1999 Project Abstract
For the Period Ending June 30, 2001

TITLE: Updating Outmoded Soil Surveys-Continuation
PROJECT MANAGER: Greg Larson
ORGANIZATION: Board of Water and Soil Resources
ADDRESS: 1 West Water Street, Suite 200, St. Paul, MN 55107
FUND: Trust Fund
LEGAL CITATION: ML 1999, Ch. 231, Sec.16, Subd. 10 C

APPROPRIATION AMOUNT: $ 500,000

Overall Project Outcome and Results
This project completed the first (of a three) biennium effort to update and digitize the soil surveys in Dodge, Fillmore, Goodhue and Wabasha Counties in southeastern Minnesota. This area comprises 1.65 million acres. During this phase of the project, the quality of existing soil maps was improved to aid their update and assist in the compilation of revised soil maps. Fillmore County has been completed and Wabasha County is 75 percent complete. A descriptive legend to guide the update effort, including the collection of soils data was started. Legend development is about 20 percent complete. To aid legend development, private sector soil soil scientists performed 300 transects. Some of the original soil maps were updated. About 400,000 acres have been addressed. Research and technical support for digital and field science is underway by the University of Minnesota Department of Soil, Water and Climate. Digital techniques for improving existing soil maps have been developed and are being tested.

Project Results Use and Dissemination
Soil data and associated maps are used by a variety of users, both public and private. As interim products from this project are developed, they will be made available to the local soil and water conservation district for dissemination to the public. The final product, in digital form, will be available after the project is completed in June 2005. It must be noted that project completion is contingent on continued funding by the LCMR.

FINAL REPORT

AUG 13 2001

Date of Report: August 8, 2001

Date of Next Status Report: January 3, 2002
Date of Work Plan Approval: June 16, 1999
Project Completion Date: June 30, 2001 for this phase of this 4-biennium effort.

LCMR Work Program Update Report

1. **PROJECT TITLE:** Updating Outmoded Soil Surveys-Continuation

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Total Biennial Project Budget:

$LCMR:	$500,000	**$Cost share:**	$196,799
-$LCMR Amount Spent:	$495,406	**-$Cost share Amount Spent:**	196,799
=$LCMR Balance:	$4,315	**=$Cost share Balance:**	$ 0

A. Legal Citation: ML 1999, [Chap.231}, Sec.[16], Subd,[10(c)]

Appropriation Language: $250,000 the first year and $250,000 the second year are from the trust fund to the board to water and soil resources for the first biennium of a four biennia project to accelerate a statewide program to begin to update and digitize soil surveys in up twenty-five counties, including Fillmore county. Participating counties must provide a cost-share.

B. Status of cost Share Requirement: Participating counties provided all cost share funds by January 1, 2001. << *County funds were spent on private sector scientists who collected data under contract.* >>

II. PROJECT SUMMARY AND RESULTS: The purpose of this project was to begin the several year process of updating outmoded soil surveys. The updating and digitizing of soil surveys in four counties in southeastern Minnesota were accelerated this biennium. The update is needed so that current soil survey maps, interpretations and a soil database are available for managing agriculture, forestry, urbanizing lands, recreation and wildlife. Soil maps and associated data will be used by resource managers of private, county, state, and federal lands, assessors, associates and zoning officials. Also, there is a need to produce soil survey maps on an orthophotographic (distortion-free) base map suitable for digitizing, GIS and other computer applications.

The update is being accomplished by refining the composition of soil map units, checking and refining soil map unit delineation's on existing soil surveys, gathering field documentation and updating the soil database.

When digitized, the updated soil survey will meet NRCS Soil Survey Geographic Database (SSURGO) standards and be part of the State of Minnesota digital soil database.

III. PROGRESS SUMMARY: To preface the progress: the guiding principles for this project are (i) assume the soil lines on the existing soil surveys are correct until proven otherwise (ii) use technology, or do not do things manually that could be done electronically (iii) make effective use of expertise in the private sector, and (iv) do not re-collect data that exists in adjacent counties and states. To those ends, the NRCS hired three experienced soil scientists to provide technical oversight to this effort. The BWSR—with LCMR funds—provided one-half of their salaries. These NRCS staff developed the specifications which were be used for bidding technical work to private sector soil scientists. Bidding occurred in June, 2000 with contractors beginning field work in September of 2000. Hennepin County officials contacted BWSR about digitizing their soil survey. Although not a part of the SE update area, the proximity of Hennepin County to the University and the ability of NRCS to support the effort made Hennepin County a logical choice to test orthorectification and other digital techniques. Hennepin County was completed in early 2001. It was reported earlier that efforts were made to acquire digital elevation data. It was anticipated that integrating digital elevation data with soils information collected by private consultants and existing data would enable the NRCS soil scientists and GIS technicians to electronically revise the existing (digitized) soil surveys. Unfortunately, efforts to acquire digital elevation data have been unsuccessful. And as reported later in this update, digital elevation data is the key technological element missing in this effort. *<<Two private sector soil scientist firms (contractors) were hired to collect data. They began work in the fall of 2000 and completed the first phase of their work by June 30, 2001. They performed 300 transects. >>*
<<Hennepin County has been orthorectified and legend development and update soil mapping is complete. The orthorectification of Fillmore County is also complete. Wabasha County is 75 percent complete. Dodge and Goodhue Counties will be completed by June 30, 2002>>
<<Legend development is 20 percent complete in SE Minnesota.>>
<<About 400,000 acres (of 1.65M) have been addressed in the SE.>>
<<UM-developed orthorectification technology has been converted to Windows NT format, which should facilitate its adoption by other users.>>

IV. OUTLINE OF PROJECT RESULTS: The project focused on southeastern Minnesota in Major Land Resource Areas (MLRAs) 104 and 105, in Fillmore, Dodge, Goodhue and Wabasha counties. Results two and three were done by NRCS soil scientists jointly employed by BWSR and by private contractors hired by the BWSR. Quality assurance was provided by NRCS soil scientists. Quality assurance ensures that the soil survey meets National Cooperative Soil Survey (NCSS) Standards. The NCSS standard ensures that soil surveys convey consistent soil information across the United States. Results one and four were done or overseen by staff of the University of Minnesota Department of Soil, Water and Climate. The BWSR administered the project and contributed to its technical support. The update is expected to take a minimum of four calendar years. In order to recruit staff and incorporate research and new technology into the project (Results 1 and 4), the project was not fully operational until January 2000. Consequently,

it was necessary to alter the timing and accomplishments of "update soil mapping" (Results 2 and 3). In any event, the project will be completed by June 30, 2005. This longer completion time will have long-term benefits to other update projects as technology and techniques developed in this project will accelerate the pace at which other soil surveys are updated, digitized and make available to users.

Result 1: Improve the quality of existing soil maps to aid their update and assist in the compilation of revised soil maps

LCMR Budget:	$65,300	Balance:	$0
County $:	$0	Balance:	$0
Completion Date:	June 30, 2001		

Soil boundaries are delineated in the field on an aerial photograph, which serves as a base map. For publication and digitization purposes, the soil lines are manually transferred—in process called compilation—to another photograph. The soil surveys proposed for updating were compiled on rectified aerial photography. Rectified photography is corrected only for camera distortion and movement of the airplane taking the photographs are not corrected for distortion caused by the variation in topography (hills and valleys), meaning that from the perspective of a user viewing soil maps, the soil lines may not be in the correct landscape position. This distortion is more pronounced in areas with hills and valleys and creates problems in GIS applications. As a platform for beginning the update process, outdated surveys in southeastern Minnesota—and other outdated surveys such as Hennepin County were recompiled to an orthophoto base map. A significant amount of some soil scientist's time (20 to 30 percent) is needed to manually compile soil maps. Digital compilation techniques developed by Professor Jay Bell, as part of the 1997 LCMR project entitled "Statewide Digital Soil Database-Phase 1"were used for this task. This result was tested as part of Result 3. This technique demonstrates that the time and cost of doing soil survey updates can be reduced.

Products: Ortho base maps and compiled updated maps for Fillmore, Dodge, Wabasha and Goodhue Counties. Hennepin County was also completed.

<< Hennepin County has been orthorectified and legend development and update soil mapping is complete. The orthorectification of Fillmore County is complete. Wabasha County is 75 percent complete.Dodge and Goodhue Counties will be completed by June 30, 2002. >>

Result 2: Develop a descriptive legend ("blueprint") to doing the update and collect soils information to improve interpretations

LCMR Budget:	$182,277	Balance:	$4,315
County $:	$124,692	Balance:	$0
Completion Date:	June 30, 2001		

During this phase, work focused on legend development, with limited update soil mapping. A soil survey legend is akin to a blueprint and consists of soil map unit symbols, soil map unit names, and descriptions of the soil map units (the extent of various soils, their physical

properties, type of landform and so forth). It is essential that a soil survey legend be developed before the start of update soil mapping. By doing so, work will proceed more efficiently and make better use of personnel and financial resources. A descriptive legend developed for the MLRA 104 portion of Fillmore County as part of an LCMR-funded soil survey update in 1999 will be integrated into this project.

The descriptive legend is being developed through the assessment of user needs, geomorphologic investigations—which involve scientists from other disciplines such as geology, transects (borings) across the landscape, soil sampling, evaluation of information from the existing soil surveys, previous special projects, geological mapping, water table studies, existing soil characterization data, and the interpretation of aerial photography. Emphasis is given to identifying and working with the users of the soil survey to ensure that the update addresses their activities.

Products: A soil survey descriptive legend developed using the National Soil Information System, preliminary interpretive tables, detailed map unit descriptions and/or preliminary edits to the soil survey database and taxonomic (scientific) descriptions. An initial draft of the soil survey manuscript as identified in the National Soil Survey Handbook will also be developed.

<<Legend development is 20 percent complete in SE Minnesota, and is complete in Hennepin County. Private contractors performed 300 transects and NRCS did 50 transects.>>

Result 3: Update, as necessary, previous soil mapping.

LCMR Budget:	$82,107	Balance:	$0
County $:	$72,107	Balance:	$0
Completion Date:	June 30, 2001		

Update soil mapping will begin after the soil survey descriptive legend is developed and approved by the NRCS. Although previous mapping is assumed to be adequate for today needs, some areas may require remapping too more accurately reflect current soil and landscape concepts and user demands.

Update soil mapping will be done using black and white NAPP (National Aerial Photography Program) orthophotography at a scale of 1:12,000, supplemented with color infrared photography. Soils will be examined to depths of at least 80 inches with data collected and soil boundaries compiled on an orthophotographic base map. The soil maps will be correlated and checked for accuracy by the NRCS as part of the quality assurance programs.

Products: Hard copy and digitized soil maps for southeastern Minnesota Counties with interpretations and other data such as CD ROM and Internet accessible products.

<< Hennepin County received a contract for $10,000 towards the updating of that soil survey. As mentioned in Result 1, update soil mapping is complete in Hennepin County. About 400,000 acres (of 1.65M acres) have been addressed in the SE.>>

Result 4: Technical and research support for digital and field science

LCMR Budget:	$120,316	Balance:	$0
County $:	$0	Balance:	$0
Completion Date:	June 30, 2001		

University involvement includes digital and landscape analysis, laboratory services to characterize soils, research on topics such as soil water movement and the training of students.

Products: Development of procedures and studies to improve the efficiency, quality and usefulness of soil survey updates using GIS and allied technologies. A computerized system for interactive delivery of soil survey information over the Internet. Special studies to improve/revise interpretations of soil processes (i.e., water table dynamics) and spatial variability of soil properties.

<<As mentioned in Result 1, research and development is continuing. Also, the NRCS has reviewed the UM technique for possible use at their regional digitizing centers. The UM methodology has been converted to a Windows NT format, which should facilitate its adoption by other users. Orthorectification of the SE counties will be completed by June 30, 2002. Other update counties, such as Pipestone, Lincoln, Nobles or Cottonwood could then begin, pending approval of a work plan amendment.>>

V. DISSEMINATION: As the products herein are developed and approved—as appropriate—by the NRCS and the University of Minnesota, they will be marked "advanced copy," and may be used and distributed by NRCS and project cooperators without restriction.

VI. CONTEXT:

1. Significance: A 2000 survey of GIS users by the University of Minnesota for the Governor's Council on Geographic Information ranked digital soil's information as the number one data need. Statewide availability of digital soils data is of great benefit to many local and state planning efforts, sustainable development efforts and site-based resource management programs. Efforts to develop a statewide "seamless" digital soil's database is proceeding, but is severely limited by outdated soils information in 25 counties. The soil resource in these 25 counties has not changed per se' in the 30 or more years since the soils were mapped, but their intensity of use –hence interpretation of those soils—has changed dramatically. Consequently, these older surveys are not adequate to meet the needs of GIS users, precision farming, land use officials and resource managers.

2. Time: Limitations in the number of soil survey updates that can be undertaken at the same time from the perspective of logistics and quality control dictate that this effort must be done over several biennia. Given the benefit to local users and officials, counties can be expected to contribute a cost-share.

3. Budget Context: This project complements a sixteen year and nearly an 11 million dollar effort of the LCMR to produce an initial soil survey in Minnesota counties. That effort ended in 1993. During that time, nearly 28 million acres were mapped in 62 counties as

part of a state, federal and local partnership. In addition to state contributions, the federal government and county government contributed 18.5 and 8.1 million dollars, respectively. Currently, the NRCS is providing 2.5 million dollars through 36 soil scientists. However, priorities limit them to finishing the "once-over" soil survey effort began by the LCMR in 1977. Hence, the NRCS can only initiate soil survey effort updates upon completion of ongoing surveys. This project has enabled the State to help direct the priorities of the NRCS toward the acceleration of soil survey updates. In addition to the current appropriation, the LCMR contributed $130,000 to the update of the Fillmore County Soil Survey. That project—as a single county effort—ended December 31,1999 and the work accomplished therein is incorporated into the four county effort described above. The previous work in Fillmore County, including management of the technical aspects of the soil survey, was done by a private contractor.

4. Completion: With the assumption of full staffing and full participation form the counties, the update will be completed by June 30, 2005

Counties were not required to pay for BWSR direct costs, University of Minnesota support (research and developments) costs, or equipment or materials related to research and development. As research and development reaches the "application" stage in subsequent biennia, counties will contribute to a portion of those costs. This four-county update is being done as a group, with Results one through four occurring at different times in different counties. From a technical perspective this approach was efficient, but it complicated the fiscal administration as it was difficult to negotiate a specific contract with a county. Rather than award contracts to individual counties, the BWSR acted as a fiscal agent on behalf of the counties, billed the counties for their contributions, and used the funds to hire private soil scientists to assist the NRCS. Contributions from the counties were determined by the project manager in consultation with the NRCS MLRA Coordinator and county officials.

July 1, 1999 – June 30, 2001
Final expenditures on this project:

1. LCMR	$495,406
2. Other State	0
3. Non State Cash	196,799
4. Unspent	$4,315
Total	$696,799

Budget:

Personnel	$279,301	(includes travel and office expense of project persons)
Equipment	156,384	(includes geotechnical equipment and computers)
County contributions	196,799	(contractors—data collection)
Direct costs	50,000	(BWSR)
Other	10,000	(Hennepin County—update)
Unspent	4,315	
Total	$696,799	

Note: Equipment such as computers have a useful life not exceeding the term of the project. Expensive items with a long useful life such as pick up trucks and geotechnical equipment, e.g., electromagnetic induction units and ground penetrating radar, were leased. Items that could not

be leased were purchased. This includes drill rigs. Purchased items will be used by the State of Minnesota for soil survey purposes after this project ends.

5. Challenges: Acquisition of digital elevation data at a resolution of 10 meters or less would greatly increase the efficiency at which soil surveys can be updated. With sub-10 meter digital data, an orthorectified "original" soil survey and field data denoting landscape and soil characteristics, a team of soil scientists and GIS technicians could very efficiently digitally edit and produce an updated soil survey. Unfortunately, digital data is not available due to cost. Consequently, manual data and image processing must be done.

VII. COOPERATION: the following personnel from federal and state agencies and the University of Minnesota – Department of Soil, Water and Climate cooperated in this project: Joe McCloskey and other NRCS personnel; Jay Bell and other University of Minnesota personnel; Greg Larson, BWSR; Soil and Water Conservation District personnel and contractor(s) hired by BWSR for the project.

VIII. LOCATION: This project focused on southeastern Minnesota in MLRA's 104 and 105.

IX. REPORTING REQUIREMENTS: Periodic work program progress reports were submitted January 3, 2000, January 4, 2001 and a program status report was submitted August 8, 2001.

X. RESEARCH PROJECTS: Not applicable.

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