

A SOIL FEASIBILITY ASSESSMENT FOR SUBDIVISION DEVELOPMENT AROUND TWO
SMALL LAKES IN LEAVENWORTH COUNTY, KANSAS

by

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INTRODUCTION AND LITERATURE REVIEW

The combined influence of more people, higher real income per capita, improved transportation, increased leisure time and changing life styles have caused outdoor recreation demands to grow at an overall rate of 10 percent annually (7). Today, many people satisfy their recreational and housing needs in one operation. Such is the case in Leavenworth County, Kansas, where subdivisions have been proposed and built around small lakes. These developments provide a modified rural life setting which attract urban dwellers (12).

If present growth policies continue, rapid development may be expected in southeast Leavenworth County and stable growth elsewhere (19). The southeast is located on the suburban fringe of the Kansas City Metropolitan Area, where rapid growth is occurring, but the entire county is affected by Kansas City Metropolitan Region's outward growth.

Small lake developments are regulated by 3 types of governmental units: state, local, and sublocal. The state of Kansas, by authority of Kansas State Article 10, (effective January 1, 1969; amended January 1, 1970) regulates development only around it's 21 federally built reservoirs whose surface water areas range from 2,330 to 15,830 acres. The regulations govern sanitary conditions around reservoirs and provide for proper sewage disposal through the use of public sewers, septic tanks, sand filter fields, stabilization ponds and holding tanks.

Local controls take the form of zoning ordinances, subdivision regulations and building codes. The Leavenworth Planning Commission and the Leavenworth

County Health Department are the local regulating agencies. Because the areas to be studied in this paper are undeveloped, a sublocal agency such as a homeowners' association is not possible, thus they will not be discussed.

The Leavenworth Planning Commission, the county-wide planning agency, has jurisdiction over zoning, subdivision regulations and building codes. The county health department controls sewage disposal as well as other public health problems. The health department conducts percolation tests, which are required before septic tank placement. Private residence absorption field size is based on percolation rate and number of bedrooms according to, "A Manual of Recommended Standards for Locating, Constructing and Operating Septic Tank Systems for Rural Homes" (16). If the percolation rate is slower than 1 inch per 60 minutes, the soil is unsuitable for use as an absorption disposal system. The slower the percolation rate, the larger the absorption field area (square feet) must be.

Two states, Vermont and New Hampshire, have published reports on lake land use and development. Vermont depends greatly on its lakeshore for economic and recreational development. Numerous problems confronting Vermont's lakeshores such as public access, sprawl development, pollution and poor lakeshore use are discussed in "Lakeshore Land Use Controls" (22). That report also outlines concepts for lakeshore planning and environmental maintenance.

Ching and Frick (6) of the University of New Hampshire suggest a guide for lake use based on the relationship of lake surface area to length of shoreline. The guide contains a chart which states the minimum number of surface water acres per user required for various ratios of shoreline to surface water area.

The purpose of this paper is to identify soil problems encountered with

housing developments around small lakes and recommend possible solutions. The soil resources of two areas in Leavenworth County, Kansas are examined. The areas were selected upon examination of county ownership and soil maps. They represent typical soil and topographic resources of northeast Kansas. Important soil factors are listed and discussed and interpretive maps are used to show areas of soil limitations. Finally, recommendations for possible solutions to soil limitations and a final evaluation of the area's potential is made.

STUDY AREA

Leavenworth County has four privately owned lakes, each containing 30 to 100 surface acres. Each has the potential for serving as a foundation for a residential development. One lakesite, plotted for residential development in 1973, contains several occupied homes. Another lake is primarily used for recreation with no residential development planned at this time.

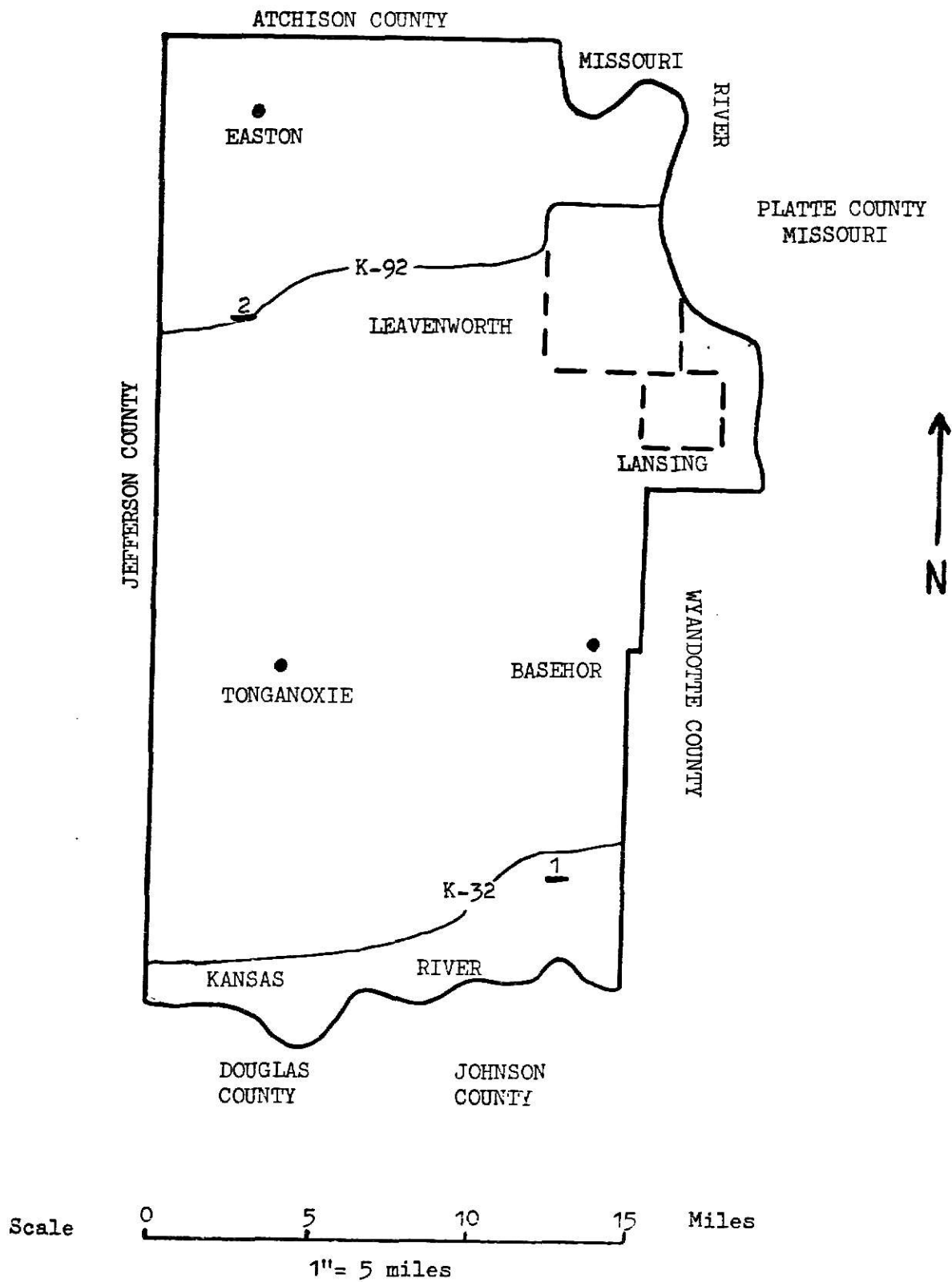
The two remaining lakes are the subject of this paper. Lake site 1 contains approximately 60 acres of water and 580 acres of surrounding land. A residential development of 292 single family dwellings and 1 multiple-family structure is planned for the area. Lake site 2 contains approximately 35 surface acres of water and 605 acres of surrounding land. No residential development is planned at this time.

Lake site 1 (Sec 34, T.11S, R.24E) (Figure 1) is located 15 miles south of the city of Leavenworth and 13 miles west of Kansas City near Kansas highway 32. Lake site 2 (SE $\frac{1}{4}$ of Sec 12, NE $\frac{1}{4}$ of Sec 13, T.9S, R.20E; and SW $\frac{1}{4}$ of Sec 7, NW $\frac{1}{4}$ of Sec 18, T.9S, R.21E) (Figure 1) is 8.5 miles west of

**THIS BOOK
CONTAINS
NUMEROUS PAGES
WITH DIAGRAMS
THAT ARE CROOKED
COMPARED TO THE
REST OF THE
INFORMATION ON
THE PAGE.**

**THIS IS AS
RECEIVED FROM
CUSTOMER.**

FIGURE 1



the city of Leavenworth and 19 miles northwest of Kansas City on Kansas highway 92. Both highways are shown as principal roads on the Rand-McNally and official Kansas highway maps.

Figures 2 and 3 are aerial photographs of the two lake sites. Aerial photographs show a wealth of ground detail such as vegetation, rock outcrops, plant cover, streams and lakes (24).

Figures 4 and 5 are topographic maps (28) and cross sections of the two lake sites. The cross sections show the steep slopes that naturally occur at adequate sites for dam construction. Those slopes cause concentrated runoff across the development area. Runoff control is discussed in the section on "Soil Limitations and Corrective Measures".

Water level fluctuation does occur on the two lakes, but spillways maintain safe water depth. The proposed subdivision of lake site 1 allows an adequate distance between the lake and residences, so water will not damage building sites. Additional problems caused by lakes are discussed later.

Figures 6 and 7 are the soil maps of the two lake sites (5). The soil mapping units designated by the map symbols are discussed in Appendix I.

Figures 8 to 11 are block diagrams that show relationships of the soils to each other and their physiographic position (5). Recent federal regulations governing floodplain use have emphasized the importance of recognizing physiographic position and hazard of flooding.

SOIL FACTORS

It is a well known fact that soil properties drastically affect the

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DOCUMENT(S) IS OF
POOR LEGIBILITY IN
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FIGURE 2 Aerial Photograph of Lake Site 1



Scale 0 500 1000 1500 2000 feet
 1" = 680 feet

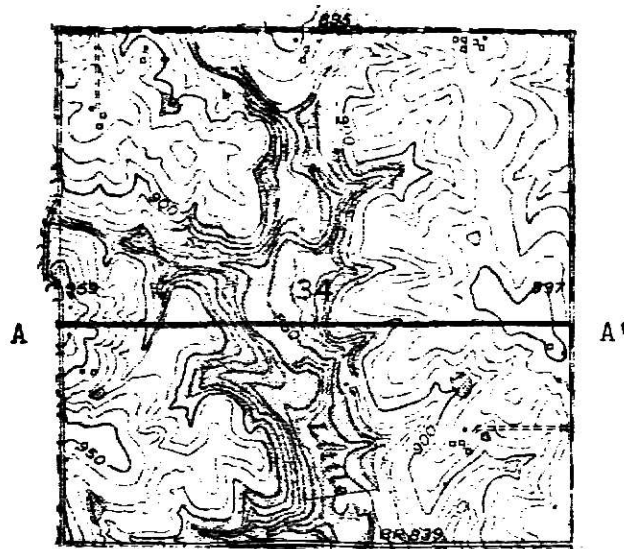
FIGURE 3 Aerial Photograph of Lake Site 2

7.

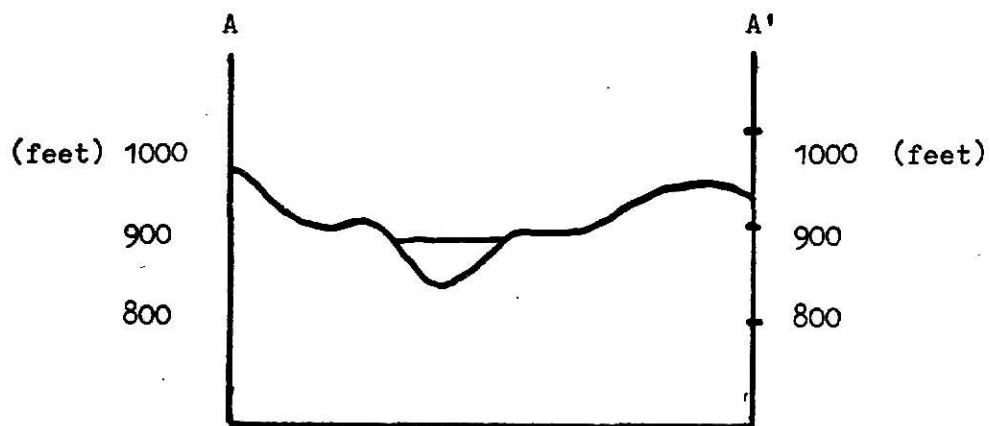


Scale 0 500 1000 1500 2000 feet
1" = 680 feet

FIGURE 4



Topographic Map of Lake Site 1



Topographic Cross-section of Lake Site 1 along A-A'

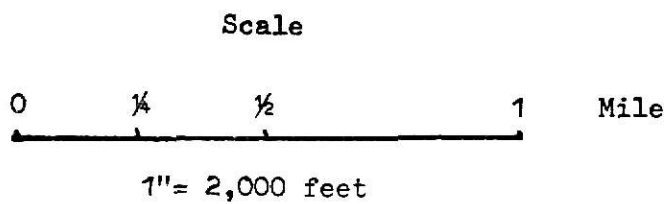
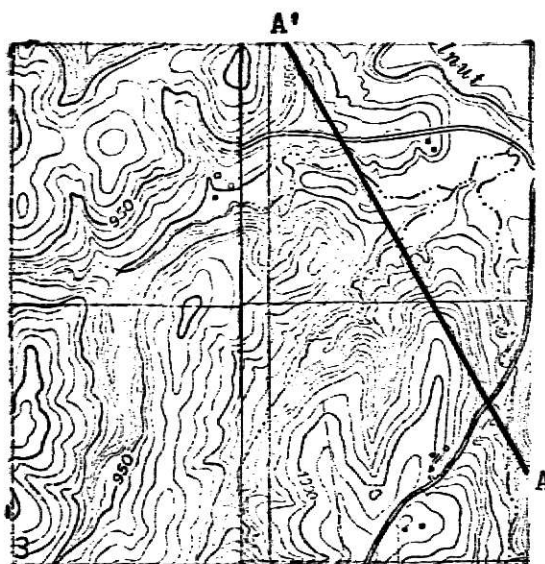
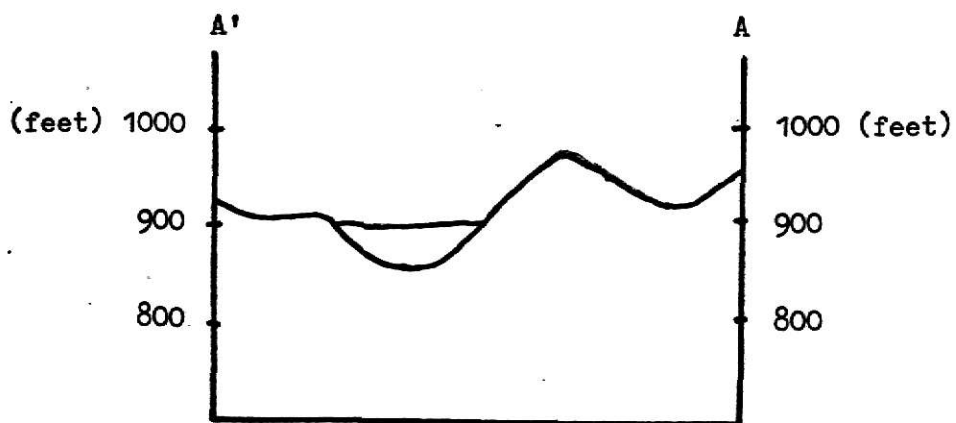


FIGURE 5



Topographic Map of Lake Site 2



Topographic Cross-section of Lake Site 2 along A-A'

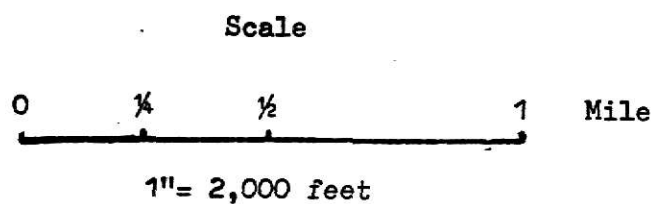
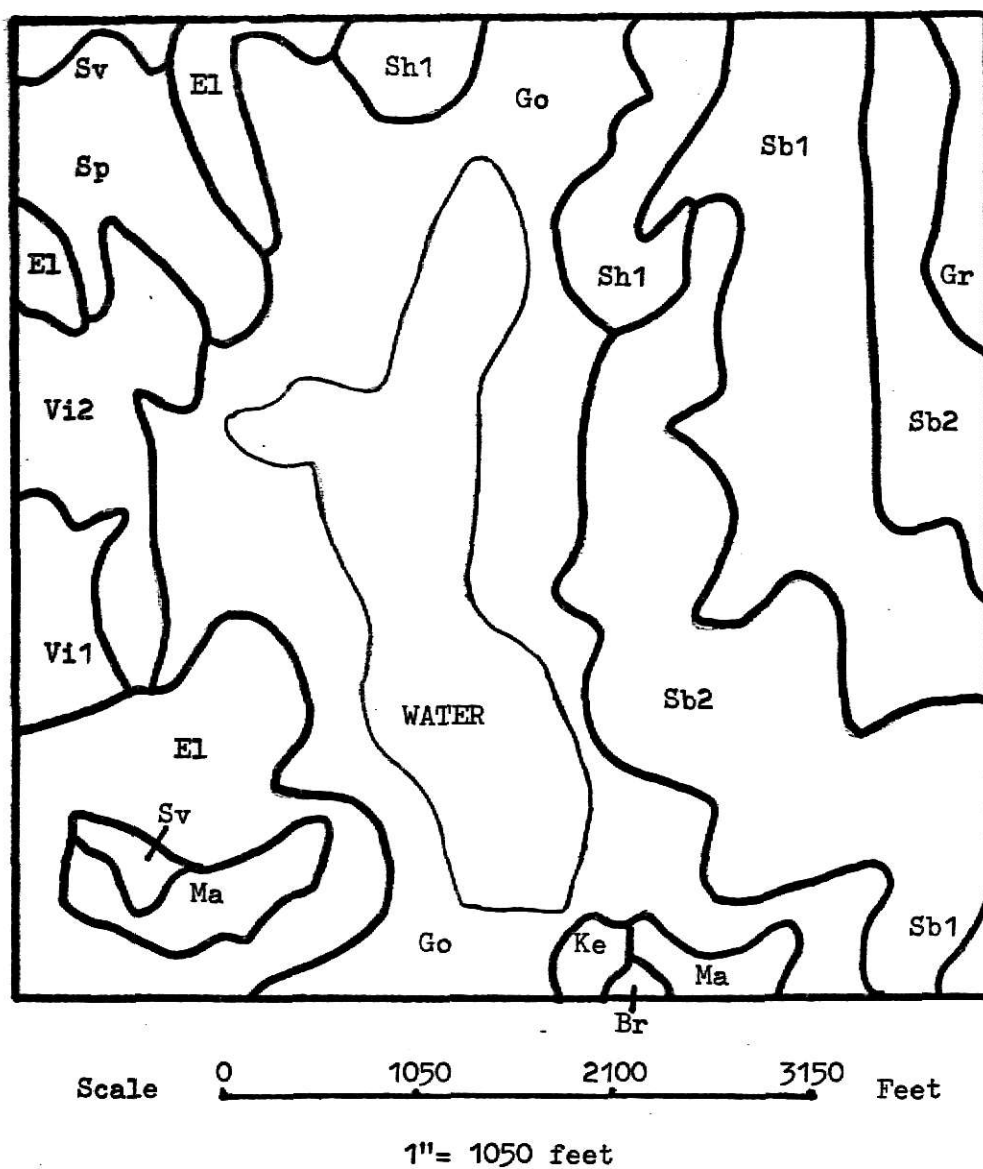


FIGURE 6 Soil Map of Lake Site 2



Br Bremer silty clay loam 0-2%

El Elmont silt loam 3-7%

Go Gosport-Sogn complex 7-35%

Gr Grundy silty clay loam 3-7%

Ke Kennebec silt loam 0-2%

Ma Martin silty clay loam 4-7%

Sb1 Sharpsburg silty clay loam 1-4%

Sb2 Sharpsburg silty clay loam 4-8%

Sh1 Shelby loam 4-8%

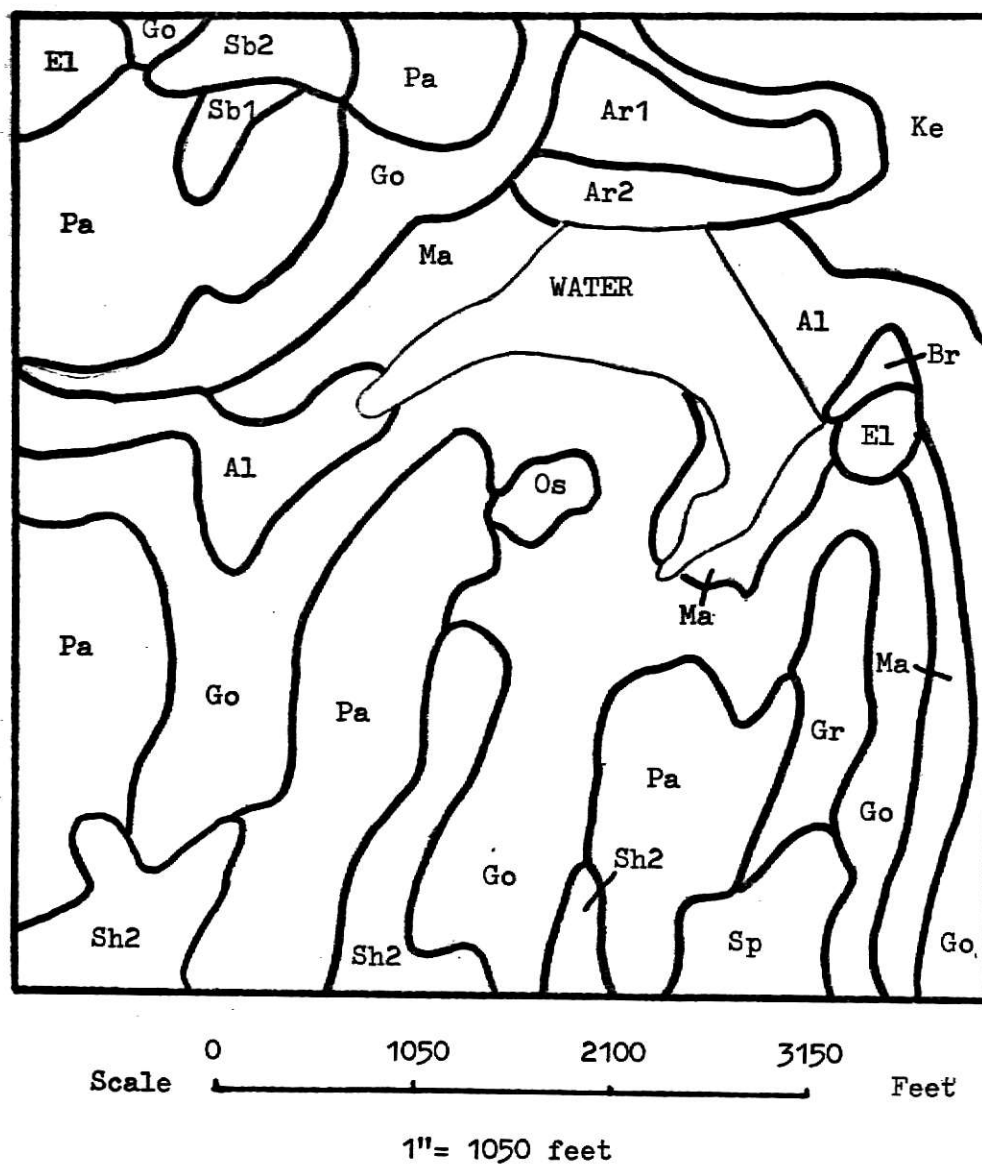
Sp Shelby-Pawnee complex 4-8%

Sv Sibleyville loam 4-8%

Vi1 Vinland-Sibleyville complex 4-8%

Vi2 Vinland-Sibleyville complex 8-12%

FIGURE 7 Soil Map of Lake Site 2



- | | |
|--------------------------------|-------------------------------------|
| Al Alluvial land | Ma Martin silty clay loam 4-7% |
| Ar1 Armster loam 3-8% | Os Oska silty clay loam 3-8% |
| Ar2 Armster loam 8-12% | Pa Pawnee clay loam 4-7% |
| Br Bremer silty clay loam 0-2% | Sb1 Sharpsburg silty clay loam 1-4% |
| El Elmont silt loam 3-7% | Sb2 Sharpsburg silty clay loam 4-8% |
| Go Gosport-Sogn complex 7-35% | Sh2 Shelby loam 8-12% |
| Gr Grundy silty clay loam 3-7% | Sp Shelby-Pawnee complex 4-8% |
| Ke Kennebec silt loam 0-2% | |

FIGURE 8

12.

Knox-Ladoga Association with
Eudora-Haynie-Onawa Association (5)

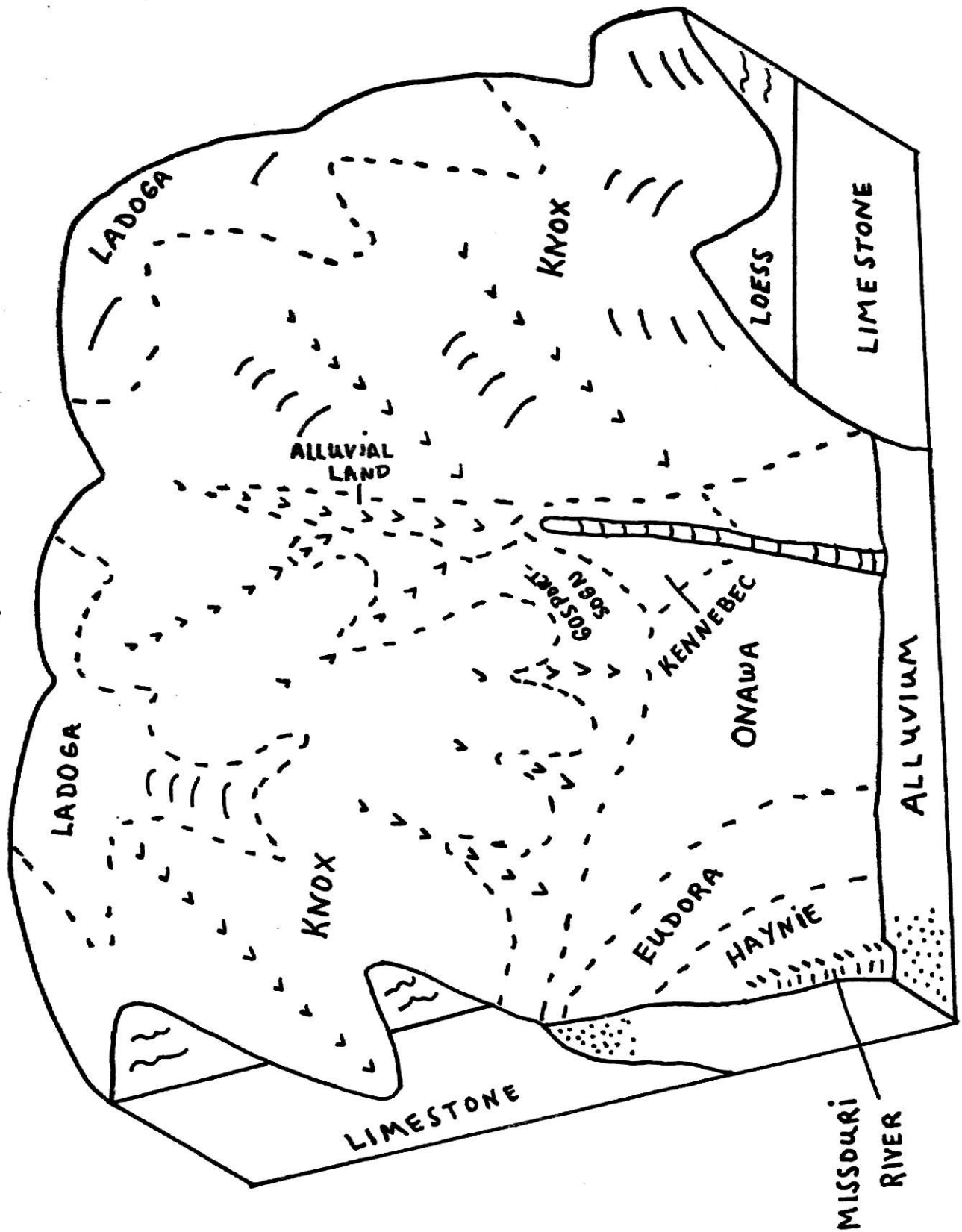


FIGURE 9
Grundy-Pawnee-Shelby (5)
Association

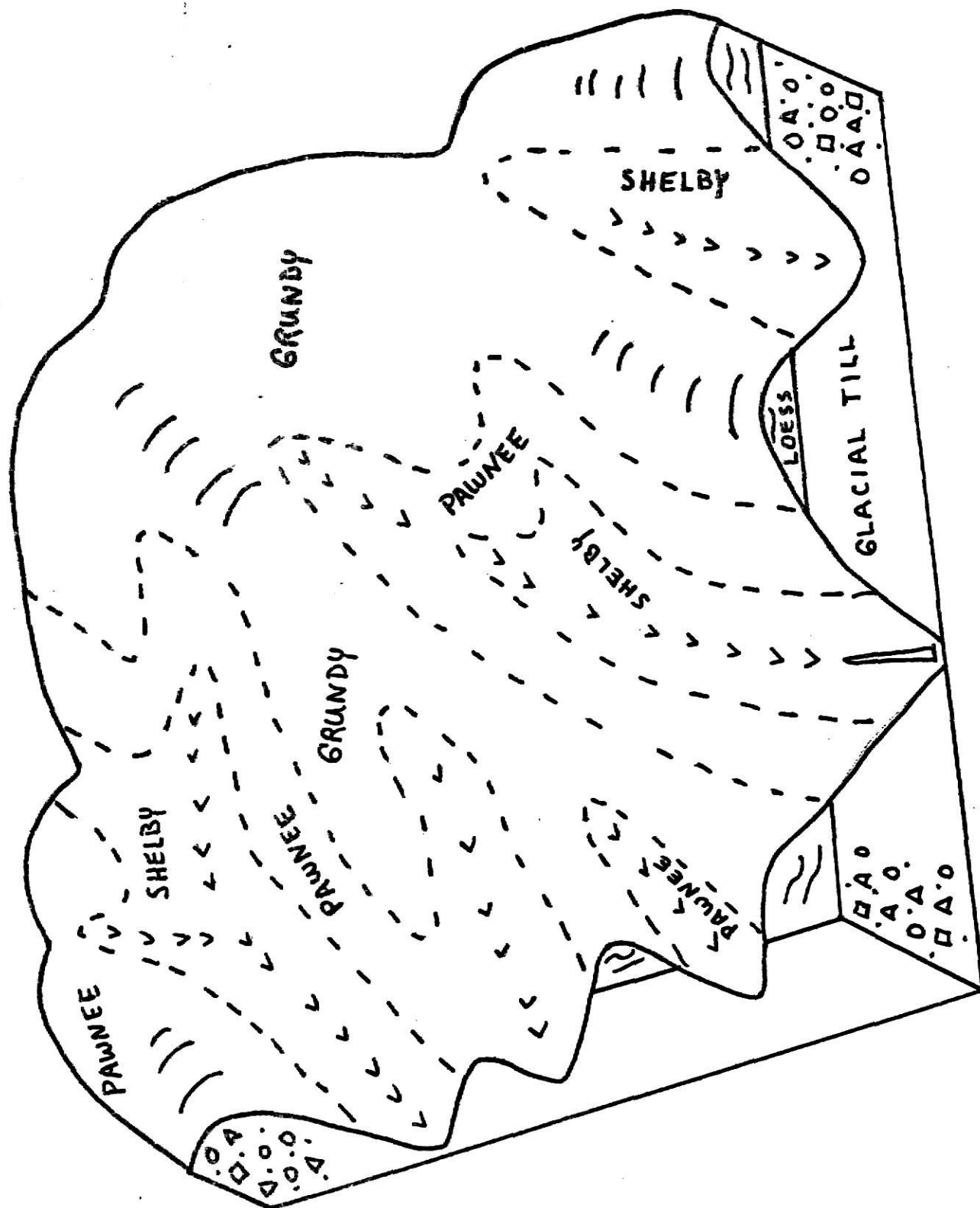


FIGURE 10

Gosport-Sogn Association with
Bremer-Wabash-Kennebec Association (5)

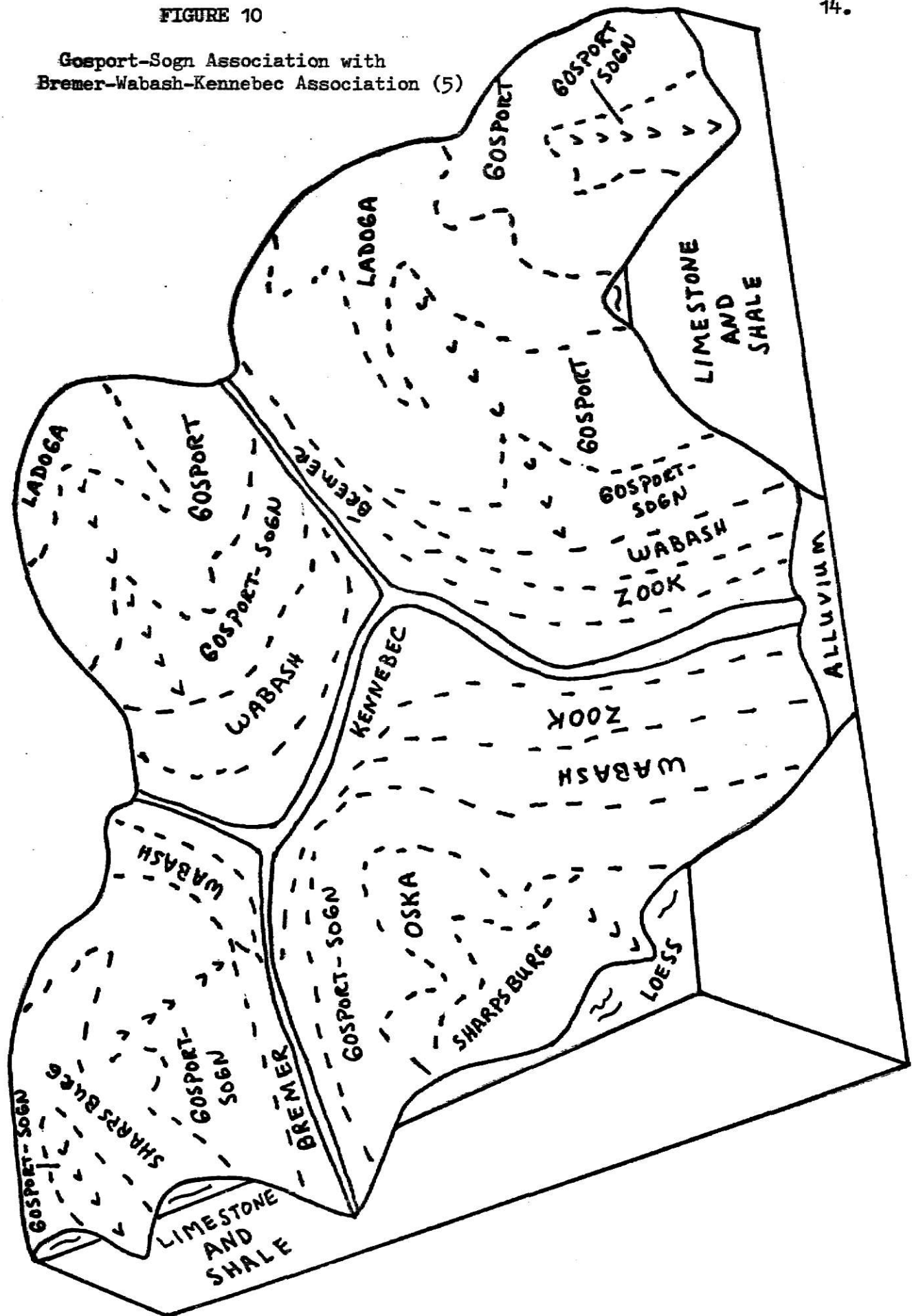
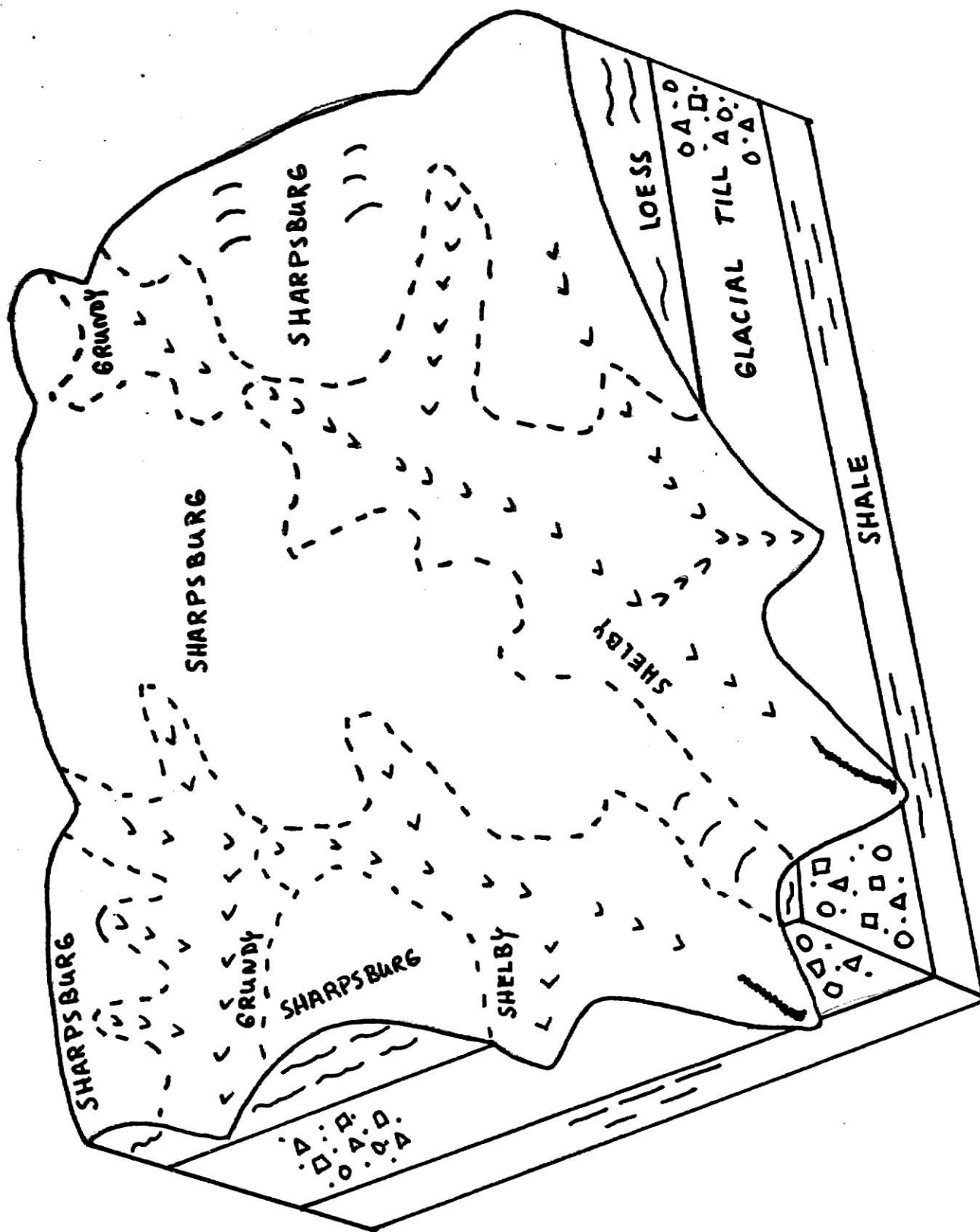


FIGURE 11

Sharpsburg-Shelby Association (5)



construction, upkeep and longevity of a residential subdivision.

The U.S. Department of Agriculture, Soil Conservation Service evaluates 14 soil factors when interpreting soils for residential development. These factors are: permeability, hydraulic conductivity, percolation rate, depth to water table, frequency of flooding, slope, depth to bedrock, stoniness, amount of rock outcrops, percentage of organic matter, drainage class, soil texture, shrink-swell potential and potential frost action (26).

The above factors were taken from the guide sheets of limitation rating for the 5 soil uses representing residential developments (26). These uses are Septic Tank Absorption Fields, Shallow Excavations, Dwellings with Basements, Dwellings without Basements and Local Roads. Factors that affect the proposed residential developments in the two lake areas are:

Permeability. Soil permeability is that quality of soil that enables it to transmit water and air. The measure of this quality is the rate which soil transmits water while saturated. Soil permeability classes are: (24)

<u>Permeability Class</u>	<u>Inches/hour</u>
Very slow	less than 0.06
Slow	0.06-0.2
Moderately slow	0.2-0.6
Moderate	0.6-2.0
Moderately rapid	2.0-6.0
Rapid	6.0-20.0
Very Rapid	more than 20

Soil properties affecting permeability are soil texture, structure, aggregate stability, pore size and exchangeable sodium percentage. As soil texture becomes finer, permeability decreases. The finer and less stable the soil aggregation, the slower the permeability.

In the presence of appreciable amounts of colloidal clay, as the percentage of exchangeable sodium increases, the permeability decreases (2).

Depth to Bedrock. Depth to bedrock refers to the vertical depth of the soil to consolidated rock such as sandstone, limestone, shale or unconsolidated clays that restrict root and water movement. Some bedrock such as shale may be ripped. Table 1 shows the effect of soil depth on selected land uses (3).

Slope. Slope refers to the steepness of the surface or the vertical rise or fall for 100 feet of distance expressed in percent. Urban land use considerations require broader and different slope ranges than agricultural lands. Table 2 shows the effect of slope on selected land uses (3).

Shrink-swell potential. Shrink-swell potential is the quality that determines the soil's volume change with change in moisture. Building foundations, roads and other structures may be severely damaged by shrinking and swelling. Soil volume change depends on the amount of moisture change and the amount and type of clay. In general, shrink-swell potentials for selected textural classes are (3):

Sands, loamy sands, sandy loams- low shrink-swell potential.

Silt loams, clay loams, silty clay loams- moderate shrink-swell potential.

Silty clays, clays- high shrink-swell potential.

Drainage. Drainage refers to the rapidity and extent of the removal of

TABLE 1

The Effect of Variations in Soil Depth on Selected Land Uses

(Limitations are: SL=slight; M=moderate; S=severe; and VS=very severe) (3)

<u>Description</u>	<u>Depth</u>	<u>Dwellings</u>		<u>Septic systems</u>	<u>Sewage lagoons</u>	<u>Roads</u>
		<u>without basements</u>	<u>with basements</u>			
Very shallow	0-10"	S	VS	VS	VS	S
Shallow	10-20"	M	VS	VS	VS	M
Moderately deep	20-40"	SL	S	S	S	SL
Deep	40-72"	SL	M	M	M	SL
Very deep	over 72"	SL	SL	SL	SL	SL

TABLE 2

The Effect of Variations of Slope on Selected Land Uses

(Limitations are: Sl=slight; M=moderate; S=severe; VS=very severe.) (3)

<u>Description</u>	<u>Slope</u> (%)	<u>Dwellings</u>		<u>Septic</u> <u>systems</u>	<u>Sewage</u> <u>lagoons</u>	<u>Roads</u>
		without basements	with basements			
Nearly level	0-.5	M	Sl	Sl	Sl	Sl
Gently sloping	0.5-5.0	Sl	Sl	Sl	Sl	Sl
Moderate	5.0-8.0	Sl	M	Sl	M	Sl
Strong	8.0-15.0	M	S	M	S	M
Very strong	15.0+	S	VS	S	VS	S

water from the soil, in relation to additions especially by surface runoff and by flow through the soil to underground spaces. The 7 soil drainage classes are (24):

Very poorly drained. The water remains at or near the surface the greater part of the time. Soils of this drainage class occupy level or depressed areas and are frequently ponded.

Poorly drained. The soil remains wet for a large part of the time. The water table is at or near the surface during a considerable part of the year. This condition is due to a high water table, to a slowly permeable layer within the profile, to seepage or to some combination of these conditions.

Somewhat poorly drained. The soil remains wet for significant periods, but not all the time. This condition can be caused by the same conditions mentioned under poorly drained.

Moderately well drained. The soil is wet for a small but significant part of the time. This condition can be caused by the conditions mentioned under poorly drained.

Well drained. Water is removed readily but not rapidly. These soils are commonly intermediate in texture, although soils of other textural classes also may be well drained.

Somewhat excessively drained. Water is removed from the soil rapidly. Many have little horizon differentiation and are sandy and very porous.

Excessively drained. Water is removed from the soil very rapidly. These soils are commonly shallow and may be steep, very porous or both.

SOIL MAPS

A soil map is designed to show the distribution of soil types or other soil mapping units in relation to other prominent physical and cultural features on the earth's surface. The 3 general kinds of soil maps are: Detailed, reconnaissance and detailed reconnaissance. The soil maps used in Leavenworth County are detailed, which are the most useful and important (24).

Best use of a soil map to identify an area's potential for development requires that: 1. The map be of high quality and of sufficient detail and 2. On-site investigation be carried out (21). Although normal detailed soil maps prepared by the National Cooperative Soil Survey may be of high quality, they may have other deficiencies for detailed planning.

Deficiencies may occur because: 1) Insufficient time was taken to make a detailed soil map, 2) The series control section only was used to distinguish soils, 3) Mapping scale was too small to show soil variation or to eliminate inclusions.

Accelerated soil-mapping work schedules require that soil scientists maintain a consistent high daily acreage in order to complete the survey in a reasonable time. For example, if a survey area has 600,000 acres and a party of 4 soil scientists, each man must map approximately 240 acres a day to meet a 4-year completion date if the field season has 160 mapping days a year.

When mapping the soils of Leavenworth County, soil scientists considered the soil profile to a depth of 40 inches, unless, of course, the soil was less than 40 inches deep. The soil profile between 10 and 40 inches is called the series control section. Soil properties within this section such

as texture, color and structure enable us to distinguish the soil series. Thus, most of the soils of Leavenworth County were not observed at depths greater than 40 inches.

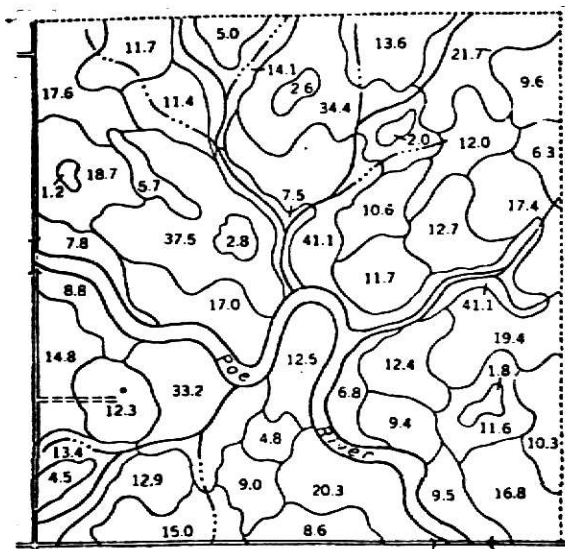
Soil properties that can occur below 40 inches such as bedrock, water table and impervious layer are not generally identified on a soil map. These properties are important in planning for most types of development as shown by the section on criteria for soil limitations.

Detailed soil maps are made at various scales depending upon the purpose to be served, the intensity of soil use, pattern of soils and scale of other cartographic materials available. Detailed soil maps are published at scales of 1:15,840 (4"= 1 mile), 1:20,000 (3.17"= 1 mile), or 1:24,000 (2.64"= 1 mile). The Leavenworth County soil maps (5) are the scale of 1:24,000. The soil maps in Figures 5 and 6 were enlarged from that scale and are now approximately 1:12,700 (5"= 1 mile). The soil limitation maps in Figures 13 to 22 are the scale of 1:24,000.

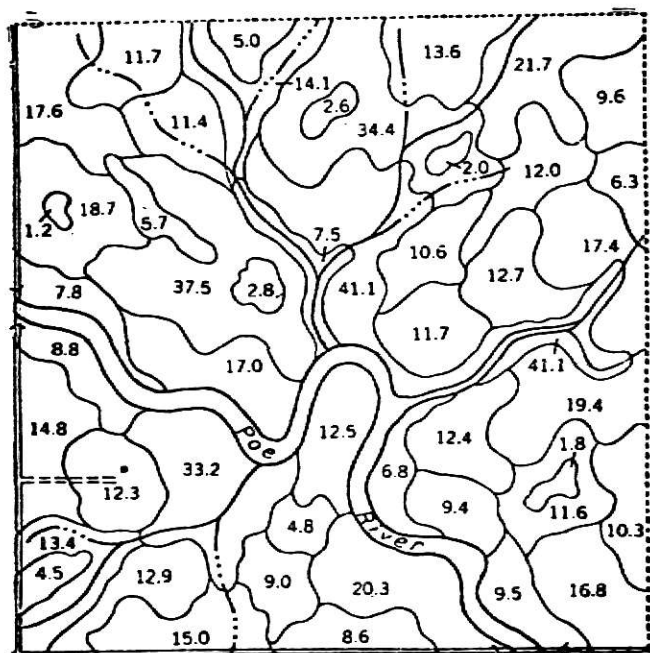
Figure 12 shows examples of mapping unit acreages at the scale of 1:24,000 and 1:20,000. The common publication scale of present soil surveys is 1:20,000. The figures show that smaller acreages can be shown more easily on a larger scale. The more detailed the mapping the larger the scale must be. The Soil Conservation Service recommends delineations of not less than 1½ acres.

For engineering work such as highway or residential construction the detail necessary requires a field mapping scale of 1:2,500 (25.3"= 1 mile) or 1:1,000 (63.4"= 1 mile) (24). The mapping scale available for this study is not detailed enough for positive assessment of the study areas' potential for residential development. Consequently on-site studies of the soil are necessary to determine specific uses for specific areas (11).

FIGURE 12



Mapping Unit Acreages at the Scale of 1:24,000



Mapping Unit Acreages at the Scale of 1:20,000

Very few, if any mapping units are pure, that is, contain only the designated soil series or phase. Recent detailed studies of mapping units have shown that the proportions of mapping inclusions are commonly greater than 15% (25). Consequently a mapping unit containing 40 acres may include at least 6 acres of soils other than those designated by the mapping symbol. The included soils may be totally or only slightly different in physical properties from the major series in the unit.

LAKES POSE ADDITIONAL PROBLEMS FOR DEVELOPMENT

The need for sewage-disposal facilities that do not deteriorate water quality and the possibility of shoreline erosion add to the normal soil-related problems encountered when developing around small lakes. Because the lake within a residential subdivision may be used for recreation as well as drinking water it is important to maintain high water quality. The Washington state monograph on subdivisions reads, "the developer shall install the septic tank in the upland, 100 feet from the meander line (of a stream)" (1). The Kansas State Department of Health states that septic tank absorption fields must be at least 50 feet from water wells (17).

A Texas study showed that certain vegetation effectively controls shoreline erosion. Water-loving or water-tolerant plants, with strongly rhizomatous or extensive root systems work best. Also tall plants with stiff canes and stems that dissipate wave energy are given preference. Common reedgrass, giant reedgrass, switchgrass and prairie cordgrass have proven well adapted in controlling wave erosion. Other plants such as giant cutgrass, maidencane, indigobush and buttonbush are also promising in preventing erosion.

Studies of this type are also being conducted in Kansas and Oklahoma (9). Rock riprap can be used against erosion, but where rock is unavailable, hauling costs make it expensive.

Maintenance of vegetative cover around a lake can preserve water quality by catching sediment carried by runoff. Sediment pollutes lakes and it's accumulation shortens lake life. Soil erosion and sediment control are the subject of Senate Bill Number 12, proposed by the Special Committee on Conservation and Natural Resources of the Kansas Senate in 1975.

CRITERIA USED FOR SOIL INTERPRETATIONS

Specific criteria used for judging soil factors found limiting in the study area are listed under the 5 residential land-use classifications in Tables 3 to 7. In addition, Kennebec soils are subject to flooding, and if unprotected, pose severe limitations to development.

SOIL LIMITATIONS AND CORRECTIVE MEASURES

Soil interpretive maps show 3 types of limitations, slight, moderate and severe.

Slight Limitation. The soil is relatively free of limitations that affect the intended use, or the limitations are easily overcome.

Moderate Limitation. The soil has moderate limitations that can be overcome with correct planning, careful design and good management.

Severe Limitation. The soil has severe limitations that make the use of the soil doubtful for the proposed use. Careful planning and above-

TABLE 3
Soil Limitation Ratings for Septic Tank Absorption Fields (26)

	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
Permeability	rapid to moderately rapid	moderate	moderately slow to slow
Depth to Rock	72"	48-72"	above 48"
Slope	0-8%	8-15%	over 15%

TABLE 4

Soil Limitation Ratings for Dwellings with Basements (26)

	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
Drainage	excessively to well	moderately well	somewhat poorly
Slope	0-8%	8-15%	over 15%
Depth to Rock	60"	40-60"	above 40"
Shrink-swell potential	low	moderate	high

TABLE 5
Soil Limitation Ratings for Dwellings without Basements (26)

	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
Drainage	excessively to well	somewhat poorly	poorly to very poorly
Slope	0-8%	8-15%	over 15%
Depth to Rock	40"	20-40"	above 20"
Shrink-swell potential	low	moderate	high

TABLE 6
Soil Limitation Ratings for Shallow Excavations (26)

	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
Drainage	excessively well	moderately well	somewhat poorly to poorly
Slope	0-8%	8-15%	over 15%
Depth to Rock	60"	40-60"	above 40"
Texture	fine sandy loam- silty clay loam	silt and gravel	clays and very gravelly

TABLE 7
Soil Limitation Ratings for Local Roads (26)

	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
Drainage	excessively to moderately well	somewhat poorly	poorly to very poorly
Slope	0-8%	8-15%	over 15%
Depth to rock	40"	20-40"	above 20"
Shrink-swell potential	low	moderate	high

average design and management, including major reclamation work are required (20).

Cost must be considered in every design practice, including the correction of soil limitations. The Soil Conservation Service suggests that practices for overcoming slight limitations are available at costs judged locally to be feasible, practices for overcoming severe limitations are not considered feasible locally, because of high cost and practices for overcoming moderate limitations are intermediate between those for slight and severe (27).

Almost one-third of all the reasons given by non-users of soil stabilization was excessive cost (14). Because local supply and contract costs fluctuate, it is impossible to give positive figures on the cost of soil stabilization practices. Average unit costs of construction items necessary for several of the corrective measures mentioned are listed in Appendix II.

In the future the Soil Conservation Service will emphasize a more positive approach to soil use called "soil potentials". They will give the land-user more information about soil behavior so he can better plan and evaluate it's use. The word limitation is too discouraging, when the fact is that many severely limited soils can be used as shown in the above definition (10).

Tables 8 and 9 show the acreages of each limitation for the 5 residential land uses.

Figures 13 and 14 show the areas of soil limitation for dwellings with basements. Both lake sites have sizable areas of severe limitations. Some corrective procedures enabling the development of limiting soils for dwellings with basements are:

1. Foundations can be reinforced with steel rods to combat soil expansion (8).
2. Foundations can be poured in oversized trenches to allow for the expansion of soils without damage to the foundation. The space

TABLE 8

Acreages of Slight, Moderate and Severe Limitations in Lake Site 1

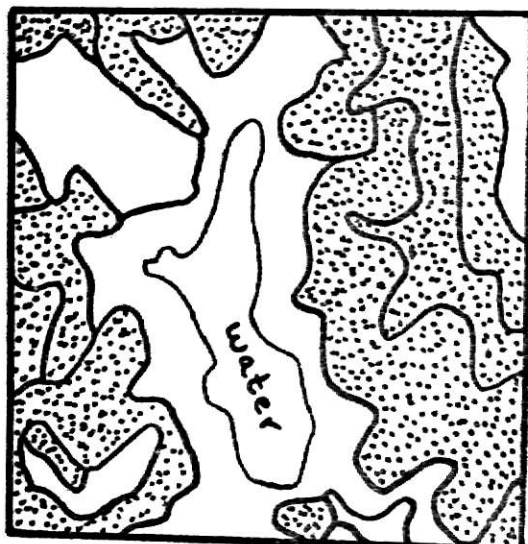
	<u>Dwellings with basements</u>	<u>Dwellings without basements</u>	<u>Septic Tank absorption fields</u>	<u>Shallow excavations</u>	<u>Local roads</u>
Slight	0	0	0	55	0
Moderate	270	320	0	265	300
Severe	310	260	580	260	280

TABLE 9

Accreages of Slight, Moderate and Severe Limitations in Lake Site 2

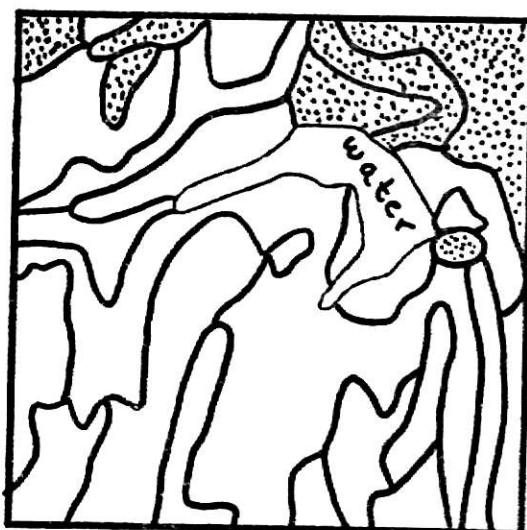
	<u>Dwellings with basements</u>	<u>Dwellings without basements</u>	<u>Septic Tank absorption fields</u>	<u>Shallow excavations</u>	<u>Local roads</u>
Slight	0	0	0	10	0
Moderate	65	260	0	250	105
Severe	540	345	605	345	500

FIGURE 13



Lake Site 1

FIGURE 14

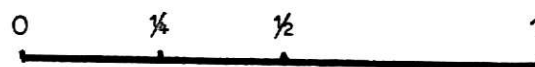


Lake Site 2

Limitations for
Dwellings with Basements

-  Severe
-  Moderate
-  Slight

Scale (miles)



1" = 2,000 feet

between the soil and foundation should be filled with material of low shear strength or left unfilled with a collar formed on top of the foundation to prevent soil from filling the trench. The space should not be filled with sand due to it's high shear strength when compressed (18).

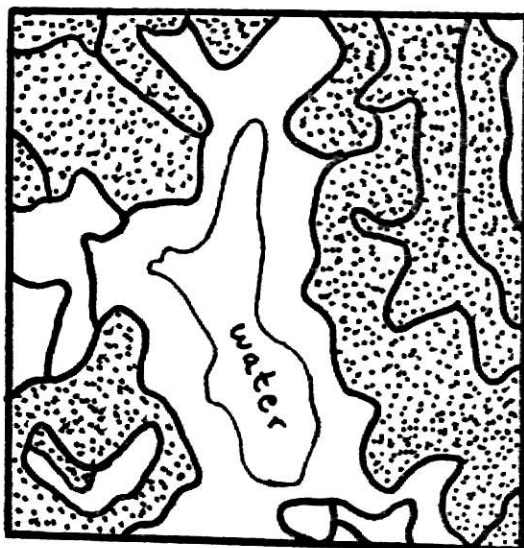
3. The structure can be supported on piers with a space provided for air beneath the structure (15).
4. Tile drains can be placed around foundations to dispose of excess water in very poorly, poorly and somewhat poorly drained soils (8).
5. Surface runoff and seepage can be conveyed to storm drains or ditches in very poorly, poorly and somewhat poorly drained soils and from soil below high runoff areas.

Figures 15 and 16 show the areas of soil limitation for dwellings without basements. Both lake sites contain soils that limit development. Some corrective procedures for constructing dwellings without basements on limiting soils are:

1. Addition of several meters of sandy or loamy fill to the surface of the area enabling construction without the hazards of expanding clays and wetness (30).
2. Use of corrugated cardboard to form the underside of a slab and beam concrete floor system on expansive soils. Jayhawk Box Company in Lawrence, Kansas has cardboard materials for such a system (29).
3. Use of floating slabs that ride out the movement of the soil (18).
4. Placement of footings to a depth near the water table where moisture is not affected by climatic conditions (18).

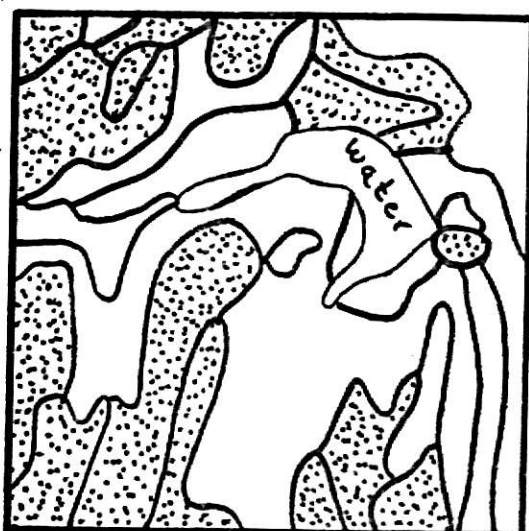
Figures 17 and 18 show the areas of soil limitation for septic tank absorption fields. All soils of the two lake sites have severe limitations. Possible corrective measures include:

FIGURE 15



Lake Site 1

FIGURE 16

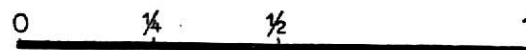


Lake Site 2

Limitations for
Dwellings without Basements

- Severe
- Moderate
- Slight

Scale (miles)



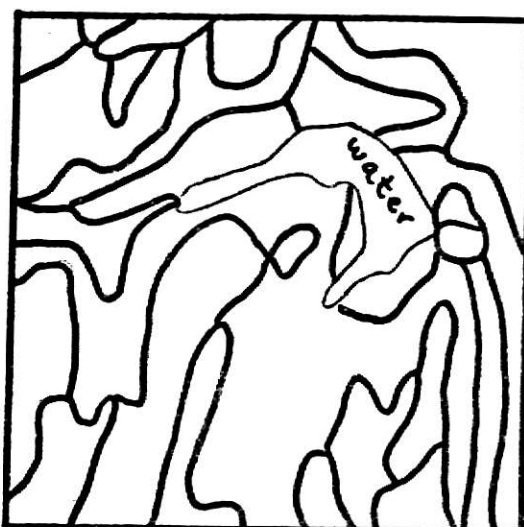
1" = 2,000 feet

FIGURE 17



Lake Site 1

FIGURE 18

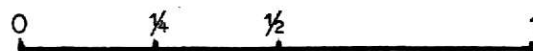


Lake Site 2

Limitations for
Septic Tank Absorption Fields

- Severe
- Moderate
- Slight

Scale (miles)



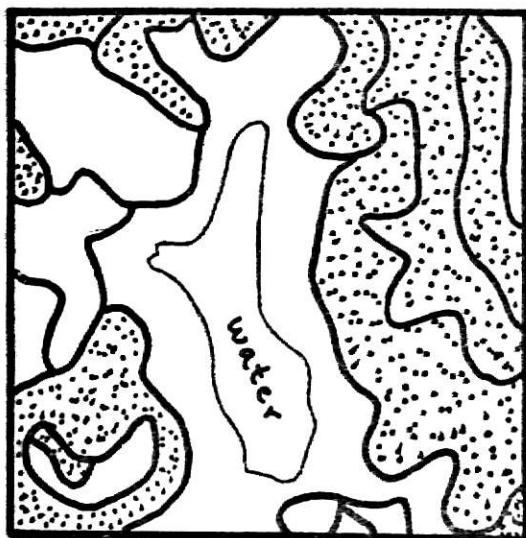
1" = 2,000 feet

1. Construction of a sanitary sewer system (8).
2. Application of additional soil to the area in mounds or as sub-surface seepage areas to insure adequate infiltration (4).
3. Construction of waste stabilization ponds. The Kansas State Department of Health bulletin 4-2 gives the regulations and basic design features for waste stabilization ponds (16).
4. Collecting sewage in a holding tank to be pumped out and disposed of in a sanitary landfill.

Figures 19 and 20 show the areas of soil limitation for local roads. The figures show several areas of severe limitations at both lake sites. Hicks lists five means of stabilization of soils for roadbeds (13).

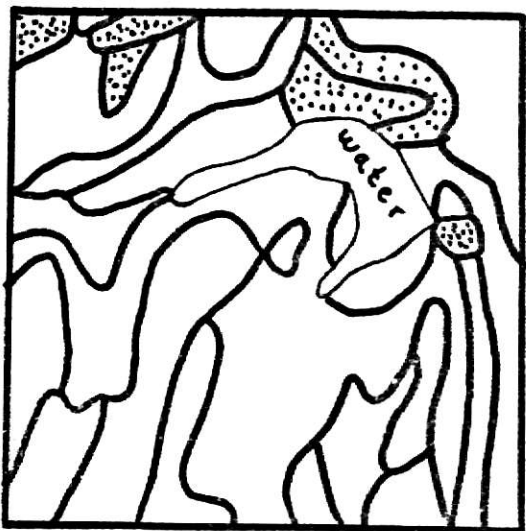
1. Mechanical Stabilization. This process mixes the soils to produce a resulting soil mixture having the required characteristics for adequate stability. In this process only soil materials are used.
2. Portland Cement Stabilization. This process mixes portland cement with the soil to produce a compact mass of sufficient strength to serve as a base course. A portland-cement stabilized soil will not soften in the presence of water and will withstand frost action.
3. Bituminous Stabilization. This process mixes butuminous materials with the soils to waterproof the particles and furnish the necessary cohesion for stability. Although this method of stabilization has been used with clay soils, it's chief use is with sands and sandy soils.
4. Vinsol Resin Stabilization. This process mixes a treated resin, obtained in the extraction of other substances from pine stumps, with the soil. The resulting mixture, if the soil responds favorably to the treatment, resists the penetration of water. The resin itself adds no strength to the soil mass, but causes the soil to repel

FIGURE 19



Lake Site 1

FIGURE 20



Lake Site 2

Limitations for
Local Roads



Severe

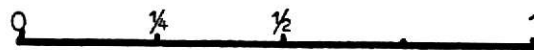


Moderate



Slight

Scale (miles)



1" = 2,000 feet

moisture, so the strength of the mass depends upon the strength of the original soil. Many soils do not respond to this treatment, thus its use requires great care in soil selection.

5. Other stabilization methods such as the use of lime, many types of resins and even chemicals have been attempted with more or less success. Scientists and engineers constantly are seeking new stabilization processes for soils. Much effort is being expended searching for substances that in only small amounts will stabilize soils.

Figures 21 and 22 show the areas of soil limitation for shallow excavations. Shallow excavations are those for utilities such as gas, sewer, water, electric and telephone lines. The best routes for these utilities are identified in the figures as areas with slight and moderate limitations. Such information can be identified on county or large area maps to locate the most suitable and economical routes for long distance utilities as oil and gas pipe lines.

CONCLUSIONS

Lakeside housing developments are more difficult to construct than non-lakeside housing developments. The use of the lake as water supply and for recreation makes proper runoff and sewage disposal important. Lakes must be constructed in water courses where the surrounding land generally is steep and subject to severe erosion when disturbed by cultivation or in the course of housing construction.

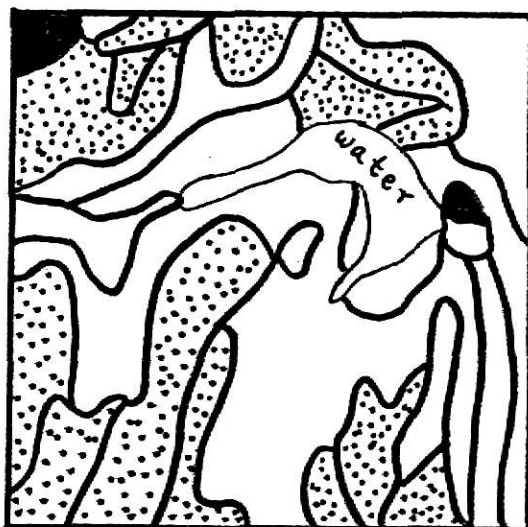
Because soil maps are available for the two lake sites, we have a means of predicting the suitability of the areas for residential development. This

FIGURE 21



Lake Site 1

FIGURE 22

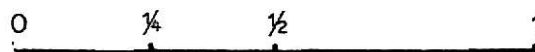


Lake Site 2

Limitations for
Shallow Excavations

- Severe
- Moderate
- Slight

Scale (miles)



1" = 2,000 feet

study permits, in the planning stage, a broad adjustment of the development pattern based on soil properties. More specific adjustments must be confirmed by on-site inspection. Both lake sites contain soils that have limitations for residential development. By spending more time and money in design and site management most of the soil limitations encountered can be overcome.

GLOSSARY (23)

Alluvial soil- A soil developing from recently deposited alluvium and exhibiting essentially no horizon development or modification of the recent deposited materials.

Buried soil- Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Clay- A soil separate consisting of particles less than 0.002 mm in equivalent diameter.

Course texture- The texture exhibited by sands, loamy sands, and sandy loams except very fine sandy loam. A soil containing large quantities of these textural classes.

Fine texture- Consisting of or containing large quantities of the fine fractions, particularly of silt and clay.

Loess- Material transported and deposited by wind and consisting of predominantly silt-sized particles.

Medium texture- Intermediate between fine-textured and course-textured (soils).

Percolation, soil water- The downward movement of water through soil.

Especially, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.

Physical properties (of soils)- Those characteristics, processes, or reactions

of a soil which are caused by physical forces and which can be described by, or expressed in, physical terms or equations.

Porosity- The volume percentage of the total bulk not occupied by solid particles.

Profile, soil- A vertical section of the soil through all its horizons and extending into the parent material.

Residual soil- A soil formed from, or resting on, consolidated rock of the same kind as that from which it was formed, and in the same location.

Runoff- That portion of the precipitation on an area which is discharge from the area through stream channels. That which is lost without entering the soil is called surface runoff and that which enters the soil before reaching the stream is called ground water runoff or seepage flow from ground water.

Sand- A soil particle between 0.05 and 2.0 mm in diameter.

Silt- A soil separate consisting of particles between 0.05 and 0.002 mm in equivalent diameter.

Soil map, detailed- A soil map on which the boundaries are shown between all soil types that are significant to potential use as field-management systems. The scale of the map will depend upon the purpose to be served, the intensity of land use, the pattern of soils, and the scale of the other cartographic materials available.

Soil map, detailed reconnaissance- A reconnaissance map on which some areas or features are shown in greater detail than usual, or than others.

Soil map, reconnaissance- A map showing the distribution of soils over a large area as determined by traversing the area at intervals varying from about 1/2 mile to several miles. The units shown are soil associations. Such a map is usually made only for exploratory purposes to outline areas of soil suitable for more intensive development. The scale is usually much smaller than for detailed soil maps.

Soil structure- The combination or arrangement of primary soil particles into secondary particles, units, or peds. These secondary units may be, but usually are not, arranged in the profile in such a manner as to give a distinctive characteristic pattern. The secondary units are characterized and classified on the basis of size, shape, and degree of distinctness into classes, types, and grades, respectively.

Soil texture- The relative proportions of the various soil separates in a soil as described by the classes of soil texture shown in Appendix III.

Solum (plural: sola)- The upper and most weathered part of the soil profile; the A and B horizons.

Stratified- Arranged in or composed of strata or layers.

Surface soil- The uppermost part of the soil, ordinarily moved in tillage, or its equivalent in uncultivated soils and ranging in depth from 3 or 4 inches to 8 or 10.

Terrace- A level, usually narrow, plain bordering a river, lake, or the sea. Rivers sometimes are bordered by terraces at different levels.

Till- Unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel, and boulders intermingled in any proportion.

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APPENDIX I

The following soil descriptions were produced from National Cooperative Soil Survey established series descriptions and reference number 5.

Alluvial land, 0 to 2 percent slopes, (A1).

These soils occur on flood plains in areas less than 300-feet wide. They border a meandering stream and flood frequently. They have a loam or silty clay loam texture and are stratified.

Armster loams, 3 to 8 and 8 to 12 percent slopes, (Ar1), (Ar2).

These very gently and gently sloping, deep soils occur where geologic erosion has uncovered a buried soil formed in glacial till on upper valley convex sideslopes and low convex ridgetops.

In a representative profile the surface layers are loam 10 inches thick. The next layers are clay loam to a depth of 60 inches. Armster soils are well drained and have medium runoff and moderately slow permeability.

Bremer silty clay loam, 0 to 2 percent slopes, (Br).

This nearly level deep soil formed in medium-textured alluvium on low stream benches and second bottoms.

In a representative profile the surface layer is silty clay loam 13 inches thick. The subsurface layer is silty clay 21 inches thick. The next layer is silty clay loam below 34 inches. Bremer soils are poorly drained and have slow runoff and permeability.

Elmont silt loam, 3 to 7 percent slopes, (E1).

This gently sloping deep soil formed in residuum from non-calcareous

silty shales on upland sideslopes.

In a representative profile the surface layer is silt loam 15 inches thick. The next layer is silty clay loam from 15 to 65 inches. Elmont soils are well drained and have medium runoff and moderately slow permeability. Gosport-Sogn complex, 7 to 35 percent slopes, (Go).

This complex consists of soils that are shallow and very shallow to consolidated shale and interbedded limestone. The shallow Gosport soils occur on convex sideslopes and excarpment-like areas. The very shallow Sogn soils occur on gently and strongly sloping uplands. This complex is generally over 50 percent Gosport soils.

In a representative profile Gosport soils have a silt loam surface layer 6 inches thick. The next layer is silty clay 17 inches thick over consolidated shale. Typically, Sogn soils have a silty clay loam surface layer 16 inches thick over limestone.

Gosport soils are well drained and have rapid runoff and very slow permeability. Sogn soils are somewhat excessively drained and have rapid runoff and moderate permeability.

Kennebec silt loam, 0 to 2 percent slopes, (Ke).

This nearly level deep soil formed in dark-colored alluvium on bottomlands.

In a representative profile the surface layer is silt loam 45 inches thick. The next layer is silty clay loam to 72 inches. Kennebec soils are moderately well drained and are flooded occasionally. They have slow runoff and moderate permeability.

Martin silty clay loam, 4 to 7 percent slopes, (Ma).

This gently sloping deep soil formed in residuum of silty and clayey shales and clay beds on upland sideslopes, generally below limestone outcrops.

In a representative profile the surface layer is silty clay loam 8 inches thick. The next layer is silty clay to 75 inches. Martin soils are moderately well drained and have medium runoff and slow permeability. Oska silty clay loam, 3 to 8 percent slopes, (Os).

This gently sloping moderately deep soil formed in residuum of limestone and calcareous shales on uplands.

In a representative profile the solum is silty clay loam 38 inches thick over limestone. Oska soils are well drained and have medium runoff and slow permeability.

Pawnee clay loam, 4 to 8 percent slopes, (Pa).

This gently sloping deep soil formed in glacial till of Kansan or Nebraskan age on convex and concave slopes of rolling upland ridges.

In a representative profile the entire solum is clay loam. Pawnee soils are moderately well drained and have medium runoff and slow permeability.

Sharpsburg silty clay loams, 1 to 4 and 4 to 8 percent slopes, (Sb1), (Sb2).

These nearly level and gently sloping deep soils formed in 6 to 14 feet of loess containing less than 5 percent sand on convex ridgetops and sideslopes and upland divides.

In representative profiles the entire sola are silty clay loam. Sharpsburg soils are moderately well drained and have medium runoff and moderately slow permeability.

Shelby loams, 4 to 8 and 8 to 12 percent slopes, (Sh1), (Sh2).

These gently sloping and sloping deep soils formed in glacial till of Kansan or Nebraskan age on convex sideslopes in the uplands.

In representative profiles the surface layers are loam 13 inches thick. The next layers are clay loam to 75 inches. Shelby soils are

moderately well drained and have rapid runoff and moderately slow permeability.

Shelby-Pawnee complex, 4 to 8 percent slopes, (Sp).

This complex consists of deep soils formed in glacial till of Kansan or Nebraskan age on convex and concave sideslopes in the uplands. This complex is generally over 50 percent Shelby soils. The Shelby and Pawnee profiles are described above.

Sibleyville loam, 4 to 8 percent slopes, (Sv).

This gently sloping moderately deep soil formed in residuum from sandstone and sandy or silty shale on the crest and sideslopes of rolling uplands.

In a representative profile the surface layer is loam 13 inches thick. The next layers are clay loam from 13 to 28 inches and loam from 28 to 32 inches resting directly on sandstone. Sibleyville soils are well drained and have medium runoff and moderate permeability.

Vinland- Sibleyville complex, 4 to 8 and 8 to 12 percent slopes, (Vi1), (Vi2).

This complex consists of shallow and moderately deep soils that formed in residuum from sandstone and sandy or silty shale. Vinland soils were found on strongly sloping erosional uplands. The complex is generally over 50 percent Vinland soils.

In a representative profile Vinland soils have a loam surface layer 18 inches thick over limestone. Vinland soils are somewhat excessively drained and have medium runoff and moderate permeability. The profile of the Sibleyville soil is described above.

APPENDIX II

Average Unit Costs of Selected Construction Items

<u>Construction Item</u>	<u>Unit</u>	<u>Cost (\$)</u>
Earth moved and earth fill - semi-compacted	cu. yd.	.31
Earth fill - compacted	cu. yd.	.50
Reinforcing steel	lb.	.33
Foundation drains - sand and gravel for filter	cu. yd.	4.75
6" diameter 16 gauge perforated helical pipe for foundation drains	per ft.	2.75
Tile	lin. ft.	.30

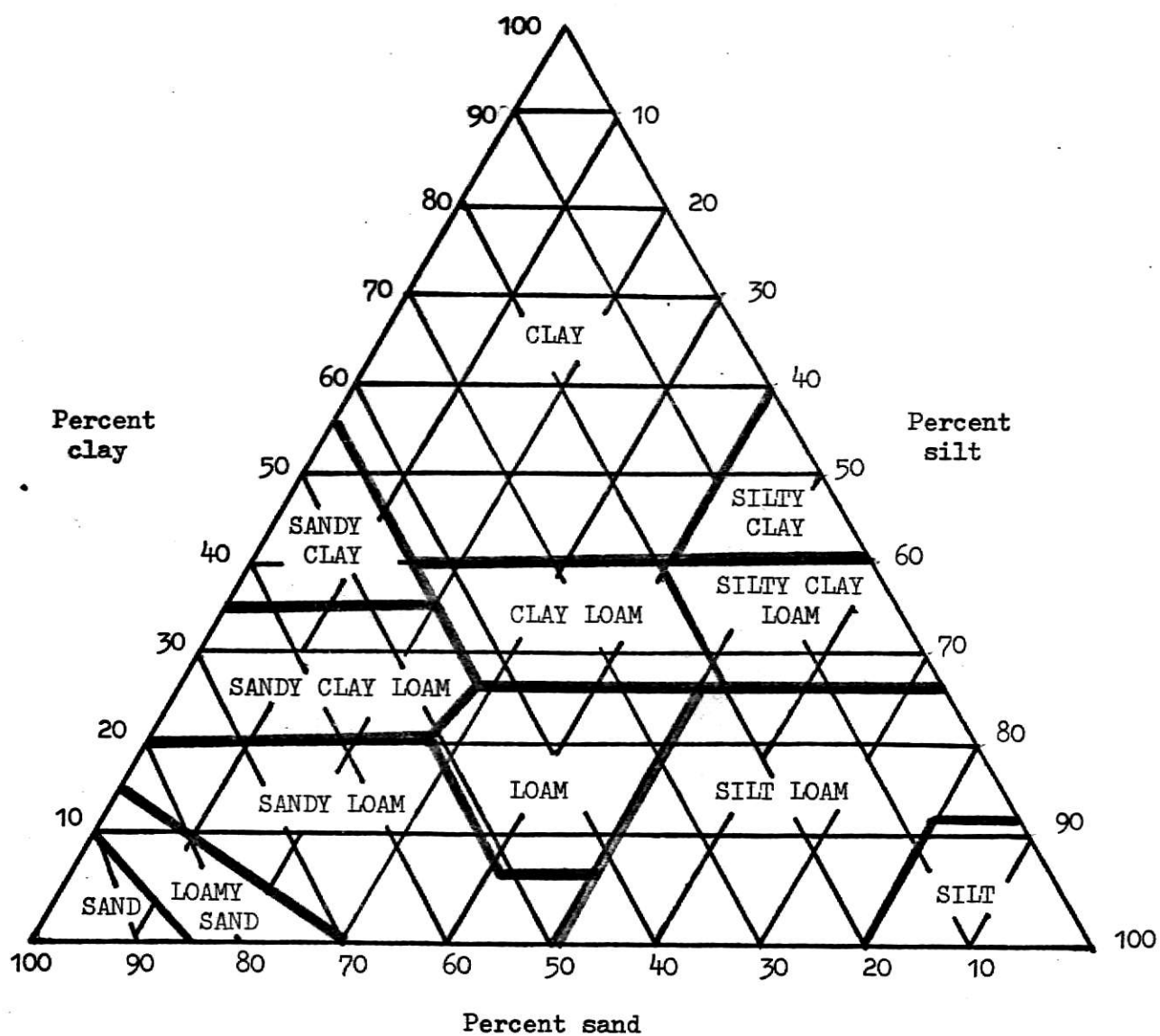
Source: Soil Conservation Service, Great Plains Conservation Program.

Cost of Selected Soil Stabilization Techniques for Roadbeds (14)

<u>Stabilizer</u>	<u>Cost per cubic meter soil treated (\$)</u>
Bitumin	4.00
Lime	2.00
Cement	2.50

APPENDIX III

GUIDE FOR TEXTURAL CLASSIFICATION (24)



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Mr. Robert J. Hrabak, principal planner of the Leavenworth Regional Planning Commission, and his staff, Carol and Steve.

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**A SOIL FEASIBILITY ASSESSMENT FOR SUBDIVISION DEVELOPMENT AROUND TWO
SMALL LAKES IN LEAVENWORTH COUNTY, KANSAS**

by

MARK STEVEN KUZILA

B. S., Kansas State University, 1973

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agronomy

**KANSAS STATE UNIVERSITY
Manhattan, Kansas**

1976

Residential subdivisions have been built and are proposed around small lakes in Leavenworth County, Kansas. Two lake sites are assessed for their potential as nuclei for residential developments. Aerial photographs, soil and topographic maps and block diagrams define the sites. Available soil maps do not allow complete assessment of the areas. They do show slowly permeable, steep and expandable soils common to northeast Kansas, that produce problems for subdivision development. Subdivision development is possible if the design and site management procedures mentioned are used, coupled with on-site soil investigation.