joined soil survey for the geographic area. Quality joins will be line to line, map unit name to map unit name, and interpretation to interpretation across the geographic area. The survey area is the MLRA 72 boundary. Sufficient field documentation will be collected to characterize and describe the map unit concepts as to name, composition, setting, and interpretation. Sufficient field checking of map units contained in the MLRA for each soil survey subset area will be made to ensure that delineations meet the map unit criteria-i.e. the map unit delineations are as described and will interpret as stated in the map unit descriptions and tables at an 80 percent confidence level. The taxonomic series pedons selected may be represented by one typical pedon within the MLRA survey area. This pedon can be moved to adjacent subset areas if a more representative area is identified. Ranges will include the ranges within the soil survey area. Only one pedon is required for each map unit identified on the MLRA soil survey legend. The ranges of soil properties must yield a similar behavior. If not, and a need for specifying the behavior difference exists, another map unit will be used if it is mappable. Productivity levels will be represented as a mean. If differences of more than 15 percent from the mean are recognized another map unit should be recognized.

A data base will be defined for all components of named series correlated in a map unit. Dissimilar soil components of minor extent that are named will have attribute information. New data elements added to the data base in this update will be agreed to by steering committee.

INFORMATION NECESSARY TO ORGANIZE AND PLAN THE WORK: Specific dates for planning and managing the work will be maintained in the Soil Survey Schedule. Estimated staff years to complete the project are identified in the section "Estimated staff years and dates." Plans are contingent on funding. Some special studies may extend beyond this date.

__PUBLICATION PLANS__: The Soil Conservation Service, unless specified otherwise by amendment to this Memorandum of Understanding, will be responsible for preparing the manuscript materials, text, maps, and interpretations for the project soil survey. Publication of subsets within the MLRA, such as county or multi-county reports, will be optional and will be prepared by the associated state involved using the project soil survey information. The subset soil survey report will provide the same information as contained in the project soil survey, but tailored to fit the selected area.

Publications will be in a two part format. The maps and technical descriptions will make up one part and the soil interpretations and management recommendations will make up the other. The published maps will be 1:24,000 full quad format. Publications for each county subset are anticipated. Before publication, interim office copies of the completed MLRA subset text and maps will be available upon request. Text sections will be copied in each subset office and maps will be photo copies reproduced at the National Cartographic Center in Ft. Worth, TX. States will provide MLRA-72 states copies of the completed subset survey as a Final Correlation Document, subset survey interim reports, and published texts.

Digital information for each subset survey will meet NCSS standards and will be archived at the SCS National Cartographic Center in Ft. Worth, TX.

The program or activities conducted under this memorandum of understanding will be in compliance with the non-discrimination provisions contained in the Titles VI and VII of the Civil Rights Act of 1964, as amended; and other non-discrimination statutes: namely, Section 504 of the Rehabilitation Act of 1973, Title IX of the Education Amendments of 1972, and the Age Discrimination Act of 1975. They will also be in accordance with regulations of the Secretary of Agriculture (7 CFR-15, Subparts A and B), which provide that no person in the United States shall on the grounds of race, color, national origin, age, sex, religion, marital status, or handicap be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity receiving Federal financial assistance from the Department of Agriculture or any agency thereof.

APPROVAL

KANSAS

Signed ______________________________ ____________
State Conservationist — Date
USDA Soil Conservation Service

Signed ______________________________ ____________
Director — Date
Agricultural Experiment Station
Kansas State University

NEBRASKA

Signed ______________________________ ____________
State Conservationist — Date
USDA Soil Conservation Service

Signed ______________________________ ____________
Director, Nebraska — Date
Agricultural Experiment Station

COLORADO

Signed ______________________________ ____________
State Conservationist — Date
USDA Soil Conservation Service

Signed ______________________________ ____________
Director — Date
Cooperative Extension Service
The Colorado State University

EXHIBIT 7: Table 1

subsets in MLRA 72
(Designated by Political Boundaries)
Colorado, Nebraska, and Kansas
Central High Tableland

State	County	FIPS	Publication Scale	Publication Date	% in MLRA
Colorado	Washington	121	1:24,000	1986	30
	Logan	075	1:24,000	1977	50
	Sedgwick	115	1:15,000 1:20,000	1970	100
	Phillips	095	1:20,000	1971	100
	Yuma	125	1:24,000	1981	100
	Kit Carson	063	1:24,000	in progress	40
	Cheyenne	017	1:24,000	await publ.	10
	Kiowa	061	1:24,000	1981	5
	Prowers	099	1:31,680	1966	1
Nebraska	Kimball	105	1:20,000	1962	10
	Morrill	123	1:20,000	1985	10
	Cheyenne	033	1:20,000	await publ.	90
	Garden	069	1:20,000	in progress	20
	Deuel	049	1:20,000	1965	100
	Keith	101	1:20,000	await publ.	85
	Perkins	135	1:20,000	await publ.	100
	Banner	007	1:20,000	await publ.	3
	Lincoln	111	1:20,000	1978	85
	Chase	029	1:20,000	1982	100
	Dundy	057	1:20,000	1963	100
	Hayes	085	1:20,000	1982	100
	Hitchcock	087	1:20,000	1970	100
	Frontier	063	1:20,000	1978	2
	Red Willow	145	1:20,000	1967	2

Kansas	Cheyenne	023	1:20,000	1989	100
	Sherman	181	1:31,680	1973	100
	Wallace	199	1:20,000	1986	100
	Greeley	071	1:20,000	1961	100
	Hamilton	075	1:20,000	1961	100
	Stanton	187	1:20,000	1961	100
	Morton	129	1:31,680	1963	60
	Rawlins	153	1:20,000	1981	100
	Thomas	193	1:20,000	1980	100
	Logan	109	1:20,000	1964	100
	Wichita	203	1:20,000	1965	100
	Kearny	093	1:20,000	1963	100
	Grant	067	1:20,000	1969	84
	Stevens	189	1:20,000	1961	97
	Haskell	081	1:20,000	1968	97
	Finney	055	1:20,000	1965	80
	Scott	171	1:20,000	1965	100
	Lane	101	1:20,000	1972	80
	Gove	063	1:20,000	1978	75
	Sheridan	179	1:20,000	1984	60
	Decatur	039	1:20,000	1989	50
	Gray	069	1:20,000	1968	30
	Meade	119	1:24,000	1977	15
	Seward	175	1:20,000	1965	15

EXHIBIT 8: Subset Agreement

Agreement No.___________

Joint Agreement

between the

Board of Morton County Commissioners

and the

Soil Conservation Service

United States Department of Agriculture

Relative to: Updating and Digitizing of Soil Surveys

Authority: PL-74-46, 16 U.S.A.. 590a(3)

This agreement is made on this _________ day of ____________, 1990, between the Board of Morton County Commissioners, hereinafter referred to as the "Commission," and the United States Department of Agriculture, Soil Conservation Service, hereinafter referred to as the "Service."

Purpose:

The Board of Morton County Commissioners and the Soil Conservation Service have a mutual interest in obtaining current soil data and related information for use in reappraising Morton County and for use in administering Title XII of the Food Security Act of 1985. Therefore, the Commission and the Service deem it mutually advantageous to cooperate in this undertaking.

The Commission and the Service agree as follows:

A. The Commission Agrees:

1. To contribute $34,570 to update public land soil survey in Morton County. A contribution of $4,940 will be made quarterly, beginning on April 1, 1991 and ending on October 1, 1992.

B. The Service Agrees:

1. To make available to the Commission a copy of the digital soil survey maps of Morton County on or about October 30, 1992. They would be at a scale of 1:24,000 and in a format readable by ARC/INFO or GRASS.

2. To provide a computer copy of soil properties and soil interpretations for Morton County on or about October 30, 1992.

3. To provide an updated soil survey publication in two part format. The maps and technical descriptions will comprise one part and the soil interpretations and management recommendations will make up the second. The published maps will be 1:24,000 full quad format.

C. It is Mutually Agreed:

1. That both parties shall maintain their respective databases and make available to the other party copies of updated digital data on at least an annual basis.

2. That the parties will, in the future, exchange additional data that is of mutual interest and is mutually agreed upon.

3. That no member of or delegate to Congress or resident commissioner shall be admitted to any share or part of this agreement or to any benefit that may arise therefrom.

4. That this agreement shall be effective on the date hereof and remain in effect until terminated as provided for below or until the objectives are achieved. It may be amended by agreement of the parties in writing. It may be terminated by either party upon sixty days' written notice to the other party.

5. Officials Not to Benefit - No member of or delegate to Congress shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement is made for a corporation for its general benefit.

6. Audit Records - The Comptroller General of the United States or his duly authorized representative and accredited representatives of the Department of Agriculture or cognizant audit agency shall, until the expiration of three years after this agreement, have access to and the right to examine any directly pertinent books, documents, papers, and records of the District, or any contractors or subcontractors engaged in the performance of or involving any transactions related to this agreement.

7. The program or activities conducted under this agreement or memorandum of understanding will be in compliance with the nondiscrimination provisions contained in the Titles VI and VII of the Civil Rights Act of 1964, as amended; the Civil

Restoration Act of 1987 (Public Law 100-259); and other nondiscrimination statutes: namely, Section 504 of the Rehabilitation Act of 1973, Title IX of the Education Amendments of 1972, and the Age Discrimination Act of 1975. They will also be in accordance with regulations of the Secretary of Agriculture (7 CFR-15, Subparts A & B), which provide that no person in the Unites States shall on the grounds of race, color, national origin, age, sex, religion, marital status, or handicap be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity receiving federal financial assistance from the Department of Agriculture or any agency thereof.

Board of Morton County Commissioners

By:__________________________________
Date:____________________________

Title:________________________________

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

By:_________________________________
Date:_____________________________

Title:_______________________________

EXHIBIT 9: Subset Agreement

Agreement No.____________

Joint Agreement

between the

Forest service

United States Department of Agriculture

and the

Soil Conservation Service

United States Department of Agriculture

Relative to: Updating and Digitizing of Soil Surveys

Authority: PL-74-46, 16 U.S.A.. 590a(3)

This agreement is made on this _________ day of _____________, 1990, between the United States Department of Agriculture, Forest Service, hereinafter referred to as the "FS," and the United States Department of Agriculture, Soil Conservation Service, hereinafter referred to as the "SCS."

<u>Purpose:</u>

The Forest Service and the Soil Conservation Service have a mutual interest in obtaining current soil data and related information for use in land management for Morton County and for use in administering Title XII of the Food Security Act of 1985. Therefore, the FS and the SCS deem it mutually advantageous to cooperate in this undertaking.

The FS and the SCS agree as follows:

A. <u>The FS Agrees:</u>

1. To contribute $6,910 to update public land soil survey in Morton County. A single contribution of $6,910 will be made on or about September 1, 1991.

B. <u>The SCS Agrees:</u>

1. To make available to the FS a copy of the digital soil survey maps of Morton County on or about October 30, 1992.

They would be at a scale of 1:24,000 and in a format readable by ARC/INFO or GRASS.

2. To provide a computer copy of soil properties and soil interpretations for Morton County on or about October 30, 1992.

3. To provide an updated soil survey publication in two part format. The maps and technical descriptions will comprise one part and the soil interpretations and management recommendations will make up the second. The published maps will be 1:24,000 full quad format.

C. It is Mutually Agreed:

1. That both parties shall maintain their respective databases and make available to the other party copies of updated digital data on at least an annual basis.

2. That the parties will, in the future, exchange additional data that is of mutual interest and is mutually agreed upon.

3. That no member of or delegate to Congress shall be admitted to any share or part of this agreement or to any benefit that may arise therefrom.

4. That this agreement shall be effective on the date hereof and remain in effect until terminated as provided for below or until the objectives are achieved. It may be amended by agreement of the parties in writing. It may be terminated by either party upon sixty days' written notice to the other party.

5. Officials Not to Benefit - No member of or delegate to Congress shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement is made for a corporation for its general benefit.

6. Audit Records - The Comptroller General of the United States or his duly authorized representative and accredited representatives of the Department of Agriculture or cognizant audit agency shall, until the expiration of three years after this agreement, have access to and the right to examine any directly pertinent books, documents, papers, and records of the District, or any contractors or subcontractors engaged in the performance of or involving any transactions related to this agreement.

7. The program or activities conducted under this agreement or memorandum of understanding will be in compliance with the nondiscrimination provisions contained in the Titles VI and VII of the Civil Rights Act of 1964, as amended; the Civil

Restoration Act of 1987 (Public Law 100-259); and other nondiscrimination statutes: namely, Section 504 of the Rehabilitation Act of 1973, Title IX of the Education Amendments of 1972, and the Age Discrimination Act of 1975. They will also be in accordance with regulations of the Secretary of Agriculture (7 CFR-15, Subparts A & B), which provide that no person in the United States shall on the grounds of race, color, national origin, age, sex, religion, marital status, or handicap be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity receiving federal financial assistance from the Department of Agriculture or any agency thereof.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

By:______________________________
Date:_________________________

Title:____________________________

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

By:______________________________
Date:___________________________

Title:___________________________

3. MLRA PROJECT PLAN

The third item to be submitted for MLRA project approval is a Project Plan. The MLRA Project Plan is a long-range plan. It outlines the procedures, standards, and schedules that will be used to gather, evaluate, organize, and disseminate the soil survey and related resource information specified in the Memorandum of Understanding for the MLRA. The plan preparation requires a sharing and interdisciplinary approach. The content and details contained within the project plan will vary but may include:

1. a summary of the county or other subset soil survey evaluation with estimates of staff and budget needs;
2. a schedule for updating that identifies imagery needs and priority;
3. a plan for obtaining consistency in official series descriptions and interpretations;
4. a plan for providing special investigations and laboratory data as required to fill data voids or provide for interpretation;
5. a plan for consistent description of landforms and landform segments;
6. a plan for quality control/quality assurance functions, including legend control and kind and amount of documentation;
7. a plan for interdisciplinary participation to coordinate resource groupings, such as range site, capability subclass, and K and T factors;
8. a plan for MLRA data base development;
9. a plan for publication.

An example of a completed project plan is illustrated by EXHIBIT 10, MLRA 99.

Preparing the Project Plan

Preparation of the project plan for a MLRA maintenance project requires a sharing and interdisciplinary approach. Preparation of a quality project plan requires a strong, timely input and effort on the part of several people.

Several specific items need to be considered when preparing a project plan. The following lists the items to consider when preparing this plan:

1. Description of Work Area
   - Location and size and name of MLRA.
   - Major Soils, taxonomic classification and landscape.
   - Land use, trends, climate, elevation, etc.
   - Reference the book Land Resource Regions and Major Land

Resource Areas of the United States, Ag. Handbook 296.

2. Purpose for Doing Work:
   - need to bring existing soil surveys to a common standard;
   - soil surveys outdated due to technology;
   - need for uniform scale of mapping where landscapes and land uses are similar;
   - provide consistent delineations and names of soil map units;
   - improve the use of spatial and attribute soils data in Geographic Information Systems (GIS).
   - develop a coordinated soil survey database for use in informational display systems;
   - collect new and/or better soil property data and update soil interpretations to meet present user needs.

3. Status of Project
   - Identify when the project starts and projected completion dates.
   - Current status of work completed toward evaluation of older soil surveys, data, etc.
   - Potential availability of other local, State, or Federal cost share funds to accelerate project work.

4. Maintenance Approach
   - Define methods and procedures to be used in the initial maintenance phase.
   - Initial work will include: legend development, investigations, data gathering.
   - User needs are assessed.
   - Evaluation of existing information from current soil surveys.
   - Geomorphology investigation and geological mapping available.
   - Special studies completed or in progress, i.e., water table, water movement (irrigation).
   - Characterization data available.
   - Listing of counties or survey areas needing both remapping and correlating.
   - Identify problem soils across entire MLRA.
   - Stratify work by broad landscapes and parent materials, i.e., bottom lands.
   - Concentrate on legend development by broad landscapes and parent material, i.e., bottom land.
   - Investigate across entire MLRA.
   - Early field work on transecting existing map units.
   - Soil characterization on problem areas early in the soil survey project.
   - Work in one specific landform or landscape at a time.
   - Promote consistent progressive soil correlation.
   - Identify planned cooperation between states, i.e., sharing of people, equipment, and participation in progressive correlation and/or special studies.

5. Data Collection (Appendix 5).

   A. *Gather and evaluate existing data and soil models*:
      - Original soil maps that may be archived;
      - Old field notes;
      - Notes on correlation decisions;
      - Laboratory data;
      - Geology reports;
      - Thesis and research reports;
      - Flood plain management studies, etc.

   B. *Detailed sampling plan to be prepared*:
      - Target sampling to fill data voids and weak soil models;
      - Adequate laboratory data for: estimation of soil properties, classification, interpretation;
      - Sampling soils on representative landscapes;
      - Sample to at least 80 inches or below, where possible.

   C. *Items for Documentation Consideration*:
      - Transects to determine map unit composition for naming and listing of major components in map unit;
      - Assist in correlating of map unit;
      - User needs and expectations considered in refinement of soil mapping;
      - Transects to determine reliability of map unit for making soil interpretations;
      - Computer storage and analyzing of transects.

   D. *Special studies*:
      - Piezometers for measurement of moisture states or water tables;
      - Ground Penetrating Radar (GPR) and composition of soil map units;
      - Soil geomorphology studies;
      - Soil water movement (irrigation, water quality);
      - Soil temporal properties, i.e., erosion, tilth;
      - Representative soil property values.

   E. *Performance data*:
      - Crop yield;
      - Range, pasture data;
      - Woodland, windbreak, site index;
      - Engineering, wildlife, etc.;
      - coordination of soil groupings, i.e., capability class, sustainable agriculture.

6. Classification for Correlation and Naming of Map Units
   - Evaluation of miscellaneous areas, taxadjuncts, and some phases of series and correlating of Variants;
   - May require correlating to current series;
   - May require new series to be established;

- Update of series descriptions;
- Map unit ranges as related to Official Soil Series Range (OSED);
- Use of Pedon Program to store and analyze soil descriptions.

7. Legend Development (Appendix 5).
   - Initially developed using current MUUF;
   - Experienced soil scientists using field studies of similar landscapes and MUUF to prepare field mapping legend;
   - Legend consistent with design of map unit and user needs;
   - Continually tested in field mapping, re-evaluation of soil maps, and field reviews.

8. Field Reviews
   - Timely scheduled and conducted by State Office, Area Office and cooperators;
   - States responsible for quality control;
   - Not confined to single counties;
   - Cover specified geographic area;
   - Involve multi-disciplines, i.e., agronomy, woodland, and range.
   - National Soil Survey Center (NSSC), and MLRA Steering Committee involved early in survey.

9. Remapping *(refer to sections on transecting)*
   - Needs identified through transecting;
   - Estimate of acres needing remapping;
   - Partial remapping of selected areas, selected map units;
   - Complete remapping;
   - Identify specific problems;
   - Identify where problems occur on the landscape.

10. Correlating
    - Estimated number of soil map units to correlate;
    - Estimate of acreage to be correlated;
    - Continual testing of correlating by use of transects, field notes, observations, etc.;
    - Soil Taxonomy, problems in classification within MLRA.

11. Map Transfer and Map Compilation
    - Scale and quality of aerial photography for fieldwork and remote sensing;
    - Scale of publication document;
    - Scale of digitized product;
    - Procedure to go from field mapping update to publication document and digitized product;
    - Publication format.

12. Interpretations
   - New Soil Interpretation needs, i.e., water quality, radon, soil tillage, temporal soil properties, engineering, sustainable agriculture, fertility capability classification, excavation difficulty;
   - Involvement of other disciplines;
   - Coordinate needs (update existing or develop new) with NTC, NSSC, and other cooperators;
   - Data collection on properties to improve interpretations, i.e., moist bulk density for root restriction.

13. Manuscript Development
   - Plans for publication to users;
   - Required by Congress;
   - Flexible on area to include in report: county or Parish, multiple county, MLRA, State by MLRA, other appropriate large areas, i.e., watershed, other agencies or administrative areas.

14. Soil Database Development
   - Standard set of soil properties for each map unit in MLRA;
   - Data tailored for individual soil map unit;
   - Each map unit data set will provide attribute data to use with digitized soil map in GIS analysis;
   - Each map unit data set is coordinated.

15. Staffing
   - Includes an overview of all resources needed to initiate and complete MLRA project;
   - Planning, management, and equipment;
   - Field operation;
   - Data collection;
   - Digitizing;
   - Interpretations;
   - Publication products.

Supporting Documents

Several documents provide support and additional data to the project plan. These include:

1) a completed evaluation worksheet for each county or parish in the MLRA (see EXHIBIT 4);
2) a summary of land use and percent of area for each county or parish in MLRA;
3) evaluation sheet on publication scale, correlation data and when field work was completed for older soil survey or parish;
4) evaluation sheet on staff years by county or Parish required to do update, i.e., mapping, documentation, interpretation, map digitizing, and preparation of final products.

EXHIBIT 10: Project Plan

PROJECT PLAN FOR MLRA 99

Description of the Work Area: MLRA-99 is about 8.1 million acres and includes all or parts of 33 counties, 17 of which are in Michigan, 15 are in Ohio, and one county in Indiana. The existing MLRA boundary may be altered slightly during the project if a revision of the boundary is warranted.

Nearly nine-tenths of the MLRA is in farms, about two-thirds of which is cropland. Corn, soybeans, winter wheat, and hay are the major crops, but sugar beets and canning crops also are important. Some fruit and truck crops are grown on the coarser textured soils. Livestock operations are an important enterprise but are limited in number and are typically large confinement operations. The remaining farmland is permanent pasture and other uses, such as small farm woodlots. About one tenth of the MLRA is in urban land, the largest concentration of which is in the Detroit area, with a population of over one million people. Almost all of the area is in private ownership.

Elevation ranges from about 575 to 725 feet, gradually increasing inland from the lake shore. Local relief on this nearly level, broad lake plain is typically less than 10 feet, but some beach ridges and low moraines rise 15 to 30 feet above the general level. The average annual precipitation ranges from 27 to 36 inches. The average annual air temperature ranges from 45 to 52 degrees F.

The dominant soils are very deep, somewhat poorly to very poorly drained, and fine textured, with some well drained coarse textured soils on beach ridges. These soils formed in lacustrine sediments, eolian deposits, and glacial drift on lake plains, beach ridges, outwash plains, and deltas.

Purpose for Doing the Work: The purpose of this project is to coordinate and maintain soil surveys in MLRA-99 in accordance with National Cooperative Soil Survey (NCSS) standards. It is also the intent to study and refine the Major Land Resource Area (MLRA) boundary line placement and align its relationship with other natural resource boundaries, such as a watershed. County soil surveys were published from 1961 to 1987, except for Saginaw County, Michigan, which is scheduled for publication in 1994. About half of the soil surveys were published before 1975. About two-thirds of the surveys are at a map scale of 1:15,840 and the remainder are at a scale of 1:20,000. The field work was completed about 2 to 16 years before the reports were published. Information provided in the reports reflect our knowledge of soil properties and soil behavior relative to the interpretation needs at the time of the field mapping. Allen, Erie, Hancock, and Paulding Counties, Ohio are presently being modernized according to NCSS standards at a scale of 1:12,000.

The published reports remain an excellent source of data. However, most surveys do not meet NCSS standards since new information about soils is needed due to changes in demographics, technologies, environmental questions, and intensities of land use. There is a need to build on the existing soil surveys and develop a coordinated database to address local, regional, and national concerns. The project will provide a coordinated soil database for use by private and public service sectors to enable decision makers to make more informed environmental assessments and resource management decisions.

The project will provide more comprehensive soil and site data for managing cropland and woodland, conserving water and protecting water quality, improving and maintaining pasture, developing wildlife habitat, developing soil potential ratings, and preparing watershed, recreational, and urban plans.

Status of the Project: This project is scheduled to begin in 1992 with field work to be completed by 2015 as per draft Memorandum of Understanding (MOU) and as local, state, and Federal funding permits. To date work has been on evaluating existing surveys, reviewing laboratory data, compiling individual county legends into an MLRA legend, formulating modernization plans, and soliciting local cost share funds.

Project Approach: Initial work will be directed toward legend development, conducting investigations and collecting data to build on work already done in the evaluation process. This will include user needs assessments; conducting geomorphology investigations; evaluation of existing information from the current soil surveys; evaluating previous special projects including geological mapping, water table studies, existing soil characterization data; and reviewing various air photos, and any other pertinent information. A strong emphasis will be placed on working with all users of the soil survey to assure that the modernization addresses user needs. Initial fieldwork activities for the project soil scientists will include transecting existing map units and collecting information about the soils in selected areas. Correlating, map revision, remapping and map compilation activities will begin later in the project when the legend development is more complete.

An action plan for the project soil survey needs to be developed requiring that work will be grouped with an attempt to address a specific problem or resolve concerns with a specific group of soils across the entire MLRA. For example, in several counties in Michigan and Ohio the major flood plains were mapped as alluvial land (coarse, medium and moderately fine textured in Michigan). The action plan will require that these areas be remapped and correlated to soil series and correlated to a coordinated map unit name throughout the MLRA. Enough investigation across the MLRA will assure that the legend design and correlation will be valid. Previous documentation and completed soil survey handbooks for areas within the MLRA can and should be used as a starting point in the development of the MLRA legend. Individual areas or subset surveys can be updated as funds and staff are available.

Segments that could be worked on as specific tasks are:

1. Flood plain soils
2. Beach ridge soils
3. Till areas (out-liers) within MLRA-99
4. Frigid soils correlated in this MLRA prior to Soil Taxonomy
5. Hydric and non-hydric soils mapped and correlated in complexes
6. Soils developed over bedrock
7. Broad areas of soils with glacial till under the lacustrine sediments at depths of 40 to 60 inches and 60 to 80 inches
8. Relationship of prime farmland to non-prime farmland

> ***By working on specific landforms and parent materials at one time, we should be able to make accurate and consistent correlations in the most efficient way possible. Sufficient work will be done on all major landform types early in the project to assure proper legend development. Some investigative work will need to be completed in all counties even if local cost-share agreements have not been reached.***

Investigative work in the first year or two of the project will be the key to establishing a sound, stable legend that can be used throughout the MLRA and the life of the project. Using this approach we will be able to show progress with specific tasks completed. We will also lay the ground work and set up the tools to complete the project efficiently.

A. ***Data Collection***

1. ***Retrieval of archived information and scientific papers***

The State Soil Scientist will ensure that all archived information is supplied to the project leader upon arrival to the survey area. Information will include correlation memoranda, available field notes, original map sheets, correlation notes, laboratory data, geology reports, etc. The State Soil Scientist will solicit the cooperating agencies, and other government agencies, to compile a list of monographs, publications, research papers, issue papers, and local environmental problems that pertain to the improved understanding of the Major Land Resource Area. This task will be completed and the information will be available to the project leaders upon their arrival to the survey area.

2. ***Evaluation of Current Data and Information***

a) The Ohio State University will work with NSSL to index all state lab data into the NSSL database. Ellis Benham and Benny Brasher are the contacts in NSSL. Expected date of completion is _______.

b) All lab data will be updated on SCS-SOIL-8s - Index of Laboratory Data. An ad hoc committee, assigned by the Steering Committee chairperson, will classify the assembled lab data and pedons. Latitude and longitude will be provided where possible. This will allow spatial referencing of pedons for evaluation of data voids. Expected date of completion is _______.

c) A *"landform/soil classification and characteristics genetic key"* will be prepared by an ad hoc committee. The genetic key will be used to identify soils that require specific investigation. This key will also be extremely useful in familiarizing all soil scientists with the soil series and the specific landforms on which they occur. The key will provide the necessary detail to guide the soil scientist in differentiating soil series. Expected date of completion is _______.

d) An ad hoc committee, assigned by the steering committee chairperson, will evaluate the soil series. Plans are to study suites of soils by major landform. All series and Soil Interpretation Records will be evaluated, compared with existing laboratory data, and updated early in the MLRA maintenance project. Lab data will be used to update series range in characteristics to provide quantified statements. Differentiation with competing series will be evaluated. Where separations with other series are not clear, plans will be made to either:

1. combine the series, or
2. identify special studies needed to fill data gaps and support series separations.

Expected date of completion is _______.

3. *Detailed Sampling Plan*

The information gathered from #2 above will determine where emphasis is needed for detailed sampling and investigations. It is already known that characterization data are limited. There is fairly good data on particle-size for most of the dominant or benchmark soils. Samples will be taken to a depth of 80 inches, (2 meters), or to bedrock if it occurs within that depth. Expected date of completion is ________.

4. *Documentation*

Transects by field soil scientists will determine map unit composition and additional mapping needs. Refer to Attachment #1 for the minimum standards of documentation that will be adhered to in the survey area. The Field Soil Survey Information System (FSSIS) will be used to store and analyze transects and will facilitate data sharing.

The Pedon Description Program will be used for all profile descriptions taken in the project.

5. *Special Studies*

a) ***Water table depth and duration*** - Long term monitoring sites will be established early in the survey in areas determined to be representative. An ad hoc committee, assigned by the steering committee chairperson, will provide necessary guidance. Studies will be initiated by the University Experiment Stations during the first year of the project survey in the following areas:

1. Determine the relationship between redoximorphic features and water table depth, the kind of water table, and zones and duration of wetness.

2. Assess the occurrence and significance of perched zones of free water in the plow layer and its effect on timing of tillage operations. Establish guidelines for drainage classes based on this study.

b) ***Crop yield and woodland inventory*** - Additional data is needed. Interdisciplinary ad hoc committees will be assigned the responsibility of developing an inventory plan. Current data will be evaluated, data voids will be determined, and a inventory plan will be developed during the first 2 years of the project soil survey. An agronomist and woodland specialist will provide leadership to assure their needs are addressed.

c) ***Soil temperature and moisture*** - Soil climate will be monitored in areas of the survey related to woodland, hydric soils, and to separate mesic and frigid temperature regimes. Methods and procedures will be developed by the appropriate ad hoc committee in the first year of the project soil survey. Long term monitoring sites will be established within 2 years.

d) ***Saturated hydraulic conductivity*** - The U.S. Geological Survey has a vested interest in the collection of saturated hydraulic conductivity in the Erie-Huron Lake Plain. The Steering Committee has invited a representative of the U.S. Geological Survey to be an associate member of the Committee. Sites will be designed on representative soils and landforms so that the needs of all interested parties are met. Methods and procedures will be developed by the appropriate ad hoc committee in the first year of the project soil survey. Sampling sites will be established within 2 years.

e) Water quality/chemical leaching models - Data needed to make effective predictions for water quality/chemical leaching models must be determined. The Steering Committee will solicit the advice of specific interdisciplinary scientists and modelers to determine needs. An ad hoc committee will be formed to address this issue within 2 years of the beginning of the project soil survey.

f) Research efforts currently under way
Describe any research efforts that are currently under way. Describe how the project soil survey will interface with these studies, to the mutual benefit of all parties, during the maintenance project.

g) Soil Potential Ratings - The need to provide soil potentials will be determined by an interdisciplinary ad hoc committee. If feasible, methods and procedures of current soil potential studies in the United States will be collected, evaluated, and used to guide the development of a specific soil potential schema to meet the needs of local users.

h) Geomorphology - A geomorphology tour is scheduled for 1992. A list of approved geomorphic terms will be developed from this tour. Further studies identified during this tour will be considered by the steering committee and will be added to this project plan.

B. *Legend Development*
An initial overall MLRA legend will be developed using existing information such as MLRA-99 MUUF and MLRA database. A subcommittee will begin work on this effort during 1992. In addition to an initial list of map unit names, consideration will need to be given to coordinate soil symbols, whether alpha or numeric symbols will be used. Conventional and special symbols will be coordinated throughout the project soil survey.

C. *Field reviews*

1. MLRA Maintenance Field Reviews
Maintenance field reviews will be conducted by the SCS in cooperation with all cooperators in accordance with National Soil Survey Handbook guidelines. Reviews will be conducted annually and may occur over multi-county areas. The State Soil Scientists and the MLRA Steering Committee will be kept abreast of all field review activities and will have the option of attending all field reviews.

At this time, correlation of the subset field review and technical guidance to the subset surveys is a function that remains with the associated state. Items that are mutually agreed to for survey coordination are part of the steering committees "MLRA Standards Handbook," which is used to conduct subset soil surveys. The NSSC will maintain a role of quality assurance of the information for individual subset surveys as well as the overall MLRA data base. A future direction may be to assign a Soil Correlator to each MLRA for coordination and review.

Since the subset survey has been through a previous correlation, the field reviews are considered as MLRA maintenance reviews for clarity. Thus the "Initial" Field Review has previously been conducted.

2. Land Use Field Reviews

To further enhance interdisciplinary involvement and MLRA coordination, land use reviews will be conducted in addition to the project soil survey progress field reviews. "Maintenance" field reviews generally are unable to provide the time necessary to adequately cover all of the use and management concerns of our users. Land use reviews, conducted by ad hoc committees assigned responsibility for a particular land use, will provide an ideal forum for dialogue in the field. These reviews will help identify data gaps and ensure that user needs have been adequately covered in the descriptive legend. Participants will include conservation district board members, local county specialists, county extension personnel, private consultants, and environmental agencies. Soils grouped according to similar use and management will be reviewed. Inventory-related documentation will be presented and discussed. Soil limitations and suggested management will be discussed and recorded. These reviews will be conducted by an interdisciplinary specialist assigned by the steering committee at least every two years, or at shorter intervals when appropriate.

3. Final Field Review and Correlation

Each subset soil survey will be required to have a Final Maintenance Field Review to ensure that appropriate standards have been met. A Correlation Report will be completed for each subset survey. After the last subset area has been completed and a correlation document prepared a final MLRA correlation for the MLRA will be generated by the steering committee.

D. *Remapping*

Based on county soil survey evaluations, it is estimated that ___ acres, or ___ percent of the MLRA will need to be remapped. Much of this will be relatively minor, subdividing existing units into two or more units or changing some line placement. The evaluations identify specific problems and generally identify where to expect them in the landscape. In some map units individual delineations may not change, but delineations on different landform positions will be correlated to different map units. Some remapping will be needed to correct joining problems and where transect information indicates no other alternative.

Joins will be made as directed in Attachment 2.

E. *Correlation*

It is estimated, based on the county evaluation worksheets, that approximately _____ percent (___ acres), of the MLRA will need to be correlated. Many of these areas, mapped prior to Soil Taxonomy, can be correlated to new series based on recent correlations in adjacent counties, when supported by documentation as described in Attachment 1. New series will need to be proposed to correlate some of these map units.

F. *Map compilation*

The remainder of the acreage can be accepted and transferred to new base maps; however, the documentation described in attachment 1 will also be needed for these series and map units. A heavy map compilation work load is anticipated. In some recent surveys the major task will be to compile the survey to new orthophoto base maps.

G. *Manuscript development*

Plans are to have one comprehensive manuscript and publish individual county subsets as needed. This should improve efficiency and greatly improve consistency. The comprehensive manuscript will be published in two or more parts. The map unit descriptions and interpretive data, which requires the most frequent updating, will be published in one part. Maps will be published on quarter quad orthophoto base maps at a scale of 1:12,000.

H. ***Computer soil database development***

The soil attribute database will be developed and maintained as the project progresses, using the National Soil Information System (NASIS) software. It will be used to help guide the planning for field investigations and to test interpretations. County subsets of the database will be used to provide attribute data for the Field Office Computing System (FOCS), for use with Geographic Information Systems (GIS) of all cooperating agencies, and for other computer and interpretive applications that may be developed during or following the project.

I. ***Interpretations***

Data from research studies will be used to develop new interpretations, especially water quality interpretations and interpretations for local needs. Special emphasis will be placed on coordinating interpretations between similar soils and soils that are associated on given landscapes.

J. ***Map finishing and digitizing***

Map finishing and digitizing will be handled by the individual states. All map work will be done following current SCS standards and specifications for map finishing or digitizing.

Potential Special Research Projects

This project will take a new approach to soil surveying. Many new technologies and methods will be used or tested during the project. The following is a list of potential special projects. The university experiment stations and the Soil Conservation Service will take the lead in these projects, with assistance from the National Soil Survey Center and the National Cartographic and GIS Center. Some research has already been done on these items and the project soil survey will apply them, where economically feasible. The development of these and other special projects are dependent on availability of funds from local, state, and federal sources.

List of Potential Special Projects

1. Role of GIS technology and ancillary digital geographic databases in soil survey updates.

   GIS technology has primarily been viewed as a tool to display and manipulate soil survey information once the mapping is completed. However, GIS technology can also contribute to soil survey operations by analyzing spatial relationships among ancillary geographic data sources (such as Digital Elevation Models, digital aerial photos, satellite imagery, geologic mapping, surface hydrology, and/or existing soil mapping) and producing premapping products. These GIS derived products describe and map combinations of landscape features correlated to the spatial distribution of soil properties. In essence, this approach uses GIS to exploit existing resource mapping to enhance soil surveys.

Attachment 1

Summary and Organization of Support Data

The project leader ensures the systematic collection of useful notes by providing each party member with a list of specific instructions about the kind of information needed for each taxonomic unit or map unit.

The official description of a new soil series is based on descriptions of at least 10 pedons that represent the central concept of the series plus laboratory data and field notes. See Part 609.07(b)(1). A recommended minimum standard of documentation needed to support the taxonomic units and map units in a project soil survey descriptive legend is:

1. Taxonomic unit.
   Each named component in a map unit must be described. Three complete pedon descriptions that represent the concept of the taxon in the survey area are required before a taxonomic unit is added to the descriptive legend. This documentation is adequate for correlation of established soil series or higher taxonomic categories used to name map units of fewer than 1,000 acres extent. For map units of 1,000 to 10,000 acres extent one additional pedon description per 3,000 acres is required. One additional pedon description is recommended for each 10,000 acres of a map unit surveyed thereafter. Pedon descriptions may be from transects within the named map units.

2. Map unit.
   Three 10 stop transects of representative areas of each map unit are required before a map unit is added to the descriptive legend. This documentation is adequate for correlation of map units of fewer than 1000 acres extent. For map units of 1000 to 10,000 acres extent one additional 10 stop transect per 3000 acres is required. One to three additional 10 stop transects are required for each 10,000 acres of a map unit surveyed thereafter.

3. Exceptions.
   Exceptions to the minimum standards for documentation of taxonomic and map units apply when small acreage map units are added along the boundary of an ongoing soil survey or modem published soil survey for purpose of effecting a quality join. See Part 609.05-1(g). In these instances, the documentation from the joining soil survey area having the larger acreage may be used for correlation.

MLRA COORDINATION

MLRA coordination includes the activities necessary for the operation and development of a consistent MLRA project soil survey.

Management

The management of the maintenance project will vary depending on the size and complexity of the survey area and the number of states involved. If the MLRA is fairly small and entirely or almost entirely within one state, then that state would likely be responsible. If the MLRA is large and divided among several states, then management is more complex. It would seem logical that the Steering Committee would provide the oversight and guidance necessary to ensure coordination of all resource data and interpretations, whereas each state would share the people and funds required to complete the maintenance soil survey. One state (usually the one having the largest portion) is assigned overall MLRA correlation responsibility.

Thought must be given to the location of personnel that will be needed for the MLRA. Stratigically locating and sharing personnel between states is recommended. Work should be on specific landforms and/or parent material to ensure accurate and consistent correlation. Similarly, obtaining and utilizing cost share, reimbursable, and other local funds should be planned in a way that will compliment the MLRA maintenance effort. We must avoid hopscotching from county to county but rather locate people strategically for long term assignments to reduce moving cost, improve morale, and obtain consistency.

At this time correlation of the subset field review and technical guidance to the subset surveys is a function that remains with the associated state and guidance provided by the Steering Committee. Items that are mutually agreed on for survey coordination are part of the Steering Committees "MLRA Standards Handbook," which is used to conduct subset soil surveys. The NSSC will maintain a role of quality assurance of the information for individual subset surveys as well as for the overall MLRA data base. In the future, a Soil Correlator may be assigned to each MLRA for correlation and review.

Steering Committee

The project activities, standards, and coordination of the MLRA soil survey will be directed by a Steering Committee. Assignment of staff positions to the committee is usually determined during the first organizational meeting, when representatives of all of the cooperating agencies meet to discuss the status of existing information and the possibility of proceeding with a maintenance soil survey. Assignments to the Steering Committee need to be provided by the State Conservationist from each state. The State Soil Scientist will advise the State Conservationist of the needs and activities of the committee.

The State Soil Scientist assuming the leadership role in the project will conduct the organizational meeting. He/she may appoint or may fill the role of the Steering Committee chairperson. The assignment of chairperson could follow the list in Section 649 of the National Soil Survey Handbook, which assigns responsibility of each MLRA to a state.

Composition of the Steering Committee is flexible. Primarily, the committee should remain small, with 1 or 2 representatives from each participating state, to enable the committee to carry out timely completion of their assigned functions efficiently. Generally, the committee will be made up of one Soil Conservation Service representative from each state and one representative of other cooperating agencies from each state. A project leader and another discipline (i.e. agronomist, resource conservationist) from each state may also be included. Assignment of a representative from the National Soil Survey Center is optional. The NSSC needs to be involved, however, in the process of providing quality assurance of a consistent modernized data base.

Steering Committee Role

The following is a list of responsibilities of the steering committee:

1. **Define the soil survey product expected from the maintenance project**. The intended product is initially formulated by representatives of the cooperating agencies during the first organizational meeting. Product definition is further refined by the Steering Committee and recorded in the Memorandum of Understanding (MOU) for the Soil Survey of the MLRA. The MOU is the official record of the expected product. If there are adjustments and refinements to the product definition subsequent to signing of the MOU, they must be presented to the Steering Committee for evaluation and concurrence. The MOU will be amended accordingly.

2. **Collect and summarize the results of the individual evaluations of existing soil surveys**.

3. **Develop the project plan for the survey**. A well prepared project plan provides direction to carrying out the desires and specifications identified in the Memorandum of Understanding. Several specific items need to be considered when preparing a project plan.

4. **Develop the MOU**. The committee may assign responsibility for drafting the MOU to somebody other than a committee member. For instance, a State Soil Scientist capable of drafting the MOU may not be on the Steering Committee but could develop a draft MOU for the committee. A representative from the Quality Assurance Staff could also draft the MOU upon request. The committee reviews and comments on the draft MOU. Final revisions are submitted to the chair of the committee, who prepares the MOU for submittal to SSQA for review and to the Director, Soil Survey Division for approval.

5. **Assemble the following documents for submittal to the Director, Soil Survey Division via SSQA, NSSC along with the request to begin the maintenance soil survey**:

- a) MLRA Memorandum of Understanding;
- b) Summary of individual county or parish soil survey evaluations (evaluations will be maintained at SSQA for the extent of the project);
- c) MLRA Project Plan.

6. Coordinate all activities of the maintenance project to ensure that the end product is a fully joined and coordinated soil survey. Development of the guidelines and procedures to follow (refer to "Data Collection," pg. 51) is an activity that will improve overall coordination within the MLRA soil survey.

7. Advise the State Soil Scientists regarding coordination of staffing and mapping schedules of the area to ensure that aerial photography is ordered well in advance and available when needed. Advise the State Soil Scientist of equipment needs.

8. Assemble and provide information to appropriate staff that will help in the progressive correlation of the project, such as laboratory data, research projects, Official Series Descriptions (OSEDs), Soil Interpretation Records (SIRs), material from literature searches, archived original soil maps, notes, profile descriptions, transects, and correlation documents.

9. Analyze the available data for its applicability and developing a project sampling plan that identifies data gaps. Coordinate soil investigation projects.

10. Ensure that all OSEDs and SIRs being used in the area contain the most recent revisions and are revised in a timely manner as series are progressively correlated.

11. Provide quality control in the development and maintenance of the MLRA Identification Legend and the accompanying SOIL-6 file.

12. Ensure that each map unit has only one set of assigned soil properties and interpretations throughout its area of extent.

13. Establish and provide quality control of minimum documentation standards. Coordinate map unit development and mapping detail.

14. Devise a system that ensures documentation is gathered in a common format and enables survey crews or project offices to access the data.

15. Responsible for quality control of items identified in the project plan.

16. It is projected that one or more Soil Correlators assigned responsibility for the MLRA will conduct quality control reviews regardless of state lines. At the present time a Soil Correlator from the subset survey state is providing correlation and is a representative from that state on the Steering Committee.

17. Make ad hoc committee assignments in order to involve representatives of other disciplines during the maintenance project. This will ensure that plans are enacted to address the needs of user groups.

18. Ensure that the MLRA boundary coincides with some portion of the map unit delineations on the general soil map.

19. Evaluate the integrity of the MLRA boundary and make recommendations for boundary revision if needed. The draft section 649 of the National Soil Survey Handbook describes the procedure for revising the MLRA boundary.

Ad Hoc Committees

Ad hoc committees are assigned by the Steering Committee to address specific interpretations and soil management needs. They play a critical role in seeing that user needs are met during the maintenance project. Interdisciplinary involvement, through the assignment of ad hoc committees, must be addressed during development of the project plan.

Each action item in the project plan that requires completion by an ad hoc committee should also identify the staff person responsible for leading the action item. To the extent possible, this lead role should be assigned to someone besides a soil scientist. This will ensure active interdisciplinary involvement.

Ad hoc committees might include area resource soil scientists, agronomists, foresters, range conservationists, engineers, NSSC liaisons, and local governmental officials. These individuals would be called upon to provide input into the types of information that their respective disciplines would like to see in the maintenance soil survey. They could also help answer concerns that come to light during reviews and collect data to help provide needed interpretations.

Each inventory-related interpretation, such as crops and pasture, woodland, windbreaks, and rangeland, should be assigned to an interdisciplinary ad hoc committee. The committee will periodically review the respective documentation and information. It will assure that current and useful information relative to program needs and to the other specific needs within their discipline is provided for use and management.

Interdisciplinary ad hoc groups can provide direction where the plan identifies a need for consensus of a common terminology. Agreement must be reached on the same definition and use of such terms as drainage class, runoff, erosion hazard, capability subclass, habitat types, range sites, woodland sites, and terms for describing landforms. Various factors, such as K and T, and WEG need to be reviewed to assure that they are being applied consistently in the MLRA. A MLRA standards handbook of definitions, terms, and interpretive guidance assembled and agreed to by all committee members will help in their consistent use.

Land Use Field Reviews

To further enhance interdisciplinary involvement and MLRA coordination, land use reviews should be conducted in addition to the scheduled progressive soil survey progress field reviews. Progress field reviews generally are unable to provide the necessary time to adequately cover all of the use and management concerns of our users. Land use reviews, conducted by ad hoc committees assigned responsibility for a particular land use, will provide an ideal forum for dialogue in the field. These reviews will help identify data gaps and ensure that user needs have been adequately covered in the descriptive legend. Participants are not limited to ad hoc members and could include conservation district board members, local county specialists, county extension personnel, and private consultants. Soil management groups should be reviewed. Inventory-related documentation can be presented. Soil limitations and suggested management should also be discussed and recorded. These reviews should be considered part of progressive correlation.

Sharing Information

1. SoilNet is the primary communication network to use. The Soil Geography and Information Systems (SGIS) staff will provide assistance and software necessary to connect offices within approved MLRA maintenance areas. Contact the 3SD hotline (402-437-5423) for details about being connected. Procedures are operational and simple.

2. Cost is that of equipment as shown below plus the transmission expenses. All transmissions go from originating office to the National Soil Survey Center (NSSC) to the receiving office. Transmission costs are shared equally by the NSSC and the originating state.

3. Large data sets will probably take a long time to move data over the system but usually no data is lost.

4. There is a range of hardware and software that will work with the existing SoilNet system. Two acceptable configurations are below. The costs are approximations.

Recommended System

386/486 computer (AT&T, Everex, Dell) --- $5000
300MB hard disk
3.2 UNIX ---------------------------------- $1000
2400 or 9600 baud modem ------------------- $500
dedicated phone line for modem

Minimum System

AT&T 3B2/400 computer
2.0.5 UNIX
1200 baud modem
shared phone line for modem and voice

*** An alternative system is available for some users. MWNET is a networking system that has direct access to the other three National Technical Centers, and National Headquarters. Currently there is a shared list for 12 State Soil Scientists to transfer information. For special projects, such as MLRA projects, a new list can be created by the MNTC IRM staff to include persons or offices for transmittal of data within a defined group. This list could include the MNTC states, the other NTCs, and other states that are connected to the NTCs. The MWNET is operational and the only information required is each user's E-mail address to transfer data or mail. Contact (402-437-5360) for details. Configurations and costs are as described for SoilNet.

DATA COLLECTION

The following sections describe some items to consider in the selection of sites for pedon descriptions and in the collection and use of pedon information. Standards should be set and agreed on by all of the participants of the MLRA Steering Committee. The national standards (National Soil Survey Interpretations Handbook, National Soil Survey Handbook, Soil Survey Manual, and Soil Taxonomy) are used in the coordination and development of a MLRA standards handbook for MLRA guidance. Additional information to improve the standard definitions, terminology or interpretive guidance are agreed on by the Steering Committee.

New Data Needs

Since the late 1980s additional soil property information has been approved for use in the soil survey data base. The approved soil property data are identified and defined in chapter 3 of the Soil Survey Manual, and in the National Soil Survey Handbook (NSSH 618). The following data should be described and/or included where appropriate with the soil data base in MLRA maintenance project soil surveys:

- calcium carbonate equivalent ($CaCO3$),
- cation-exchange capacity (CEC),
- gypsum,
- organic matter for each layer,
- sodium adsorption ratio (SAR),
- stability, slope
- sulfides,
- restrictive layers (root restriction caused by inadequate air and water movement),
- rock fragment free K (Kf) for each layer,
- iron, free
- water table (depths by month)
- water state classes (if described for each layer this information helps in defining the range in characteristics through use of a common natural condition),
- free water occurrence (zones of saturation)
    a. redoximorphic features (Keys to Soil Taxonomy),
    b. type of saturation for aquic conditions (describe as a range in characteristic, Keys to Soil Taxonomy),
- degree of reduction (field test for reduced iron ions (Keys to Soil Taxonomy),
- penetration resistance,
- excavation difficulty,
- rupture resistance.

If new data is included in a MLRA survey it needs to be described consistently. The Steering Committee should adapt the use and develop the appropriate field methods and recording protocols, i.e., carbonate kits to measure percent of calcium carbonate. Where data records are not available to record and store the new data, an electronic storage file (flat file) needs to be developed by the Steering Committee.

Some of the older data elements or classes, such as pH, natural drainage, permeability, flooding duration and runoff, were slightly changed in the Soil Survey Manual (Draft - 1991). These changes need to be recognized in the data maintenance activities. Refer to Appendix 5: Pedon Field Guide for the current terms.

Notes and Descriptions

The MLRA maintenance projects or subset soil surveys need to use a common standard for describing soil properties and recording site information. If the MLRA Steering Committee is made up of members from several states, they should agree on the format for note taking, the kind and amount of notes needed, how those notes will be collected, and how the information will be analyzed and disseminated. This is important to ensure that all of the subset surveys in the MLRA have a coordinated data base.

Descriptions of soils in an MLRA maintenance project should be guided by the Steering Committee. To coordinate an accurate, complete soil survey data base, the Steering Committee will define those properties important to the MLRA, and will decide on the methods to use when taking notes on those properties, i.e., the kind of reagent or test for pH measurement. Appendix 5 includes some of the more widely used soil properties and terms including information from the Soil Survey Manual. This Appendix could be tailored for a specific MLRA.

The soil properties important for soil classification, series placement, or interpretive use within the MLRA should be identified. Some soil properties often overlooked include faint redoximorphic concentrations; secondary lime accumulations; coatings on peds; size, lithology, and amount of rock fragments; and consistence.

The MLRA Steering Committee should evaluate data available at present and decide what additional information is needed. Temporal soil properties and human induced soil changes are becoming increasingly important to recognize in order to improve the soil's interpretation. The Steering Committee should address how to collect and store this information. The soil staffs at the regional technical centers (NTCs) should be requested to assist with this effort. These properties will be important in future modeling efforts and other interpretive data base needs.

Site Selection

Site selection is critical before any method is used to examine the soil. Every effort should be made to observe sites that are representative for the map units and landforms separated in mapping. Soils related to landforms need to be mapped consistently within the geographic area (MLRA). Transect data from soil probes or augers could be used to locate sites that are typical and that can be excavated later for more detailed pedon information.

The following lists some of the site information that can be collected:

1) Series name (if known)
2) Soil survey sample number
3) Map unit symbol
4) Aerial photo number
5) Location
6) Latitude & longitude
7) Physiography
8) Geomorphic position
9) Microrelief
10) Slope characteristics (percent, slope length, aspect)
11) Land use
12) Stoniness
13) Erosion
14) Runoff
15) Vegetation
16) Survey Area ID
17) Note ID (where needed)
18) Transect ID (where relevant)
19) Range ID (where relevant)
20) Elevation
21) Air temperature and precipitation
22) MLRA
23) General Soil Map Unit
24) Notes of discussions with landowners and others knowing know about soil productivity, flooding patterns, cultural patterns, and problems encountered in soil use
25) Photo documentation of the soil profile, landform position, and land use at the site.

Soil Observation Methods

The soil observation methods identified in this section are commonly used in soil descriptions. Selecting the proper method for the kind of information needed is important.

For any observation method used try to describe at least 2 meters deep or to a nonrippable layer, such as a lithic contact. A backhoe, auger, and spade will excavate a paralithic contact, but with some difficulty. For cyclic soils, the pit should be opened several meters in length. If possible, go at least 10 inches into a root limiting layer. Where rippable soil material exists the pedon should be described to 2 meters.

Backhoe or hand dug pit

A backhoe or hand dug pit is preferred for describing all typical pedons because every dimension of the pedon is observable, including its variability. Where properties have variability, such as depth to carbonates, descriptions need to be from the average condition and the upper and lower limits measured for the variable depth. In areas of frozen soils, a jackhammer with a chisel end is effective in cutting into the dense material.

Safety precautions are always a concern, and shoring equipment is often needed when observations are made to more than one meter. For additional information, refer to the "Construction Industry Standards and Interpretations" manual by the Occupational Safety and Health Administration.

Probe or bucket auger

When the soil is moist and where gravel and coarse sand contents are minimal, push and power probes allow a soil scientist to easily pull and observe soil properties as a soil core. This method has limitations when describing soil structure, temporal properties, and pedon variability. Compaction of the soil, particularly in the upper part, will reduce the accuracy of horizon thickness and soil depths. Large structural aggregates are difficult to see from small diameter tubes.

A variety of commercial hand augers are available for various soil textures including sand and clay. Soil probes or bucket augers are not preferred for describing typical pedons but are useful in mapping and verifying soils at sites. An organic soil can be described with peat sampling instruments. Hand held screw augers are useful in mapping soils in very gravelly areas.

Road cuts, natural cuts, excavation sites

Road cuts, natural cuts, such as river banks, and excavation sites provide an opportunity to observe horizon thickness. They are not recommended as sites for sampling or describing typical pedons because of the changes caused by exposure, such as road dust, disturbance, and moisture and temperature alteration.

Where perpendicular to hillslopes, road cuts are useful, however, for collection of transect data and field notes. Excavated trenches are useful for transecting, but may not be suited as typical sites for pedons because of the disturbance to the soil's upper layers.

Soil Descriptions

The NSSC encourages the states to adopt the "pedon program" developed for soil descriptions.

Complete descriptions of the soils are essential. The descriptions serve as a basis for soil identification, classification, correlation, mapping, and interpretation. A complete description also documents the conditions at the site of any soil-related research.

Soil descriptions must be objective, complete, and clear. The descriptions are used by different people for different purposes. Precisely defined standard terms are needed if different people are to record their observations so that others can understand. Standard terms are brief yet meaningful.

For some soils, standard terms are not adequate and must be supplemented by a narrative to ensure the accuracy of the description. The field scientist must always evaluate the adequacy of standard terms and add needed information.

Standard pedon description formats aid the soil scientist in consistent observations of soil properties and makes the information easier for users to read. A standard format simplifies the coding of data for automatic processing in an orderly and systematic manner. Some soils have unique characteristics and must be described at least partly in narrative form. Also, it is not practical to dig deep enough into some soils to reveal all of the relationships between soils and plants.

For description of soil profiles, whether an entire pedon or a sample within it, record the kinds of layers, their depths, and thicknesses, and the properties of each layer. These properties include color, texture, structure, reaction, roots, boundaries, and all other soil properties needed to adequately describe the soils in more detail. All of the approved soil properties are listed in the National Soil Survey Handbook (Draft 1992) and Soil Survey Manual (Draft 1991).

Soil descriptions should contain the part of the landscape that the pedon represents. Descriptions of pedons that represent an extensive mappable area are generally more useful than pedons that represent the border of an area or a small inclusion. Other factors that affect soil development, such as climatic features, age and kinds of parent material or source of materials, and the present land use should also be recorded.

Additional Soil Description Information

a) Who made the description or the source of the information,
b) Correlated taxonomic or soil name,
c) Geographically associated soils,
d) Field classification for the pedon described,
e) Water table depth,
f) Drainage class,
g) Estimated hydraulic conductivity,
h) Particle-size control section,
i) Diagnostic horizons observed for the pedon described,
j) Described by and date of description,
k) Other nontechnical notes important to understanding classification questions or behavior predictions.

After any pedon is described it should be classified by family and possible given an appropriate series name where possible. Questions concerning classification or interpretive use should be addressed at the site to ensure that if samples are needed they can be collected for laboratory analysis and that the correct diagnostic tests be made.

Field notes need to be compared against the national data records (OSD, SIR). Determine if the pedon fits within the range of characteristics for the national records. If it doesn't fit a decision for revising the national records needs to be reached between the project leader and the soil correlator for the area. Incomplete data descriptions, as well as failure to compare against the national records, will lead to a less accurate data base.

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Indexing Soil Laboratory Data: SCS-SOI-8

To aid in the retrieval and evaluation of the NSSL data, it is very important that the SCS-SOIL-8 forms be completed for all pedons. These forms include data for latitude-longitude location, MLRA, pedon classification, and current series name of the pedon. The latitude-longitude data are valuable in the development of a map showing the pedon sample locations if entered into a GIS.

Soil characterization data should be indexed early in the soil survey update process. However, the data may be indexed at anytime before the maintenance of a MLRA project soil survey.

The National Soil Characterization Data Base will include field descriptions and laboratory data for complete pedons from the National Soil Survey Laboratory data base and similar descriptions and data that are available for general distribution from state agricultural experiment stations and other laboratories. Data will be linked to the source laboratory and methods codes.

The procedures for assembling and maintaining the National Soil Laboratory Data Index are defined. The objectives are to provide an index to data for each pedon for which laboratory data are available to cooperators in the National Cooperative Soil Survey and to establish a mechanism for handling input to the index. To be indexed, the data must have been obtained by procedures that are widely used or are widely accepted as reliable, the pedon must be classified according to soil series or soil family, and a description to the site and pedon must be available. However, data may also be indexed if determinations for only one or a few properties of one or a few horizons are available, provided the data are helpful for classification of the pedon. Data obtained only to verify field observations, such a texture checks, ordinarily will not be included in the index; however, if the requirements for classification and descriptions are met, they may be included. The SCS State Soil Scientist is responsible for determining whether or not to index.

For each pedon the index includes the pedon classification, latitude, longitude, state, and soil survey area location of the pedon sampled, source of the data, kinds of analyses available, and other information as indicated on the SCS-SOI-8 form.

The index data can be accessed by several procedures. They can be stratified by state and county, by major land resource area, by classes of Soil Taxonomy, or by several other criteria. States may update the file any time by returning an updated SCS-SOI-8 form to the data base manager.

The specific procedures for indexing soil laboratory data are identified in Instructions for completing SCS index of Laboratory Data with SCS-SOI-8 form. Copies of the document have been mailed to each state and additional copies can be obtained from the NSSL.

QUALITY ASSURANCE

Correlation

The MLRA or other geographic area approved as a maintenance soil survey is the survey area. The county or other areas within the MLRA are subsets. For maintenance or project soil surveys the correlation of the survey area will be complete when a Final Classification and Correlation report has been agreed on by the Steering Committee participants in the project survey and signed by the chair of the Steering Committee and State Soil Scientists of the states involved.

Completed maintenance of subset areas, such as a county, will have a Classification and Correlation Document; however, a final correlation report will be completed when all subset surveys are completed. The subset correlation reports will facilitate documenting the quality of the subset area before its publication and it will certify that this segment of the survey has been through a quality review and progressive correlation. Follow instructions in the NSSH, section 609.09-3 for preparation of this correlation document. Title the report:

> "Classification and Correlation of the Soils of Alpha County, Somestate; subset of MLRA-77 Soil Survey."

Project Leadership

Strong project leadership is needed to implement, coordinate, and complete an MLRA project soil survey. It is vital that a Soil Survey Project Development Specialist who will be in charge of the legend and management of the MLRA survey area and who later technically directs Soil Survey Project Leaders in the initial stages be assigned and agreed to by the Steering Committee. Once assigned the project leader will work closely with members of the Steering Committee to maintain a close working relationship.

All states must be committed to minimize political boundaries and work towards common agreement in all areas. All must agree on the project plan and the procedures, standards, and schedules that will be used to gather, evaluate, organize, and disseminate the soil survey and related resource information specified in the MOU.

Mapping and Detail

The MLRA is an area that has similar climate, topography, water resources, land use, and soil patterns. The similarity in climate, soil pattern, land use, etc., within the MLRA suggests that a maintenance survey for a MLRA should have a common map scale, map legend, and mapping intensity that meets the needs of most users.

Maps will be completed by full or quarter quadrangles. County or other political boundaries will be placed on these maps, but soil lines and cultural features will cross the political boundaries to affect a quality join. No insets of map sheets for MLRA maintenance projects will be made. The intent is to minimize costs and improve efficiencies in quality control, storage, and publication.

Soil Survey Legends

A single descriptive legend will be approved and used for the MLRA. An initial legend needs to be assembled and agreed to by states before approval for the MLRA Maintenance Project Soil Survey. The initial legend could be part of the MOU supporting documents. Subset soil survey legends will be extracted from the MLRA legend. Additions to the legend will be approved through progressive correlation. The chairperson or MLRA Soil Survey Project Specialist acting for the Steering Committee will ensure that a coordinated legend is assembled and agreed to by all.

A standard map unit symbol that identifies a specific map unit will be used for the legend. The Steering Committee will use a numerical legend for ease in GIS application. Subset soil survey areas could decide to use the same numbers for the same map unit or develop a conversion legend for the use of alphabetic letters. The "Classification and Correlation" report for the subset area needs to display conversion symbols for both the approved soil survey and corresponding MLRA map unit symbols (if different).

A single set of ad hoc symbols will be coordinated and approved for the MLRA. Efforts to develop a uniform symbols legend for the geographic area are encouraged. Each symbol must have the same descriptive use, such as size, throughout the area.

Soil Survey Area ID
Updates to soil survey areas (county, multicounty, or other) by MLRAs will not require different state, county, or MLRA information on the soil-6 files unless the subset boundaries are changed, i.e., a single county merged with another for a planned two-county published report. If this is done a new county soil survey area ID will need to be approved and added to SSD.

It may be important for states to archive the existing information once the maintenance and progressive correlation for the subset begins. This presents us with an interesting concept. If we assume that the existing information is good and our intention is to only build on it, then what should our progressive correlation begin with?

Procedure:
The existing legend from the old Classification and Correlation document will be used for the Initial Field Review. The approved names and symbols will be shown as "Outdated Legend" in the first two columns and the "Approved Field Name and Symbols" will be shown in the next two columns. This assures that we have a current legend for progressive correlation that improves the existing information without deleting the old.

Documentation

Minimum documentation standards for taxonomic units and map units as described in NSSH 609 are to be used. Other specified documentation standards can be developed by the MLRA Steering Committee as minimum documentation, but these standards will not be less than those specified in NSSH 609. Documentation not meeting minimum standards will be considered insufficient. Documentation must be collected in all areas as required by the Steering Committee to assure completeness.

Standards in the NSSH and Soil Survey Manual that are not covered or are inadequate for the project area will be developed and agreed on by the Steering Committee.

Soil information collected and analyzed during the course of a project soil survey must become a routine part of the project's work. Mapping and documentation are activities that require regular analysis and periodic review in order to achieve the best information. This is a part of progressive correlation.

Crop, pasture, range and forestry yields for soils in map units should vary only within a defined range. This range needs to be set by the Steering Committee and agreed on by the major users. In the past, a rule of thumb was that a change plus or minus 12.5 percent from the average crop yield could be used for a different map unit. Map unit separations are needed if significant differences in management or productivity have been determined and differences in soil properties are negligible.

Progressive Correlation

Progressive correlation procedures (NSSH 609 Soil Correlation) used for county or other area soil surveys will be used for the MLRA maintenance surveys.

Just as mapping and documentation need to be a progressive activity, evaluating and revising the national data bases (OSED, SIR) need to become a routine part of the project's work. Revision of the data records requires coordinating the information with surrounding areas where used to maintain consistency in the use of information. These records should be reviewed and tested before and updated during **"maintenance"** field reviews.

MLRA Standards Handbook

The MLRA standards handbook is a handbook assembled by the MLRA steering committee. The intent of the handbook is to guide subset soil survey areas toward the use of consistent soil survey standards.

A. *Quality control standards*

Coordination and development of appropriate quality control standards is vital to ensure consistent geographic data bases. Some important questions to consider include:

- are we together in our definitions?
- do we apply the terms consistently?
- do we share information?
- how can we improve?

These standards should be developed in the initial stages of a maintenance project.

B. *Consistency*

A uniform data base that is consistent with our national standards is needed by modelers and others who use computerized information. Soil series and interpretations need to follow current guides and definitions. All of the terms used must be coordinated and applied consistently throughout the geographic area. Data assigned to a soil property class must be developed from approved national or MLRA guides.

If national guides are not available to group soils, or the national guides do not work for the geographic area, or additional criteria need to be agreed upon for ease in application then MLRA standards placed in a handbook or need to be developed and approved. The MLRA Steering Committee should maintain a handbook of guides accepted by all members of the committee. Each state and subset survey will have a reference copy for use. Examples of guidance:

1. T value classes. Use the approved National Soil Survey Interpretations Handbook (NSSIH) guide. The assignment of a "T value" for all soils that are 20 inches to hard bedrock must be the same if bedrock is the most critical value used in the

evaluation. The same criteria must be applied uniformly throughout the geographic area.

2. Soils classified according to Soil Taxonomy must have the required criteria. Use of the taxonomic criteria must be adhered to throughout the geographic area and will meet the standards as specified in the latest Keys to Soil Taxonomy.

C. *Use of Common terms and definitions*:

1. Terrace - refers to a soil on an old alluvial surface and no longer has a hazard of flooding within a 100 year frequency storm event.

2. Flood plain - surface that has a hazard of flooding within a 100 year frequency storm event.

3. Wind erodibility interpretive group 4L. What definition is being used for calcareous? Some researchers suggest 5 meq/l $CaCO_3$, others say 1 meq/l is enough to reduce bonding strengths, or will you use an observed matrix effervescence with dilute HCL?

4. Carbonate subscript "k" - since carbonate translocation is a pedogenic process the use of "k" is nearly always recommended to be used with a B horizon.

Refer to Appendix 1 for an example of developing local "Rules of Thumb" to make better use of local research data. It provides good guidance for special needs.

Quality Joins

The survey area as identified by the Memorandum of Understanding can be a MLRA or other geographic area. Subset areas within a MLRA project soil survey, such as a county or parish, need to conform to quality join requirements as described in NSSH 609. Quality joins to adjacent MLRA soil surveys are also required.

Interpretations: SIR

Interpretations should be agreed to by all users. Map units that join (agree) across political boundaries (i.e., county to county or state to state) should also have interpretations that agree. Agreement on joining spatial and tabular information should be easier in a MLRA. The Steering committee needs to provide guidance on yield or productivity levels for phasing soil series. A rule of thumb for cropland has been that individual map units should not vary in productivity by more than 15 percent.

Guidelines are provided in the NSSH to ensure proper routing of the SIR and for resolving disagreements between states or regions. When modernizing (maintaining) a soil survey the interpretations need to be addressed in the initial stages to ensure quality of information by quick queries to the data base. The information contained on the SIR needs to be tested and maintained if it is incorrect, but individual areas should not "tailor" the information contained on it for published reports. If the SIR does not satisfy the interpretive needs for an area then another interpretive record is probably needed.

The subset soil surveys contained within a MLRA will probably all have the same basic interpretive needs. However, some local areas will need interpretations for specific uses that are not practiced throughout the MLRA. Developing these interpretations are encouraged. The soil interpretation staff of the National Technical Centers should be contacted for assistance when special interpretations need to be developed.

Where several subset soil surveys provide the same interpretation for the same soil and the same map unit, the interpretive rating needs to be the same. Again SIRs are not to be "tailored" for published reports. If the interpretations are different another SIR is needed. Remember a quality join considers line to line, name to name, and interpretation to interpretation. Try not to let your interpretive bias influence your decision.

Disagreements between areas in soil interpretation as well as any soil property data, should be resolved early in the project survey through field study or other coordinated effort by the Steering Committee. An example of an interpretive study is provided, EXHIBIT 11.

EXHIBIT 11: Interpretation Coordination

To: Paul F. Larson, Director, SNTC, Ft. Worth, TX
August J. Dornbusch, Jr., Director, MNTC, Lincoln, NE
William Puckett, State Soil Scientist, Stillwater, OK
Richard Babcock, State Soil Scientist, Lubbock, TX

Subject: SOI - C, Cr Study - Oklahoma and Texas

A field study to examine concept and definition differences for C, Cr and paralithic contacts between Oklahoma and Texas was held October 5 to 7, 1992. The information contained in this trip report constitutes our understanding of the current definitions; how the states are using the information; and our proposals to improve data base consistency of Cr or paralithic information both in use and interpretation. A glossary of terms is included in Appendix 1 for quick reference.

I would like to commend the soil staffs from Oklahoma and Texas for their cooperation and support toward making a consistent soil survey data base.

PARTICIPANTS
Bill Broderson, Soil Scientist, SSQA Staff, NSSC, Lincoln, NE
Earl R. Blakely, SIS, SNTC Soils Staff, Ft. Worth, TX
Jim Ford, Assistant State Soil Scientist, Stillwater, OK
Mike Risinger, Assistant State Soil Scientist, Lubbock, TX
Dwaine Gelner, ARSS, Clinton, OK
Dennis Ressel, ARSS, Vernon, TX

BACKGROUND
The focus of the field study centered around five shared soil series: Vernon, Knoco, Aspermont, Woodward, and Quinlan. These soils formed in materials over weakly consolidated Permian shales or sandstones. Numerous sites were examined from Vernon, Texas to Altus, Oklahoma. During this study we all agreed that where Cr horizons were described, roots had difficulty in penetrating the material except along fracture plains; fracture plains were probably more than 10 centimeters apart in areas not disturbed but quickly separated into finer sized fragments after disturbance; slaking of fragments was very rapid (minutes instead of hours).

The previous disagreements between Oklahoma and Texas centered around whether the "soft rocklike" materials presented engineering construction problems and the use of the Cr horizon designation as being the beginning depths used for the Depth to Bedrock columns on the Soil Interpretations Record. The following points out some weaknesses in our understanding of the current Cr and/or paralithic contact definitions and application of the interpretations.

1. Soft bedrock is used on the Soil Interpretations Record and in the interpretation rating guides primarily for engineering excavation difficulty; however, some soft bedrock may not always be limiting for excavation equipment. Thus, if the Cr horizon was inferred to be soft rock, then the ratings may be in error if those depths were used.

2. Cr horizons and materials below the paralithic contact are both root restrictive; however, the paralithic materials are also "difficult to dig" (high excavation difficulty), whereas the Cr horizon materials presently are defined as being "low to moderate" in excavation difficulty. It seems as if two separate uses are applied to the same horizon designation (rooting limitation and excavation difficulty).

3. In the past most Cr horizons were thought to be rocklike or paralithic. But with the current "r" horizon description in comparison with the paralithic description it appears they are not synonymous.

4. Materials under the paralithic contact are "C" horizons. The current definition requires that they slake in water within 15 hours and have a high excavation difficulty unless they are a single mineral. No minimum time for slaking is required. Permian red bed materials slake within minutes and have a low or moderate class of excavation difficulty, which excludes the materials from being paralithic (high excavation difficulty). Materials that slake in water very quickly may also be less restraining to excavation equipment. In fact, most users have suggested that these materials pose minor restrictions to excavation.

5. Excavation difficulty changes with differences in moisture states yet there is no indication in the definition of horizon subscript "r" what that state is. We assume that since the paralithic material is defined in a moist state, this definition should be similar. If this is true, then horizon subscript "r" does not fit the definition of paralithic contact (material), since paralithic would have a high excavation difficulty.

6. Interpretive ratings for just one moisture state also seem to be misleading for the user. Some materials may never be in a moist state, while some will periodically be in a moist or dry state that will have completely different excavation difficulties.

CONCLUSIONS - RECOMMENDATIONS

1. A quick fix of the data base for the ongoing soil surveys in this area will be to allow the following:

- It would be acceptable at this time to have a Cr1 and a Cr2 horizons to indicate different limiting features, such as root restriction, and excavation difficulty.

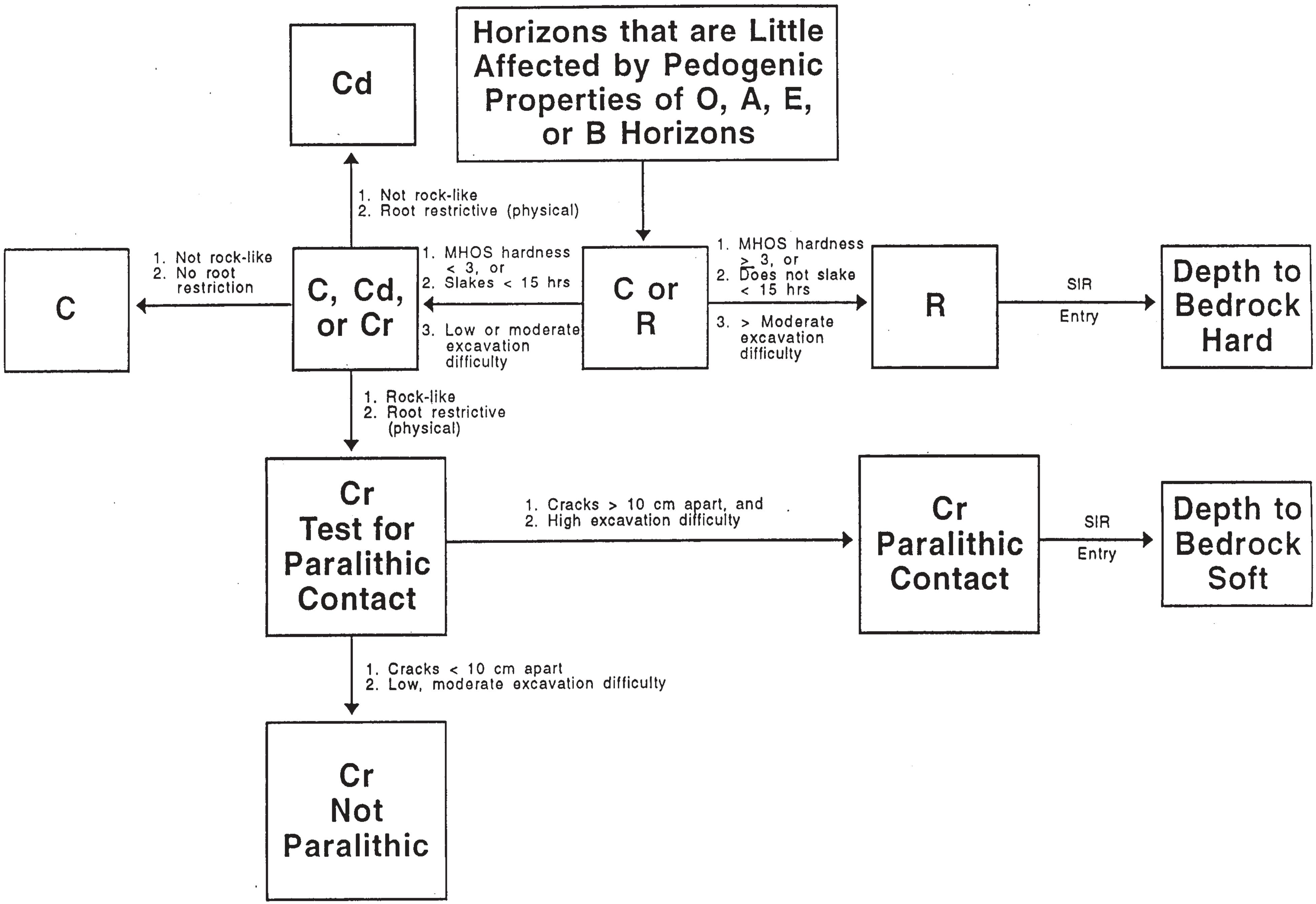
- At the present time, Cr horizons in all instances are considered to be root restrictive. Future decisions may be to limit the descriptor as an indication of soft rocklike material that may have a definition that includes the properties of the material below a paralithic contact (high excavation difficulty).
  NOTE: This has been recently changed.
- Only Cr horizons that fit the definition of paralithic (high excavation difficulty) will be used as the beginning depth for the Depth to Bedrock column on the Soil Interpretations Record. Horizons will be described in sufficient detail to indicate which applies. Descriptors include moisture state, distance between cracks, slaking time, consistence (rupture resistance and perhaps penetration resistance), and excavation difficulty class.

2. The consistence requirements (excavation difficulty) needs to be reviewed by NSSC for paralithic and/or Cr horizons to make the national guides consistent. Another item that needs attention is the water state that the material has should have a bearing on the interpretive ratings. Should we suggest the moisture state for the majority of the time, or perhaps address some temporal change. The latter may be more realistic for the user needs in areas that have distinct moist/dry periods.

3. The NSSC should consider a lower limit for slaking for paralithic contacts if its use is primarily engineering. The participants suggested that a one hour limit would be sufficient. On the other hand, perhaps the slaking requirements should be reconsidered, since end over end slaking is not a practical field test anyway. In any event a revised definition should allow use of the Cr horizon (or other appropriate designation) for the Permian red bed and similar soft rocklike materials to be root restrictive in all situations, but not necessarily a problem for construction. Materials below a paralithic contact would remain an interpretive need for excavation. Some members of the SSQA staff suggested that it may be useful in the future to make some hardness separations for soft bedrock in the data base to support different excavation interpretations.

William D. Broderson
Soil Scientist, SSQA Staff, NSSC

Decision Chart: C, Cd, Cr, R



Attachment 1: Glossary as of 6/93.

C horizon -- Horizons or layers excluding hard bedrock, that are little affected by pedogenic processes ... Included as C layers are sediment, saprolite, unconsolidated bedrock, and other geologic materials ... characterized by low or moderate excavation difficulty. (Keys to Soil Taxonomy, edition 5, pg. 517).

d horizon suffix -- Physical root restriction
Symbol "d" indicates root-restricting layers in naturally occurring or manmade unconsolidated sediments or materials, such as dense basal till, plowpans, and other mechanically compacted zones.

r horizon suffix -- Weathered or soft bedrock
Symbol "r" is used with C to indicate root-restrictive layers of saprolite such as weathered igneous rock, or of soft bedrock such as partly consolidated sandstone, siltstone, and shale. Excavation difficulty is low or moderate. (Keys to Soil Taxonomy, edition 5, pg. 521). The next release of Keys to Soil Taxonomy will define Excavation difficulty here as low to high.

paralithic contact -- A paralithic (lithiclike) contact is a boundary between soil and a continuous, coherent underlying material. If underlying rock is a single material it differs from lithic by having a Mohs hardness of less than 3. If underlying rock is not a single material, chunks of gravel size that can be broken out disperse more or less completely during 15 hours of shaking in water, and when moist, the material can be dug with difficulty with a spade. Normally the material underlying a paralithic contact is a partly consolidated sedimentary rock such as sandstone, siltstone, marl or shale, and its bulk density or consolidation is such that roots cannot enter. There may be cracks in the rock, but their horizontal spacing is 10cm or more. (Keys to Taxonomy, edition 5, pg. 31).

Depth to Bedrock -- This refers to fixed rock. Hard and soft bedrock are distinguished. Hard bedrock is usually indurated but may be strongly cemented, and excavation difficulty would be extremely high. Soft bedrock meets the consistence requirements for paralithic soil material. (Soil Survey Manual, 10/91).

Excavation Difficulty -- Classifications by which to judge the difficulty of making an excavation:

LOW -- Can be excavated with a spade using arm-applied pressure only. Neither application of impact energy nor application of pressure with the foot to a spade is necessary.

MODERATE -- Arm-applied pressure to a spade is insufficient. Excavation can be accomplished quite easily by application of impact energy with a spade or by foot pressure on a spade.

HIGH -- Excavation with a spade can be accomplished, but with difficulty. Excavation is easily possible with a full length pick using an over-the-head swing. Note: excavation with a spade with difficulty matches requirements for paralithic contact.

Official Series Description (OSED)

The documentation required to establish a new series is based on descriptions of 10 pedons that represent the central concept of the series plus supporting laboratory data and field notes.

Record revisions: (OSED, SIR)

Evaluating and revising OSED and SIR data records needs to become a routine part of the survey maintenance. Progressive correlation includes revising the data records once approval is given. Revision of the data records requires coordinating the information with surrounding areas where used to help maintain consistency in the use of the information throughout the update. However, before changes are made to the official data records, an evaluation should be made to consider whether the change will affect the use of the information where it was originally used.

Additions to the records should also be evaluated to ensure that the series maintain its integrity. Adding to the record may cause the series to overlap with another series. Care should also be exercised in enlarging or expanding ranges. Ranges in soil characteristics need to be defined by the major occurrence of those characteristics. The minor characteristic occurrences need to be kept as an inclusion when describing the areas mapped.

-- Who should control the series concepts used in a MLRA? A Steering Committee made up of representatives from NSSC, all states within the project MLRA, and individuals from local management areas. Soil correlators will conduct subset soil survey reviews and submit copies of the review reports for comments to states and NTCs involved in the MLRA maintenance as well as the NSSC.

-- Who should provide quality assurance for the technical information on the OSED and SIR as being unique and realistic and can be reliably separated? Again, the Steering Committee and the MLRA soil correlators need to have control of this. The NSSQA staff will continue to review changes to the OSED records and major changes to the Soil Interpretations.

Survey Series

Only one taxonomic unit description is REQUIRED for the MLRA or other survey area. Other sites can be selected or located by political areas if desired. If the OSED is used for the taxonomic description, the information must match.

Helpful Hints:

First Paragraph. Use one drainage class, one permeability (by definition the slowest horizon) and landscape for the site that is being described. If differences in these properties exist throughout the survey area, then describe within the range in characteristics. Such landscape terms as "upland" will keep the terminology broad enough to prevent inconsistencies. Remember, if the soil is placed on summits, then it cannot be on any other position on the hillslope in the survey. If the soil is on uplands, it can have a variety of landforms and hillslope positions. In the parent material statement, avoid saying the soil formed in "sediments or deposits" unless modified to clarify the kind of material. The mechanism of emplacement of parent material gives knowledgeable users an idea of the gradation of materials and the kinds of soil materials one would expect to be present.

Typical Pedon. Give dry and moist colors where necessary. Describe consistence, roots, pores, accumulations, mottles, or redoximorphic features and other important features that are pertinent. Be sure to mention characteristics that are part of classification, i.e., brittleness in a fragic soil and cracks, slickensides, pressure faces in a vertic soil. Use the proper horizon subscripts (i.e., k, n, ss, etc.). Be sure to include any new soil properties important to the MLRA maintenance, such as rupture resistance or other consistence terms. Refer to Chapter 3, Soil Survey Manual.

Range in Characteristics. In the first paragraph give ranges that reflect where features occur within the soil's 80 inch profile, such as "depth to lime concretions ranges from 10 to 20 inches." Give those ranges that affect classification that are not obvious, such as a soil with clay loam or silty clay loam textures but classifies in the fine family. Say for instance,

> "Clay content in the upper half of the series control section (particle-size control section) averages 35 to 38 percent clay. Subhorizons have from 28 to 44 percent."

Do the same for other important features such as rock fragments. If needed, give pertinent ranges (averages and extremes) by sections of the series control section. Divide into as many as four parts, if necessary. Make any disclaimers, such as high organic matter masks the red iron accumulations, or low chroma colors in the C horizon are lithic-chromic.

Differentiae for series. Use those definitive soil properties that meet the following tests:

- Soil property differences occur within the series control section.
- Soil properties are mappable and can be observed, measured, or inferred with reasonable assurance.
- Soil properties have a range of values that are significantly more than the normal errors of measurement, perception, or

inference by qualified soil scientists.

- Soil properties used do not vary significantly from year to year or from management.
- Soil properties used are important to the behavior or use of the soil.

EXHIBIT 12: Official Soil Series Description

LOCATION ALPHA AA

Established series
Rev. AAA-BBB-CCC
5/91

ALPHA SERIES

The Alpha series consists of very deep, well drained soils that formed in loamy marine sediments. Alpha soils are on broad tops and side slopes of deeply dissected high marine terraces. Slope ranges from 0 to 30 percent. The mean annual temperature is 52 degrees F, and mean annual precipitation is about 80 inches.

TAXONOMIC CLASS: Fine-loamy, siliceous, isomesic Typic Palehumults.

TYPICAL PEDON: Alpha loam, on a north facing, convex, 4 percent slope under conifers at an elevation of 700 feet. (Colors are for moist soil unless otherwise noted. When described March 13, 1991, the soil was moist throughout.)

Oi--0 to 2 inches; fibric material; slightly decomposed needles, leaves, twigs, woody materials. (1 to 3 inches thick)

A1--2 to 5 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak fine granular; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many fine and very fine and few medium and coarse roots; many fine and very fine pores; very strongly acid (pH 4.9); clear smooth boundary.

A2--5 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; weak very fine subangular blocky structure parting to weak fine granular; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and few medium and coarse roots; many very fine and fine irregular pores; very strongly acid (pH 4.5); abrupt smooth boundary. (Combined thickness of the A horizon ranges from 10 to 20 inches)

2Bt1--17 to 31 inches; dark brown (7.5YR 3/4) loam, strong brown (7.5YR 5/6) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine and few medium and coarse roots; many very fine continuous tubular pores; few faint clay films on faces of peds, common faint clay films in pores; 10 percent gravel; very strongly acid (pH 4.9); gradual smooth boundary.

2Bt2--31 to 39 inches; reddish brown (5YR 4/4) loam, yellowish red (5YR 5/8) dry; moderate medium and coarse subangular blocky structure; hard, firm, moderately sticky and moderately plastic; common fine and few medium and coarse roots; common very fine continuous tubular pores; common distinct clay films on faces of peds and in pores; 10 percent gravel; very strongly acid (pH 5.0); clear smooth boundary.

2Bt3--39 to 53 inches; brown (7.5YR 4/4) clay loam, strong brown (7.5YR 5/6) dry; moderate medium and coarse subangular blocky structure; slightly hard, firm, moderately sticky and moderately plastic; common fine and few medium and coarse roots; many very fine continuous tubular pores; common distinct clay films on faces of peds and in pores; 10 percent gravel; very strongly acid (pH 5.0); gradual smooth boundary. (Combined thickness of the 2Bt horizon is 29 to 47 inches)

2BC--53 to 63 inches; yellowish red (5YR 4/6) gravelly clay loam, strong brown (7.5YR 5/8) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; common fine continuous tubular pores; 20 percent gravel; very strongly acid (pH 5.0); gradual smooth boundary. (6 to 15 inches thick)

2C--63 to 80 inches; yellowish red (5YR 4/6) gravelly clay loam, reddish yellow (5YR 6/6) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine continuous tubular pores; 20 percent gravel; very strongly acid (pH 5.0).

TYPE LOCATION: Any County, Anystate; located about 750 feet south and 2,220 feet east of the NW corner of section 31, T. 40 S., R. 13 W; USGS Named topographic quadrangle; lat. 42 degrees, 4 minutes, 31 seconds N., and long. 24 degrees, 17 minutes, 30 seconds W.

RANGE IN CHARACTERISTICS: The mean annual soil temperature is 51 to 54 degrees F., the mean summer soil temperature is 54 to 57 degrees F., and the mean winter soil temperature is about 46 to 50 degrees F. The difference between mean summer and winter temperature ranges from 5 to 8 degrees F. The soils are usually moist and are dry for less than 45 consecutive days in all parts of the soil moisture control section between depths of 4 and 12 inches in the four months following the summer solstice. The particle-size control section averages 25 to 35 percent clay. Depth to a lithic contact is 80 inches or more. The solum is very strongly acid or extremely acid. The umbric epipedon is 10 to 20 inches thick. The depth to the base of the argillic horizon is 40 to 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 moist, 3 or 4 dry and chroma of 2 or 3 moist or dry. It is loam with 10 to 20 percent clay, greater than 30 percent sand, and 0 to 10 percent gravel. It is weakly smeary throughout.

The 2Bt horizon has hue of 7.5YR or 5YR, value of 3 or 4 moist and 4 or 5 dry, and chroma of 4 to 6 moist and 6 to 8 dry. It is gravelly loam, gravelly clay loam, loam, or clay loam. It averages 25 to 35 percent clay, 30 to 45 percent sand, and 5 to 20 percent gravel.

The 2BC horizon has hue of 7.5YR or 5YR, value of 4 to 6 moist and 5 to 8 dry, and chroma of 6 to 8 moist or dry. It is gravelly loam, gravelly clay loam, loam, or clay loam. It averages 25 to 35 percent clay, 30 to 45 percent sand, and 10 to 30 percent gravel.

The 2C horizon has hue of 7.5YR or 5YR, value of 4 to 6 moist, and 6 to 8 dry, and chroma of 6 to 8 moist or dry. It is gravelly loam, gravelly clay loam, loam or clay loam. It averages 25 to 35 percent clay, 25 to 45 percent sand, and 10 to 30 percent gravel.

COMPETING SERIES: This is the Beta series. Beta soils average less than 30 percent sand in the argillic horizon and hue of 10YR or yellower throughout the argillic horizon.

GEOGRAPHIC SETTING: Alpha soils are on broad tops and sides slopes of deeply dissected high marine terraces. Slope ranges from 0 to 30 percent. The soils formed in marine sediments. Elevations are 600 to 800 feet. The climate is humid, characterized by cool wet winters and cool moist summers with fog. A strong marine influence limits the diurnal and annual range of temperature. The mean annual precipitation is 70 to 90 inches. The mean annual temperature is 50 to 53 degrees F. The frost-free period is 210 to 300 days. Alpha soils are on the Griggs geomorphic surface.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Delta and Gamma soils. Delta soils have 35 to 45 percent clay in the argillic horizon and are on an adjacent higher marine terrace. Gamma soils have a cambic horizon, an umbric epipedon 20 to 30 inches thick, and are on an adjacent lower marine terrace.

DRAINAGE AND PERMEABILITY: Well drained, low to high runoff, moderately slow permeability.

USE AND VEGETATION: These soils are used for homesites, timber production, recreation, water supply, pasture, and wildlife habitat. Native vegetation is Sitka spruce, Douglas-fir, red alder, red elderberry, salmonberry, evergreen huckleberry, salal, western swordfern, evergreen violet, and sweetscented bedstraw.

DISTRIBUTION AND EXTENT: On marine terraces thought to be Pleistocene in northwestern U.S.A.; MLRA 1. The series is of moderate extent.

SERIES ESTABLISHED: Any County, Anystate, 1991.

REMARKS: Diagnostic horizons and features in this pedon include: Umbric epipedon - from 2 to 17 inches (A1 and A2 horizons).

Argillic horizon - from a depth of 17 to 53 inches (2Bt1, 2Bt2, and 2Bt3 horizons).

ADDITIONAL DATA: Partial reference samples from pedon 89P197, samples 89P1199-1202 from Any County, Anystate, samples by NSSL, Lincoln, NE, 12/89. Soil Interpretation Record: AA0023.

National Cooperative Soil Survey
U.S.A.

OSED Format

After the introductory paragraph, the format for soil series descriptions arranges the subject matter in two main parts. The first part is the taxonomic classification, the description of the typical pedon, the type location, and the sections on range in characteristics, and competing series. This part, along with the description of the diagnostic horizons and features in the remarks section, defines the soil series as a class in the soil classification system insofar as available information permits. The second part is all the remaining sections of the soil series description. This part provides additional descriptive information.

Keying. Guidelines for keying soil series descriptions are as follows--

- Left margin in column 1. Right margin in column 66.
- Do not use tabs, stop codes, required hyphen codes, required backspace codes, automatic centering, or underlining. Use the space bar instead of tabs.
- Everything is left justified except the horizon designations, which are indented 4 spaces (column 5). Use the space bar.
- Section headings are in capital letters, e. g., TAXONOMIC CLASS, TYPICAL PEDON, etc.
- Depths legal descriptions, or locations are in English units of measure. Express the number 1 using the number key not the letter l key.
- Special symbols, subscripts, and superscripts must be expressed as words. Example include:

-43^{o} = 43 degrees
- $CaCO_3$ = calcium carbonate
-10% = 10 percent
- The first 8 lines and the last line of the soil series description must be standardized in order to make the OSED computer program work. All entries are left justified and start in column 1.

The line-by-line instructions are as follows:

Line 1--LOCATION ALPHA NE (This line is entered in capital letters. The first letter of the state responsible for the soil series must be in column 33.

Line 2--Blank line

Line 3--Tentative Series or Established Series

Line 4--Rev. MLD-JRC (These are the initials of the individuals who last revised the soil series, on tentative series only the initials appear.)

Line 5--7/87 (This is the month and year that the soil series draft was sent to the official series description file. The Ames computer enters this date automatically.)

Line 6--Blank line

Line 7--ALPHA SERIES (In capital letters.)

Line 8--Blank line

Line 8 is followed by the introductory paragraph and the rest of the soil series description.

Next to last line--National Cooperative Soil Survey

Last line--U.S.A. (In capital letters and without spaces between the letters.)

The completed description must be run through spell check.

Features Described for Horizons.

These are as follows:

- color (dry or moist, whichever is the most common condition),
- texture,
- color (dry or moist, but opposite of the condition given initially),
- mottles (dry or moist),
- structure (Do not use commas to separate terms in the phrase that describes structure. Use the word "structure" only once in describing compound structure, e. g., "weak coarse prismatic structure parting to moderate medium subangular blocky;"),
- consistence (dry, moist, stickiness, plasticity),
- roots,
- pores,
- additional features (include redoximorphic depletions and accumulations),
- reaction,
- consistence statements such as excavation difficulty,
- lower boundary, and
- thickness range.

Refer to Chaper 3, Soil Survey Manual for other items to consider.

Descriptive Legend.

The soil survey of a MLRA will consist of the same items contained in county soil survey reports. For a maintenance project it is important to initally build a combined descriptive legend that will unify all of the subset areas into one legend. Appendix 4 includes a shell script for building an initial legend along with an example legend it can produce.

Combining many of the subset areas into one legend may require reviewing and possibly combining some minor inconsistencies, such as map units with two different ranges in slope or surface texture differences. This legend will be maintained and agreed to by the Steering Committee.

Taxonomic Unit Descriptions. Only one type location for each taxonomic unit within the MLRA is REQUIRED. This will often be the location of the Official Series Description (OSED).

Locations of a similar taxonomic unit can also be given within subset survey areas for local reference. These areas need not be described. However, specify in the location part of the taxonomic description the location of the description given and the location of a similar taxonomic unit within the subset area, if this is desired. Attempt to locate sites which are anticipated to last and that can be located and observed easily.

Map Unit Descriptions. Describe the coordinate location of a representative area for each map unit description. It is desired that these be located and viewed easily and which are expected to remain in its existing land use. One is sufficient for the MLRA; however, subset areas may wish to use a more local area.

Descriptions for all map units will be agreed on by the Steering Committee. Agreement can be achieved in part by developing a common documentation format (refer to map unit description examples); by using common data elements and common use and management statements and terms; and by developing and using standardized MLRA survey procedures. These items are developed by and are agreed on and provided for guidance for the conduct of subset surveys by the Steering Committee. National standards (Soil Taxonomy, National Soil Survey Handbook, and Soil Survey Manual) will be used for the project area. If certain items in these national guides need to be refined for a more precise definition or if additional guides are needed, the Steering Committee will secure its development.

Agreement on common terms and definitions will improve mapping consistency. For example, development of a standard list of landscape, landform, and position on landform terms will improve the understanding of relationships of soils and soil development, which will make the transfer of knowledge much easier for the geographic area. The following are examples:

- -- EXHIBIT 13 is an example of a hierarchy of standard geomorphic terms use in a geographic area;
- -- EXHIBIT 14 is an example of soil and landform relationships.

Agreed on text formats also increase consistency in items described and used. The following are some examples:

- -- example of a narrative taxonomic unit description, EXHIBIT 15;
- -- example of semitabular taxonomic unit description, EXHIBIT 16;
- -- example of narrative map unit description, EXHIBIT 17;
- -- example of semitabular map unit description, EXHIBIT 18.

EXHIBIT 13: Hierarchy of Geomorphic Terms

This exhibit is only an example for a geographic area (in this case an upper midwest MLRA). It is recommended that MLRAs build a hierarchy for consistent application of terms and definitions.

Suggested Hierarchy: MLRA ____

"LANDFORM" DESCRIPTION (terms defined in NSSH Section 629)

A) LANDSCAPE NAME

basin
breaks
meander belt
plains
till plain (also landform name)

B) LANDFORM NAME

alluvial fan
backswamp
bar
beach
beach ridge
beach terrace
berm
blowout
bluff
bog
channel
cliff
collapsed ice-floored lakebed
collapsed ice-walled lakebed
collapsed lake plain
collapsed outwash plain
crevasse filling
cutoff
delta
diapir
disintigration moraine
divide
drainageway
drumlin
dune
earth flow
end moraine
escarpment
esker
fen
flood plain
flood-plain splay
flood-plain step
fosse
free face
glacial drainage channel
glacial lake (relict)
ground moraine
hill
interdune
interfluve
kame
kame moraine
kame terrace
kettle
knob
knoll
lakebed
lake plain
lakeshore
lake terrace
flute
landslide
lateral moraine
ledge
levee
longshore bar (relict)
marsh
meandering channel
meander scroll

medial moraine
monadnock
monocline
moraine
mud flat
mudflow
natural levee
outwash fan
outwash plain
outwash terrace
oxbow
oxbow lake (ephemeral)
paha
pediment
pitted outwash plain
plain (also landscape)
point bar
pothole
raised beach
raised bog
ravine
recessional moraine
ridge
roche mountonnee
rotational landslide
saddle
sand flow
scarp
shoreline
shrub-coppice dune
slide
slough
slump
slump block
strath terrace
stream terrace
string bog
structural bench
swamp
syncline
terminal moraine
terrace
till plain (also landscape name)
translational slide
transverse dune
tunnel valley
valley
valley floor
valley side

C. MICROFEATURE

bar and channel
break
earth pillar
gullies
mound
pothole
scour (mark)
swale
tank
terracettes
tree-throw mound
tree-throw pit

EXHIBIT 14: Landform - Soil Relationships

SOILS ON BOTTOM LANDS - MLRA 134

Four soil orders have been recognized on bottom lands in the area (figure 1). Alfisols represent the soils that are on the most stable positions (terraces) and have the greatest degree of soil profile development. Entisols are on the least stable positions (flood plains) and represent the least degree of development. Inceptisols and Mollisols are intermediate in profile development, having either cambic subsoil horizons or mollic epipedons.

All of the soils have formed in alluvial sediments ranging from sand to clay in texture, with the greatest number of soils having either a coarse-silty or fine-silty particle-size class. Most of the soils are acid, although some soils are in non-acid categories.

ALFISOLS

The Alfisols are located on the higher, more stable positions within the area, including low stream terraces. Ten series make up this group (figure 2). The presence of an argillic horizon indicates that the soils have been forming in place longer than other soils within the bottom land area. They dominantly have mixed mineralogy, although although the Guyton soil has siliceous mineralogy. They can be grouped into two broad classes based on the particle-size class: coarse-silty and fine-silty.

Coarse-Silty Alfisols

Two soils make up this group. They are differentiated by drainage class.

Leverett - Coarse-silty, mixed, thermic Haplic Glossudalfs.

Type location - Tallahatchie County, Ms. This soil is on high, stable positions on flood plains and on some low stream terraces. This soil is well drained. The lower part of the argillic horizon is degrading and is a Glossic horizon.

Tippo - Coarse-silty, mixed, thermic Aquic Glossudalfs.

Type location - Tallahatchie County, Ms. This soil is somewhat poorly drained and is in broad, stable positions on the landscape. The soil has a buried glossic horizon below 20 inches.

Fine-Silty Alfisols

Two soils make up this group. They are differentiated by drainage class, mineralogy, and soil profile characteristics, such as lithologic discontinuities and the presence of natric, glossic, or albic horizons.

Guyton - Fine-silty, siliceous, thermic Typic Glossaqualfs.

Type location - Ouachita Parish, La. This soil is on flood plains and late Pleistocene age terraces. It is somewhat poorly drained and has an albic horizon, a glossic horizon, and an argillic horizon. The solum is more than 50 inches thick. This is the only siliceous Alfisol recognized on the flood plain in the area.

Dubbs - Fine-silty, mixed, thermic Typic Hapludalfs.

Type location - Tallahatchie County, Ms. This soil is well drained and is on natural levees and low stream terraces. It has an argillic horizon extending to depths of between 20 and 60 inches.

INCEPTISOLS

The Inceptisols consist of soils that are in positions which are stable enough to have developed a cambic horizon, either on high positions within the flood plain or on low stream terraces. Nine series make up this group (figure 3). Particle-size classes are coarse-silty, fine-silty, or very-fine. Six Dystrochrepts, one Eutrochrept, and two Haplaquepts have been recognized. Mineralogy is mixed, siliceous, or montmorillonitic. The soils range from well drained to poorly drained.

Coarse-Silty Inceptisols

Four soils are in this group. Reidtown is a Eutrochrept and the others are Dystrochrepts. The soils are furthur divided by drainage class and mineralogy.

Ariel - Coarse-Silty, mixed, thermic, Fluventic Dystrochrepts.

Type location - Montgomery County, Ms. This soil is on flood plains and some low stream terraces. This soil is well drained and has a buried Cambic horizon between 20 and 50 inches which is brittle in 20 to 40 percent of the matrix and contains some albic material between ped faces.

Velda - Coarse-silty, siliceous, thermic Fluventic Dystrochrepts.

Type location - Lawrence County, Ms. This soil is on flood plains and some low stream terraces. It is well drained and has a Cambic horizon extending to a depth of between 20 and 55 inches. It is the only siliceous soil within this group.

Oaklimeter - Coarse-silty, mixed, thermic Fluvaquentic Dystrochrepts.

Type location - Benton County, Ms. This soil is on flood plains and some low stream terraces. It is moderately well drained and has a Cambic horizon underlain by a buried argillic horizon below a depth of 20 to 50 inches.

Reidtown - Coarse-silty, mixed, thermic Fluvaquentic Eutrochrepts.

Type location - Hinds County, Ms. This soil is moderately well drained. It is on flood plains and low stream terraces. The subsoil consits of a Cambic horizon, the lower part of which is a buried soil extending to depths of greater than 60 inches. The middle part of the Cambic horizon contains pockets and seems of albic material (thus resembling a glosssic horizon). Reaction ranges from medium acid to moderately alkaline.

Fine-Silty Inceptisols

Three soils are in this group. All are Dystrochrepts. The soils are differentiated primarily by drainage class and mineralogy.

Cascilla - Fine-silty, mixed, thermic Fluventic Dystrochrepts.

Type location - Grenada County, Ms. This soil is on natural levees and is well drained. It has a Cambic horizon extending to depths of between 45 and 80 inches.

Ouachita - Fine-silty, siliceous, thermic Fluventic Dystrochrepts.

Type location - Ouachita County, Ar. This soil is well drained and is on flood plains and natural levees. It has a Cambic horizon extending to a depth of 40 inches or more.

Chenneby - Fine-silty, mixed, thermic Fluvaquentic Dystrochrepts.

Type location - Talladega County, Al. This soil is somewhat poorly drained and is on nearly level or slightly depressed areas on flood plains. It has a Cambic horizon extending to depths of between 40 and 70 inches.

Very-Fine Inceptisols

There are two soils in this group. Both are poorly drained Vertic Haplaquepts with montmorillonitic mineralogy. They are differentiated by reaction class.

Alligator - Very-fine, montmorillonitic, acid, thermic Vertic Haplaquepts.

Type location - LeFlore County, Ms. This soil is in depressions or old drainageways. It has formed in clayey slackwater sediments and has a sticky and plastic Cambic horizon which extends to depths of between 40 and 60 inches. This soil is very strongly or strongly acid to depths of at least 40 inches.

Sharkey - Very-fine, montmorillonitic, nonacid, thermic Vertic Haplaquepts.

Type location - West Feliciana Parish, La. This soil is on lower parts of natural levees and backswamps on the Mississippi River flood plain. It has formed in clayey alluvium and has a sticky and plastic Cambic horizon extending to depths of between 36 to 60 inches. The soil is medium acid through moderately alkaline.

MOLLISOLS

Only two Mollisols have been recognized. Both are in the northern part of the region, and are on nearly level areas or in depressions. These soils are characterized by the presence of the mollic epipedon which is a reflection of the accumulation of organic matter as the major soil forming process. These soils are differentiated primarily by particle-size class and drainage.

Dekoven - Fine-silty, mixed, thermic Fluvaquentic Haplaquolls.
Type location - Henderson County, KY. This soil is very poorly drained. It is in depressional areas on the flood plain adjacent to loess covered uplands. The mollic epipedon ranges from 11 to 24 inches thick. Reaction is slightly acid to mildly alkaline throughout the soil.

Egam - Fine, mixed, thermic Cumulic Hapludolls.
Type location - Davidson County, TN. This soil is well drained. It is on nearly level to gently sloping areas on flood plains and in depressions. It has a thick mollic epipedon (24 to 55 inches) and a Cambic horizon. Reaction is moderately acid to moderately alkaline throughout the soil.

EXHIBIT 15: Narrative Taxonomic Unit Description

Johns Series

The Johns series consists of somewhat poorly drained and moderately well drained soils that formed in loamy marine sediments. Slopes range from 0 to 2 percent.

Typical pedon of Johns loamy sand, 0 to 2 percent slopes, on Roanoke Island, approximately 0.2 mile west of the intersection of Secondary Road 1144 and North Carolina Highway 345, about 50 feet south of Secondary Road 1144, in a woods; USGS Wanchese topographic quadrangle; lat. 35 degrees, 50 minutes, 30 seconds N., and long. 75 degrees, 39 minutes, 40 seconds W.

Oe--3 inches to 0; partially decomposed needles, leaves, and twigs; abrupt smooth boundary.

A--0 to 4 inches; very dark gray (10YR 3/1) loamy sand; weak fine granular structure; very friable; common fine and medium roots; common clean sand grains; very strongly acid; abrupt smooth boundary.

E--4 to 8 inches; gray (10YR 5/1) loamy sand; weak fine granular structure; friable; common fine and medium roots; weakly cemented; very strongly acid; abrupt smooth boundary.

Bh--8 to 13 inches; very dark brown (7.5YR 2/2) loamy sand; massive; weakly cemented; very strongly acid; clear smooth boundary.

Bt1--13 to 17 inches; yellowish brown (10YR 5/4) sandy loam; weak fine subangular blocky structure; friable; common medium distinct brownish yellow (10YR 6/8) soft masses of iron accumulation and very pale brown (10YR 7/3) iron depletions; few opaque minerals; very strongly acid; clear smooth boundary.

2Bt2--17 to 26 inches; yellowish brown (10YR 5/4) sandy clay loam; weak fine subangular blocky structure; friable, slightly sticky; common medium faint yellowish brown (10YR 5/6) soft masses of iron accumulation and few fine distinct grayish brown iron depletions; few faint clay films on faces of peds; few opaque minerals; very strongly acid; clear smooth boundary.

3C1--26 to 32 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; few fine distinct light gray (10YR 7/1) iron depletions; common opaque minerals; very strongly acid; clear smooth boundary.

3C2--32 to 37 inches; very pale brown (10YR 7/4) sand; single grain; loose; common fine distinct reddish yellow (7.5YR 7/8) soft masses of iron accumulation and light gray (10YR 7/1) iron depletions; common opaque minerals; very strongly acid; clear smooth boundary.

Cg--37 to 72 inches; light brownish gray (10YR 6/2) sand; single grain; loose; common medium distinct strong brown (7.5YR 5/8) and few fine distinct yellow (10YR 7/8) soft masses of iron accumulation and common medium distinct brown (10YR 5/3) iron depletions; common opaque minerals; very strongly acid.

The thickness of the solum ranges from 26 to 40 inches. The depth to top of argillic horizon is 10 to 15 inches. The depth to the base of the argillic horizon is 20 to 40 inches. Reaction is very strongly acid or strongly acid throughout the profile.

The A horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 to 3. The E horizon has hue of 10YR to 5Y, value of 5 to 7, and chroma of 1 to 4. It is loamy sand or loamy fine sand.

The Bh horizon has hue of 5YR to 10YR, value of 2 to 5, and chroma of 2 to 4. It is loamy sand or loamy fine sand.

Some pedons have an E′ horizon. It has hue of 10YR to 5Y, value of 5 to 8, and chroma of 2 to 4. It is loamy sand, loamy fine sand, fine sandy loam, or sandy loam.

The Bt horizon has hue of 10YR to 5Y, value of 5 to 7, and chroma of 3 to 8. It has redoximorphic concentrations and depletions in shades of red, gray, and brown in most pedons. It is sandy clay loam, clay loam, fine sandy loam, or sandy loam.

Some pedons have a Btg horizon. It has hue of 10YR to 5Y, value of 5 to 8, and chroma of 1 or 2. It is sandy clay loam, clay loam, fine sandy loam, or sandy loam.

The C horizon has hue of 10YR to 5Y, value of 4 to 7, and chroma of 3 to 8. It is loamy sand, loamy fine sand, sand, or fine sand.

The Cg horizon has hue of 10YR to 5Y, value of 5 to 8, and chroma of 1 or 2. It is fine sand, sand, loamy fine sand, or loamy sand.

EXHIBIT 16: Semitab Taxonomic Unit Description

Andover Series

Depth class: Very deep, shallow to fragipan
Drainage class: Poorly drained
Permeability: Moderate above the fragipan and slow in the fragipan
Landform: Mountains
Position on the landform: Footslopes
Parent material: Colluvium weathered from acid sandstone and shale residuum
Slope range: 3 to 8 percent
Associated soils: Dekalb. Hazleton, Laidig, Buchanan

Taxonomic class: Fine-loamy, mixed, mesic Typic Fragiaquults

Typical Pedon:
Andover gravelly silt loam, 3 to 8 percent slopes, in Franklin County, Fannett Township, 2.75 miles northeast of Amberson, 1.25 miles northeast of the intersection of Pennsylvania Township Route T591 and Pennsylvania Route 4005, and 500 feet south of Pennsylvania Route 4005. Latitude 40 degrees, 15 minutes, 45 seconds N., Longitude 89 degrees, 40 minutes, 50 seconds W.

Ap -- 0 to 8 inches, dark grayish brown (2.5Y 4/2) moist, light yellowish brown (2.5Y 6/4) dry gravelly silt loam; weak fine granular structure; friable, slightly sticky and slightly plastic; few fine distinct light gray (10YR 6/1) iron depletions; 15 percent subangular sandstone rock fragments; very strongly acid; abrupt smooth boundary.

Btg1 -- 8 to 14 inches; gray (10YR 5/1) gravelly loam; common medium distinct very dark grayish brown (10YR 3/2) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm, slightly sticky and slightly plastic; common medium distinct light gray (10YR 6/1) iron depletions; common faint clay films on peds; 15 percent subangular sandstone rock fragments; very strongly acid; clear smooth boundary.

Btg2 -- 14 to 19 inches; grayish brown (10YR 5/2) gravelly clay loam; weak medium prismatic structure parting to weak fine subangular blocky; firm, sticky and slightly plastic; many coarse prominent yellowish brown (10YR 5/8) and light yellowish brown (10YR 6/4) soft masses of iron accumulation; few faint clay films on peds; 20 percent subangular sandstone rock fragments; very strongly acid; clear wavy boundary.

Btgx -- 19 to 46 inches; grayish brown (10YR 5/2 gravelly clay loam; moderate very coarse prismatic structure parting to weak medium platy; brittle; very firm, slightly sticky and slightly plastic; many coarse prominent strong brown (7.5YR 5/6) soft masses of iron accumulation and gray (10YR 6/1) iron depletions; few faint clay films on faces of peds; 20 percent subangular rock fragments; very strongly acid; gradual wavy boundary.

Cg -- 46 to 60 inches; brown (7.5YR 5/2) gravelly sandy clay loam; weak coarse prismatic structure; firm, slightly sticky and slightly plastic; common medium prominent light gray (N 7/0) and dark yellowish brown (10YR 4/4) soft masses of iron accumulation; 25 percent subangular sandstone rock fragments; very strongly acid.

Range in Characteristics:
Solum thickness: 40 to 60 inches
Depth to bedrock: More than 60 inches
Depth to fragipan: 20 to 28 inches
Depth to dominant chroma of 2 or less: Directly below the surface
Content of clay in the control section: 18 to 34 percent
Kind of rock fragments: Sandstone, siltstone, and shale
Reaction: Unless limed, very strongly acid or strongly acid throughout the profile

A horizon:
Hue -- 7.5YR to 2.5Y
Value -- 2 to 4
Chroma -- 1 to 6
Texture of the fine-earth fraction -- silt loam, loam, sandy loam
Content of rock fragments -- 10 to 40 percent

E horizon:
Hue -- 7.5YR or 10YR
Value -- 2 to 5
Chroma -- 1 to 6
Texture of the fine-earth fraction -- silt loam, loam, loam
Content of rock fragments -- 10 to 40 percent

Btg horizon:
Hue -- 7.5YR or 10YR
Value -- 4 to 6
Chroma -- 1 or 2
Texture of the fine-earth fraction -- sandy clay loam, loam, sandy clay loam

Btx horizon:
Hue -- 7.5YR or 10YR
Value -- 4 or 5
Chroma -- 1 to 8
Texture of the fine-earth fraction -- sandy clay loam,

loam, clay loam
Content of rock fragments -- 10 to 40 percent

C horizon:
Hue -- 7.5YR to 10YR
Value -- 4 to 6
Chroma -- 1 to 8
Texture of the fine-earth fraction -- sandy loam to clay loam
Content of rock fragments -- 10 to 50 percent

EXHIBIT 17: Narrative Map Unit Descriptions

12--Alpha silt loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, moderately well drained soil is on long narrow summits and on the smooth upper back slopes in the uplands. Individual areas are long and narrow. Some extend for several miles and are several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil extends to a depth of more than 60 inches. In sequence downward, it is strong brown, friable silty clay loam; brown, mottled, firm silty clay; brown, mottled, firm silty clay loam; a fragipan of brown, mottled, very firm, hard, compact silt loam and silty clay loam; and strong brown, mottled, very firm clay. In several areas, the soil is not eroded, and the surface soil is very dark grayish brown and dark grayish brown silt loam 10 or more inches thick. In places the subsoil is clay loam.

Included with this soil in mapping are small areas of the cherty Ruphy soils. These soils are in landform positions similar to those of the Alpha soil. Also included are some severely eroded areas on summits of ridges where the plow layer is brown silty clay loam and concave areas of a nearly level, poorly drained soil that has a thick, light gray subsurface layer. Included soils make up about 10 percent of the unit.

Permeability is moderate in the upper part of the Alpha soil, slow in the fragipan, and moderately slow below the fragipan. Available water capacity is moderate. Runoff is medium in cultivated areas. A perched water table is at a depth of 1.5 to 3.0 feet for brief periods during winter and early spring. Natural fertility is low, and the content of organic matter is moderately low. The surface layer is friable and can be easily tilled. Root development is severely restricted by the fragipan below a depth of about 28 inches. The shrink-swell potential is moderate in the subsoil.

Most areas of this soil are used for pasture or hay. A large acreage is used to grow grain sorghum and wheat. A small acreage is used to grow corn or soybeans.

The suitability of this soil for different crops depends largely on the needs of each crop for soil moisture. During dry periods less than 7 inches of moisture is available in the soil. This amount is not enough to prevent serious moisture stress in most years. Consequently, the soil is better suited to grain sorghum than to corn or soybeans and is somewhat better suited to soybeans than to corn. This soil is well suited to small grain. If corn is grown, high plant populations should be avoided and planting early in spring is beneficial in most years. During wet periods planting or harvesting is delayed by seepage of ground water moving laterally above the fragipan.

When used for crop land, protection against soil erosion is a major management concern. Erosion can be controlled by no-till planting or another system of conservation tillage that leaves a protective crop residue on the surface. Some of these may include winter cover crops, a combination of terraces and grassed waterways, contour farming, and a cropping sequence that includes pasture or hay. Grade-stabilization structures may be needed where grassed waterways are established. The cost effectiveness of terraces and other mechanical erosion-control measures is questionable on this soil. Some areas are unsuitable for terracing because they are long and narrow and have complex slopes.

When this soil is used for legumes, such as lespedeza and birdsfoot trefoil; to cool-season grasses, such as tall fescue and orchardgrass; and to warm-season grasses, such as big bluestem and indiangrass available water capacity, accelerated erosion, pH, and thickness of soil above the fragipan are major management concerns. If ladino clover and red clover are grown lime is usually needed to improve the surface pH. The rooting depth is only moderate, and an insufficient supply of moisture is a problem during summer. Erosion control is needed in areas where the pasture is tilled and newly seeded. Timely tillage and a quickly established ground cover help to prevent excessive soil loss.

When this soil is used for woodland, thickness of soil above the fragipan is a management concern. A substantial acreage supports native hardwoods. Some areas that formerly were cleared of trees and farmed are reverting to woodland. Some tracts have been planted to pine. In most of the wooded areas, selective cutting and stand improvement are needed to reduce the plant competition caused by soil depth.

If this soil is used for building site development, the shrink-swell potential and the wetness are limitations. The structural damage caused by shrinking and swelling can be minimized by using adequately reinforced concrete in basement walls and floors and by backfilling with sand and gravel. The wetness can be reduced by installing tile drains around footings and foundations. Septic tank absorption fields do not function well because of the wetness and the slowly permeable fragipan. Properly designed sewage lagoons can function adequately if the site is leveled.

The land capability classification is IVe. The woodland ordination symbol is 3A.

32 -- Beta-Rho complex, rolling. These very deep, excessively drained and well drained soils are on side slopes of hills and moraines. Slopes range from 3 to 15 percent. Individual areas are irregular in shape and generally range from 20 to 500 acres

in size. They are about 50 percent Beta soil and 35 percent Rho soil.

Typically, the surface layer of the Beta soil is dark gray, very friable sandy loam about 1 inch thick. The subsoil is friable sandy loam about 22 inches thick. The upper part is dark brown, the next part is yellowish brown, and the lower part is light olive brown. The substratum to a depth of 65 inches or more is light yellowish brown, loose coarse sand.

Typically, the surface layer of the Rho soil is about 3 inches thick. It is black, very friable loamy coarse sand in the upper part and gray, loose coarse sand in the lower part. The subsoil is about 26 inches thick. In sequence downward, it is dark brown, very friable, gravelly loamy coarse sand; strong brown, very friable, gravelly loamy coarse sand; yellowish brown, very friable gravelly loamy coarse sand; and light yellowish brown, loose, gravelly coarse sand. The substratum extends to a depth of 65 inches or more. It is light brownish gray, loose, gravelly coarse sand in the upper part and pale brown, loose, coarse sand in the lower part.

Included with these soils in mapping are small areas of the poorly drained Lambda and Eta soils in depressions and the well drained Zeta soils on summits. Included soils make up about 15 percent of the unit.

Permeability is moderately rapid in the subsoil of the Beta soil and rapid or very rapid in the substratum. It is rapid in the subsoil of the Rho soil and very rapid in the substratum. Available water capacity is moderate in the Beta soil and low in the Rho soil. Depth to the seasonal high water table is more than 6 feet in both soils.

Most areas of these soils have been developed for homesites. Many areas are used as pasture, and some are used as woodland. A few areas have been developed as golf courses.

These soils are suited to cultivated crops. Because of the variability of the soils, however, crop growth may vary. Erosion is a management concern in the steeper areas. Stripcropping, terracing, minimizing tillage, growing cover crops, and including grasses and legumes in the cropping system help to control runoff and erosion. Droughtiness is a limitation in areas of the Rho soil. Irrigation is needed for most cultivated crops. Mixing crop residue and manure into the surface layer improves tilth and increases the content of organic matter.

These soils are suited to hay and pasture. The main management concern is overgrazing, which reduces the hardiness and density of desirable plants and increases the hazard of erosion. Proper stocking rates, timely deferment of grazing, and restricted use during wet periods help to maintain plant density and minimize surface compaction.

These soils are suited to woodland. No major hazards or limitations restrict woodland management on the Beta soil. Some seedling loss can be expected on the droughty Rho soil. Thinning dense stands to standard stocking levels results in more vigorous tree growth. Removal or control of competing vegetation may be necessary for optimum growth of newly established seedlings. The most common trees are pitch pine, white oak, scarlet oak, eastern white pine, and black oak.

Areas of these soils that have slopes of more than 8 percent are limited as sites for buildings. Land grading is generally needed. Buildings and lots should be designed so that they conform to the natural slope of the land. Erosion is a hazard during and after construction. Planting well adapted grasses as soon as possible after the surface is disturbed minimizes this hazard.

These soils are limited as sites for septic tank absorption fields. The slope is a limitation. Also, the soils may not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water, especially in areas where the density of housing is high. The distribution lines should be installed on the contour, or the site should be graded during construction.

The land capability classification of both soils is IIIe.

EXHIBIT 18: Semitabular Map Unit Description

Note: The elements in the following sample map unit descriptions may be used in a different order.

17 -- Keomah silt loam

Setting

Landform: Hills
Landscape positon: Broad summits
Shape of areas: Irregular
Size of areas: 5 to 150 acres
Major use: Cropland

Major Composition

Keomah soil and similar soils: 85 to 95 percent

Minor Composition

Contrasting components: 5 to 15 percent
- -- Poorly drained Rushville soils in flat or slightly depressional areas below the Keomah soil;
- -- Soils that have less clay in the subsoil (Alpha soil).

Similar components: 0 to 5 percent
- -- Soils that have a surface layer that is slightly darker (Beta soil).

Typical Profile

Surface layer:
0 to 7 inches -- dark grayish brown, friable silt loam

Subsurface layer:
7 to 10 inches -- grayish brown, friable silt loam

Subsoil:
10 to 17 inches -- brown, mottlesd friable silty clay loam
17 to 38 inches -- grayish brown, mottled, firm silty clay
38 to 55 inches -- grayish brown, mottled, firm silty clay loam
55 to 80 inches -- light brownish gray, mottled, friable silt loam

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Slow
Runoff: Slow
Available water capacity: High
Seasonal high water table: 2 to 4 feet below the surface, May to June
Organic matter content: Moderately low
Erosion hazard: None or slight
Tilth: Easily tilled throughout a wide range in moisture content

Shrink-swell potential: High

Use and Management

Cropland
Suitability: Well suited
Management measures:
- The seasonal high water table may delay planting in some years. Subsurface tile drains and surface ditches help to remove excess water.
- Returning crop residue to the soil helps to maintain soil tilth.

Dwellings
Suitability: Poorly suited
Management measures:
- Subsurface tile drains and land shaping help to remove excess water.
- Reinforcing footings and foundations help to prevent structural damage caused by shrinking and swelling.

Septic tank absorption fields
Suitability: Poorly suited
Management measures:
- Curtain drains and land shaping help to remove excess water.
- Increasing the size of absorption field or adding suitable fill material on the surface help to overcome restricted permeabilty.

Interpretive Groups
Land capability classification: IIw
Woodland ordination symbol: 3A
Tillage group: 4

DIGITIZING: Maintenance and Quality Control

Digitizing of the completed soil survey maps is an integral part of the MLRA maintenance process. Digitized spatial data greatly enhances the potential uses of soil information. It also serves as an excellent tool for quality assurance and correlation of the soil survey. Several questions have been asked and are addressed in this section that relate to MLRA such as:

- Who will digitize the MLRA if it crosses state boundaries? Agreements to share work between states is vital in order to maximize use of people and equipment. The answer to this question may be in answering who is capable of doing the digital work. States will need to agree on this task, as well as other areas where projects can be shared.
- Who will assure quality of the digital work? Ultimately, the State Soil Scientists for their respective areas are responsible, however, quality control for the project soil survey whether digital data or other activities should be viewed as part of progressive soil correlation.

When incorporated in a fully integrated geographic information system (GIS), the digital soil layer can become a base with which other layers may be combined to produce new interpretive maps for a wide range of purposes. After the digital soil layer is approved, the soil information should not be changed (unless officially recorrelated) to make any thematic map. When combining the digital soil layer with other spatial layers, such as geology or vegetation, **CAUTION** needs to be exercised to avoid making changes to the soil survey, such as adjustments to map unit lines to fit a land use change.

Digitizing the soil survey maps makes it possible for a wider range of products to be produced upon completion of the soil survey, as well as the traditional soil survey manuscript.

Digital Standards

1. All MLRA soil surveys will be digitized following the SSURGO and STATSGO requirements outlined in the National Soil Survey Handbook, part 648.

2. All soil maps will be digitized from compiled soil lines on a mylar overlay of a controlled base with a scale of 1:12,000 or 1:24,000 for SSURGO and 1:250,000 for STATSGO.

3. All digitizing will meet SCS digitizing standards in National Instruction No. 170-303 "Technical Specifications for Digitizing Soil Survey Maps," Second Edition, September 1990.

4. Ideally, all digitizing should be done for complete quads, even if part of the quad is from a soil survey that is not being updated at the time of the MLRA Soil Survey. Published soil survey information can also be by complete quad. Political

boundaries, such as state or county boundaries, need to be digitized, as well as the geographic boundaries such as the MLRA boundary.

5. The MOU for the MLRA Soil Survey will state that SCS will archive and distribute soil geographic data. In addition, the MOU will state who is responsible for digitizing.

6. The State Soil Scientist will maintain responsibility for certification of the accuracy for all digital data contained within his/her area of responsibility. The Steering Committee will coordinate the quality control of the spatial and tabular information through progressive correlation and spot review.

7. Computer files of the digital data will be sent to the National Cartographic Center for review and inclusion in the SSURGO database. NCC will review the files for accuracy of digitizing and for compliance with specifications.

Updating MLRA Boundaries (NSSH 649)

Section 649 of the National Soil Survey Handbook describes the procedure for revising the MLRA boundary. Briefly it says that states submit the following documentation to the appropriate Director, NTC:

- draft MLRA map with suggested change(s) on a 1:7,500,000 scale map generated from the most current digital version of the MLRA map;
- draft MLRA descriptions;
- documentation stating reasons for the suggested change(s);
- letters from the state conservationists who share the MLRA concurring in the change(s) and documenting a correct join if the change(s) affect the states that share the MLRA.

The approximate minimum MLRA area that is delineated is 580,644 hectares (1,434,803 acres), which is represented on a map of 1:7,500,000 scale by an area approximately 1 cm by 1 cm. The following procedures should be followed when changes are made:

1. The State Soil Scientist having the major part of the MLRA within his/her state coordinates suggestions from all NCSS cooperators. This activity could be accomplished with an ad hoc committee from guidance from the MLRA Steering Committee.

2. The State Conservationist submits proposals for changes to the appropriate NTC director and other states that would be impacted by the proposed changes, for concurrence.

3. The NTC director usually has the NTC soils staff review, and concur and if acceptable route to other NTCs.

4. The director of the NTC submits the approved changes and documentation to the director of the MNTC who forwards them to the Assistant Director, National Soil Survey Center, who provides the information to appropriate quality assurance staff for final approval.

5. The Assistant Director, NSSC, forwards the changes and documentation to the National Leader, SGIS, who initiates the digitizing of the changes and archiving of the information by the National Cartographic Center.

Updating STATSGO (NSSH 648)

1. Quality of maps and units is assured through the progressive correlation process.

2. The State Conservationists coordinate any changes with the surrounding states.

3. When new or updated General Soil Maps are prepared STATSGO will be updated to reflect the more modern information. This is an integral part of achieving a quality join for the soil survey.

4. The State Conservationist certifies the quality of this information.

5. The State Conservationist submits any new soil survey geographic data base to the National Cartography and GIS Center by December 31 of each year.

6. The state office maintains the Official Copy of STATSGO.

REFERENCES

National Cooperative Soil Survey Soil Map Digitizing Handbook, 1992, USDA, SCS.

SSURGO Data Users Guide, Misc. Pub., 1992, USDA, SCS.

STATSGO Data Users Guide, Misc. Pub. No. 1492, August 1991, USDA, SCS.

Technical Specifications for Photobase Map Compilation from Soil Survey Field Sheets for the NCSS Program, January 1989, USDA, SCS.

Technical Specifications for Preparing Atlas Style Soil Maps for Lithographic Printing on Photo Image Background by New Procedures, January 1989, USDA, SCS.

Technical Specifications for Line Segment Digitizing Soil Survey Maps using the DLG-3 Optional Format, April 1990, USDA, SCS.

National Instruction No. 430-302 -- State Soil Geographic Data Base, November 1984.

National Instruction No. 430-304 -- Development and Distribution of Digital Soil Data, October 1991.

Appendix 1: MLRA Standards Handbook Guidance

As is often the case, quantitative measurements of soil facts are meager or lacking at the time we wish to make judgments about rooting depths, available moisture, and soil fertility. Many of these interpretations involve an understanding of requirements of a specific crop or of some other things which you may not know. Very seldom are any two real problems exactly alike, and their solution depends on knowing what kind of information is needed, how to get it, and how to use it.

This exercise demonstrates how to interpret field observations by applying some rules of thumb obtained for this region (NY) of the country. The data are relatively crude in terms of quantitative precision, yet they are approximations within the range of variability of soils as they occur in the field. In place of laboratory data, you are provided some approximate relationships between field properties and values we would like to determine procisely. For example, range of the amount of water held by various classes of texture has been generalized from laboratory measurements and these can be used in lieu of having values for the specific soil being considered. This is the way one must attack most practical problems and, although crude, these can be useful pragmatic approximations.

Because of the generalizations used, you should be more concerned with the way to reason than with absolutely correct answers. Keep in mind that approximations such as these cannot be extrapolated to highly contrasting soil situations. In those cases, it is generally necessary to establish different guidelines.

For the most part, you will be using soil descriptions that occur in soil survey reports. Read the description carefully attempting to visualize each horizon in terms of the facts that are recorded about it. Note that these descriptions provide you facts and not with interpretations.

A. ROOTING DEPTH

As far as we know, all of the common crop plants can be grown successfully in water culture if the water is aerated. It is a lack of air, not an excess of water, that limits crop growth when soils are saturated. Either excess water or pores too small or disconnected to permit adequate gaseous layers that inhibit root growth because of mechanical impedance.

1. **<u>Permeability as an indicator of rooting limitation</u>**.

Permeability is the ability of soil to transmit water or air. Poor aeration is generally associated with slow permeability. The deeper the horizon, the slower is the exchange of air and the more critical is a given degree of restriction of permeability.

Based on the observed distribution of roots of deep rooted crops, such as corn, alfalfa, and some tree species, the following guidelines for potential rooting depths have been developed for common conditions in this region:

Table 1.

Permeability of most restricting horizon	Permeability of overlying soil layer	Depth to top of restricting layer-IN (d)	Potential Rooting Depth-IN
Rapid	Rapid	-	>60
Moderate	Moderate	-	42
Slow	Moderate	30	30
		24	26
		18	22
PRD =10 + d - d/3		15	20
		12	18

The task is to judge from the pedon description the depth to any restricting horizon (with slow permeability), the thickness and permeability of the soil above this horizon, and then estimate the potential rooting depth (inches or centimeters). Some shallower rooted crops, such as onions, may not take advantage of the full potential rooting depth. The depth may be modified or controlled by soil factors other than permeability, such as a high water table.

2. **Soil wetness as an indicator of rooting limitation**.

This can often be estimated by interpreting the pedon in terms of its drainage class. Indicators of wetness and drainage class such as depth, kind and amount of mottling,do not commonly reflect a static condition. Within a given region fluctuations of water tables throughout the year are detected in most soils. Average depths to saturated soil during part of the year in our humid continental environment are indicated below:

Table 2.

Drainage Class	Average depth to saturated soil on: APR 1	MAY 1	JUNE 1	JULY 1	AUG 1
Well	20	41	52	52	69
Moderately Well					
without pan	11	27	41	41	61
with pan	11	18	28	35	44
Somewhat poorly					
without pan	11	22	31	32	49
with pan	3	9	17	21	32
Poorly	1	2	5	9	18

B. AVAILABLE MOISTURE

1. Available moisture capacity

The moisture held by a soil between field capacity (water held against the force of gravity) and the wilting point (when plants wilt beyond recovery) is considered to be available moisture. These values are approximated in the laboratory by measuring the moisture held against forces of 1/3 and 15 atmospheres or bars, respectively. The moisture is expressed as percent of the dry weight of soil and can be converted to volumes of water if the soil bulk density is known. Sufficient laboratory data has been assembled to provide the following crude approximations for textural classes:

Table 3.

Texture	Available Moisture Capacity (IN / FT of soil)
A. Surface layers (avg. organic matter)	
1. Sands and loamy sands	0.5 - 0.7
2. Fine sandy loams	1.3 - 1.6
3. Very fine sandy loams and loams	2.5 - 3.0
4. Silt loams	2.8 - 3.2
5. Clay loams and silty clay loams	2.5 - 3.0
B. Subsoils (low in organic matter)	
1. Sands and loamy sands	0.3 - 0.6
2. Fine sandy loams	1.0 - 1.5
3. Very fine sandy loams and loams	1.8 - 2.4
4. Silt loams	2.5 - 3.0
5. Clay loams and silty clay loams	2.0 - 2.5

Silts have the highest available moisture capacity and sands the lowest. Most coarse fragments in soils do not contribute significant amounts of moisture and commonly are considered as filler. When channery, gravelly, flaggy, or stony adjectives are applied to horizon textures, the available water can be reduced by about 20 percent. Slowly permeable layers, such as compact till and fragipans, have less pore space than friable horizons and commonly hold much less available moisture.

C. SOIL FERTILITY

1. Total nitrogen

This is roughly proportional to organic matter at a ratio of about 1 part N to 20 parts organic matter. Organic matter in surface soils can be very crudely estimated from soil color, especially color value if the parent materials were not dark. Dark gray or black shales and dark colored sands must be discounted.

In this region the following crude approximations can be made:

Table 4.

Color value and chroma on mineral surface layers	Organic Matter	
	PCT	1000 lbs/ac/plow layer
5/2 - 4/2	1.5-2.5	30-50
3/3 - 3/2	3.0-4.5	60-90
3/1 - 2/2 (wet soils)	5.0-7.5	100-150
2/2 - 2/1 (wet soils)	8.0-10+	160-200+

2. Available nitrogen

Biological transformations (nitrification) are very slow when the soil temperature is below 41 degrees F or when the soil is wet, and under either condition plant growth is also slow. In this region, both nitrification and plant growth are very slow until May 1 under the best of conditions, and winter grains, such as wheat and barley, almost always exhibit nitrogen deficiency in early May if unfertilized, regardless of soil conditions. Starter nitrogen is essential for most crops in this region, even though demands of small plants are small. The main consideration is whether or not supplemental nitrogen is needed in mid-summer when soils are relatively dry and warm.

3. Available phosphorus

Very sandy soils and very acid soils have very low phosphorus supplying power. Observable soil properties are not good clues to available phosphorus. If reliable soil test results are not available, one should assume that the soil is unable to supply adequate phosphorus. Common field crops, such as corn, small grains, and hay, respond to about 20 to 40 pounds of P_2O_5 (about 9 to 17 lbs P). Such crops as potatoes need 2 to 4 times these amounts.

4. Available potassium

Potassium supplying power in this region is closely related to the amount of illitic clay. Illite is generally the dominant clay mineral present in subsoils in New York and illite and vermiculite is predominant in surface layers; consequently, percent clay is a good guide to potash supplying power.

In many soils in New York, medium textured horizons overlay a clay enriched argillic horizon. Where the rooting zone includes part or all of the textural B horizon, the rating for potassium supplying power is based on the soil texture of the argillic horizon.

a. Less than 15% clay --- (sands, loamy sands mostly sandy loams, and loams and silt	Low potassium supplying power. Soils need potassium fertilization at planting time and may need side- or top-dressing at least one other time during the growing season.
b. 15-27% clay (most --- silt loams and sandy loams highest in clay).	Moderate potassium supplying power. Potassium fertilization is needed at planting but crops may not respond to a second application.
c. 27-40% clay (silty --- clay loams, clay loams, sandy clay loams).	Moderately high potassium supplying power. If large yields are removed, supplemental K is needed and supplying power decreases with time.
d. More than 40% clay --- (silty clays, sandy clays, clays and loams low in clay).	High potassium supplying power. Response is unlikely except for special crops like sugar beets.

Appendix 2. Table 1 Random Numbers -- 1 to 25

7	17	10	9	10
8	1	18	18	16
15	17	4	8	5
21	11	18	2	24
11	24	18	23	21
5	1	8	8	7
1	10	13	25	12
11	5	2	22	15
24	1	10	3	13
1	2	3	2	17
20	18	2	20	15
19	1	7	12	21
12	8	20	23	13
9	23	13	4	20
12	6	13	2	18
1	18	25	1	25
25	24	11	1	14
19	9	7	16	11
17	9	2	15	1
10	13	22	3	19
3	7	8	5	9
24	7	8	6	17
15	1	10	19	11
13	2	2	25	11
15	21	20	22	1
8	4	22	16	25
10	24	23	12	20
20	5	1	9	11
1	13	10	5	25
13	10	1	14	12
8	11	21	7	9
16	2	14	11	4
25	23	11	25	21
14	10	9	14	3
17	10	15	10	7
2	22	4	23	4
3	23	3	6	20
24	10	25	18	17
10	17	7	10	15
15	8	20	18	9
21	17	16	19	23
3	24	16	19	14
11	12	22	23	10
6	17	9	11	16
23	20	22	24	7
3	14	6	10	3
22	7	3	18	3
20	22	1	11	18
18	14	5	3	14
16	6	13	20	23
25	13	25	22	6
14	5	13	23	6
5	16	6	19	17

Table 2. Random Numbers -- 1 to 50

28	30	2	22	3
7	2	30	22	19
6	9	33	48	21
13	3	24	28	38
49	28	26	8	38
1	37	31	14	23
13	32	32	31	8
26	20	40	10	40
12	31	7	32	49
17	29	15	1	43
16	15	9	16	48
35	46	33	38	36
48	32	11	13	33
40	1	16	21	40
16	37	27	22	22
36	28	24	33	29
3	7	15	9	17
9	27	31	12	9
18	15	14	29	10
18	40	31	29	37
5	48	10	27	39
19	39	14	49	17
50	45	23	7	30
50	21	43	50	8
38	3	15	45	47
46	4	4	48	48
36	21	17	42	48
30	38	2	49	12
39	39	12	26	9
36	9	33	25	45
31	13	29	23	12
3	3	34	42	8
2	36	29	50	16
11	49	7	45	4
23	11	40	39	12
39	17	14	18	45
21	30	3	8	14
36	18	1	36	48
20	11	28	44	27
4	10	5	36	21
26	35	30	18	34
32	17	38	25	2
5	35	26	28	37
36	31	46	41	39
31	5	14	50	50
27	21	22	48	10
5	43	27	16	12
47	17	50	20	28
29	32	2	50	1
5	47	30	6	18
17	3	50	32	18
34	27	45	17	33
4	44	28	14	47

Table 3.
Random Numbers
(1 to 75)

50	53	56	36	22	49	26
25	73	40	8	47	4	12
69	39	58	45	3	13	5
45	39	30	49	51	37	43
46	44	67	61	48	28	63
9	34	75	45	64	29	27
66	10	67	61	66	65	54
72	70	60	12	70	37	75
8	69	58	12	57	27	42
18	70	31	16	3	54	27
75	30	54	27	58	14	35
33	14	26	48	1	62	64
28	17	23	41	31	54	74
42	74	45	64	43	61	24
71	37	7	21	1	47	2
10	26	44	45	12	43	73
73	50	48	54	57	40	33
71	17	45	29	35	36	67
33	30	18	61	57	44	66
69	2	73	67	62	7	3
7	50	20	36	14	1	44
34	30	46	31	12	10	42
50	51	64	70	3	48	61
22	9	34	7	8	20	56
1	63	11	30	20	67	20
55	54	16	29	35	46	31
68	35	40	13	59	1	64
37	58	21	19	17	65	2
69	9	28	46	6	7	33
62	34	58	66	53	23	7
34	57	31	40	20	33	33
54	40	6	64	34	27	51
68	10	60	2	52	39	39
1	58	18	18	18	31	72
51	71	6	64	54	5	56
65	63	17	73	8	61	16
17	66	12	54	71	27	62
8	57	73	26	11	44	46
40	39	50	20	20	61	28
15	54	29	57	58	7	66
61	44	21	38	33	23	29
63	60	5	56	12	53	37
7	13	18	74	1	61	18
40	57	25	11	45	22	2
5	65	47	70	62	24	72
45	10	54	69	65	74	70
37	72	38	23	36	17	51
38	18	5	60	52	39	52
63	6	1	25	25	35	21
29	53	73	71	15	23	23
4	68	49	68	15	18	65
16	53	9	23	47	58	31
53	1	53	17	37	5	41
1	14	51	18	8	58	38

Table 4. Values of t

df	Probability of a larger value of t, sign ignored			
	80%	90%	95%	99%
1	3.078	6.314	12.706	63.657
2	1.886	2.920	4.303	9.925
3	1.638	2.353	3.182	5.841
4	1.533	2.132	2.776	4.604
5	1.476	2.015	2.571	4.032
6	1.440	1.943	2.447	3.707
7	1.415	1.895	2.365	3.499
8	1.397	1.860	2.306	3.355
9	1.383	1.833	2.263	3.250
10	1.372	1.812	2.228	3.169
11	1.363	1.796	2.201	3.106
12	1.356	1.782	2.179	3.055
13	1.350	1.771	2.160	3.012
14	1.345	1.761	2.145	2.977
15	1.341	1.753	2.131	2.947
16	1.337	1.746	2.120	2.921
17	1.333	1.740	2.110	2.898
18	1.330	1.734	2.101	2.878
19	1.328	1.729	2.093	2.861
20	1.325	1.725	2.086	2.845
21	1.323	1.721	2.080	2.831
22	1.321	1.717	2.074	2.819
23	1.319	1.714	2.069	2.807
24	1.318	1.711	2.064	2.797
25	1.316	1.708	2.060	2.787
26	1.315	1.706	2.056	2.779
27	1.314	1.703	2.052	2.771
28	1.313	1.701	2.048	2.763
29	1.311	1.699	2.045	2.756
30	1.310	1.697	2.042	2.750
40	1.303	1.684	2.021	2.704
60	1.296	1.671	2.000	2.660
120	1.289	1.658	1.980	2.617
	1.282	1.645	1.960	2.576

Appendix 3: Soil Description Guide

Soil Description Guide. This appendix is a draft of information intended for field use. It will be developed as a color book insert once completed.

Soil Description Guide
Instruction, Definitions, and Codes

USDA-SCS
National Soil Survey Center
Lincoln, Nebraska

DRAFT August, 1993

CONTENTS — page

The following instruction, definitions, and codes of soil description elements are intended to be used as a quick field guide. References include: Soil Survey Manual galley proof of chapter 3, August, 1993; the computerized PEDON program Version 3, 1993; and National Soil Survey Interpretations Handbook, Draft, 1992. The information is arranged in a sequence that follows the SCS-232 format, draft Dec. 1992. Class codes from PEDON are used. A * indicates a need to be tailored for MLRA or other geographic area.

SLOPE,

PERCENT: give gradient (in percent) of the elevation change through the site in a direction that surface water would be expected to flow. CAUTION - some clinometers may show a slightly different percent upslope vs downslope.

ASPECT: give direction of slope (facing downslope), expressed as an angle between 0 and 360° clockwise from true north.

SHAPE: in the following order, give perpendicular (up-down slope) shape - LL linear (**PL** plane), **CC** concave, or **CV** convex; and horizontal (on the contour) shape - LL linear (**PL** plane), **CC** concave, or **CV** convex. LL is used in NASIS.

SOIL WATER,

DRAINAGE: give the natural drainage class. Classes include:
VP very poorly, **P** poorly, **SP** somewhat poorly,
MW moderately well, **W** well, **SE** somewhat excessively,
E excessively drained.

FLOODING: give the class for the estimated frequency and duration, plus the normal months that flooding can be anticipated at the site.

Frequency Class		NASIS	Criteria: flood years/100 years
NO	None	NONE	No reasonable possibility
RA	Rare	RARE	1 to 5 times in 100 years
OC	Occasional	OCCAS	5 to 50 times in 100 years
FR	Frequent	FREQ	> 50 times in 100 years

Duration Class		Criteria: tenth hour to days/event
BE	Extremely Brief	< 4 hours (NASIS .1-4 hours)
BV	Very Brief	4 to 48 hours
B	Brief	2 to 7 days
L	Long	7 days to 30 days
LV	Very Long	> 30 days

PONDING: give an estimate of or monitor the frequency, depth, and duration of standing water.

Frequency Class	Criteria
Use the frequency class and criteria from **FLOODING**.	

Duration Class		Criteria: time per event
BV	Very Brief	< 2 days
B	Brief	2 to 7 days
L	Long	7 to 30 days
LV	Very Long	> 30 days

WATER STATE: give the (**wetness**) class of the soil water state (**D** dry, **M** moist, **W** wet) for the material. Estimate not frozen. Classes are estimated from matrix suction and gravametric water content. Class subdivisions can also be made (SSM page 90 to 98). Data input on PEDON 232 shown as the "wet" column under Miscellaneous Information.

Class	Criteria	Field Test
D Dry	>1500 kPa	*
		(old use): < about
DV Very Dry	(see SSM)	15 bars, wilting
DM Moderately dry	(see SSM)	point most plants.
DS Slightly dry	(see SSM)	
M Moist	<1500 to >1 or 1/2 kPa/1	*
MS Slightly moist	(see SSM)	(old use): > 15 bars
MM Moderately moist	(see SSM)	wilting point to
MV very moist	(see SSM)	1/3 bar, field capacity, most plants
W wet	<1 or 1/2 kPa/1	
		Water films are
WN nonsatiated	No free water.	readily apparent on
WA satiated	Free water is present.	sand grains and structural units; it glistens.

/1 less suction is needed for coarse soil material.

BEDROCK: give kind (such as **HO** for shale bedrock from PEDON codes), fractures, and describe hardness within the layer including excavation difficulty and cementation.

Joint Fractures:		
	1	< 10cm between
	2	10-45cm between
	3	45cm-1m between
	4	1-2m between
	5	> 2m between

DEPTH, LAYER: give the beginning and ending layer depths (inches) for the pedon. Reference chapter 3 SSM, pg. 117-132.

HORIZON,

CODES: reference Keys to Soil Taxonomy, or chapter 3 SSM pages 117-133 for the current horizon codes.

BOUNDARY: record distinctness and topography for each layer. In PEDON the column is shown as BND, which follows the user defined properties.

dst:Distinctness	Criteria (cm thick)
A abrupt	< 2 cm
C clear	2-5 cm
D diffuse	5-15 cm
G gradual	> 15 cm

tpo:Topography	Criteria
S smooth	Plane with few or no irregularities
W wavy	Undulation in which depressions are wider than deeper.
I irregular	Pockets that are deeper than wider.
B broken	One or both of the horizons or layers separated by the boundary are discontinuous and boundary is interrupted.

COLOR,

MATRIX: give moisture state (**D** dry, **M** moist); then the condition described such as **1** interior, **2** exterior, **3** crushed, **8** broken face, **9** rubbed, **5** exposed to air; then the color (or mixed colors) that occupies the greatest volume first even if it is a redoximorphic feature color (see CONCENTRATIONS and DEPLETIONS and Diagram A).

MOTTLES: give the color of splotches contained within the matrix color (excluding redoximorphic features - colors related to present day and past wetness). Do not describe features associated with compositional properties such as clay films (see PED SURFACE FEATURES and CONCENTRATIONS). In order, give quantity (volume percent in PEDON), size, contrast, color, etc.

Quantity	criteria for quantity class
few	< 2 percent of surface area
common	2 to 20 percent of surface area
many	> 20 percent percent of surface area

Size	Criteria (mm)	Size
1 fine	< 5	**12** fine and medium
2 medium	5 to 15	**13** fine and coarse
3 coarse	> 15	**23** medium and coarse

Size: record length if <2 times width, record smaller diameter if length >2 times width.

MOTTLES, cont.

con:Contrast	Criteria
F faint **D** distinct **P** prominent	(see contrast chart, or SSM)

__TEXTURE__: give estimated textural class or subclass of the fine earth fraction, such as sandy loam or fine sandy loam, or give a term instead of texture. If needed give a modifier, such as gravelly, or mucky to modify a mineral texture.

<u>Textural Classes</u>

COS	Coarse sand
S	Sand
FS	Fine sand
VFS	Very fine sand
LCOS	Loamy coarse sand
LS	Loamy sand
LFS	Loamy fine sand
LVFS	Loamy very fine sand
COSL	Coarse sandy loam
SL	Sandy loam
FSL	Fine sandy loam
VFSL	Very fine sandy loam
L	Loam
SIL	Silt loam
SI	Silt
SCL	Sandy clay loam
CL	Clay loam
SICL	Silty clay loam
SC	Sandy clay
SIC	Silty clay
C	Clay

<u>Modifiers</u>

BY	Bouldery
BYV	Very bouldery
BYX	Extremely bouldery
CB	Cobbly
CBV	Very cobbly
CBX	Extremely cobbly
CN	Channery
CNV	Very channery
CNX	Extremely channery
FL	Flaggy
FLV	Very flaggy
FLX	Extremely flaggy
GR	Gravelly
GRC	Coarse gravelly
GRF	Fine gravelly
GRM	Medium gravelly
GRV	Very gravelly
GRX	Extremely gravelly
MK	Mucky
PF	Nonconsolidated permafrost
SR	Stratified
ST	Stony
STV	Very stony
STX	Extremely stony

<u>Terms used in lieu of texture</u>:

APUM	Ashy-pumiceous	**ASHY**	Ashy
ASK	Ashy-skeletal	**CE**	Coprogenous earth
CEM	Cemented (this term conflicts with CEMENTATION)	**CIND**	Cinders
CNDY	Cindery	**CPF**	Consolidated permafrost (ice rich)
DE	Diotomaceous earth	**FB**	Fibric material
FRAG	Fragmental material	**G**	Gravel
GYP	Gypsiferous material	**HM**	Hemic material
HPUM	Hydrous-pumiceous	**HSK**	Hydrous-skeletal
HYDR	Hydrous	**IND**	Indurated
MARL	Marl	**MEDL**	Medial
MPUM	Medial-pumiceous	**MSK**	Medial-skeletal
SP	Sapric material	**PUM**	Pumiceous
SG	Sand and gravel	**UWB**	Unweathered bedrock
VAR	Variable	**WB**	Weathered bedrock

STRUCTURE: give the grades, sizes, shapes, and percents (up to 3 if needed). Structureless is recorded massive or single grain. Structure sizes very thin, thin, thick and very thick are only used with platy shapes; medium is used with all shapes.

Grade	Code Size /1	Shape
1 weak	**VF** very fine	**ABK** angular blocky
2 moderate	**FF** very fine, fine	**COL** columnar
3 strong	**F** fine	**GR** granular
5 weak and moderate	**FM** fine, medium	**LP** lenticular platy
6 moderate and strong	**M** medium	**MA** massive
	MC medium, coarse	**SBK** subangular blocky
	CO coarse	**PR** prismatic
	CV coarse, very coarse	**SGR** single grain
	VC very coarse	**WEG** wedge shaped aggregates
		CDY cloddy
		PL platy

SIZE of structure measured by shape diameter /1	Measure of SHAPE in (mm)			
	wide GR	thick PL	wide COL, PR	wide ABK, SBK, WEG
very fine	<1		<10	<5
fine	1-2		10-20	5-10
medium	2-5		20-50	10-20
coarse	5-10		50-100	20-50
very coarse	≥10		≥100	≥50

/1 substitute thin for fine and thick for coarse for platy (PL)

CONSISTENCE,

RUPTURE RESISTANCE: give rupture classes for 2.5-3 cm square blocks (as needed) for -- dry and moist consistence, cementation; cementing agent; manner of failure; stickiness; plasticity; rupture resistance for platelike specimens (surface crust); toughness classes, penetration resistance, and excavation difficulty.

Rupture Resistance for **SURFACE CRUST**		
Classes, air dried	Force: Newtons	Operation, tactile /1
F fragile		
EW extremely weak	Not removable	NA
VW very weak	Removable, <1	
W weak	1-3	
------------------	------------	---------------------
M medial	3-20	
M moderate	3-8	
MS moderately strong	8-20	
------------------	-----------	---------------------
R resistive	>20	
S strong	20-40	
VS very strong	40-80	
ES extremely strong	>80	

/1 Tactile feel needs to be determined by each describer.

Rupture Resistance for Blocks			
DRY	MOIST	CEMENTATION	OPERATION
L loose	L loose	NA	NA
S soft	VFR very friable	CO non-cemented	Fails w/ very slight force, thumb-4finger. Stress <8N.
SH slightly hard	FR friable	EWC extremely weakly cemented	Fails w/ slight force, thumb-4finger. Stress 8-20N.
MH moderately hard	FI firm	VWC very weakly cemented	Fails w/ moderate force thumb-4finger. Stress 20-40N.
H hard	VFI very firm	WC weakly cemented	Fails w/ strong force, thumb-4finger. Stress 40-80N.
VH very hard	EFI extremely firm	MC moderately cemented	Fails between both hands. Stress 80-160N
EH extremely hard	SR slightly rigid	SC strongly cemented	Fails w/ slow full body foot pressure. Stress 160-800N.
R rigid	R rigid	VSC very strongly cemented	Fails w/ < 3J blow, <2kg wt. drop from 15cm Stress 800N-3J
VR very rigid	VR very rigid	I indurated	Fails w/ blow ≥ 3J, >2kg wt. drop from 15cm

CEMENTING AGENTS. Record the cementing agent for the layer for Rupture Resistance. The column in PEDON is "ag."

- **X** carbonates and silica
- **L** carbonates
- **G** gypsum
- **H** humus
- **I** iron
- **S** silica

MANNER OF FAILURE. Record the manner of failure class for either (A) 1 inch square specimen, or (B) wet deformed handful of soil material.

MOIST CONSISTENCE

B brittle	Ruptures abruptly when (A) is pressed between digits (thumb and forefinger).
SD semideformable	Deforms to < 1/2 original thickness prior to rupture when (A) is pressed between digits.
D deformable	Deforms to > 1/2 original thickness without rupturing when (A) is pressed between digits.

WET CONSISTENCE

NF nonfluid	No (B) flows through fingers w/ full compression.
SF slightly fluid	Full compression some (B) flows through fingers.
MF moderately fluid	Full compression most (B) flows through fingers, some residue remains on palm.
VF very fluid	Gentle pressure most (B) flows through fingers, very little residue remains.

MOIST CONSISTENCE, ASHY MATERIALS

NS non-smeary	Shear force applied to (A) between digits, material does not change to fluid, does not skid, no smearing occurs.
WS weakly smeary	Shear force applied to (A) between digits, at failure changes to fluid, fingers skid and soil smears, little water remains on digits.
MS moderately smeary	Shear force applied to (A) between digits, changes to fluid, fingers skid, soil smears some free water seen on digits.
SM strongly smeary	Shear force applied to (A) between digits, change to fluid, fingers skid, soil smears and is very slippery, free water easily seen on digits.

STICKINESS: give the stickiness class at the moisture content with greatest adherence when pressed between thumb and forefinger.

SO nonsticky	Little soil material adheres to thumb or forefinger.
SS slightly sticky	Adheres to both digits, but doesn't stretch, comes off one digit rather cleanly.
MS moderately sticky	Adheres to both digits, slightly stretches, but doesn't come off either finger cleanly.
VS very sticky	Adheres strongly to both digits and decidedly stretches; soil remains on both digits.

PLASTICITY: give the plasticity class estimated for wet puddled soil material formed into a roll.

PO nonplastic	Roll 4cm long and 6mm thick cannot support its own weight.
SP slightly plastic	Roll 4cm long and 6mm thick can support its own weight, but 4mm thick cannot.
MP moderately plastic	Roll 4cm long and 4mm thick can support its own weight, but 2mm thick cannot.
VP very plastic	Roll 4cm long and 2mm thick can support its own weight.

TOUGHNESS: toughness class is the force to form a roll 3mm in diameter with fingers at a water content near the plastic limit. Record in Rupture Resistance under "tgh" column in PEDON.

Class		Criteria
L	low	<8N
M	medium	8-20N
H	high	>20N

PENETRATION RESISTANCE is the capacity of the soil in its confined state to resist penetration from a rigid object (SSM pages 182-183). Measure at or near maximum water (or specify the water) content for the pressure require to push the flat end of a cylindrical rod with a diameter of 6.4 mm a distance of 6.4 mm into the soil within 1 second. Orientation of the axis of insertiod should be specified (vertical or horizontal). Record in PEDON the direct reading from penetrometer under the Miscellaneous information heading, "pnt" column.

	Class	Criteria: Penetration Resistance (MPa)
EL	extremely low	<0.01
VL	very low	0.01-0.1
L	low	0.1-1
M	moderate	1-2
H	high	2-4
VH	very high	4-8
EH	extremely high	$\geq$ 8

EXCAVATION DIFFICULTY. Record the class of excavation difficulty for each layer, horizon or most limiting layer for the pedon. If this element is described the water state must also be described as it is controlled by and related to it. Describe in PEDON as a "User Defined property".

Class	Criteria
L Low	Can be excavated with a spade using arm pressure only. Impact energy or pressure with the foot is not necessary.
M Moderate	Arm pressure is insufficient. Easy excavation by impact energy with or by foot pressure on a spade.
H High	Excavation with a spade can be made with difficulty, but easily possible with a pick using an over-the-head swing.
VH Very High	With a full length pick swing over-the-head is moderately to markedly difficult. Backhoe excavation by 50-80hp tractor be made in a reasonable time.
EH Extremely High	Nearly impossible with a full length pick swing. Backhoe excavation cannot be made in a reasonable time with 50-80hp tractor.

PED SURFACE FEATURES. Ped features include coats, concentrations on surfaces, and stress formations. If needed give kind; percent (used in PEDON) occupied or amount as a class; continuity; distinctness; location; and dry or moist color.

Amount: estimate the average percent (%) of surface area occupied by the feature for the layer in PEDON.

Class	Criteria
very few	< 5 percent
few	5 to 25 percent
common	25 to 50 percent
many	> 50 percent

Continuity: (optional)

Class	Criteria
C continuous	Films do not break
D discontinuous	Films break
P patchy	Isolated spots

Distinctness:

Class	Criteria
F faint	Seen only by ≥ 10X magnification, little contrast.
D distinct	Seen without magnification, significant difference w/ adjacent material.
P prominent	Conspicuous without magnification compared with broken soil, sharp contrast with adjacent material.

Kind	Location
P pressure faces	**B** between sand grains
L carbonate coats	**I** in root channels and/or pores
C chalcedony on opal	**M** on bottom of plates
T clay films	**O** on concretions
D clay bridging	**F** on faces of peds and in pores
U coats	**P** on faces of peds
G gibbsite coats	**H** on horizontal faces of peds
K intersecting slickensides	**L** on lower surfaces of peds or rocks
A skeletans over cutans	**N** on nodules
S skeletans	**R** on rock fragments
R silt coats	**S** on sand and gravel
Q nonintersecting slickensides	**C** on tops of columns
O organic coats	**U** on upper surfaces of peds or rocks
	V on vertical faces of peds
	Z on vertical and horizontal faces of peds
	T throughout

EFFERVESCENCE. Record the soils reaction class and location with 1:10 concentrated HCL (1 normal HCL) as applied to soil matrix (avoid masses of carbonates). See PEDON for use of other effervescent agents "ag." Record percent of carbonate as a "user defined property" measured by carbonate field kit.

Class	Criteria
4 noneffervescent	No bubbles seen.
0 very slightly effervescent	Few bubbles seen
1 slightly effervescent	Bubbles readily seen.
2 strongly effervescent	Bubbles form low foam.
3 violently effervescent	Forms thick foam quickly.

Location: use codes and definitions of locations for effervescence from ped surface feature location codes.

ROOTS: record the quantity, size and location. Quantity is measured in numbers of each size per unit area. Count the number of roots in each size for the areas as follows: 1 cm^2 area for very fine and fine roots; 1 dm^2 area for medium and coarse roots; and 1 m^2 area for very coarse roots. Root counts are used in PEDON and quantity class in narritive description.

Root Quantity		Root Size		
Class	Count	Class		Diameter
Few	<1 per area	V1	very fine	< 1 mm
Very few	<0.2 per area	1	fine	1-2 mm
Moderately few	0.2 to 1 per area	2	medium	2-5 mm
Common	1-5 per area	3	coarse	5-10 mm
Many	≥ 5 per area	4	very coarse	≥ 10 mm
		11	very fine, and fine	
		V2	very fine to medium	
		V3	very fine to coarse	
		12	fine,medium	
		13	fine to coarse	
		23	medium and coarse	

Location: **P** between peds
C in cracks
T throughout
M in mat at top of horizon
S matted around stones

PORES: record quantity (number count) and size. In addition, shape and vertical continuity can be described. Vertical continuity is the average vertical distance through which the minimum dia. exceeds 0.5 mm when ≥ moderately moist. The same size information given for roots are used for pores.

Shape			
TS	constricted tubular	**TC**	continuous tubular
TE	dendritic tubular	**TD**	discontinuous tubular
IE	filled with coarse material	**IR**	interstitial
TU	tubular	**IT**	interstitial and tubular
VS	vesicular	**VT**	vesicular and tubular
IF	void between rock frgments		

Vertical Continuity		
L	low	< 1 cm
M	moderate	1 to 10 cm
H	high	10 cm or more

CONCENTRATIONS and **DEPLETIONS**: (see Diagram A) give the soil features that reflect an accumulation or removal of a kind of material, its percentage, and its shape, size, location, color, consistance and boundary. Also include the color contrast (**F** faint, **P** prominent, **D** distinct). Redoximorphic features, such as iron concentration or depletion, is included here. Reference SSM pages 169-172.

Kind	
B1 barite crystals	**M4** magnetic shot
C1 calcite crystals	**F4** ironstone nodules
C3 carbonate concretions	**M7** manganese concretions
C4 carbonate nodules	**M9** manganese nodules
K5 carbonate threads	**B2** masses of barite
A2 clay bodies	**K2** masses of carbonate
A3 clay depletions	**D2** masses of dark accumulations
D3 dark concretions	**G2** masses of gypsum
D4 dark nodules	**M2** masses of iron-manganese accumulation
S4 durinodes	**F2** masses of iron accumulation
H2 salt masses	**C2** masses of lime
E3 gibbsite concretions	**M8** masses of manganese accumulation
E4 gibbsite nodules	M6 masses of oxide accumulation
G1 gypsum crystals	**S2** masses of silica
G4 gypsum threads	**D1** mica flakes
H1 halite crystals	**G3** nests of gypsum
T3 insects casts	**M1** nonmagnetic shot
F3 iron concretions	**S1** opal crystals
F5 iron depletions	**F1** plinthite segregations
M3 iron-manganese concretions	**S3** silica concretions
M5 iron-manganese nodules	O1 masses of oxide accumulation
T4 worm nodules	**T2** worm casts

Shape:
- **Z** irregular
- **P** platelike
- **O** rounded
- **T** threads
- **C** cylindrical
- **D** dendritic

Size:

Class	Criteria	Class
1 fine	<2mm	**12** fine and medium
2 medium	2-5mm	**23** medium and coarse
3 coarse	5-20mm	**34** coarse and very coarse
4 very coarse	20-76mm	
5 extremely coarse	>76mm	**45** very coarse and extremely coarse

Concentrations and Depletions cont.

Location: describe where the concentration/reduction features are located within the horizon.

- S1 around stones,
- M1 top of horizon,
- P1 between peds,
- C1 in cracks,
- T1 throughout,
- O2 lining pores,
- P2 on faces of peds,
- P3 on horizontal faces of peds,
- P4 on vertical faces of peds,
- P5 on ped faces and in pores,
- O1 in the matrix adjacent to pores,
- R3 in the matrix surrounding redox depletions,
- R2 in the matrix surrounding redox concentrations,
- R1 in the matrix.

Consistance: use the same criteria codes from block-like Rupture Resistance page 7. In PEDON give masses a DRY or MOIST resistance; nodules or concretions give the consistance for CEMENTATION.

Boundary: give the gradation to adjacent material.

Class	Criteria
S Sharp	Gradation in color is not discernable even with a 10X hand lens.
C Clear	Color grades < 2mm, is descernable with 10X hand lens.
D Diffuse	Color grades > 2mm.

Diagram A: Guide to redoximorphic features vs mottles.

1. Is the color difference associated with a compositional feature such as a clay film, or concentration?

   - (NO) → Describe as a **MOTTLE**, ie. mixed colors, variegated.
   - (YES) → 2. Is the feature formed by the process of reduction, translocation, and oxidation of Fe, and Mn oxides?
     - (NO) → Describe as a **CONCENTRATION** or **PED SURFACE FEATURE**, i.e. carbonate mass, clay film or organic coat.
     - (YES) → Describe as a redoximorphic feature (**CONCENTRATION**, **DEPLETION**, or REDUCED **MATRIX COLOR**)

3. Redoximorphic features:
   - A. Bodies contained within a matrix color that show an accumulation of Fe-Mn oxides (higher chroma) is a **REDOX CONCENTRATION.**
     - 1) nodules - cemented bodies easily removed.
     - 2) concretions - cemented bodies with concentric rings and can easily be removed.
     - 3) masses - noncemented bodies.
     - 4) pore linings - accumulations along pores.
     - 5) If the feature is RELICT, include in your notes.
   - B. Bodies where chroma is less than the matrix is evidence that Fe-Mn oxides have been stripped out and are called **REDOX DEPLETIONS.**
     - 1) iron depletions - areas with lesser amounts of Fe
     - 2) clay depletions - often called silt coats, areas of low amounts of Fe, Mn, and clay.
   - C. Low-chroma matrix that changes color within 30 minutes after exposure to air is evidence of a **REDUCED MATRIX.**
   - D. Positive reaction to a'a' dipyridyl dye is evidence of reduced iron.
   - E. Monitoring of the temporal water table features by piezometer may be needed to support saturation. If saturation is in all layers to > 80 inches it is endosaturation; if saturated < 80 inches and has layer(s) that are unsaturated above 80 inches it is episaturation. Anthric saturation is controlled saturation by flooding, usually for rice production.

FRAGMENTS: unattached material larger than 2mm in diameter. In order, describe the kind of material, volume percent of the different kinds, roundness or shape, and size. Rock fragments have a hardness ≥ strongly cemented. Other fragments < strongly cemented, including wood, can be recorded. Rock fragment classes in volume percentages are as follows:

< 15 percent:	No modifier
15-35 percent:	The adjective term for the dominant size of rock fragment, such as gravelly or cobbly, is used.
35-60 percent:	The adjective term plus the modifier "very" is used, as in very gravelly.
≥ 60 percent:	If more than 10 percent fine earth is present the adjective term plus the modifier "extremely" is used. If < 10 percent fine earth, material is called gravel, cobbles, stones, or boulders.

Size	Shape: spherical, cubelike or equiaxial	
	Noun	Adjective
2-75 mm dia.	pebbles	gravelly
2-5 mm dia.	fine	fine gravelly
5-20 mm dia.	medium	medium gravelly
20-75 mm dia.	coarse	coarse gravelly
75-250 mm dia.	cobbles	cobbly
250-600 mm dia.	stones	stony
≥ 600 mm dia.	boulders	bouldery
Size	Flat	
2-150 mm long	channers	channery
150-380 mm long	flagstones	flaggy
380-600 mm long	stones	stony
≥ 600 mm long	boulders	bouldery

FEATURES: special features can be recorded as a percent of the horizon or soil profile. In PEDON record code (knd); lateral area (percent) of profile/horizon occupied by the feature code; and percent of total volume of the horizon in the pedon occupied by the feature.

Code:

A percent of profile is occupied by this horizon
I ironstone nodules
K krotovinas
P plinthite
B tongues of argillic material
E tongues of albic material
V percent of the pedon is occupied by this horizon

PERMEABILITY, layer: give the estimated horizon permeability as a class code for each layer in the Miscellaneous information section of PEDON "per" column, or give the permeability for the pedon.

Class		Rates (in/hr)
1	very slow	< 0.06
2	slow	0.06-0.2
3	moderately slow	0.2-0.6
4	moderate	0.6-2.0
5	moderately rapid	2.0-6.0
6	rapid	6.0-20
7	very rapid	≥ 20

pH: give the measured or estimated pH to nearest tenth using 1:1 water, Helgie-Truog or other field test. Calibrate kits periodically against known references. If other method is used, record as a User Defined property in PEDON.

Class	Criteria
Ultra acid	<3.5
Extremely acid	3.5-4.4
Very strongly acid	4.5-5.0
Strongly acid	5.1-5.5
Moderately acid	5.6-6.0
Slightly acid	6.1-6.5
Neutral	6.6-7.3
Slightly alkaline	7.4-7.8
Moderately alkaline	7.9-8.4
Strongly alkaline	8.5-9.0
Very strongly alkaline	>9.0

Appendix 4: Shell Scripts

1. Listing and example of map unit list.

```
# 'mulist' utility for generating map unit list for MLRA
# by Jim R. Fortner, Soil Scientist, SSQA Staff, NSSC
# 7/93
tput clear
echo "\n\n\n**********************************************************"
echo "This utility will generate a listing of the map units"
echo "included in the MUIR database for the MLRA in question.\n"
echo "The report will be sorted by muname.\n"
echo "The report will be printed to a file called mulist"
echo "with the MLRA number as an extension.\n"
echo "Your report will be run in the background.\n"
echo "*********************************************************\n\n"
echo "Enter the pathname where the MUIR data is stored.
____________\b\b\b\b\b\b\b\b\b\b\b\b\c"
read inputA
echo
echo "Enter the MLRA number, i.e. 104. ____\b\b\b\b\c"
read inputB
echo;echo
(
select -f $inputA/mapunit "mlra == '$inputB'" | project stssaid \
musym muname primfml muacres > tmp
project -f $inputA/comp stssaid musym compname s5id anflood \
drainage sclnirr > tmp1
rjoin tmp tmp1 > tmp2
project -f tmp2 stssaid musym muname s5id compname primfml \
anflood drainage sclnirr muacres > tmp3
sorttable -f tmp3 muname > mulist.$inputB
rm tmp*
) &
```

THE FOLLOWING IS AN ABBREVIATED PRINTOUT OF THE SHELL SCRIPT THAT GENERATES AN IDENTIFICATION LEGEND FROM SSSD:

stssaid	musym	muname	s5id	primfml	drainage	anflood	muacres
-------	-----	--	------	---------	----------	----------	----------
MN037	1821	ALGANSEE SANDY LOAM, OCCASIONALLY FLOODED	MI0123	0	SP	OCCAS	1581
IA017	Ab	ALLUVIAL LAND	IA0208	0	E	FREQ	9599
MN039	Ad	ALLUVIAL LAND	IA0076	2	MW,SP	OCCAS	774
IA131	C315	ALLUVIAL LAND, CHANNELED	IA0208	0	E	FREQ	4520
MN099	44	ANKENY FINE SANDY LOAM	IA0194	1	W	OCCAS	330
IA105	136	ANKENY FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES	IA0277	1	W	NONE	570
MN131	44	ANKENY LOAM	IA0277	1	W	NONE	0
IA089	136A	ANKENY SANDY LOAM, 0 TO 2 PERCENT SLOPES	IA0277	1	W	NONE	429
IA105	760	ANSGAR SILT LOAM, 0 TO 1 PERCENT SLOPES	IA0067	1	W	NONE	340

2: nssl_data Shell

```
##################################################################
#  SHELL NAME:  nssl_data                          DIRECTORY:
#
#  DESCRIPTION:  This is a front end shell designed to pull
#                 selected columns from the NSSL tables.  The
#                 shell then adds additional columns
#                 to facilitate queries using the mlra_data shell
#                 script.
#
#  AUTHOR/DATE:  Carl Wacker and Paul R. Finnell            6/93
#  CALLS:        mlra_data
#
#  ASSUMPTIONS:  The database names are soils8.dat for soil-8s
#                and mlra.dat for the characterization database.
##################################################################

project -f soils8.dat IDPED CREC STATUS YR KND PEDN FSNUM LSNUM
WHODW CDATE \
LATITUD LONGITUD CNAME CNAMFR CNAMDAT MAPSYB TAXCD SOURCD SNAME
SNAMFR FLDSYB \
LABSTAT LABKND LABAVB SITE MLRA MLRADATE SSAREA MSTRGM TAXONOMY \
TTSGM TTGG TTTEX TTMIN TTPH TTTEM TTOTH >soil8.dat

project -f mlra.dat IDPED KND IDSAM SNSFIP SNCFIP LAYER MHORIZ \
THDEP BHDEP V250 V25075 V7520 SAND SILT CLAY CO3CLY FCLAY FSILT
CSILT VFSAND \
FSAND MSAND CSAND VCSAND OC CEC7 SUMBSE BSESAT PH1H2O CACO3 \
GYPL2 ECSX NASX MGSX CASX KSX ABGLL ABGPL LEWS DFLD D3 DOD DP3EST
\
WP10 WP3 W15AD TCFRAG |

#    Determine textures (8 hours, est. on 3B2 400).

addcol -f mlra80.dat TEXTURE >5.tmp
compute -f 5.tmp "if(CLAY >=40 and SAND <45 and SILT <40)
TEXTURE='clay'" >6.tmp
compute -f 6.tmp "if(CLAY >=40 and SILT >=40) TEXTURE='sic'"
>7.tmp
compute -f 7.tmp "if(CLAY >=35 and SAND >=45) TEXTURE='sc'"
>8.tmp
compute -f 8.tmp "if(CLAY >=27 and CLAY <=40 and SAND <20) \
TEXTURE='sicl'" >9.tmp
rm 5.tmp
rm 6.tmp
rm 7.tmp
rm 8.tmp
compute -f 9.tmp "if(CLAY >=27 and CLAY <=40 \
and SAND >=20 and SAND <=45) TEXTURE='cl'" >10.tmp
compute -f 10.tmp "if(CLAY >=20 and CLAY <=35 and SILT <28 and
SAND >=45) \
TEXTURE='scl'" >11.tmp
compute -f 11.tmp "if(SILT >=80 and CLAY <12) TEXTURE='si'"
```

```
TEXTURE='vfsl'" >25.tmp
compute -f 25.tmp "if(TEXTURE=='sl' and FSAND + VFSAND >40 and
VFSAND >= \
FSAND and VCSAND + CSAND + MSAND <15) TEXTURE='vfsl'" >26.tmp
rm 24.tmp
rm 25.tmp
compute -f 26.tmp "if(TEXTURE=='ls' and VCSAND + CSAND >=25 and
MSAND <50 \
and FSAND <50 and VFSAND <50) TEXTURE='lcos'" >27.tmp
compute -f 27.tmp "if(TEXTURE=='ls' and FSAND >=50)
TEXTURE='lfs'" >28.tmp
rm 26.tmp
rm 27.tmp
compute -f 28.tmp "if(TEXTURE=='ls' and VFSAND <50 and VCSAND +
CSAND + MSAND \
<25) TEXTURE='lfs'" >29.tmp
compute -f 29.tmp "if(TEXTURE=='ls' and VFSAND >=50)
TEXTURE='lvfs'" >30.tmp
rm 28.tmp
rm 29.tmp
compute -f 30.tmp "if(TEXTURE=='sand' and VCSAND + CSAND >=25 and
MSAND <50 \
and FSAND <50 and VFSAND <50) TEXTURE='cos'" >31.tmp
compute -f 31.tmp "if(TEXTURE=='sand' and FSAND >=50)
TEXTURE='fs'" >32.tmp
rm 30.tmp
rm 31.tmp
compute -f 32.tmp "if(TEXTURE=='sand' and VCSAND + CSAND + MSAND
<25 and \
VFSAND <50) TEXTURE='fs'" >33.tmp
compute -f 33.tmp "if(TEXTURE=='sand' and VFSAND >=50)
TEXTURE='vfs'" >34.tmp
rm 32.tmp
rm 33.tmp
#
#    Set OC and CLAY = 0 when labdata value is -1 (none) or -2
(trace).
#    This conversion is necessary so that calculations can be
made using
#    OC and CLAY.  If OC or CLAY = -3 (not tested), leave at -3.
#
compute -f 34.tmp "if(OC==-1) OC=0" >51.tmp
compute -f 51.tmp "if(OC==-2) OC=0" >52.tmp
rm 50.tmp
rm 51.tmp
compute -f 52.tmp "if(CLAY==-1) CLAY=0" >53.tmp
compute -f 53.tmp "if(CLAY==-2) CLAY=0" >54.tmp
rm 52.tmp
rm 53.tmp
#
#    Compute OM (organic matter) from OC and round to 1 decimal
place.
#
addcol -f 54.tmp OM >55.tmp
```

3: mlradata Shell

```
###################################################################
#  SHELL NAME:  mlradata for 3B2   DIRECTORY:soil/soildsm/nssl
#
#  DESCRIPTION:  This shell is designed to pull several reports
#                     by series name
#
#  AUTHOR/DATE:  PRF  June 10, 1993                    soil!soildsm
#                                                      913-823-4559
#
###################################################################
# PREDEFINED DIRECTORIES
#
database=/soil/soildsm/nssl/db
export database
data=/soil/soildsm/nssl/data
export data
data2=/soil/soildsm/nssl/database
export data2
reports=/soil/soildsm/nssl/reports
export reports

##while : ; do
##rm ccname
### --- SELECT SERIESNAME---
##
##
##
### -----Beginning Initial Loop ---------------
##
##while : ; do
##
##tput clear
##echo "This program accesses the nssl characterization database
and outputs"
##echo  "several reports designed to aid in the development of
the S5 estimated"
##echo  "properties section."
##echo
##echo
##echo "Please enter the series name in UPPER CASE "
##echo
##while : ; do
##echo "\n\n                  Enter - seriesname "
##echo "                        - 'E' to end selection"
##echo "                        - 'X' to exit to menu"
##
##echo "              ---> \c"
##
##read ccname
##
```

```
columns
#

echo "Sampling Site Data from the Characterization and SOIL-8
databases" >tmp1
echo "\n" >>tmp1

project -f $data/$ccname.data SSAREA IDPED SNAME CNAME TAXCD MLRA
\ LATITUD LONGITUD NOTE |sorttable -u IDPED |clean >>tmp1

echo "\n" >>tmp1

#  This section tells the reader that only the pedons that are
coded
#  L or R in TAXCD are useable for analysis of this series.

echo "Sample Sites in this report which should be used for
Analysis" >>tmp1
echo "\n" >>tmp1
select -f $data/$ccname.data "TAXCD=='L' or TAXCD=='R'" |
project SSAREA IDPED SITE SNAME CNAME TAXCD MLRA LATITUD LONGITUD
|
sorttable -u IDPED |clean >>tmp1


echo "\n\n" >>tmp1
echo "Sampling Site Data from the Description Database" >>tmp1
echo "\n" >>tmp1

#  If the description table is populated for these pedons, this
#  report will provide the site information off of the pedon
#  description

project -f $data/$ccname.des IDPED IDSIT NOHOR LANDUSE DATE
DESCRB LOCALY |\
sorttable -u IDSIT |sorttable IDPED |block LOCALY 70 |clean
>>tmp1

echo "\n\n" >>tmp1
echo "Taxonomy Information from SOIL - 8 Database" >>tmp1
echo "\n" >>tmp1

project -f $data/$ccname.data SITE SNSFIP SNCFIP CNAME TTSGM TTGG
TTTEX \
TTMIN TTPH TTTEM TTOTH | sorttable -u SITE |clean >>tmp1

cat tmp1 |pr -145 -h "Site Data for the $ccname Series from the
NSSL Lab \
Database"  -f >$reports/$ccname.rep

#  If there is data in the description table for these pedon,
this
#  will develop a tabular report of the description.
```

```
cat tmp4 >> $reports/$ccname.rep


#  The sieve analysis report uses the supplementary engineering
#  data that is generated from the characterization data.  This
#  table had to be built from a flat file sent to me from NSSL

echo "........Processing, Sieve Analysis for $ccname..........."


project -f $data/$ccname.data SNSFIP SNCFIP SITE IDPED IDSAM
LAYER SNAME \
MHORIZ TEXTURE SAND |rjoin /soil/soildsm/nssl/database/engdata |\
project SNSFIP SNCFIP SITE IDPED IDSAM LAYER \
MHORIZ TEXTURE IN3 IN2 IN32 IN1 IN34 IN38 no4 no10 no40 no200
mm002 ll pi SAND |
sorttable -u IDSAM | sorttable TEXTURE >tmp9

cp /dev/null tmp2

echo "Percent of Material Passing Sieves for the $ccname Series
based on \
NSSL Lab Data" >>tmp2
echo "\n\n">>tmp2

for mhoriz in 'cat mhoriz' ; do

echo "Percent of Material Passing Sieves for the $mhoriz Horizon
for the $ccname Series" >>tmp2

select -f tmp9 "SAND!='NT' and MHORIZ=='$mhoriz'" |
project SITE LAYER MHORIZ TEXTURE IN3 IN2 IN32 IN1 IN34 IN38 no4
no10 no40 \
no200 mm002 ll pi |
math -l -o no4,no10,no40,no200,ll,pi \
max min mean sdev |clean MHORIZ 6L no4 F0 no10 F0 no40 F0 no200
F0 ll F0 pi F0 >>tmp2
echo "\n\n">>tmp2

done

cat tmp2 >>$reports/$ccname.rep



echo "........Processing, General Chemistry for $ccname......."

cp /dev/null tmp6

echo "General Chemistry data compiled from NSSL Lab Data for the
$ccname \
Series " >>tmp6
echo "\n\n">>tmp6
```

```
"  -f >>$reports/$ccname.rep

fi

cat $reports/$ccname.rep |lp -dglaser5 -oc -op -or

done


###  PRINTING OF THE LABDATA
##
##tput clear
##echo "\n\n"
##echo "Do you wish to read or print this report?  ( R, P ):
\c"
##read resp
##
##    if [ "$resp" = "R" -o "$resp" = "r" ] ; then
##         cat $reports/$ccname.rep |pg
##
##    elif [ "$resp" = "P" -o "$resp" = "p" ] ; then
##         cat $reports/$ccname.rep |lp -dglaser5 -or -oc -op
##
##    #elif [ "$resp" = "X" -o "$resp" = "x" ] ; then
##         #break
##    fi
###done
##
###---- LOOPING BACK------------------------
##
##tput clear
##echo "\n\n"
###echo  "Do wish wish to repeat this process?:   \c"
###read res
##
##         #if [ "$res" = "N" -o "$resp" = "n" ] ; then
##              #exit
##         #fi
##
##echo "Do you wish to remove the data and description files?
\c"
##echo "\n\n"
##echo        "(This will not remove the report file.)"
##read delete
##         if [ "$delete" = "Y" -o "$delete" = "y" ] ; then
##              rm $data/$ccname.des
##              rm $data/$ccname.dat
##              rm $data/$ccname.data
##              #rm tmp*
##         echo "\n\n"
##         echo "$ccname.data and $ccname.des removed"
##sleep 2
##fi
##
```

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Sampling Site Data from the Characterization and SOIL-8 databases

SSAREA	IDPED	SNAME	CNAME	TAXCD	MLRA	LATITUD	LONGITUD
0077	4001821	POND CREEK	BLANKET	F	H 80A	37N 635	97W5248
0155	9000930	BLANKET	BLANKET	S	H 80A	37N52 1	97W5014

Sample Sites in this report which should be used for Analysis

SSAREA	IDPED	SITE	SNAME	CNAME	TAXCD	MLRA	LATITUD	LONGITUD

Sampling Site Data from the Description Database

IDPED	IDSIT	NOHOR	LANDUSE	DATE	DESCRB	LOCALY
9000930	KS155011	12	CROPLAND	890	Rick Schlepp, Bruce Hoffman, and Jim Fortner	

Taxonomy Information from SOIL - 8 Database

SITE	SNSFIP	SNCFIP	CNAME	TTSGM	TTGG	TTTEX	TTMIN	TTPH	TTTEM	TTOTH
S76KS 77002	KS	077	BLANKET	PACHIC	ARGIUSTOLL	FINE	MIXED	DEFAULT	THERMIC	DEFAULT
S90KS155011	KS	155	BLANKET	PACHIC	ARGIUSTOLL	FINE	MIXED		THERMIC	

Particle Size Determination Guides for the BLANKET Series based on NSSL Lab Data

Particle Size Determination For the AP* Horizons for the BLANKET Series

SITE	MHORIZ	LAYER	THDEP	BHDEP	TEXTURE	SAND	SILT	CLAY	CO3CLY	FCLAY	FSILT	CSILT	VFSAND	FSAND	MSAND	CSAND	VCSAND	Ksand	Ksilt	P_OP
S76KS 77002	AP	1	0	19	sil	21	57	2		15.8	13.8	43.1	14.4	1.5	2.1	2.4	0.5	7	71	
S90KS155011	AP1	1	0	12	sil	22	57	21		16.1	16.0	40.8	13.0	4.1	4.0	0.9	0.3	9	70	
S90KS155011	AP2	2	12	25	sil	21	57	21		16.5	17.2	40.1	12.6	3.7	3.7	1.1	0.2	9	70	
						22	57	21										9	71	maximum
						21	57	2										7	70	minimum
						22	57	15										8	70	mean
						1	0	11										1	1	sdev

Particle Size Determination For the B? Horizons for the BLANKET Series

SITE	MHORIZ	LAYER	THDEP	BHDEP	TEXTURE	SAND	SILT	CLAY	CO3CLY	FCLAY	FSILT	CSILT	VFSAND	FSAND	MSAND	CSAND	VCSAND	Ksand	Ksilt	P_OP
S76KS 77002	B1	2	19	33	sicl	12	51	37		27.6	16.9	33.6	8.6	0.9	1.1	1.3	0.4	4	59	
S90KS155011	BA	3	25	36	sicl	19	41	40		30.7	15.1	26.1	11.1	3.4	3.1	1.4	0.2	8	52	
						19	51	40										8	59	maximum
						12	41	37										4	52	minimum
						16	46	38										6	56	mean
						5	7	2										3	5	sdev

Particle Size Determination For the B*T* Horizons for the BLANKET Series

SITE	MHORIZ	LAYER	THDEP	BHDEP	TEXTURE	SAND	SILT	CLAY	CO3CLY	FCLAY	FSILT	CSILT	VFSAND	FSAND	MSAND	CSAND	VCSAND	Ksand	Ksilt	P_OP
S76KS 77002	B21 T	3	33	51	sic	9	49	42		30.2	20.2	28.3	6.2	0.8	0.9	1.1	0.2	3	55	
S76KS 77002	B22 T	4	51	73	sicl	9	52	40		27.7	22.9	29.1	5.7	0.8	0.8	1.0	0.2	3	58	
S90KS155011	BT1	4	36	56	sicl	19	45	37		29.6	17.4	27.1	9.1	3.7	3.4	2.0	0.5	1	54	
S76KS 77002	B23 T	5	73	101	sicl	10	52	38		28.6	20.8	30.8	7.2	0.9	1.1	0.9	0.0	3	59	
S90KS155011	BTB 1	5	56	70	sicl	18	46	37		27.9	18.8	27.0	10.0	3.4	3.1	1.2	0.0	8	56	
S90KS155011	BTB 2	6	70	87	sicl	19	45	36		27.3	19.3	26.1	12.2	3.9	2.0	0.8	0.1	7	58	
S90KS155011	BTB 3	7	87	100	sicl	18	50	32		24.8	18.2	31.7	13.9	2.7	1.2	0.3	0.0	4	64	
						19	52	42										1	64	maximum
						9	45	32										3	54	minimum
						14	48	37										5	57	mean

Particle Size Determination For the 2AB Horizons for the BLANKET Series

SITE	MHORIZ	LAYER	THDEP	BHDEP	TEXTURE	SAND	SILT	CLAY	CO3CLY	FCLAY	FSILT	CSILT	VFSAND	FSAND	MSAND	CSAND	VCSAND	Ksand	Ksilt	P_OP
S90KS155011	2AB	8	100	122	sil	17	57	27		18.5	22.8	33.9	11.8	2.2	1.8	0.7	0.2	5	69	
						17	57	27										5	69	maximum
						17	57	27										5	69	minimum
						17	57	27										5	69	mean
						N/A	N/A	N/A										N/A	N/A	sdev

Particle Size Determination For the 2BTK* Horizons for the BLANKET Series

SITE	MHORIZ	LAYER	THDEP	BHDEP	TEXTURE	SAND	SILT	CLAY	CO3CLY	FCLAY	FSILT	CSILT	VFSAND	FSAND	MSAND	CSAND	VCSAND	Ksand	Ksilt	P_OP
S90KS155011	2BTK 2	10	156	180	sicl	19	44	36		23.8	15.7	28.5	9.5	3.5	3.6	2.0	0.8	1	54	
S90KS155011	2BTK 3	11	180	221	cl	14	46	30		23.0	15.6	30.5	12.9	5.2	4.0	1.3	0.5	11	59	
S90KS155011	2BTK 4	12	221	235	loam	33	41	26		19.1	15.0	26.0	11.9	11.3	7.5	2.1	0.2	21	53	
S90KS155011	2BTK 1	9	122	156	sicl	18	44	39		17.8	16.7	27.0	8.7	2.8	2.9	2.0	1.3	9	52	
						33	46	39										21	59	maximum
						18	41	26										9	52	minimum
						24	44	33										13	55	mean
						7	2	6										6	3	sdev

Percent of Material Passing Sieves for the BLANKET Series based on NSSL Lab Data

Percent of Material Passing Sieves for the AP* Horizon for the BLANKET Series

SITE	LAYER	MHORIZ	TEXTURE	IN3	IN2	IN32	IN1	IN34	IN38	no4	no10	no40	no200	mm002	ll	pi	P_OP
S76KS 77002	1	AP	sil	100	100	100	100	100	100	100	100	97	67	2	30	10	
S90KS155011	1	AP1	sil	100	100	100	100	100	100	100	100	98	85	21			
S90KS155011	2	AP2	sil	100	100	100	100	100	100	100	100	98	86	21			
										100	100	98	86		30	10	maximum
										100	100	97	67		30	10	minimum
										100	100	98	79		30	10	mean
										0	0	1	11		N/A	N/A	sdev

Percent of Material Passing Sieves for the ? Horizon for the BLANKET Series

SITE	LAYER	MHORIZ	TEXTURE	IN3	IN2	IN32	IN1	IN34	IN38	no4	no10	no40	no200	mm002	ll	pi	P_OP
										0	0	0	0		0	0	maximum
										0	0	0	0		0	0	minimum
										0	0	0	0		0	0	mean
										0	0	0	0		0	0	sdev

Percent of Material Passing Sieves for the C Horizon for the BLANKET Series

SITE	LAYER	MHORIZ	TEXTURE	IN3	IN2	IN32	IN1	IN34	IN38	no4	no10	no40	no200	mm002	ll	pi	P_OP
										0	0	0	0		0	0	maximum
										0	0	0	0		0	0	minimum
										0	0	0	0		0	0	mean
										0	0	0	0		0	0	sdev

Percent of Material Passing Sieves for the ? Horizon for the BLANKET Series

SITE	LAYER	MHORIZ	TEXTURE	IN3	IN2	IN32	IN1	IN34	IN38	no4	no10	no40	no200	mm002	ll	pi	P_OP
										0	0	0	0		0	0	maximum
										0	0	0	0		0	0	minimum
										0	0	0	0		0	0	mean
										0	0	0	0		0	0	sdev

Percent of Material Passing Sieves for the 2AB Horizon for the BLANKET Series

SITE	LAYER	MHORIZ	TEXTURE	IN3	IN2	IN32	IN1	IN34	IN38	no4	no10	no40	no200	mm002	ll	pi	P_OP
S90KS155011	8	2AB	sil	100	100	100	100	100	100	100	100	99	90	27			
										100	100	99	90		0	0	maximum
										100	100	99	90		0	0	minimum
										100	100	99	90		0	0	mean
										N/A	N/A	N/A	N/A		0	0	sdev

General Chemistry Data for the B*T* Horizons for the BLANKET Series

SITE	LAYER	MHORIZ	THDEP	BHDEP	OC	OM	CEC7	SUMBSE	BASESAT	PH1H2O	CACO3	GYPL2	ECSX	NASX	CASX	MGSX	P_OP
S76KS 77002	3	B21 T	33	51	0.8	1.[illegible]	26.1			6.9							
S76KS 77002	4	B22 T	51	73	0.6	1.1	24.7			7.0			0.3				
S90KS155011	4	BT1	36	56	0.8	1.4	28.2	27.3	96.8	6.4							
S76KS 77002	5	B23 T	73	101	0.5	0.8	23.2			7.3			0.3				
S90KS155011	5	BTB 1	56	70	0.7	1.1	28.0	28.1	100.0	6.7							
S90KS155011	6	BTB 2	70	87	0.6	1.0	27.4	28.9	100.0	6.8							
S90KS155011	7	BTB 3	87	100	0.4	0.7	22.8	24.0	100.0	6.9							
					0.8	1.4	28.2		100.0	7.3	0.0	0.0	0.3	0.0	0.0	0.0	maximum
					0.4	0.7	22.8		96.8	6.4	0.0	0.0	0.3	0.0	0.0	0.0	minimum
					0.6	1.1	25.8		99.2	6.9	0.0	0.0	0.3	0.0	0.0	0.0	mean
					0.2	0.3	2.2		1.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	sdev

General Chemistry Data for the BTB Horizons for the BLANKET Series

SITE	LAYER	MHORIZ	THDEP	BHDEP	OC	OM	CEC7	SUMBSE	BASESAT	PH1H2O	CACO3	GYPL2	ECSX	NASX	CASX	MGSX	P_OP
					0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	maximum
					0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	minimum
					0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	mean
					0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	sdev

General Chemistry Data for the ? Horizons for the BLANKET Series

SITE	LAYER	MHORIZ	THDEP	BHDEP	OC	OM	CEC7	SUMBSE	BASESAT	PH1H2O	CACO3	GYPL2	ECSX	NASX	CASX	MGSX	P_OP
					0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	maximum
					0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	minimum
					0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	mean
					0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	sdev

General Chemistry Data for the C Horizons for the BLANKET Series

SITE	LAYER	MHORIZ	THDEP	BHDEP	OC	OM	CEC7	SUMBSE	BASESAT	PH1H2O	CACO3	GYPL2	ECSX	NASX	CASX	MGSX	P_OP