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I am submitting herewith a thesis written by Charles E. McCroskey entitled "Development and Comparison of Single Purpose Line Printer Maps Prepared from Soil Mapping Units." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant and Soil Science.

M. E. Springer

M. E. Springer, Major Professor

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DEVELOPMENT AND COMPARISON OF SINGLE PURPOSE LINE PRINTER MAPS PREPARED FROM SOIL MAPPING UNITS

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee

Charles E. McCroskey

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ABSTRACT

Information about soils has been available for several years, but only recently has its value for diversified planning been realized. Early uses of detailed soil map information was for farm planning. Now this information is being used for city, county, state, and regional planning. Location of airports, roads, and sanitary land fills are now based upon information obtained from the soil maps. Although detailed soil survey maps and reports are available, the complexity of the information does not lend itself to widespread use where large geographic areas are involved.

This study was designed to:

1. investigate the feasibility of computerizing soil map unit data;
2. investigate methods of producing computerized interpretations and potential uses of the computerized information for land planning processes;
3. produce single purpose computer line printer maps;
4. evaluate time and cost involved with data input, analysis, and computer mapping of soil interpretations;
5. investigate the feasibility of comprehensive resource analysis by combining soil map unit data with other types of resource information.

The Bearden 7 1/2 Minute Quadrangle (Knox County, Tennessee) was selected as the analysis area because of its diverse physical and natural features. Examination of the soil maps showed it to be highly complex in terms of size of the smallest mapping unit and number of mapping units. The smallest mapping unit was approximately one acre in size, and there were 175 different soil mapping units.

The next step involved selection of methods of data capture (digitization), data intensity (cell size), and information presentation (display). Several different methods were considered, but a point sampling method exhibited results which appeared to be useful and practical. Cell size selection was based upon the constraint of the geodetic referencing system, the size of the smallest soil mapping units, time available to do the data capture and analysis, and cost of producing the interpretative displays.

Four sizes of geodetic cells (those bounded by lines of latitude and longitude) were initially considered: 7.5 seconds (10.72 acres), 3.75 seconds (2.68 acres), 2.5 seconds (1.19 acres), and 1.875 seconds (.67 acres). Actual time and cost for data capture and analysis were unknown, but it was known that both increased as the cell size decreased. After a subjective evaluation of these considerations, cell sizes of 1.19 and 2.68 acres were chosen for comparison.

Grids of geodetic cells of 1.19 acres and 2.68 acres were used for digitization of soil mapping unit information. A series of row and column coordinates were used to express each cell location from a common reference point (northwest corner of the quadrangle). Digitization involved entering a row-column coordinate and the corresponding soil mapping unit symbol on a coding sheet each time a different soil mapping unit was encountered in scanning a row of geodetic cells. After digitization, interpretive maps were produced for data validation using the MAPCLASS computer program.

Validation of the soil data was done by visually scanning several interpretive maps to detect obvious errors. Less obvious errors were corrected by using interpretation patterns to locate cells that were miscoded. After errors were corrected, final line printer interpretive maps were produced.

Choice of interpretations was based upon a subjective evaluation of diversified land planning. Depth to bedrock, slope gradient, potential flooding areas, predicted percolation rates, and soil drainage classes were chosen as they are all important in decisions about construction feasibility, sanitary waste disposal, and wildlife and forestry management. Another interpretation--potential corn yields--was chosen to illustrate the use in agricultural applications.

A time-cost comparison was performed to illustrate the economy of both cell sizes. For the Bearden Quadrangle (38,661 acres) it was found that the smaller cell size took 2.5 times longer to digitize and cost $522 more than the 2.68 acre cell. However, the advantages of the smaller cells are evident for interpretations of fine scale patterns (flooding, slope gradient). The smaller cell size more accurately defines areas that are small and irregular across the landscape.

From these observations, the following conclusions were drawn:

1. Digitization of soil mapping unit data was feasible.
2. Single purpose and composite line printer maps could be produced which would aid in providing the basis for planning decisions.
3. Time-cost considerations make this process feasible provided the resulting information is utilized in planning.
4. The choice of cell size is dependent upon the user, but as smaller cell sizes are used, the costs increase proportionally.
5. Since data capture (input) is a major cost of this process, the cost effectiveness increases with the

number of interpretations produced. For example, if only one interpretation was produced, it might be less expensive to produce a hand delineated map.

DAFLOM images

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CHAPTER I

INTRODUCTION

Detailed soil surveys comprise the most useful physical information available in many planning processes. They also form the basis for conservation and development of soil related resources. However, the complexity of the soil map for interpretations has greatly affected the use of the information. People unfamiliar with a soil map perceive that each mapping unit is a homogeneous, discrete unit ending where the line on the soil map ends. This is largely a misconception. A soil map is a visual display of the soil patterns of an area of land. Since few soil maps represent all of the soil characteristics, generalization to some degree is made when drawing a soil boundary on an aerial photograph. "The minimum sized delineation on a soil map should match the decision making unit of the user" (Nichols and Bartelli, 1972).

Soil surveys exist in various stages of completion in Tennessee. All counties have General Soil Association Maps, but these maps are too general to be used for site location planning. Many counties have some soils information in the form of farm mapping which covers approximately 20 percent

of each county in the state where there is no published soil survey or progressive soil survey.[1]

Twenty-two counties in Tennessee have 20 to 40 year old soil surveys. These surveys are still useful, but advances in the methods of classification and mapping techniques have changed some of the soil names; new soils have been established; and some old soil names have been divided into two or more different soil names. Care should be exercised in the use of these soil surveys.

Twenty-seven counties have modern soil surveys, and, for other counties photographs with soil delineations are available which will eventually be reproduced in published form. These surveys are based upon the new soil classification system, and soil mapping units and their interpretations reflect many advances made in soil classification and interpretations. Since few people fully understand the application of the soils information to planning, simple methods of preparing single purpose maps from both old and new soil surveys are needed.

The conventional method of soil interpretive displays is to group the soils for a particular interpretation, and then to color the groups a different color to reflect the different ratings. This method is laborious, but it provides

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[1]Personal communication with Mr. Ray Sims, State Soil Scientist, Soil Conservation Services, Nashville, Tennessee.

information in a simple and useful form. However, in order to combine this information with other sources of data, this new data may be color coded onto clear overlays and then used for planning purposes. This adds to the labor task each time new interpretation maps are needed.

Computer technology has opened another field of soil interpretive displays as planners seek better and more easily analyzed soils information. One of the simplest and least expensive methods of producing soil interpretation displays is through digitization and computerized grouping of the information. Soil information constitutes a data source which has a long half-life, that is, the information remains useful for a long time. In terms of time and cost involved in computerizing data, it would be more justifiable to digitize data with a long half-life than that of a short half-life such as land cover. It is the purpose of this study to investigate the effectiveness and efficiency of computerization of detailed soil survey information as a means of conveying the needed information to planners in the form of single purpose interpretive maps for use in diversified planning processes.

CHAPTER II

STUDY AREA

The Bearden 7 1/2 Minute Topographic Quadrangle was chosen for study. It is a part of Knox County which lies wholly in the Ridge and Valley Region (Figure 1). The soil survey of Knox County (Roberts, 1955) is approximately 33 years old, and many soil mapping units as small as one acre are delineated in the soil maps. Soils information contained in the survey is reliable; however, the base map used for the information is not as accurate as new base maps for the Quadrangle.[1]

This area has highly diverse physical features. The geological structure is oriented Northeast-Southwest with many folds and faults. Shale, sandstone, and limestone are the predominant parent materials of the upland soils. Past depositional surfaces of the Tennessee River have posed further difficulties relating soils to bedrock geology. For example, the Decatur and Cumberland soils are stream terraces, yet they occur on many ridge tops several feet above the nearest stream.

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[1]Personal communication with Mr. Leonard Harris, Geologist, U. S. Geological Survey, Knoxville, Tennessee.

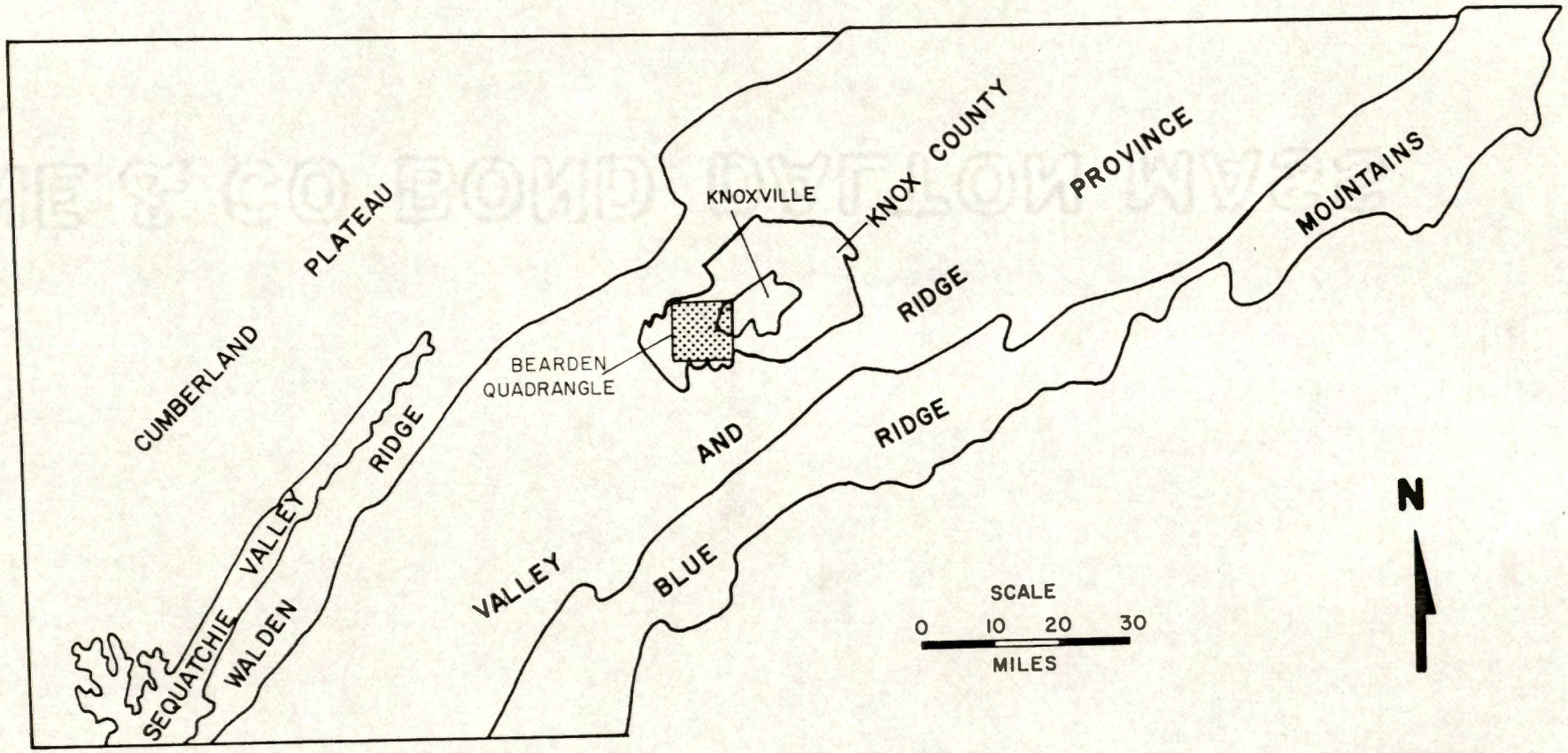

Figure 1. Location of Knox County, Tennessee, in relation to regional physiography.

Other physical features such as sinkholes, caves and underground streams are numerous. These features reflect landscape formation in regions underlain by carbonate rocks and are important in the understanding of groundwater and its movements. The recognition of areas of past uplift and subsidence is of importance, especially to those concerned with construction and waste disposal. Some natural features have developed into tourist attractions.

Parent material, time, relief, climate, and living organisms are the principal soil forming factors. A sixth factor--man--has also effected changes in the soils of the county. Climate in Knox County is humid and temperate with approximately 50 inches of rainfall evenly distributed throughout the year (U. S. Department of Commerce, 1970). Winters are mild (approximately 41°F) and summers are warm (approximately 77°F). Over a long period of time, the high rainfall and long periods of warm weather have also influenced soil formation with the result that pale-colored surface layers and red, clayey B horizons predominate.

Living organisms have contributed to soil formation, but because of lack of diversity in the small area studied, they contribute little to differences among soils. Not only have living organisms added organic matter to the soil, they have influenced the gains and losses of plant nutrients; promoted and were involved in physical and chemical changes;

contributed to soil structure and porosity; and influenced the development of soil horizons (Moneymaker, 1973).

Man has had a large impact upon soil formation and land surface characteristics. Disturbances of the soil by construction and neglect of good land management practices have greatly altered some of the original characteristics of the soil.

Parent material, time, and relief probably account for more of the differences in the soils in Knox County than do the other soil forming factors. Parent material governs the mineralogy of the soil, contributes to the texture which in turn affects the soil-water relationships and combines with the other factors to determine relief.

Many soil differences in Knox County can be attributed to the differences in relief. "On many steep slopes, the soil has eroded off about as fast as it formed resulting in weakly developed soils that are shallow to rock" (Moneymaker, 1973). Relief has influenced the kinds of soils that formed through the larger amount of runoff on steep slopes than on gentle slopes and the kinds of organisms in the soils.

The length of time that a soil has been exposed to weathering processes also influences the degree of profile development. Profile development is greater on a stable surface where sediment is not being received and active erosion

is not occurring than on a surface which is receiving sediment or eroding.

Population expansion is quickly changing West Knox County from agricultural to residential and industrial uses. Much of the highly productive farmland has already been used for subsurface residential, industrial, and service use. If the physical and chemical characteristics of the soils had been considered during development, some of the urban and industrial land would now be deemed unsuitable as construction sites. Additional knowledge of the soils by the public is needed in order to better use the soils according to their capabilities. To gain this knowledge, some form of presentation of the known soils information needs to be devised to help people use soils information.

CHAPTER III

SELECTED REVIEW OF METHODS USED TO COMPUTERIZE MAP DATA

Many methods of storage, manipulating, and displaying of resource data by the computer have been investigated. Four methods of soils digitization selected for review were MIADS2, Polygon, Dominant Feature, and Point Sampling. These four systems were also investigated and evaluated according to their capabilities and limitations for manipulating and displaying soils data. Other types of resource data can be used, but for discussion purposes soil data is being used throughout this chapter.

MIADS2

MIADS2 (Map Information and Display System--Alphanumeric) is a system for extracting and displaying geographic information (Amidon, 1966). Map information is placed in computer form by using alphanumeric symbols for each resource unit. A grid is placed over the soil map to divide the map into segments or cells. Digitization of every cell is not required since this program automatically repeats the data until a cell with a different type of data is encountered. The resource map is digitized one line at a time using row and column numbers to express the location of a cell from a

common reference point (usually one of the four corners of the grid). This system has the capability of producing either maps or individual data sets or overlaying data sets to form a composite map. After careful review of this article it was decided that this system was inappropriate for the work needed.

Polygon Method

The polygon method involves the delineation of the soil boundaries on a computer-generated grid (Meyers, Durfee, Tucker, 1974). The grid is produced by specifying the longitude, latitude, scale, and size of the soil map (Durfee, in preparation). The soil map is overlain with the grid, and a series of horizontal and vertical lines are used to outline the soil boundaries on the grid. When a soil boundary is completely outlined by horizontal and vertical lines, a soil polygon is formed. A number is then placed inside the soil polygon directly above a horizontal line. This number refers to the soil mapping unit enclosed by the soil polygon. When a soil boundary passes near the center of a cell, a decision has to be made as to which soil mapping unit makes up most of the cell.

Some of the problems encountered with the polygon method are (1) error correction, (2) map complexity, and (3) time. Chances for errors are minimal and their corrections are simple when the soil map has many large soil mapping units.

However, as the number of smaller soil mapping units (three acres or less) increases, the chance for errors and the time required for correction of errors increases proportionally with the number of smaller soil mapping units.

Types of errors encountered in using this method are:

1. Coding an invalid soil number or polygon boundary.
2. Coding a polygon without coding a corresponding soil number.
3. Failure to close a polygon by not coding a row or column number.
4. Failure to code a soil mapping unit, thereby implying that it does not exist.
5. Placing two different soil numbers within the same polygon.

Errors of these types are common when a very detailed base map covering a large land area is used. If many small delineations are included in the detail of the map, large amounts of computer time and correction time will be required to make all error corrections. This method requires that the work be done by expert soil scientists because of the number of technical decisions to be made.

Dominant Feature Method

A grid is placed over the soils map so that the map is divided by a series of rows and columns into segments or cells referenced to longitude and latitude coordinates.

Digitization is begun in the northwest corner using a series of row and column numbers followed by a soil mapping unit symbol where the soil mapping units change. Each cell is referenced from the origin by the row and column number. This method also requires soil expertise to make technical decisions on the soil mapping units since most of the decisions involve deciding upon which soil should be given preference when several soils occur in the same cell.

This method differs from the polygon method in the following ways:

1. A cell by cell decision is required rather than outlining of the soil mapping unit.
2. Only one type of coding form is used as compared to two types of forms required for the polygon method.
3. As the detail of the soil map increases, the number of decisions required to digitize soil data increases.
4. Fewer errors are made and less time is required for correction of errors since polygons are not drawn.

Point Sampling Method

This method is similar to the dominant feature method in both data collection procedures and types of errors. Instead of digitizing the dominant soil mapping unit in a cell, a point in grid form is placed at the center of each cell. The soil mapping unit underneath the point is placed on the coding

form. This is not necessarily the soil mapping unit that would be dominant in the cell. This method may sample even the smallest soil bodies on a soil map, and a decision is required only when a point falls directly on a soil boundary. By reducing the number of decisions and errors, the time involved in the data collection process is greatly reduced. The need for soil scientists is lessened when technical decisions are reduced, and untrained people in soils can be utilized to digitize the information.

Evaluations of these methods--MIADS2, Polygon, Dominant Feature, and Point Sampling--were based upon referencing systems, errors and error collections, availability of the system, and personnel needed. It was decided that the Point Sampling Method was most desirable.

CHAPTER IV

METHODS AND PROCEDURES

Selection of Mapping Program to Produce Interpretive Maps

The MAPCLASS computer program was used to produce line printer interpretive maps (Jones, McCroskey, Smart, 1975). This program takes basic resource data, performs manipulations and calculations on the data, and displays it as a line printer map. It can perform as many as 10 interpretations at a time from soil mapping unit information with as many as 10 individual classes for each interpretation. It also has the ability to make combinations of different soil interpretations or combine different types of resource data into a composite map with as many as 10 classes.

Selection of Cell Sizes

Cell size selection for computerization of resource data is influenced by the answers to the following questions.

1. How accurate is the resource data?
2. Who will be using the digitized data?
3. What combinations with other types of resource data will be made?
4. Will the data in computer form be used intensively or extensively?

5. Will it be adaptable to other computer systems with little change in the computer program?
6. Can the data be aggregated to a cell size that is compatible with less accurate resource data in order for combinations to be made with the less accurate data?
7. What is the cost of placing the resource data in computer form?
8. How long will it take to digitize the data?
9. What types of referencing systems are available?

These questions and others were considered in determining the cell sizes used in this study.

Inquiries into the accuracy of the Knox County Soil Survey indicated that the accuracy of the base map was questionable. By directly overlaying the most up-to-date topographic maps (1:24,000) onto the soils map, it was found that the roads, churches, cemeteries and buildings were incorrect by about one-half inch in some cases. The reason was that planimetric maps were used. No topographic maps were available (L. Harris, personal communication).

Features of the soil map which affected the choice of cell sizes used were inclusions in a larger soil mapping unit, and the smallest area delineated by a soil mapping unit. Cell sizes of 1.10 acres (2.50 seconds on a side, .48 hectares) and 2.68 acres (3.75 seconds on a side, 1.08

hectares) were finally chosen for comparison after careful consideration was given to the questions regarding the system, methods and data.

The line printer in its standard form contains ten characters per inch across the line (columns) and eight characters per inch down the page (rows). Thus each character of printed output is 1.25 times as long as it is wide. Fortunately, at the latitude of the Bearden Quadrangle (36 degrees N) one minute of latitude is 1.24 times as long as one minute of longitude. Thus, at this latitude a print character can with very little generalization be used to portray a rectangular area in which the units of latitude are exactly equal to the units of longitude.

For this study a rectangular cell of 3.75 seconds latitude by 3.75 seconds longitude was chosen. If a single print character is used to portray each cell, the line printer equivalent of the quadrangle map has the dimensions of 12 inches (30.5 cm) by 15 inches (38.2 cm). The quadrangle map as published at 1:24,000 scale has the dimensions of 18.5 inches (47.0 cm) by 23.0 inches (58.2 cm). For areas at different latitudes, the cell on the ground represented by the printer cell will still have a ratio of length to width of 10:8 but in terms of latitude and longitude, this cell cannot be of equal minutes and seconds.

The 1.19 acre cell and the 2.68 acre cell are a part of the geodetic cell hierarchy (Figure 2). A geodetic cell is a trapezoidal area on the earth's surface that can be exactly located by longitude-latitude coordinates. Geodetic cells change in acreage with latitude from the convergence of the lines of latitude at the poles, but as longitude changes, these lines do not converge at a point; therefore, the acreages remain the same for any particular line of longitude.

The two cell sizes selected for comparison differ in the number of cells required to cover the study area, the size of each cell and the display precision of the soils data and interpretations. For the Bearden Quad, 2.25 times more cells (32,400) were needed for the 1.19 acre size than for the 2.68 acre size (14,400). The 2.68 acre cell covers 2.25 times more area (116,740 square feet) than the 1.19 acre cell (51,836 square feet). However, the difference between the width of the two cells is only 38 yards.

In order to make any combinations of the data from the two cell sizes, they would first have to be aggregated to a common cell size of 10.72 acres. This aggregation could be accomplished by combining four 2.68 acre cells into one larger 10.72 acre cell, and by combining nine 1.19 acre cells into one 10.72 acre cell. Aggregation from one cell size to another does not mean the loss of data. The data is still readily available at the original cell size for use in making interpretations and combinations.

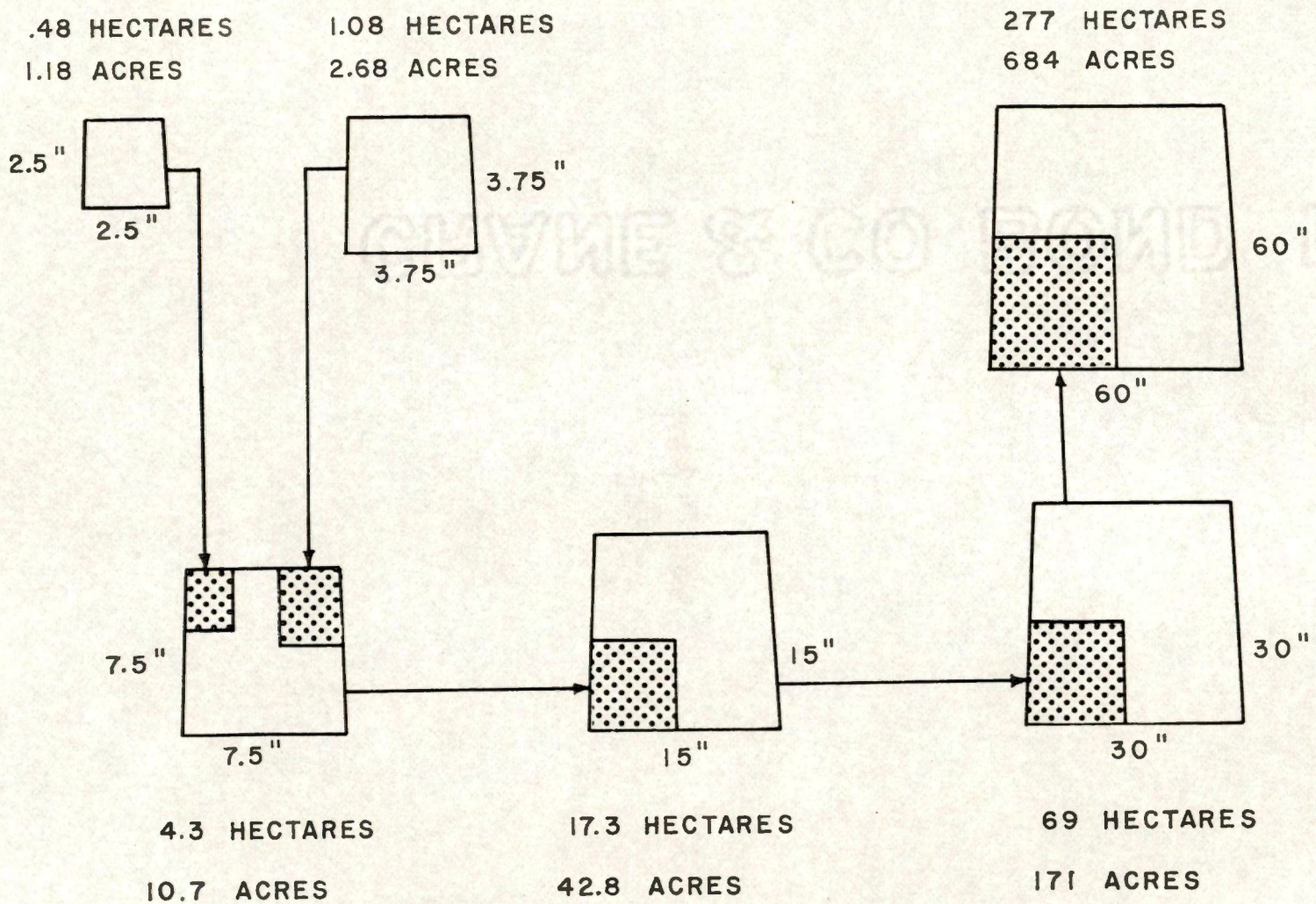

Figure 2. Geodetic cell hierarchy.

Description of Soil Data Capture Process

The point sampling method was used to digitize the soils data. This method was selected because it provides a sampling of the soil mapping units, is based upon a geodetic cell, and does not require technical people for digitization. Data for two cell sizes were digitized by this method to provide a visual and time-cost comparison.

Digitization of the soils data was the next step. A computer drawn grid (Durfee, in preparation) was placed over the soil base map and registered to longitude-latitude (Figure 3). Digitization begins in the upper left hand corner (northwest corner) using a row-column procedure. The row number was written on the coding form first, then a series of columns followed by a soil symbol was recorded on the form. The individual soil mapping unit symbols are coded onto the form; thereby, eliminating a conversion from the soil mapping unit symbol to a numeric code during digitization. When one line of the coding form was filled, coding was continued on the next line. This process was continued (going from left to right on the grid) until the entire map had been digitized, and the data recorded on the coding form.

The data, recorded on the coding forms, was then keypunched on computer cards. Various interpretations from the soil mapping unit information were made by investigating

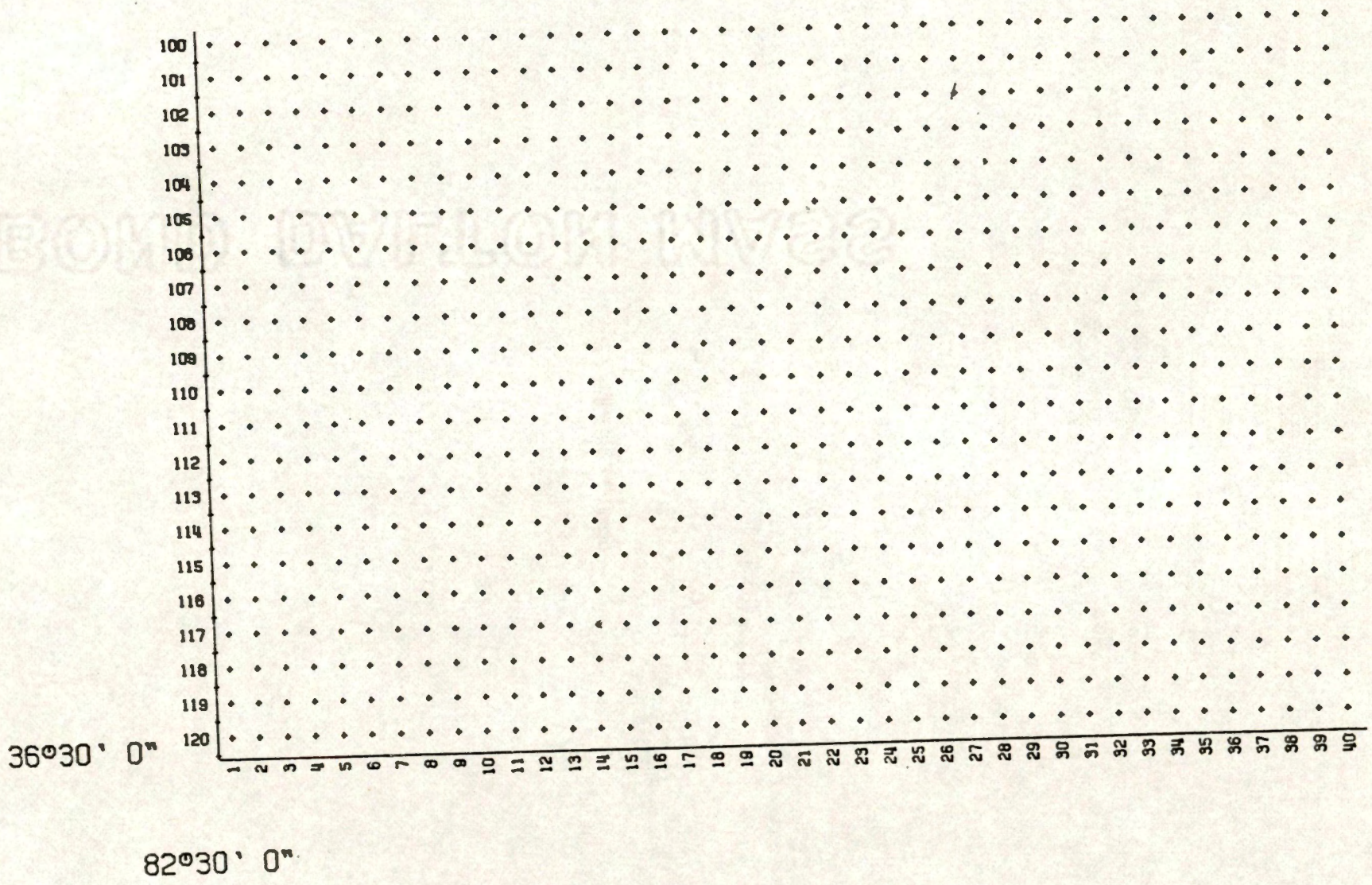

Figure 3. Grid overlay for transposing map data into machine readable form (digitization).

the description of each soil mapping unit (Table 1). Groupings of soil mapping units into classes (Table 2) were made based upon the projected use of each interpretation for future planning needs. After assigning the soil mapping units to various classes for every interpretation, line printer maps were produced.

A visual scan of the different patterns displayed by the various interpretations aided in locating and correcting many of the errors. An example of an obvious error on a line printer map is shown in Figure 4. The obvious error in this example is the string of dashes continuing through the areas where heavier overprinting occurs.

Less obvious errors are more difficult to determine, but the patterns are still useful since errors tend to be row oriented rather than column oriented. For example, dark symbols appearing in an area which has light symbols surrounding them as seen in Figure 4 could be an error. These cells would have to be compared to the original soil map to determine if they are correct. After most of the errors were found, final interpretive maps were produced.

Selection of Interpretations

Several factors enter into the selection of interpretations. Currently, interpretations are being made throughout the United States for both farm and nonfarm use.

Table 1. Example of Information Used as Basis for Single Purpose Interpretations on the Bearden Quadrangle in Knox County, Tennessee*

Soil Phase	Interpretations					
	Depth to Bedrock	Slope Gradient	Percolation Rate	Soil Drainage	Potential Flooding	Corn Yields
	feet	%	inches/hour			bu/a
Emory Silt Loam, undulating phase	5-20	2-5	0.8-2.5	well	occasionally	120
Clarksville Cherty Silt Loam, steep phase	5-25	25+	0.8-2.5	excessively	seldom	45
Melvin Silt Loam	5-25	0-2	0.2-0.8	poorly	frequently	72
Hamblen Silt Loan	5-30	0-3	0.5-1.5	somewhat poorly	occasionally	90
Colbert Silty Clay Loam, rolling phase	0.0-2.0	5-12	less than 0.2	moderately well	seldom	40
Leadvale Loam, undulating phase	3.5-5.0	2-5	0.8-2.5	somewhat poorly	seldom	65

*Corn yields are assumed under a high level of management and approved conservation practices.

Table 2. Example Assignment of Soil Mapping Units to Interpretation Classes, Bearden Quadrangle, Knox County, Tennessee

Soil Phase	Interpretations					
	Depth to Bedrock	Slope Gradient	Percolation Rate	Soil Drainage	Potential Flooding	Corn Yields
	class	class	class	class	class	class
Emory Silt Loam, undulating phase	1	1	1	2	1	1
Clarksville Cherty Silt Loam, steep phase	1	3	1	1	1	5
Melvin Silt Loam	1	1	3	5	3	3
Hamblen Silt Loam	1	1	2	4	2	2
Colbert Silty Clay Loam, rolling phase	3	2	3	3	1	5
Leadvale Loam, undulating phase	2	1	3	4	2	4

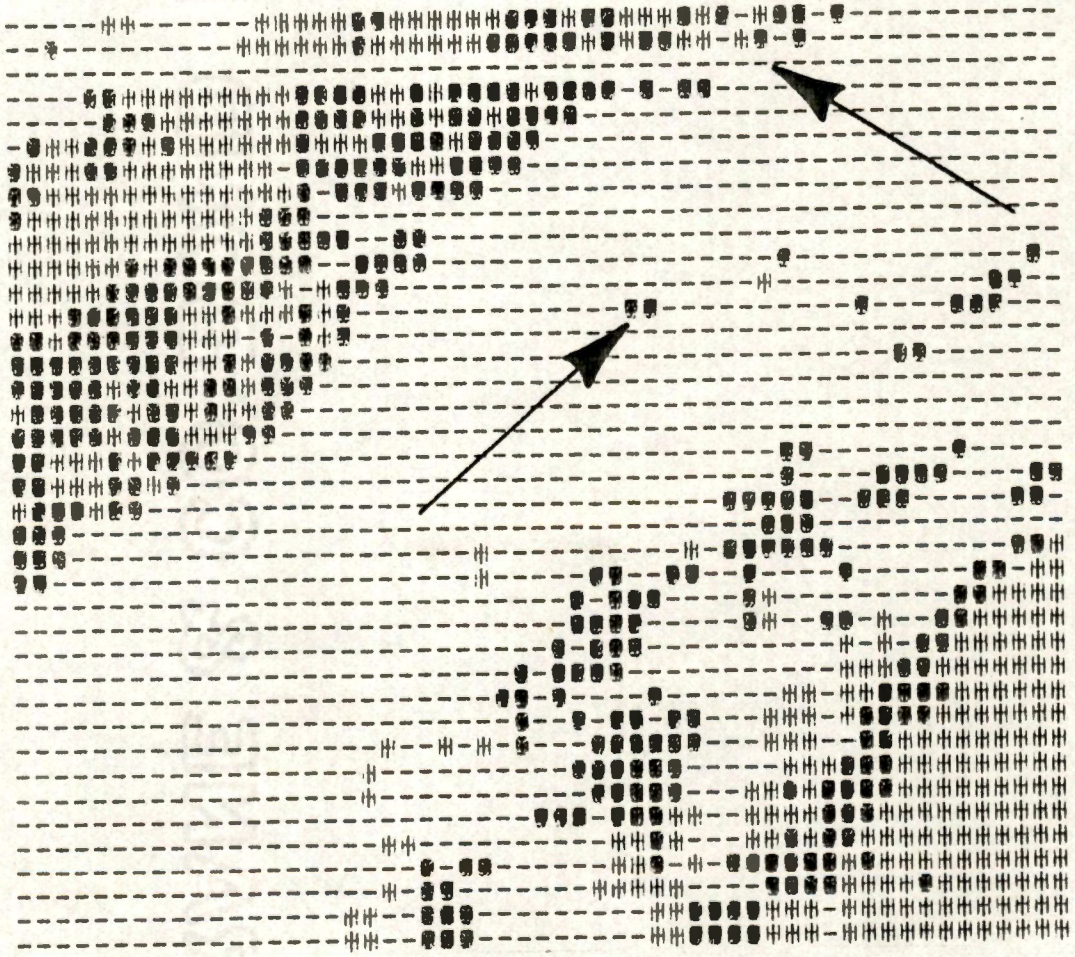

Figure 4. Examples of errors encountered during correction of digitized soil mapping units.

Some of the criteria used in the selection of interpretations to produce are:

1. land planning and zoning
2. septic tank filter field capability assessment
3. building and real estate development site location
4. tax assessment
5. outdoor recreation planning
6. wildlife habitat improvement and management
7. soil productivity assessment
8. environmental impact assessment

Six interpretations were chosen to demonstrate their various uses. They are depth to bedrock, slope gradient, predicted percolation, potential flooding, soil drainage, and potential corn yields.

Depth to bedrock is important for many reasons. Site appraisals for sanitary land fills and construction of homes, apartments and factories includes a study for the depth to bedrock in the preliminary plan of a project.

Interpretations for slope gradient serve many useful purposes. Terracing for agricultural purposes is based upon slope. Soil drainage, irrigation and cropping patterns are also influenced by slope gradient. Apartment complexes, factories, and retail businesses consider the slope in construction and design for these projects.

Predicted percolation was used for its importance in soil drainage. The ability for water movement through the soil is important in disposal fields, sanitary land fill location, runoff, groundwater recharge, recreational uses, and building location.

Potential flooding areas are of great concern to many planners. Flooding areas are especially important in flood plain zoning, wildlife habitat development, marshland management, and urban development. The classes of seldom, occasionally, and frequently were chosen for potential flooding after examination of the soil description. Cells occupied by water and outside the counter were placed in other classes. By locating areas that flood, plans can be effectively made and implemented. The weakness of basing flooding areas upon soil characteristics is that not all flooding areas can be precisely defined.

Soil drainage has many important effects. Farm planning is affected considerably by soil drainage because crop response is different on different drainage classes. Some crops produce well under wet soil conditions while other crops produce little. Soil drainage is also considered in the location of areas that will support wetland wildlife construction projects and sanitary land fills. Time and costs involved in construction can be adversely affected if site location and drainage are ignored. Soil drainage,

combined with other soil and research data for a site, reveal many of the problems that may occur.

Potential corn yields were used because of several reasons:

1. Corn grows during the warm season and reflects soil differences in available water supplying capacity.
2. Slightest changes in climatic or management inputs result in a change in yield.
3. It has a 10 to 14 day fruiting period and yield is more subject to variations in management and climatic changes.

Corn is very sensitive to moisture variations. When the optimum conditions are altered, the result is usually reflected in the yield. Corn yields are a good indicator of the productivity of the soil because of the variations obtained under less than optimum conditions.

CHAPTER V

RESULTS AND DISCUSSION

Soil Interpretations

Interpretations made from the digitized soil mapping units included depth to bedrock, potential flooding, slope gradient, potential percolation rates, soil drainage, and potential corn yields. Single purpose maps for depth to bedrock (Figures 5 and 6) were used for making comparisons between two different cell sizes (1.19 acres and 2.68 acres). Three levels used to describe depth to bedrock were: (1) greater than six feet to bedrock, (2) four to six feet to bedrock, and (3) less than four feet to bedrock. Cells occupied by water and those outside the county are assigned to other classes. The depth to bedrock for each soil mapping unit in the Knox County Soil Survey aided in establishing the classes. The various classes were selected because of their usefulness in selecting locations of septic tank filter fields.

Table 3 illustrates an acreage summary by classes for depth to bedrock for both cell sizes. The total acreage difference regardless of sign is 74 acres. This represents 0.19 percent of the total acreage for the quadrangle. Based upon acreage calculations alone, the 1.19 cell does not demonstrate a distinct advantage.

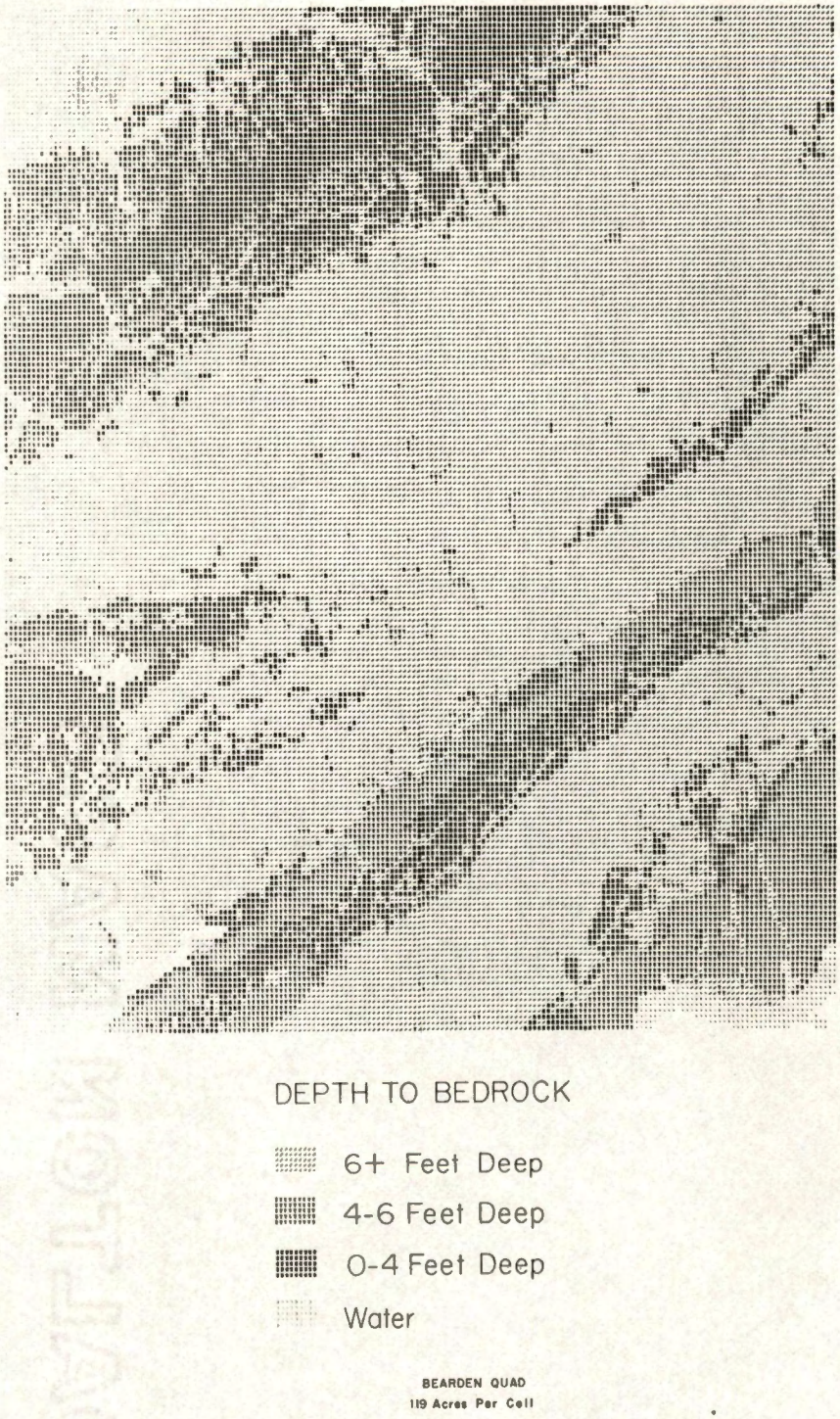

Figure 5. Single purpose line printer map for depth to bedrock for the Bearden Quadrangle using 1.19 acre cells.



Figure 6. Single purpose line printer map for depth to bedrock for the Bearden Quadrangle using 2.68 acre cells.

Table 3. Acreage Summary by Classes for Depth to Bedrock of 1.19 and 2.68 Acre Cells on the Bearden Quadrangle in Knox County, Tennessee

Class	Cell Size		Difference
	1.19 Acres	2.68 Acres	
greater than 6 feet to bedrock	24953	24962	+ 9
4 to 6 feet to bedrock	5176	5139	-37
0 to 4 feet to bedrock	7928	7928	0
outside the county	86	102	+16
water	518	530	+12
Total Acreage	38661	38661	0

Potential flooding (Figures 7 and 8) is not a property of the soil. It is a condition which is affected by the location of the soil. However, in some counties flooding is estimated and placed within the description of the soil in the soil survey. It was from the description of the soils that the frequency of flooding was estimated.

A comparison of the two cell sizes (Table 4) shows no difference in total acreage since the errors compensate to give a total difference of zero. However, if one ignores the signs for each class there is a 206 acre total difference. A careful study of the flooding patterns of the two single purpose maps reveals that the 1.19 acre cell shows the flooding areas more accurately than the 2.68 acre cell. This fact is also demonstrated in Table 4. The largest differences between totals for cell sizes are in the seldom and frequently flooding classes. These differences can be expected since the sampling intensity is greater with the smaller cell size. This greater sampling intensity will increase the probability of cells occurring in the long, narrow soil mapping units that flood frequently as shown by the visual comparison of the two single purpose maps and by the acreage comparison in Table 4. The closeness of total acres between the cell sizes for the occasional flooding class indicates that the soil mapping units making up this class are larger in area in comparison to the soil mapping

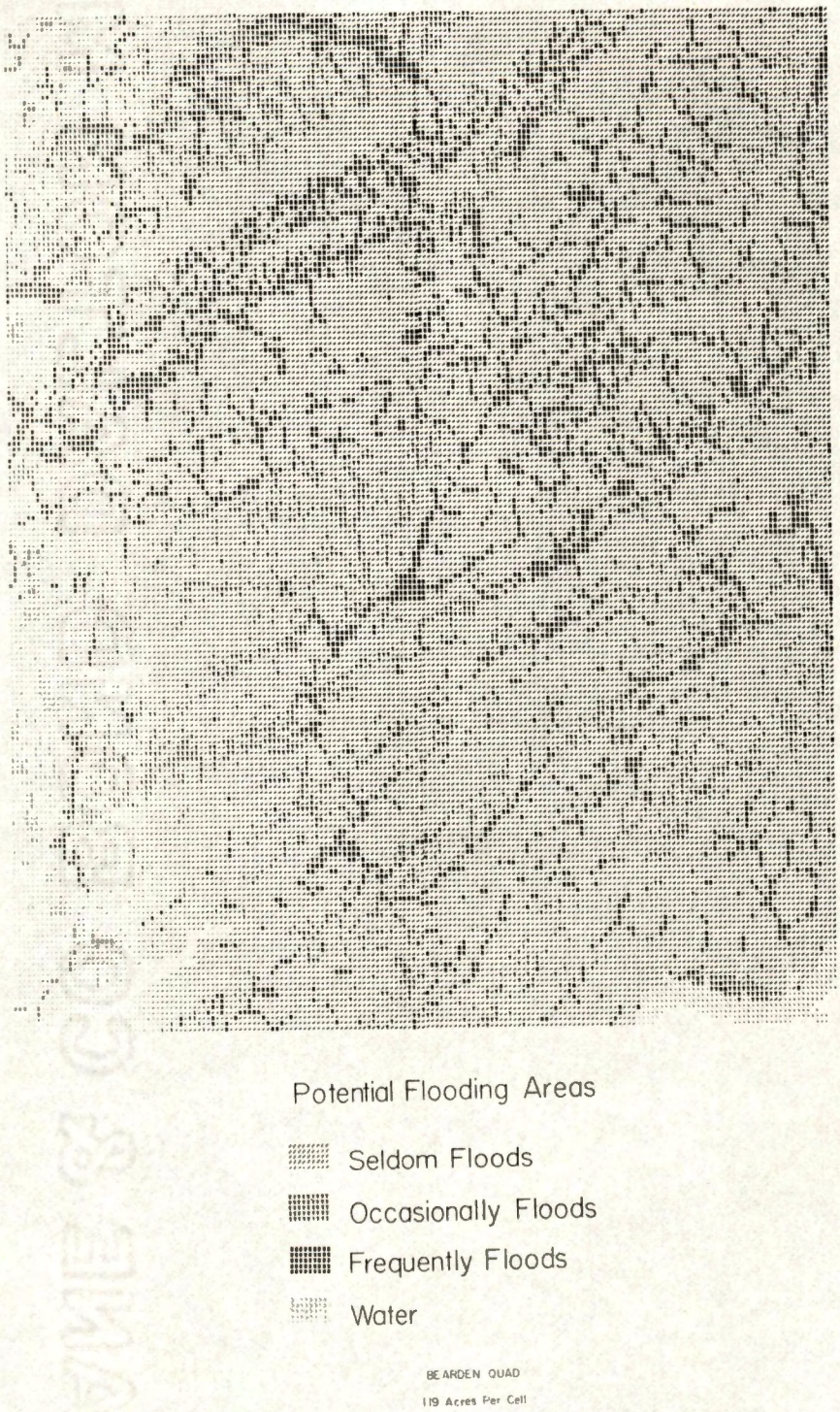

Figure 7. Single purpose line printer map for potential flooding areas on the Bearden Quadrangle using 1.19 acre cells.

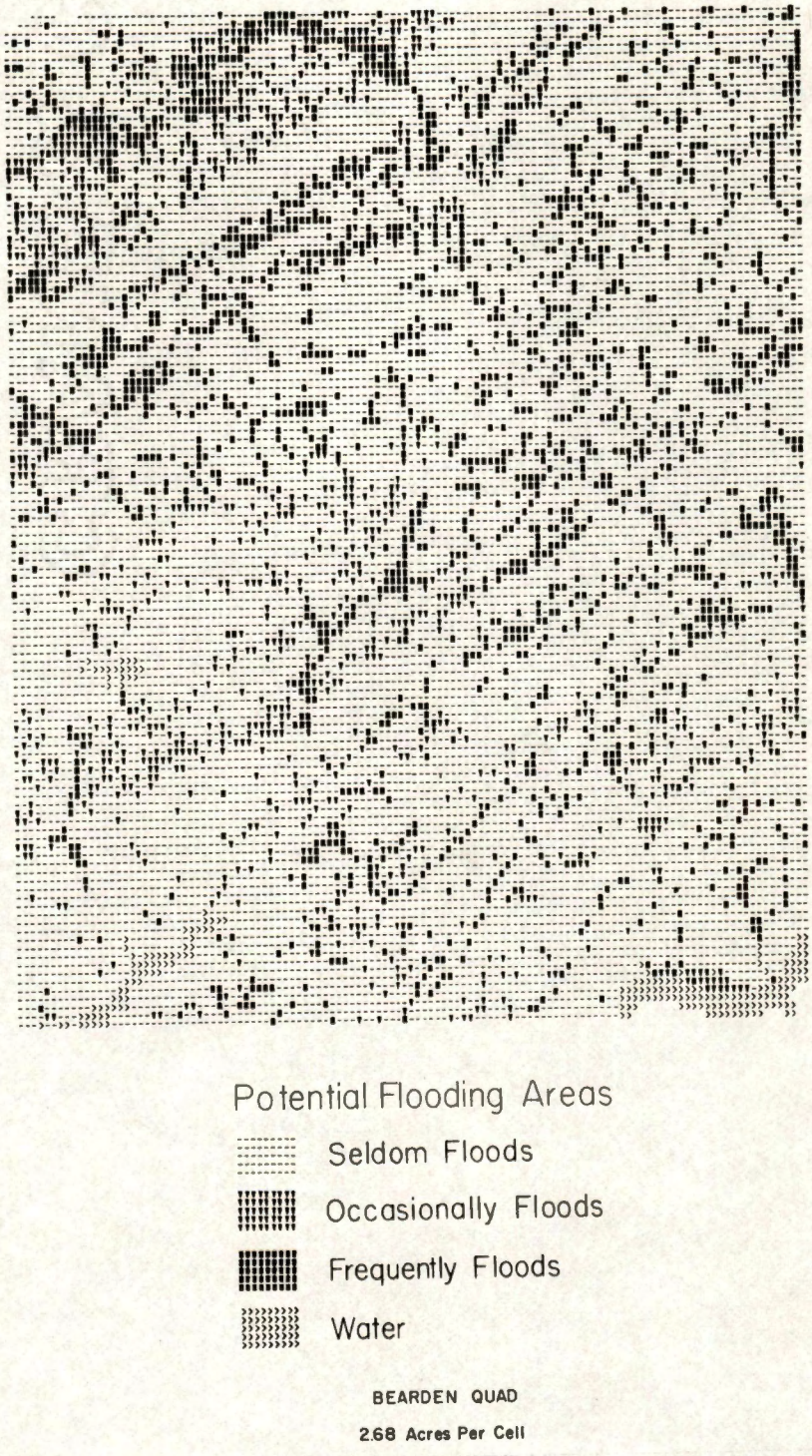

Figure 8. Single purpose line printer map for potential flooding areas on the Bearden Quadrangle using 2.68 acre cells.

Table 4. Acreage Summary by Classes for Potential Flooding Areas of 1.19 and 2.68 Acre Cells on the Bearden Quadrangle in Knox County, Tennessee

Class	Cell Size		Difference
	1.19 Acres	2.68 Acres	
seldom	29744	29819	+75
occasionally	3169	3165	- 4
frequently	5144	5045	-99
outside the county	86	102	+16
water	518	530	+12
Total Acreage	38661	38661	0

units falling in the frequently flooding class. Since they are larger, the 2.68 acre cell is able to define those areas, and display them as well as the 1.19 acre cell.

Slope gradient (Figures 9 and 10) was chosen because of its importance in various interpretations. Septic tank filter field interpretations were used as the basis for establishing the various slope classes. The slight hazard class (0 to 12 percent slopes) indicates that slope should present little hazard in filter field construction and usage.[1] The moderate hazard class (12 to 25 percent slopes) indicates the possibility of effluent seepage to the soil surface. The severe hazard class (25+ percent slopes) indicates that severe problems with filter field effluent may be encountered. Two additional classes--outside the county and water--were established for cells occurring in these classes.

Acreage comparisons (Table 5) for the two cell sizes show no difference in total acres for all classes. However, the total difference is 524 acres. This represents 1.36 percent of the total area where there is a difference occurring between the single purpose maps. This difference can be accounted for when the general relief of the area is

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[1]These levels are currently being used by the Soil Conservation Service in Tennessee for septic tank filter field ratings.

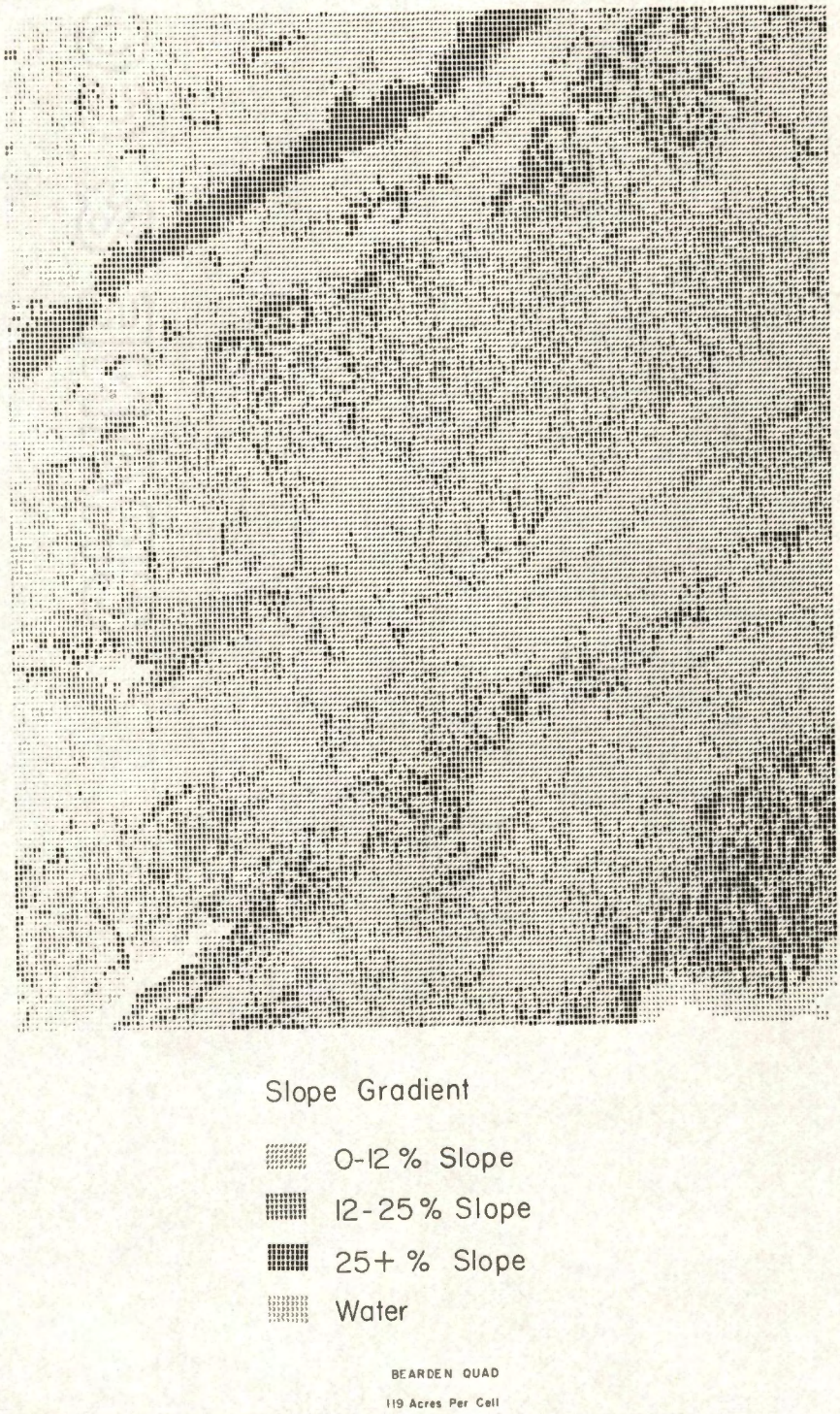

Figure 9. Single purpose line printer map for slope gradient on the Bearden Quadrangle using 1.19 acre cells.

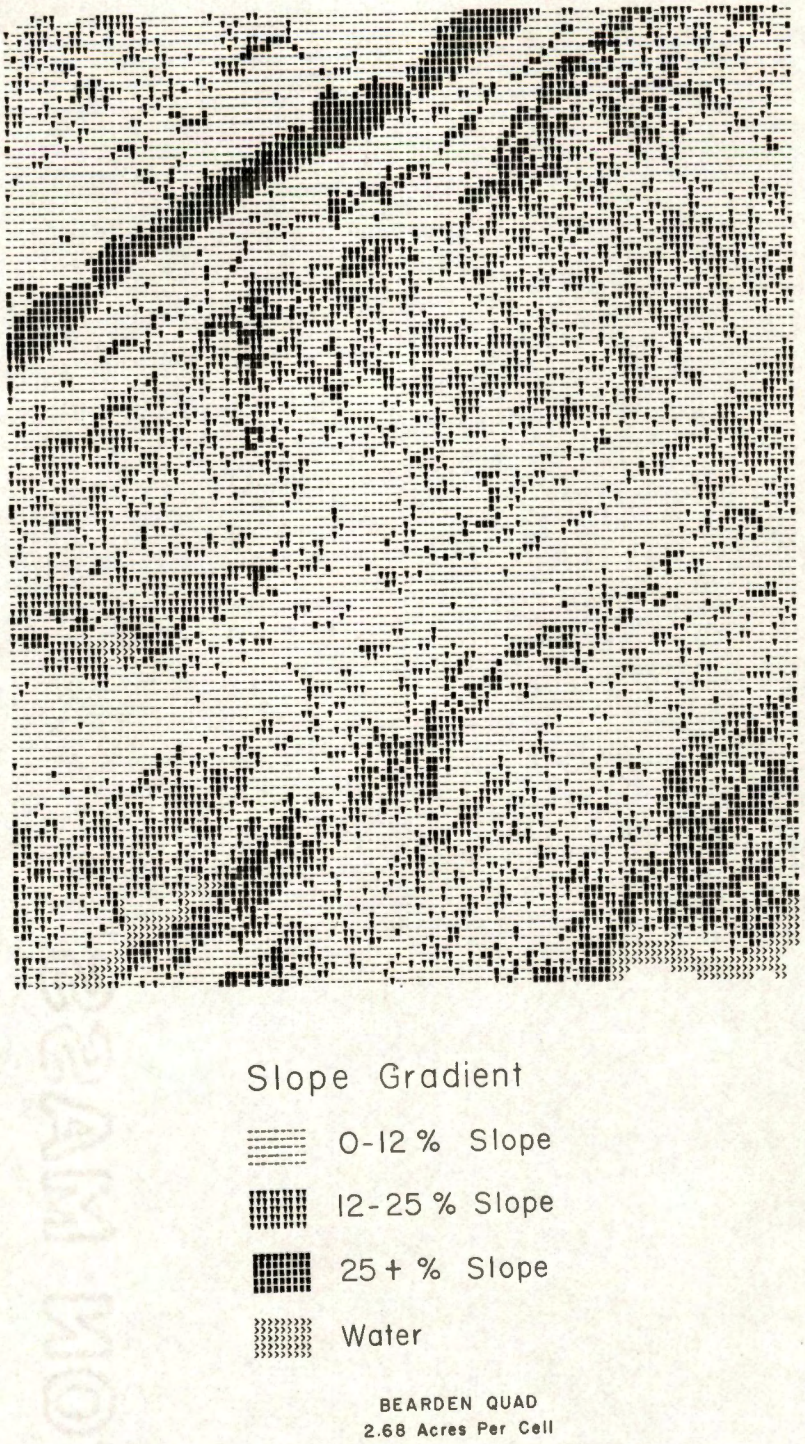

Figure 10. Single purpose line printer map for slope gradient on the Bearden Quadrangle using 2.68 acre cells.

Table 5. Acreage Summary by Classes for Slope Gradient of 1.19 and 2.68 Acre Cells on the Bearden Quadrangle in Knox County, Tennessee

Class	Cell Size		Difference
	1.19 Acres	2.68 Acres	
0 to 12% slope	24870	24962	+ 92
12 to 25% slope	9076	8814	-262
25+ % slope	4111	4253	+142
outside the county	86	102	+ 16
water	518	530	+ 12
Total Acreage	38661	38661	0

studied. The topography is predominantly rolling and hilly (0 to 12 percent and 12 to 25 percent slope classes) on the Bearden Quadrangle. When the 12 to 25 percent and 25+ percent classes are compared, the greatest differences in acreages between cell sizes are found. This indicates distinct breaks between soil mapping units with these slope ranges, and the smaller cell size records these breaks more accurately resulting in the greater differences between these two classes.

Predicted percolation is illustrated by Figure 11. Percolation measurements were estimated from soil mapping unit information. The percolation rates for the various soils listed in the Knox County Soil Survey were obtained from the modal soil descriptions. The different classes of percolation rates were taken from the State Health Department regulations for septic tank filter fields (State of Tennessee, 1974).

A percolation rate greater than 1 inch per hour indicates slight limitations for septic tank filter fields. A rating of 0.6 to 1 inch per hour indicates moderate limitations. Thus a filter field may work if construction is modified. A rating of less than 0.6 inches per hour indicates a severe limitation, and modification of the filter field is almost impractical.

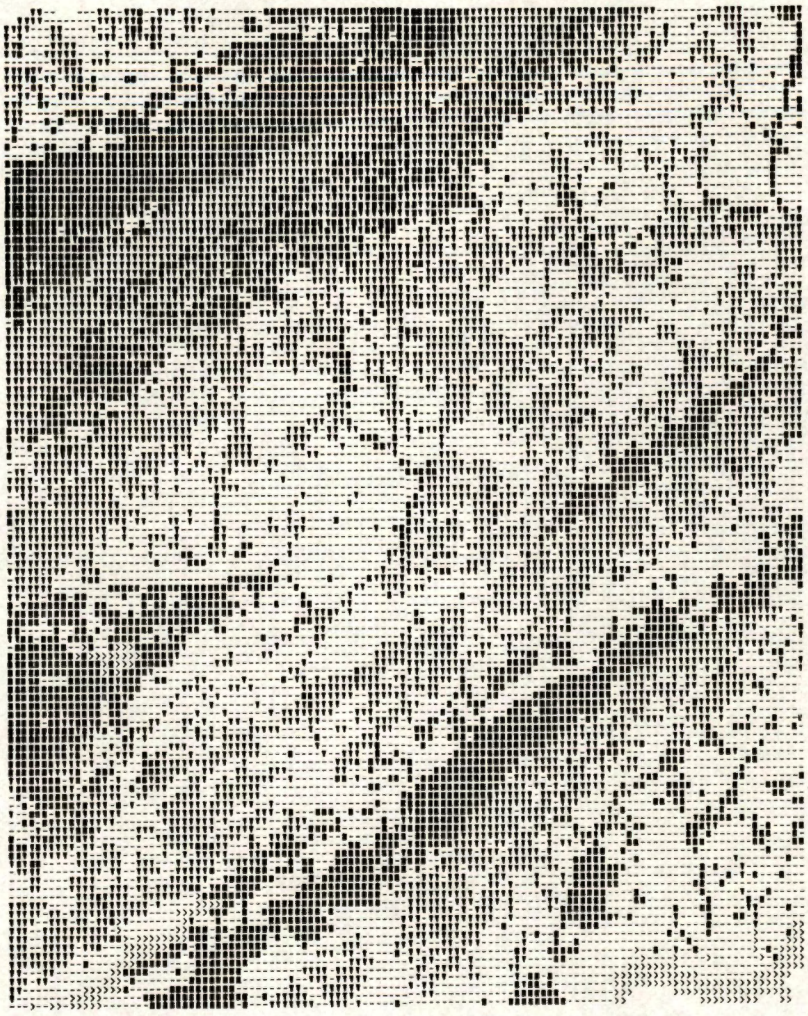

Figure 11. Single purpose line printer map for predicted percolation rates on the Bearden Quadrangle using 2.68 acre cells.

Soil drainage (Figure 12) has many different types of classifications. The different classes of drainage used were excessively, well, moderately well, somewhat poorly and poorly. Another important class is man-disturbed or disturbed areas. These areas have been disturbed in some way (grading, filling, soil removal or soil deposition) so that the soil drainage is almost impossible to determine.

Figure 13 is a single purpose computer interpretive map for potential corn yields. The classes were determined by updating estimated yields for each soil mapping unit in the Knox County Soil Survey by using similar West Tennessee soils where current yields are known. The updated yields for all soil mapping units were ranked and grouped into five yield classes.

The breakeven point for corn, using $2.50 per bushel and a high management level, is 38 bushels per acre.[2] A 50 bushel per acre minimum was established to provide a return above the original investment. Twelve bushels at $2.50 per bushel will provide a return above costs of $30 per acre. Other break points were at 67, 85, and 103 bushels per acre. These breaks were arrived at by ranking the potential corn yields for all soil mapping units and using breaks of 17 bushels per acre as the range of the classes.

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[2]Personal communication with Dr. Herbert N. Walsh, Associate Professor of Extension, Agricultural Economics, University of Tennessee, January 1975.

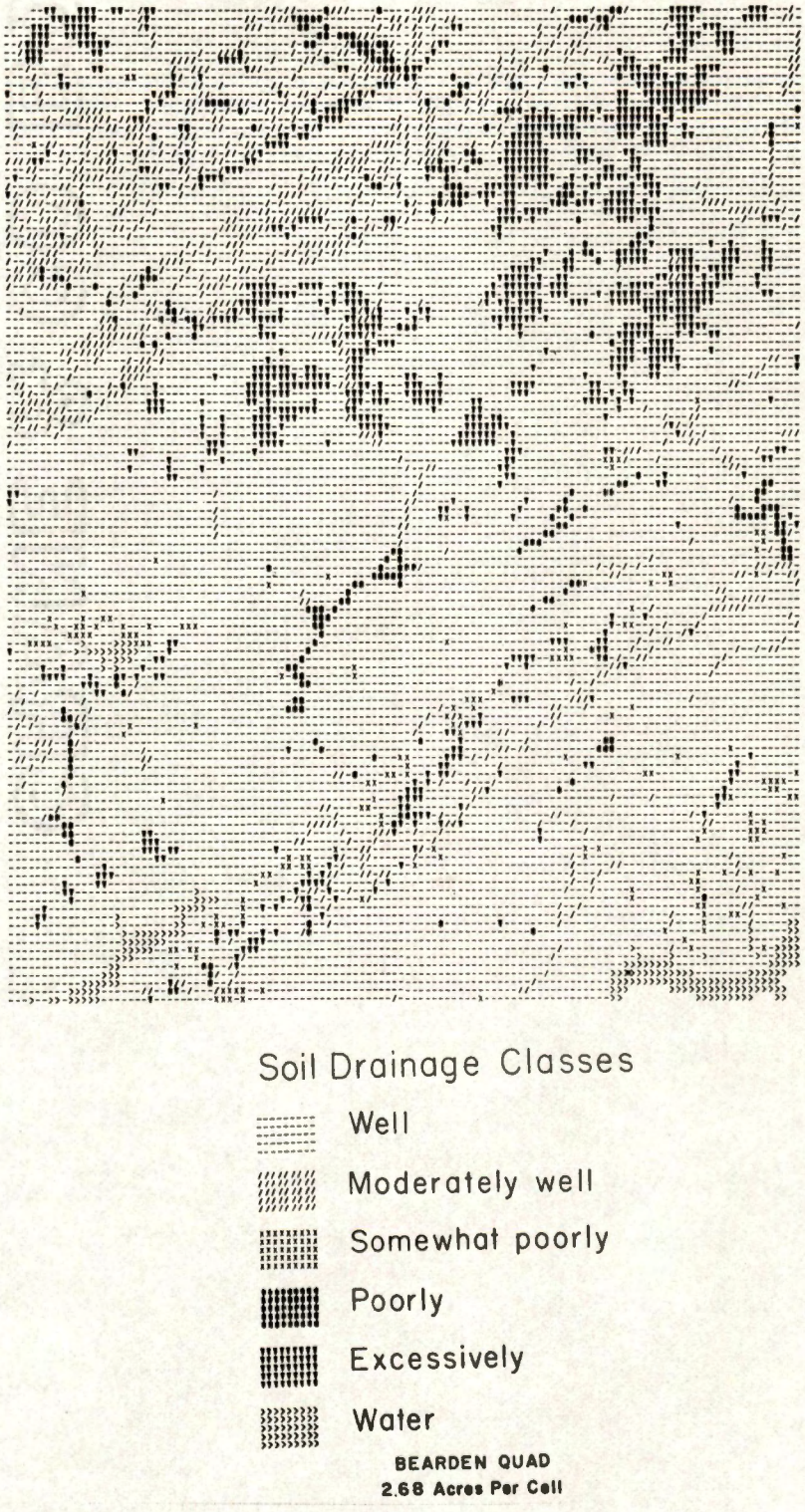

Figure 12. Single purpose line printer map for soil drainage on the Bearden Quadrangle using 2.68 acre cells.



Figure 13. Single purpose line printer map for predicted corn yields on the Bearden Quadrangle using 2.68 acre cells.

Combinations for More Efficient Planning

Single purpose maps are useful for illustrating one interpretation obtained from individual soil mapping units at a time, but sometimes planning requires the combining of several different interpretations. In Figure 14 depth to bedrock, slope gradient, predicted percolation, and potential flooding were combined by computer overlaying these interpretations to produce a map showing areas that are suitable for septic tank filter fields.

These four variables were combined because each, in its own way, is related to the success of a filter field system. Potential filter field sites require an adequate depth to bedrock to allow for installation of the septic tank and field line and for filtration of the effluent before entering the groundwater. At slope gradients greater than 25 percent septic tank effluent may seep to the soil surface rather than be retained in the soil. The site should not flood because of problems caused in the field line and the house itself. The percolation rate should be rapid enough to allow the effluent to move downward through the soil instead of remaining at or near the surface (U. S. Department of Agriculture, 1971).

The smaller cell sizes are useful for individuals or groups concerned with problems which require very detailed interpretations, but for planning on a larger scale--regional,



Figure 14. Composite map showing limitations for septic tank filter fields on the Bearden Quadrangle using 2.68 acre cells.

state, or national--a larger cell size is adequate. The ability to aggregate data from one cell size to another is especially important for planning purposes. The aggregation of data does not destroy the data of the smaller cell size, rather it presents it in a form so that it may be used over a much broader area--for example a county or multicounty region. The data of the original cell size may be used in the future to produce additional interpretations.

Corn yield interpretations at 2.68 acres per cell were aggregated to 10.72 acres per cell to demonstrate this feature (Figure 15). Comparisons of the acreages for both cell sizes (10.72 and 2.68) acres) are shown in Table 6.

This table illustrates the dramatic change in yield potential when the area being considered is enlarged four times. The greater than 103 bu./ac. class is reduced by almost one-half after aggregation as shown in the table. The same is true for the next three classes of potential corn yields. They are reduced in acreage after aggregation is accomplished. However, the less than 50 bu./ac. class increases by almost one-fifth after aggregation. A study of the topography and the area of highly productive corn acreages reveals that most of the soils with greater than 103 bu./ac. productivities lie in sinkholes, along narrow stream bottoms, and on footslopes. Many of these soils are too small in size to fill a 10 acre cell. For this reason

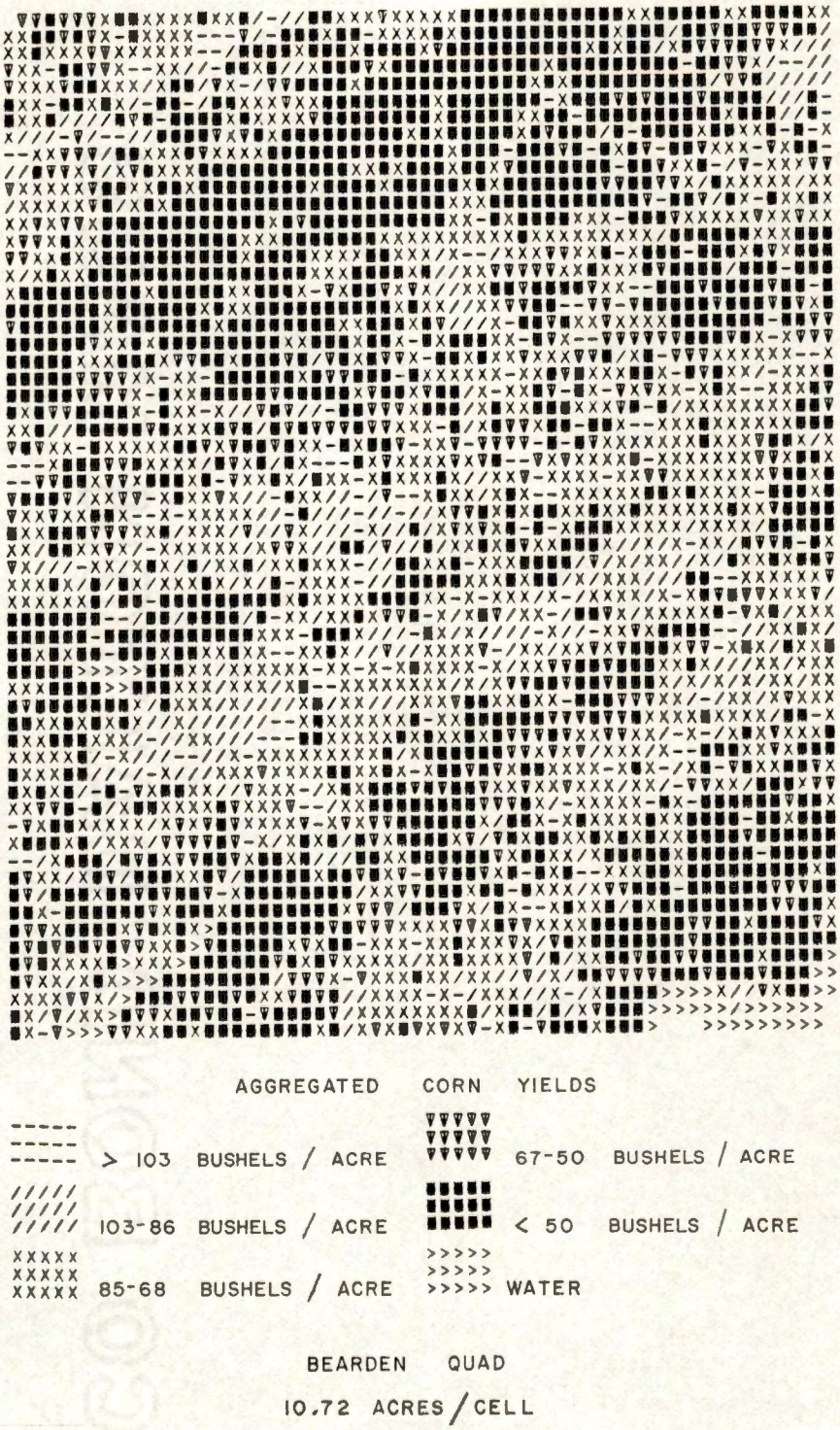

Figure 15. Corn yields on the Bearden Quadrangle aggregated from 2.68 acres to 10.72 acres.

Table 6. Acreage Summary by Classes of 2.68 Acre Cells and Aggregated 10.72 Acre Cells for Potential Corn Yields on the Bearden Quadrangle in Knox County, Tennessee

Class	Cell Size		
Bu./Acre	2.68 Acres	10.72 Acres	Gain or Loss
> 103	4500 acres	2438 acres	-2062 acres
86-103	4277 acres	3361 acres	- 916 acres
68-85	12401 acres	12146 acres	- 255 acres
50-67	4720 acres	4478 acres	- 242 acres
< 50	12133 acres	15636 acres	+3503 acres

the productivity of the surrounding soils would be dominant in a cell size of approximately 10 acres.

There are many advantages to aggregation. Data that are very detailed may be aggregated and combined with other types of data that are of a much broader scale and less detailed. The same data of a smaller cell size that is used for county planning may be aggregated and used for state planning. Data occurring in several counties with different levels of detail may be aggregated to a common cell size and used for regional planning.

Combinations of Soil Interpretations with Other Resource Data

The combination of soil information with other resource data has great potential for land planning. The productivity of the soils under different cover classes was obtained by combining (overlaying) corn yields with cover. Land cover (urban, forest, and agricultural) was obtained from the Harriman 1:125,000 land cover map using 10.72 acre cells (Tennessee Valley Authority, 1975). This discussion is included as an illustration of what can be done by making combinations of different types of resource data.

Figure 16 illustrates the former productivity of the soil for corn that is now under urban land cover. Urban land cover includes industrial, commercial, residential, urban mixed, transportation routes, and other urban

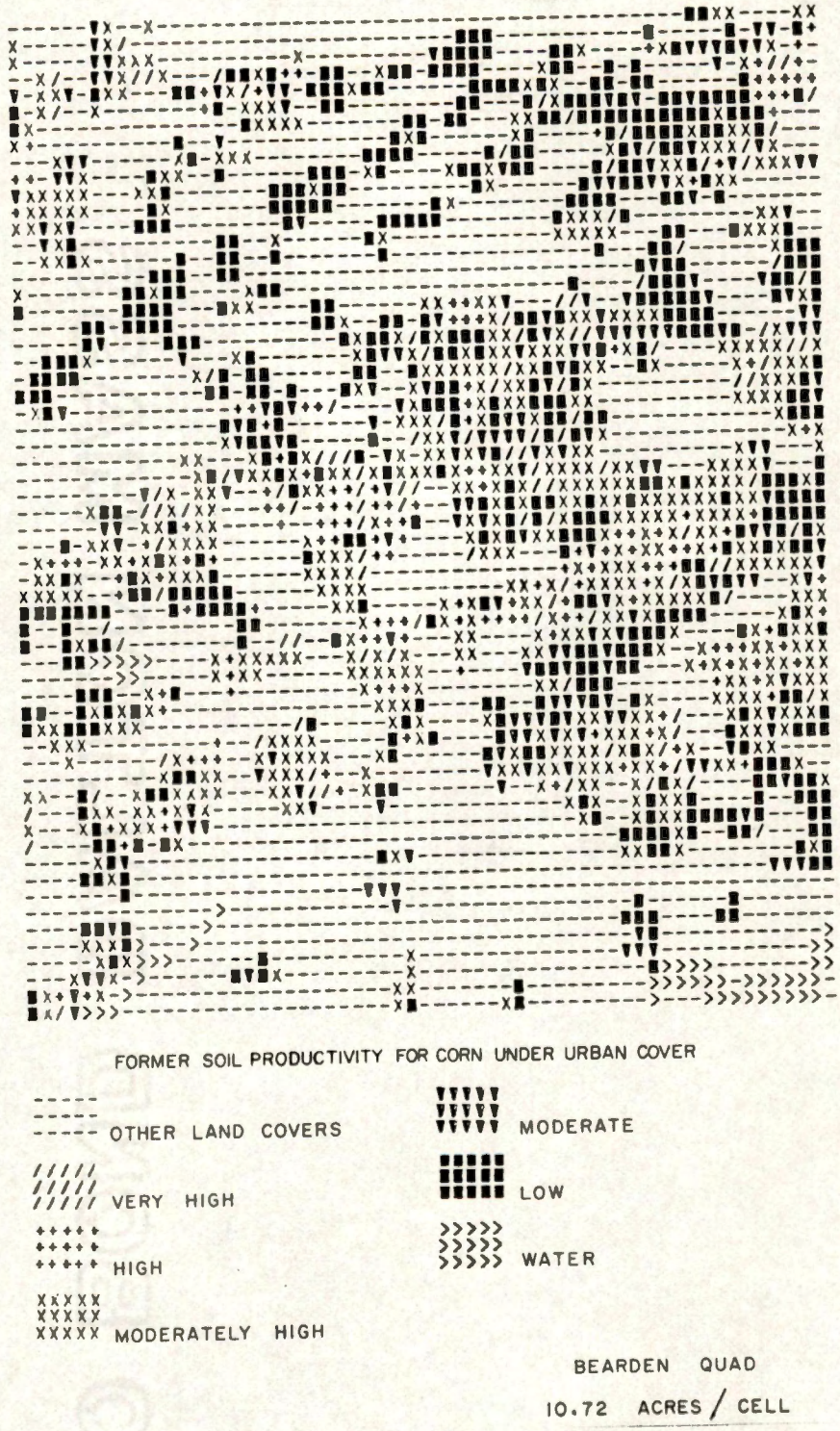

Figure 16. Composite of soil productivity for corn and urban land cover showing the former productivity of the soil for corn that is now under urban land cover.

categories. Most of the urban land cover occupies the moderately high and low productivity classes for corn. The low productivity class contains a variety of soils which have some characteristic (shallow to bedrock, low available water supplying capacity, or steep slope) which prevents the soil from belonging to a higher productivity class; however, these features do not necessarily restrict the soil from urban use. City and county planners are interested in knowing the direction of growth and productivity of the soils consumed by growth; agricultural agencies and institutions are concerned about the highly productive soils that are being diverted from agriculture each year; and developers are looking for potential areas of future development. These three interests can be served by combining urban land cover with soil productivity as shown in Figure 16.

Table 7 is an acreage comparison of each class of former soil productivity for corn under urban cover to the total acreage for each class of soil productivity. As shown in the table, 53 percent of the soils with former productivities of very high, high, and moderately high are now under urban land cover. This represents 9,547 acres on the Bearden Quadrangle which have been consumed by urbanization. As shown in Table 7, the greater portion of urban growth is occurring on the moderately high and low productivity classes of soils since the majority of the

Table 7. Acreage Summary by Classes of Former Soil Productivity for Corn Under Urban Land Cover For 10.72 Acre Cells on the Bearden Quadrangle in Knox County, Tennessee*

Class	Urban Land Cover		Total Acreage in Productivity Class
	Acres	% of Class	
very high	1289	53	2438
high	1793	53	3361
moderately high	6465	53	12146
moderate	2169	48	4478
low	6185	39	15636

*Predicted corn yields were used as an indicator of potential soil productivity.

acreage of the quadrangle is contained in these two productivity classes. By incorporating urban land cover and soil productivity, future projections using visual and mathematical expressions can be made about the direction, rate, and extent of future urban growth.

Figure 17 illustrates soil productivity for corn that is now under forest cover. As shown on the map, most of the areas of forest are on soils of lowest productivity. They generally follow a northeast-southwest orientation which corresponds to the ridge and valley orientation. Exceptions to this occur where owners are interested in forested areas for recreation, wildlife, or commercial use. Better management practices can be employed for the forested areas if the potential soil productivity is known.

Table 8 is an acreage comparison of each class of soil productivity for corn under forest cover to the total acreage of soil productivity for each class. This table further illustrates the importance placed upon forests on the Bearden Quadrangle since most of the acreages of forest occur on the lowest productive soils. Some physical characteristic exists which prevents these soils from belonging to a higher productivity class (shallow depth to bedrock, steep slope gradient, or slow percolation rate) and most of these soils are left in forest cover.

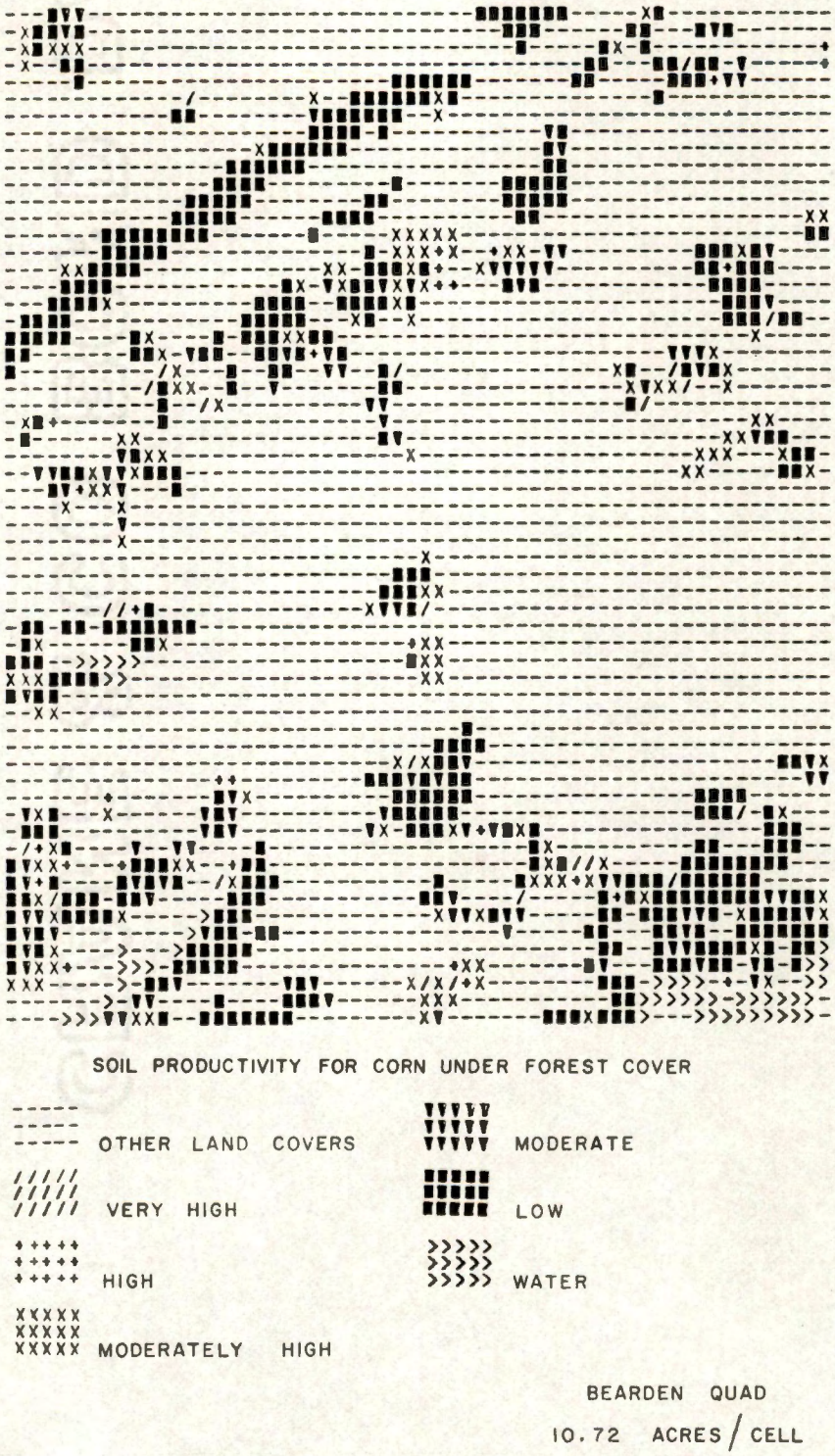

Figure 17. Composite of soil productivity for corn and forest land cover showing the soil productivity for corn that is now under forest land cover.

Table 8. Acreage Summary by Classes of Soil Productivity for Corn Under Forest Cover for 10.72 Acre Cells on the Bearden Quadrangle in Knox County, Tennessee*

Class	Forest Land Cover		Total Acreage in Productivity Class
	Acres	% of Class	
very high	258	10	2438
high	322	10	3361
moderately high	1622	14	12146
moderate	1181	27	4478
low	5273	34	15636

*Predicted corn yields were used as an indicator of potential soil productivity.

Productivity of the soil under agricultural cover is illustrated by Figure 18. Agricultural land cover includes cropland, pasture, and other land used for agricultural purposes. As seen on the map, the moderately high and low classes of soil productivity comprise the largest areas of agricultural cover on the Bearden Quadrangle. Maps showing the combination of agricultural cover and soil productivity are important from the standpoint of many agricultural agencies. Conservation, 4-H, and farm demonstrations can be better planned and implemented by use of soils information in combinations with other pertinent information, and the potential information can be used as a teaching guide for all levels of education.

Table 9 is an acreage comparison of each class of soil productivity for corn under agricultural cover to the total acreage for that class. Although the relative acreages for each class of agricultural productivity differ considerably, the percentages of the total acreage for very high, high, and moderately high classes are similar as shown in the table. Likewise, the classes of moderate and low forest productivity percentages are similar.

Maps and tables of this type are useful for general planning for an area, but many times questions are asked such as: What relationships can be drawn from comparisons of all three classes of land cover and soil productivity?

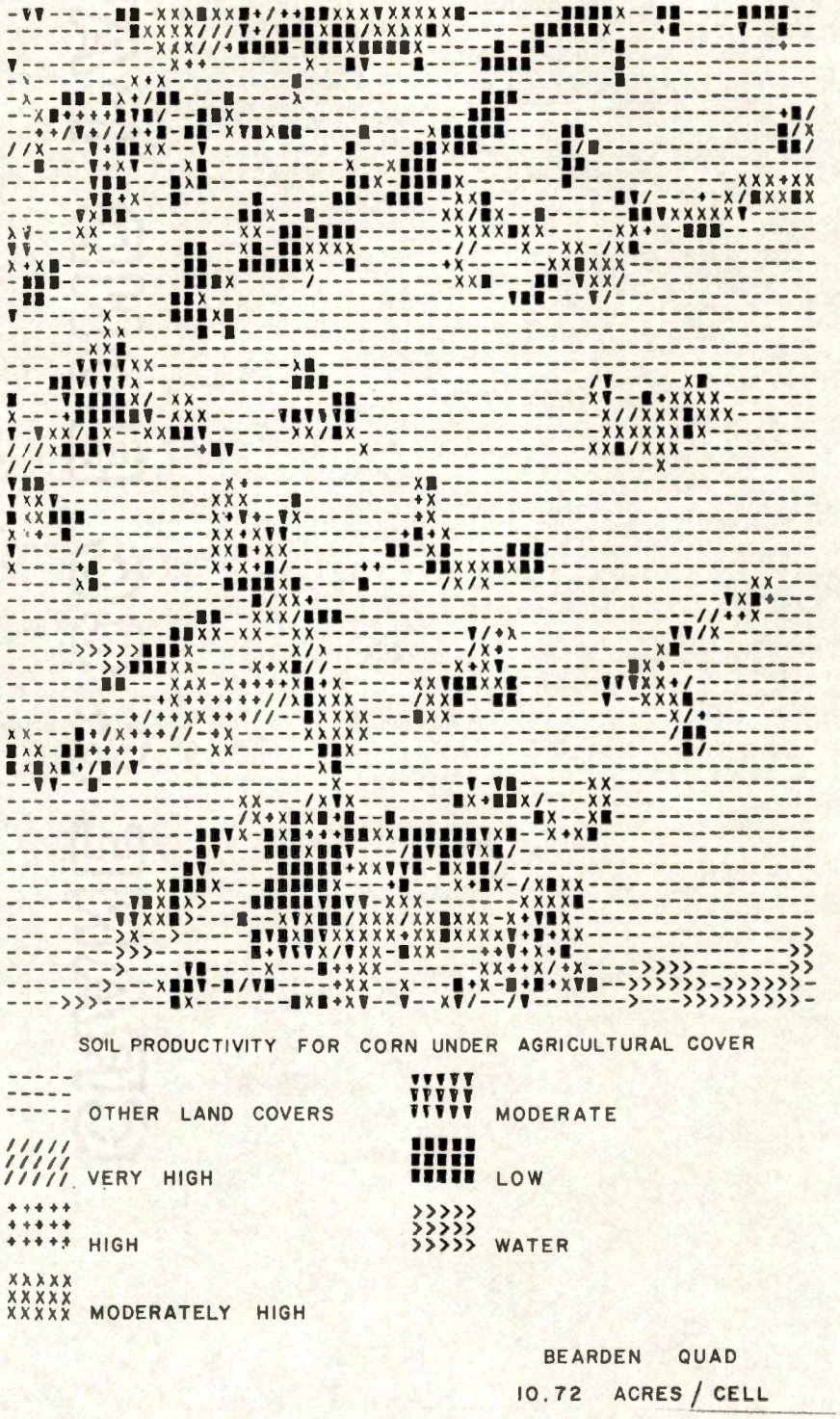

Figure 18. Composite map of soil productivity for corn and agricultural land cover showing the soil productivity for corn that is under agricultural land cover.

Table 9. Acreage Summary by Classes of Soil Productivity for Corn Under Agricultural Land Cover for 10.72 Acre Cells on the Bearden Quadrangle in Knox County, Tennessee*

Class	Agricultural Land Cover		Total Acreage in Productivity Class
	Acres	% of Class	
very high	891	37	2438
high	1246	37	3361
moderately high	4059	33	12146
moderate	1128	25	4478
low	4178	27	15636

*Predicted corn yields were used as an indicator of potential soil productivity.

How is the land use pattern changing through time? What projections for future land use changes can be made? An acreage summary of soil productivity and land cover (Table 10) will answer some of the questions.

This table presents a comparison of percentages of different types of land cover by soil productivity classes on the Bearden Quadrangle. From this comparison, one can see how the area is being used at the present. Future changes in cover classes can be anticipated. If land cover information were readily available for every five years of the past 20 or 30 years, relationships of increase or decrease in acreage of a cover type on a particular class of soil productivity, the rate of increase or decrease, and the future outlook of any cover type could be determined. For example, the rate of increase in urban cover could be estimated and projected to determine the approximate time when urban cover would consume most of the Bearden Quadrangle. This knowledge would be important from the standpoint of planning to meet the future needs of this anticipated urban growth on the Bearden Quadrangle.

Time and Cost Comparisons

In many cases the time-cost comparisons will decide the future use of a system (process). If the time involved in processing the data is short, but the cost of processing is

Table 10. Summary of Percentages by Productivity Class for Urban, Forest, and Agricultural Land Cover on the Bearden Quadrangle in Knox County, Tennessee

Class	Land Cover		
	Urban	Forest	Agricultural
	%	%	%
very high	53	10	37
high	53	10	37
moderately high	53	14	33
moderate	48	27	25
low	39	34	27

large, the system may not be used because of this high cost factor. Likewise, if the cost of data processing is low, but the time charge is large, the system may not be used. In deciding upon a specific system to use in gathering, storing and manipulating data, a trade-off between data accuracy and time-cost will be required.

In evaluating the merits of the 1.19 acre-cells and the 2.68 acre-cells, a time-cost comparison is needed. Table 11 is a comparison of processing time required of the two cell sizes for the soils data on the Bearden Quadrangle. As shown in the table it takes 2.5 times longer to digitize the soils (25 man days versus 10 man days) and almost 1.5 times longer to process the data with the computer at the 1.19 acre cell size than at the 2.68 acre cells (350 seconds versus 256 seconds).

A cost comparison for the two cell sizes is shown in Table 12. The cost of digitization is assumed to be three dollars per hour per person to digitize the data. The computer costs are for computer time only. The cost for the mylar overlay includes production of the grid and photographically transferring the grid to a stable mylar surface. Miscellaneous costs involve supervision and other materials needed.

The time-cost comparison becomes more significant when combined with other comparisons between these two cell sizes.

Table 11. Comparison of Time for Gathering and Analyzing the Soils Data for 1.19 and 2.68 Acre Cells for the Bearden Quadrangle in Knox County, Tennessee

Process	1.19 Acres/Cell	2.68 Acres/Cell
Digitization	25 man-days	10 man-days
Computer Processing	350 seconds	256 seconds
Keypunching	3 man-days	2 man-days
Data Correction	2 man-days	2 man-days

Table 12. Cost of Gathering and Analyzing Soils Data for 1.19 and 2.68 Acre Cells for the Bearden Quadrangle in Knox County, Tennessee

Process	1.19 Acres/Cell	2.68 Acres/Cell
Digitization	$ 600	$ 240
Computer Time	150	100
Keypunching	96	64
Mylar Overlay	30	20
Data Correction	95	95
Miscellaneous	350	280
Total Cost	$1321	$ 799
Cost per cell	$ .04	$ .06
Cost per acre	$ .03	$ .02

The total acreage difference between all classes for depth to bedrock was 74 acres. Comparison of the total cost of gathering and analyzing the data shows a difference of $522 ($1,321 for 1.19 acre cells versus $799 for 2.68 acre cells) and a time difference of 15 man days. These comparisons suggest that the 2.68 acre cell would be more practical than the 1.19 acre cell for an interpretation where the results would show a broad, large pattern (a northeast-southwest orientation with alternating bands--geology for example) across the landscape.

The advantage of the 1.19 acre cell over the 2.68 acre cell begins to emerge as interpretations with finer detailed patterns are made. In itself, the dendritic pattern of stream flow is an organized pattern, but it is not as bold or well defined as that of geology in this area. Acreage comparisons showed no difference between the two cell sizes, but the total acreage difference was 206 acres. Even though the smaller cell size cannot be justified on an acreage basis alone, it does delineate the flood plain more accurately. This greater accuracy may favor the use of the 1.19 acre cell.

Slope has even less pattern than depth to bedrock or potential flooding. Further, there is an even greater difference in total acreage (524 acres) between the two cell sizes. The use of the smaller cell more accurately delineates the slope of the landscape.

The cell size chosen is influenced by many factors. It depends upon the amount of time available to digitize the data and the money available to do the job. The cell size also depends upon the quality of the data and the detail of the base map. The importance of the final product for use in planning and the number of interpretations made from the data affects the cell size chosen by the user.

The Line Printer Map

Line printer maps are difficult for some people to understand because they need a reference point or physical feature to perceive the object they are looking at as a map. Transfer of cultural features, roads, and streams to a clear overlay the size of the line printer map and photographically imprinting these features onto the computer map (Figure 19) is one way of showing such features. Other means of conveying the idea of a line printer map as a map is by drawing the physical features directly onto the printer map; drawing the features onto a clear overlay and placing the overlay on the printer map; and digitizing the features and including the features as part of the composite map when produced. Methods relating the physical and landmark cultural features of an area are needed to assure convenient use of computer maps.

There is a potential for misuse of the data obtained from computer maps. The smaller the cell size, the greater

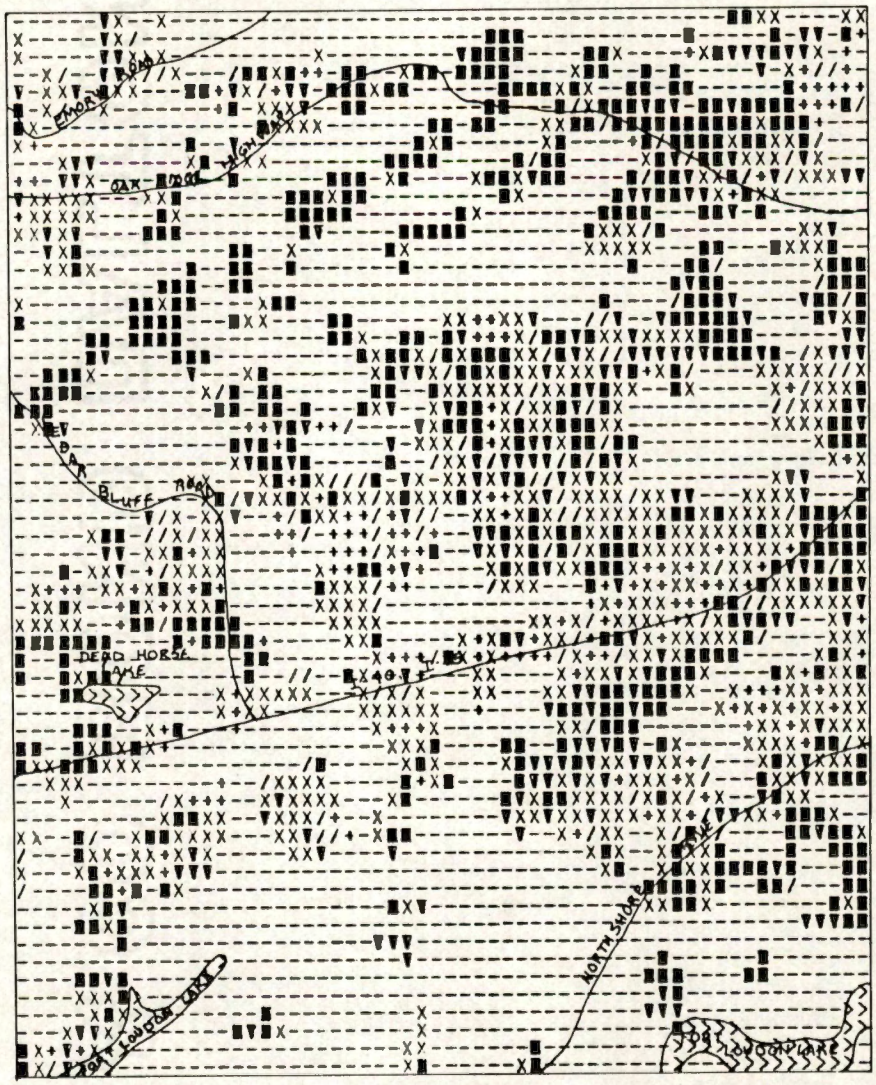

Figure 19. Composite of soil productivity for corn and urban land cover featuring physical and cultural information to aid in location.

the probability of errors in reading a line printer map since the data gathering intensity is greater. In most cases the accuracy of the base map will affect the accuracy of the data, and the uses that are made of the data. If the base map is inaccurate, then the information that is placed on the base map may be correct, but the map data may not appear on the map where it is on the landscape. With the smaller cell size, the chance of error in the computerized data would be greater if the base map is not accurate. Smaller cells might further lead to a misuse of the data because the apparent accuracy would give some planners the impression that these maps could be used for site location planning instead of for general area planning as the map was intended.

Line printer maps limit one to shades of gray by overprinting different characters. This can be confusing to some people if too many classes are represented on the printer map. Take, for example, the printer map of predicted corn yields (Figure 13, page 44). Six classes are illustrated on this printer map. Since it is difficult to easily distinguish the water class on this map, one will make the printer map more presentable and easier to interpret by reducing the number of gray levels.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Several computer programs are available to aid in the processing of soil interpretations and displays. Selection of the program to use is dependent upon the person making the interpretations and displays; the use for which the soils interpretations are made; and the availability of equipment and personnel.

The selection of the appropriate cell size is of next importance. Many factors influence the size of cell which is used. The primary factors are time and cost, reliability of the soils information, and the primary or intended use. The costs of the project often foretell its future. Reliability of the soils data affects the accuracy of the interpretations made. For example, a soils map at a scale of 1:48000 would be less precise in terms of information than would a soils map at 1:15840. The primary use of the information affects the selection of a cell size also. If the primary use is regional planning, then the cell size need not be as small as one for an area whose primary use is city or county planning since too much detail is obtained. Other factors affecting the selection of the appropriate cell size are the type of computer program, the storage space available in the computer, and preferences of supervisors. Based upon

these factors, cell sizes of 1.19 and 2.68 were chosen for use in this study.

Concurrent to the selection of the appropriate cell size is the selection of the interpretations to be made. Interpretations should be selected on the basis of their current and anticipated need. Production of irrelevant interpretations will only add to the complexity of the problem rather than aid in solving the problem. Additional interpretations can be created at a later date as the need arises.

The steps in this process were digitization of the soil information, data validation, productions of final interpretive maps, and evaluation of the line printer interpretive maps. The digitization step used a point sampling technique based upon a row-column coding scheme referenced to geodetic coordinates. Data validation required a visual scan of the line printer interpretive maps for obvious errors. A more detailed comparison of the original soil map to the line printer map was performed to correct the less obvious errors. Types of errors made in digitizing the soil mapping units were invalid row-column numbers, invalid soil mapping unit symbols, and valid symbols but incorrect for a particular cell. After many of the errors were corrected, final interpretive maps were produced for depth to bedrock, slope gradient, potential flooding areas, predicted percolation,

soil drainage and potential corn yields. Data for both cell sizes were handled in the same way.

Composite maps were produced by combining (overlaying) two or more interpretations. Composite maps produced were septic tank filter field limitations at 2.68 acres per cell, and soil productivity under three different land cover classes (urban, forest, agricultural) using 10.72 acres per cell. The ability to combine different soil interpretations and/or other types of resource data is especially important in planning since it will show areas which may be equally suited for several uses, but because of some added factors, one use will emerge as being the best suited for a particular area.

The remaining step was an evaluation of the line printer interpretive maps. A visual and acreage comparison was made between the 1.19 and 2.68 acre cells for depth to bedrock, potential flooding areas, and slope gradient. The smaller cell size more accurately recorded the changes in soil mapping units across the landscape as illustrated by the single purpose map for potential flooding and slope gradient. Potential flooding demonstrated a visual comparison between the two cell sizes in which the 1.19 acre cell more accurately defined the flooding areas. Slope gradient demonstrated an acreage comparison in which the 1.19 acre cell showed a total difference, regardless of sign,

of 524 acres difference between the two single purpose maps. However, a time-cost comparison showed that the 1.19 acre cell required 2.5 times more time in digitization and 1.65 times more cost in manipulation of the data. Even though time and costs are favored by the larger cell size, the needs of the user will determine which cell size is used. These needs, however, will be influenced by the type of resource data used, time and costs, and end products desired.

The composite maps further illustrate the potential for planning that is available through digitization of resource data. The composite for septic tank filter field limitations illustrates the ability to combine data sets from one resource (soils) into a composite map. The composite map of soil productivity and land cover illustrates the ability to combine data sets from more than one type of resource (soil and land cover). Composite maps are useful for planning by supplying the capability of overlaying data sets. The composite map expresses in visual form how the characteristics of different types of data interact. Then based upon these interactions proper planning procedures can be implemented.

Efficiency is achieved when many interpretations and uses of the data stored in computer form are made. The greater the use of the data, the greater the efficiency becomes. Digitization and line printer display of the data

is also an effective means of conveying information to planners. The use of composite maps should aid in reducing complications of a problem. The ability to generate cheaply and quickly interpretive and composite maps once the data are in the system makes the digitization and line printer display of soil mapping unit information a relatively efficient and effective tool for the resource manager.

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APPENDIXES

APPENDIX A

SCANNED BY JAF

GLOSSARY

Array - A square or rectangular set of data values, each referenced by row and column position.

Cell - A data unit representing an area of the earth's surface.

Cell Hierarchy - A logical method for grouping geodetic cell data into successively larger units. See Figure 2, page 18.

Class - A subdivision of data representing specific characteristics or combinations of characteristics. An example of three classes that may be created for soil depth to bedrock characteristics are 0-4 feet, 4-6 feet, and more than 6 feet to bedrock.

Composite Map - The combination of different variable classes for each cell to arrive at a composite map, e.g., the occurrences of any one of the following: less than 0.6 inches per hour percolation rate, less than 4 feet to bedrock, greater than 25 percent slope, or frequent flooding would classify a cell as having severe limitations for septic tank suitability.

Computer Form - Where the data are located in a form that can be processed by a computer--either in punched cards, on tape or on disc.

Computer Program - A series of statements telling the computer what operations to do and in what order to do them.

Data Set - A digital representation of resource data in the computer, such as the individual soil mapping units entered for a county.

Digitization - The process of translating resource data from maps or photographs into computer compatible forms--assigning a value to a position in an array.

Geodetic Cell - A trapezoidal portion of the earth's surface bounded by lines of longitude and latitude.

Grid - A series of rows and columns used to divide an area into cells.

Hardware - The computer and its accessories.

Interpretation - The translation of basic soil resource data into descriptive classes based on particular soil resource characteristics.

Interpretation Map - The display of the descriptive classes into map form for an interpretation.

Overprinting - The process of printing one character over another to produce a shading effect.

Resolution - The degree of precision to which data is gathered and subsequently displayed in map form. Data resolution is greater with smaller cell sizes.

Software - The computer programs which tell the computer what to do and how to do it.

Soil - A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil Mapping Unit - An area delineated on a soil map.

Variable - An individual interpretation of a soil resource characteristic, such as depth to bedrock, predicted percolation rates, or slope gradient.

APPENDIX B

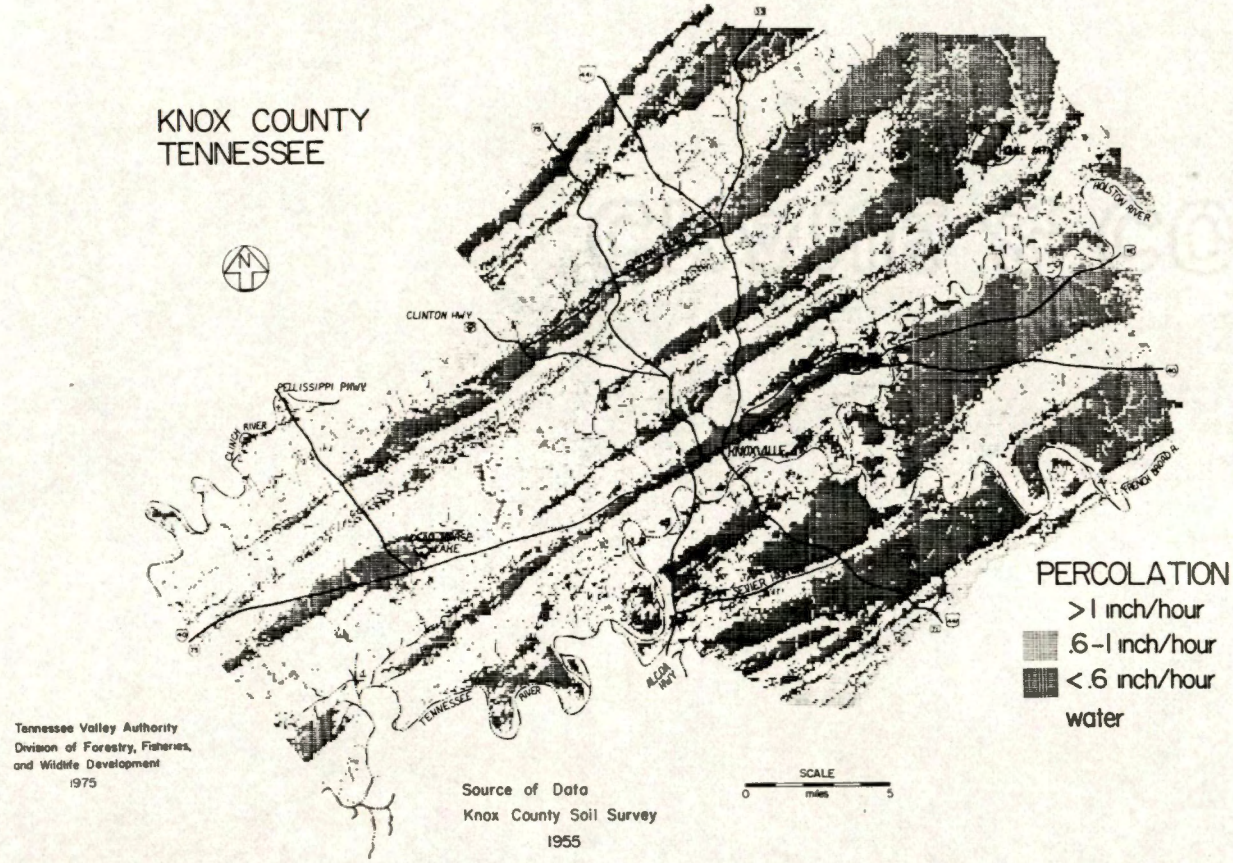

Figure 20. Line printer map of percolation rates for Knox County, Tennessee, using 2.68 acre cells overlain by the transportation system.

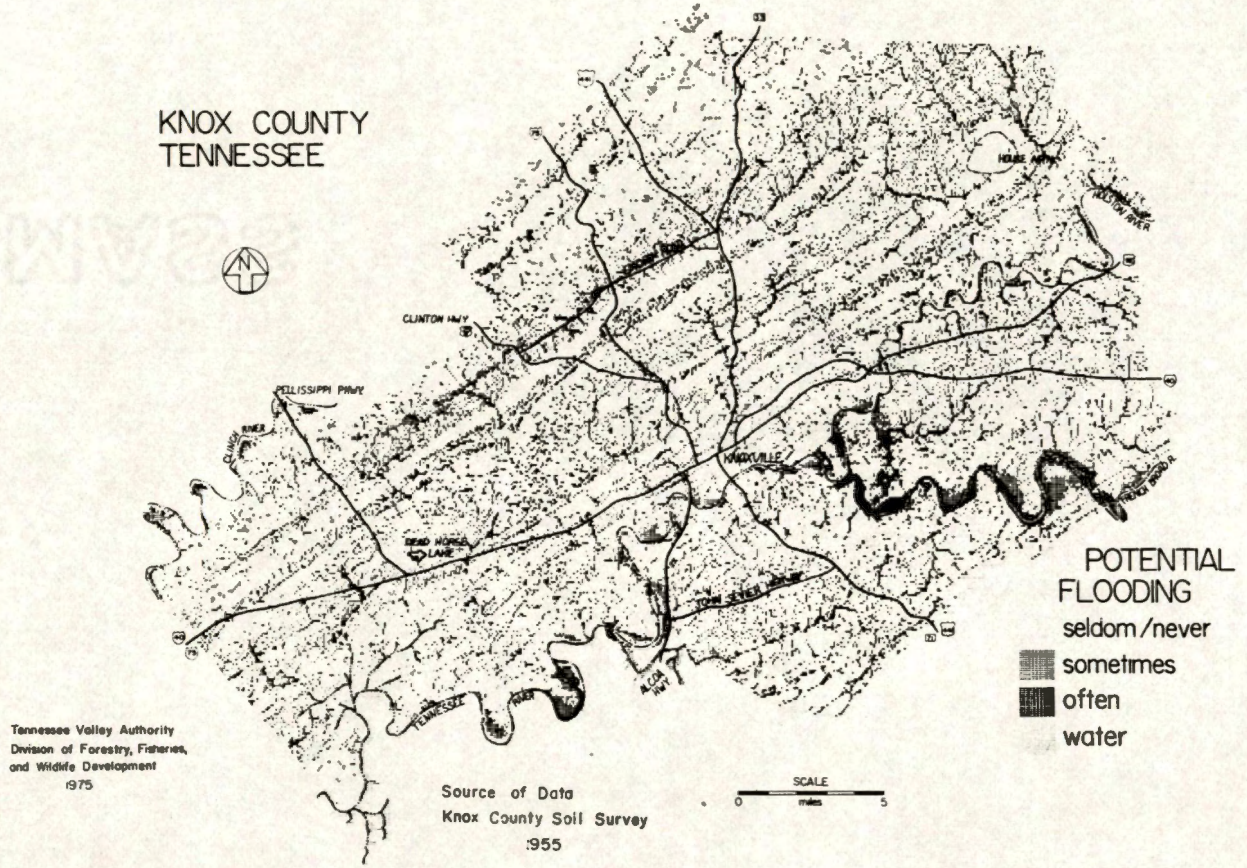

Figure 21. Line printer map of potential flooding for Knox County, Tennessee, using 2.68 acre cells overlain by the transportation system.

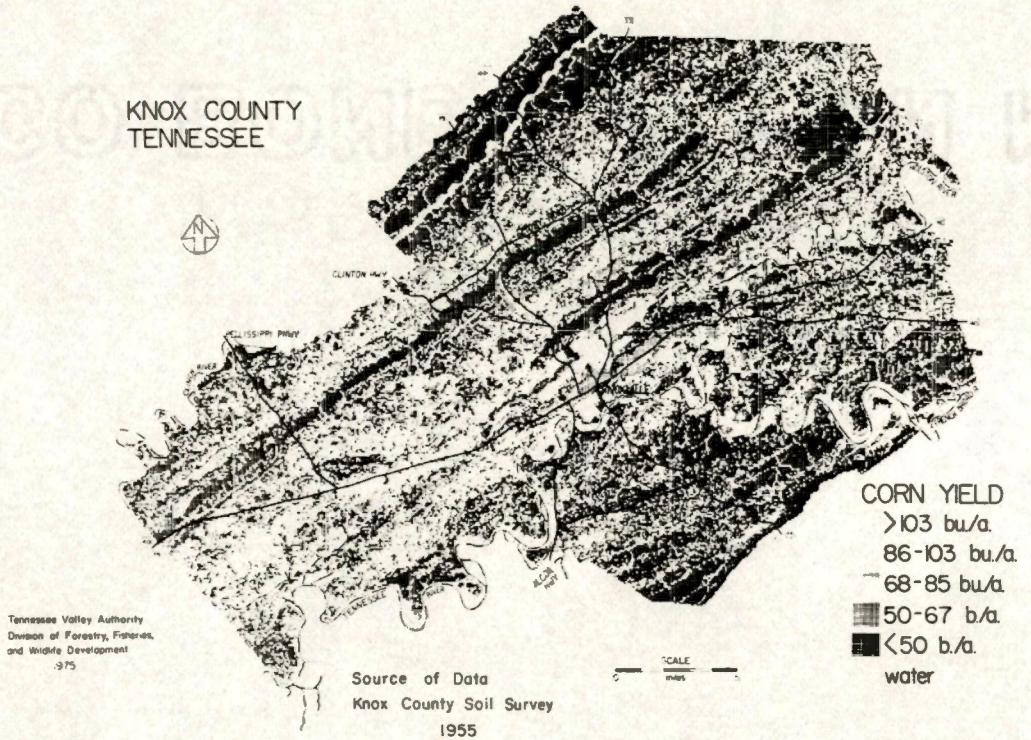

Figure 22. Line printer map of predicted corn yield for Knox County, Tennessee, using 2.68 acre cells overlain by the transportation system.

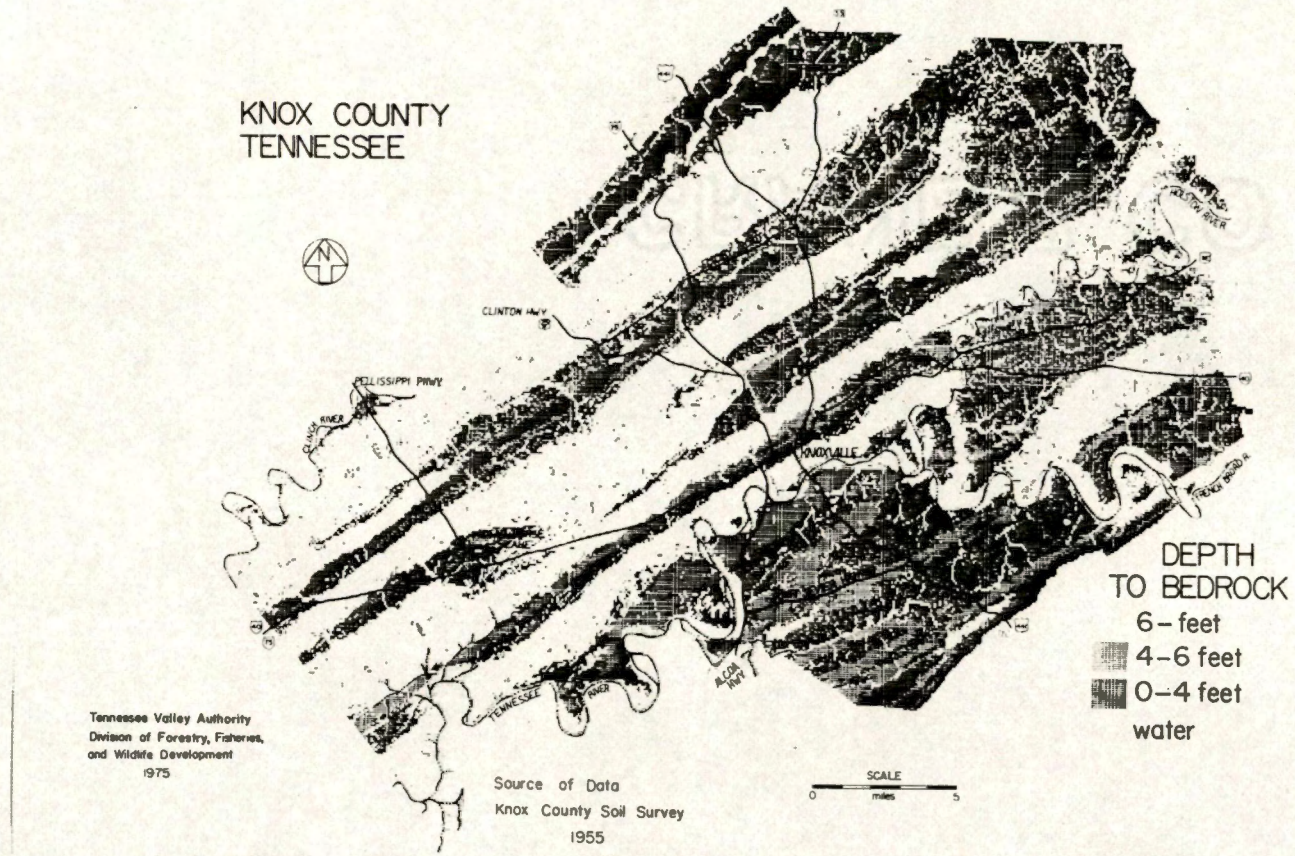

Figure 23. Line printer map of depth to bedrock for Knox County, Tennessee, using 2.68 acre cells overlain by the transportation system.

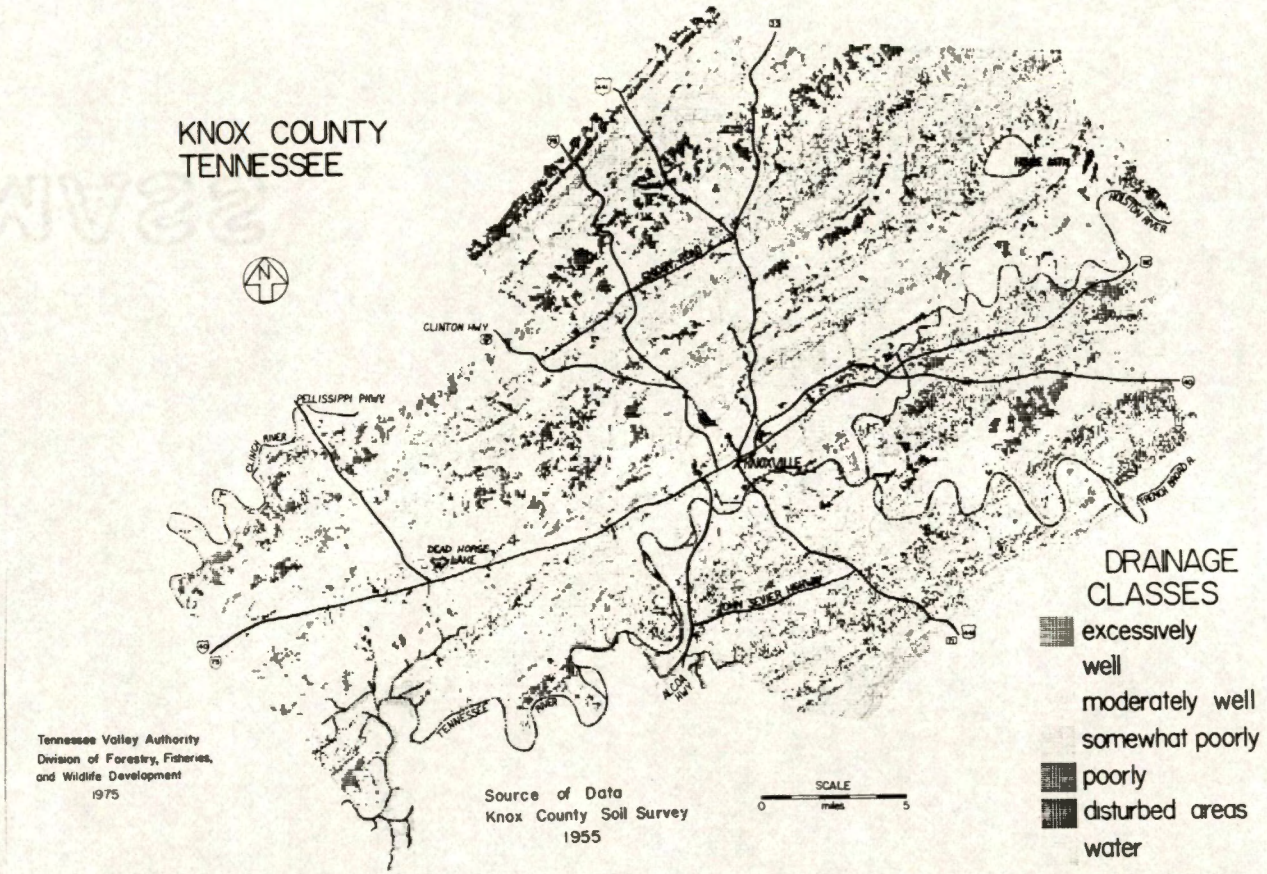

Figure 24. Line printer map of drainage classes for Knox County, Tennessee, using 2.68 acre cells overlain by the transportation system.

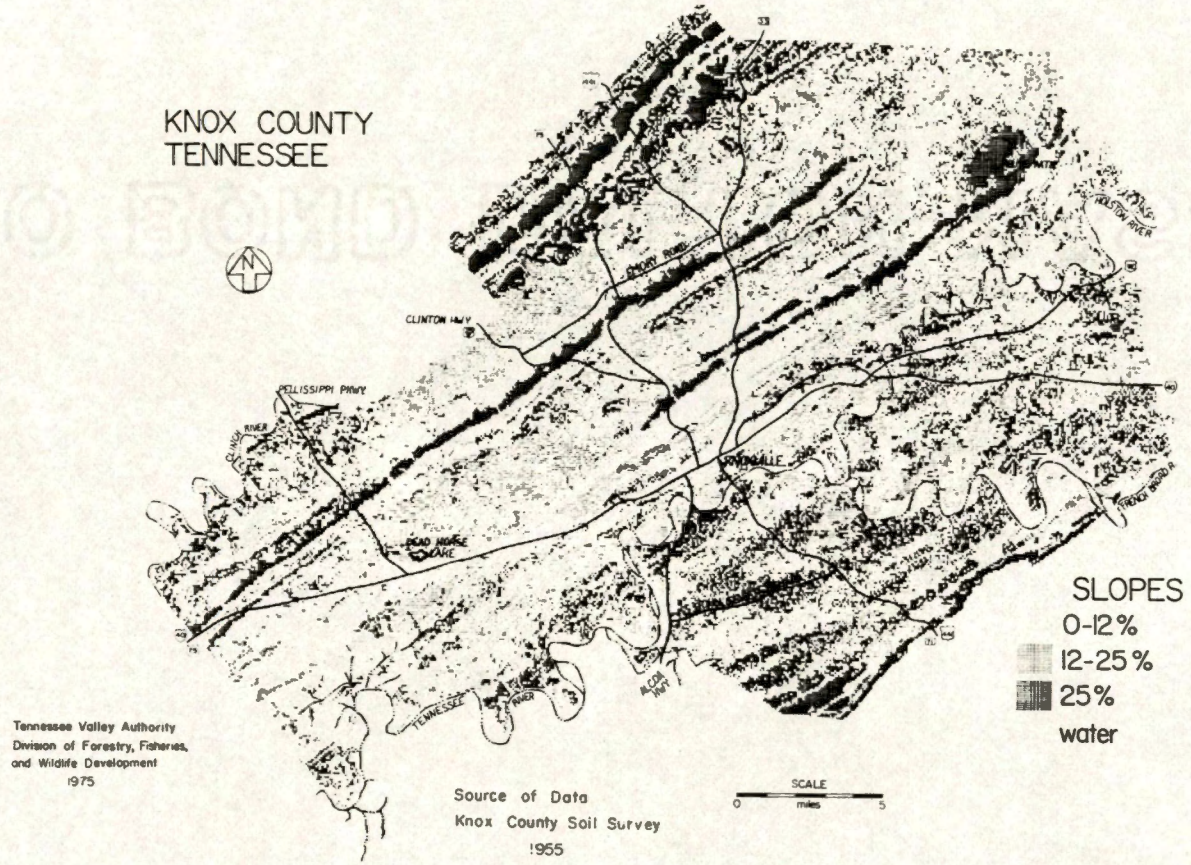

Figure 25. Line printer map of slope gradient for Knox County, Tennessee, using 2.68 acre cells overlain by the transportation system.

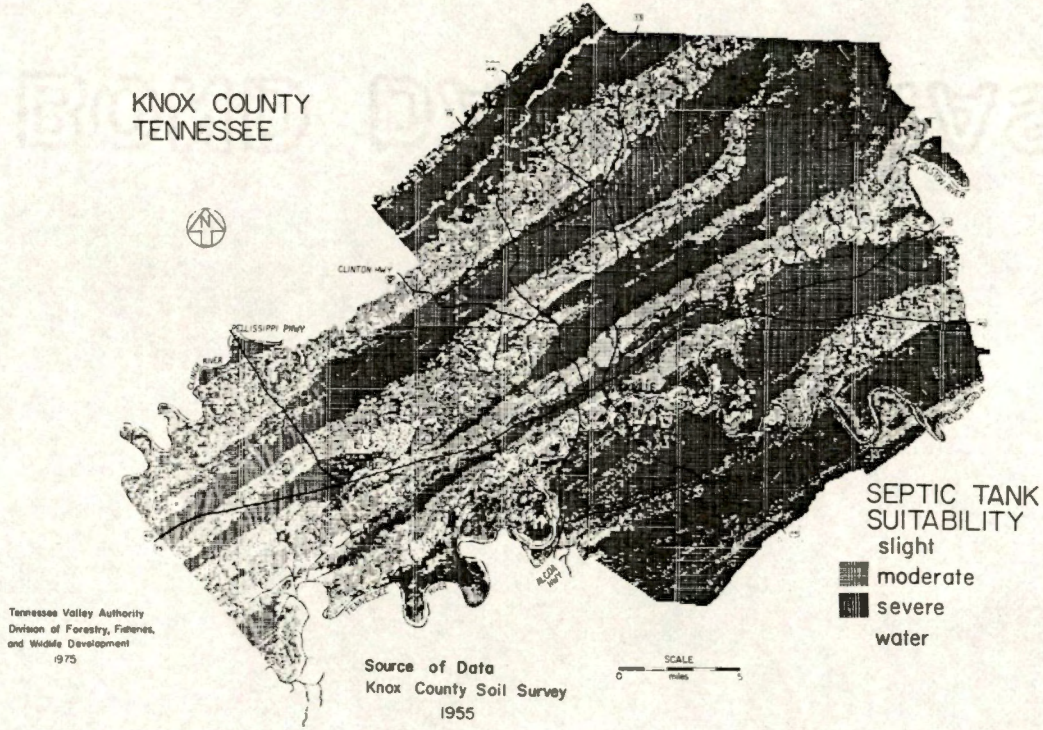

Figure 26. Line printer map of septic tank suitability for Knox County, Tennessee, using 2.68 acre cells overlain by the transportation system.

VITA

Charles E. McCroskey was born in Sevier County, Tennessee, on November 24, 1950. He was reared on the farm of his parents, William D. and Lillian McCroskey. He attended elementary school in Blount County and was graduated from Porter High School in May 1968. He entered The University of Tennessee in June and received his Bachelor of Science degree in June 1972. In November he accepted a position with the Soil Conservation Service as a soil scientist.

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He is married to the former Margaret Yvonne West of Roanoke, Virginia.