IV. GEOLOGY FOR PLANNING IN LAKE COUNTY

Keith L. Stoffel and Jean I. Larsen

Illinois State Geological Survey

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INTRODUCTION

Lake County, in the northeastern corner of Illinois, has a total population of approximately 382,600 and a land area of about 470 square miles (12,200 km^2). It is bounded on the east by Lake Michigan and its southern boundary is only 20 (32 km) miles north of downtown Chicago. The southeastern part of the county, between Lake Michigan, the Des Plaines River, Waukegan and the Cook County line, is the most densely populated. Waukegan and North Chicago, on Lake Michigan, are the industrial centers of this region, whereas the remaining villages and towns in the area are almost exclusively residential suburbs. Small towns are dispersed throughout the rest of the county, clustered around the numerous inland lakes.

The publication "Geology for Planning in Lake County, Illinois," (Larsen, 1973) served as a basis for this study. Portions of the information present in this report have been summarized from Larsen's publication. Although some of the maps produced for this study are similar to those produced for Larsen's report, the addition of the 20 foot (6.1 m) depth dimension to the geologic material mapping, the new criteria established for the interpretive maps prepared for this study, as well as the addition of some new data, in essence have provided new maps. Only the buried sand and gravel aquifer map has been reproduced directly from Larsen's publication. The remaining maps and text in her report which are not presented in this study are a source of useful information.

For this report, the geologic materials mapping was first compiled in detail on 7½' U. S. Geological Survey Topographic Quadrangle sheets at a scale of 1:24,000 and then reduced to a 1:62,500 scale county base (plate 1) generated by the ILLIMAP system. Units less than 40 acres (16

hectares) in extent were eliminated from the reduced map. Various types of data were utilized for mapping surficial materials such as field observations and laboratory studies of samples, logs and sample descriptions of water wells and engineering borings, test data from engineering borings, previously published and unpublished reports, and published soils maps. Included in this report are a terrain map (plate 2), a map of the poorly-drained soils (plate 3), five interpretive maps detailing conditions for various waste disposal practices (plate 4a-4e), cross-sections (plate 5), a map showing buried sand and gravel aquifers (plate 6), and two maps for interpretations for land utilization (plates 7a and 7b). Criteria and methods for both the geologic materials maps and the interpretive maps were described in volume 1.

Acknowledgements

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GEOLOGY

The drainage, topography, and unconsolidated surficial materials in Lake County primarily result from the action of glacial ice and running water. The layered bedrock lies below these unconsolidated surficial deposits at depths ranging from slightly more than 75 feet (22.5 meters),

where the Des Plaines River leaves the county, to greater than 300 feet (90 meters) in small areas in the western part of the county.

The bedrock surface of the county is mostly composed of Silurian-age dolomite except for small areas along the McHenry County line, where Ordivician-age shale of the Maquoketa Group is present. The general stratigraphy and age relationships of both the glacial deposits and bedrock are shown in Figures 1 and 2 in volume 1. Detailed descriptions of the bedrock geology can be found in Buschbach (1964) and Willman (1973) and a summary of both the glacial and the bedrock geology can be found in Willman (1971). Some of the data available on the glacial deposits has been presented by Lund (1966).

The major topographic features in Lake County reflecting the influence of glacial deposition include both broad and narrow north-south trending hilly ridges (moraines), till plains and sand and gravel outwash plains, a few knob-like hills of sand and gravel (kames), and the Des Plaines and Fox River valleys which were the main drainageways for glacial meltwater. Along these rivers sand and gravel accumulated as valley trains.

Adjacent to the Lake Michigan shoreline, features resulting from the various stages of a glacial lake larger than the present Lake Michigan are in evidence. These include flat expanses of sand and silt (lake plains) and long, narrow ridges of sand and gravel (beaches and bars). A detailed description of the formation of these features and a discussion of the geologic history of the region are given by Willman (1971).

Glacial and Unconsolidated Surficial Deposits

The unconsolidated surficial geologic materials are mapped to a depth of 20 feet (6 meters) on plate 1. These materials exert the major physical control on man's activities within the county. In the legend on

plate 1, the materials are listed in stratigraphic order; that is, the oldest is at the bottom and the youngest at the top. For convenience, the unconsolidated materials are also listed in alphabetical order in Table 1, volume 1. The cross sections on plate 5 show the vertical distribution of the deposits, one above the other, from ground surface to the bedrock surface, along several lines across the county (also see Larsen, 1973, fig. 3, p. 11).

In this report the deposits are described in groups of similar materials: Till, glacial sand and gravel, glacial lake and wind-blown deposits, and recent deposits. The available physical and mineralogical properties of the geologic units in Lake County are summarized in Table 1. The character of each individual geologic unit and the geologic processes which formed it are discussed in volume 1 of this series.

Till

Till is the most abundant glacial material in Lake County, lying from the surface to a depth of 20 feet (6 meters) in approximately 80 percent of the county. It is unsorted debris deposited directly by glacial ice and is composed of pebbles, cobbles and boulders embedded in a matrix of clay, silt, and sand. Only one surficial till unit is present in the county - the Wadsworth Member of the Wedron Formation. The cross sections show the stratigraphic relationship of the Wadsworth Till and the buried basal till units (which have not been identified for this report). The cross sections also show the variability in till thickness across the county, and areas where some tills do not occur. Other till members of the Wedron Formation (the Haeger, Yorkville, Malden and, Tiskilwa) form the surface till in the adjacent counties of Kane, McHenry, and Cook and descriptions of them can be found in volumes 2, 3, and 5 of this study.

TABLE 1

Physical and Mineralogical Properties of
Geologic Units Mapped in Lake County

Units		Data										
		N	qu	w	δd	Gvl	Sd	St	Cl	M	I	C-K
Grayslake Peat (gl)	$\bar{X}$	3	.3	38.5	-	-	-	-	-	-	-	-
	n	2	2	2	-	-	-	-	-	-	-	-
	R	1-5	.2-.4	34-43	-	-	-	-	-	-	-	-
Cahokia Alluvium (c)	$\bar{X}$	7	.97	29	-	3.6	24.6	37.7	37.5	-	-	-
	n	5	4	5	-	9	9	9		-	-	-
	R	3-11	.5-1.5	11-42	-	-	-	-	-	-	-	-
Equality Formation Dolton Member (ed)	$\bar{X}$	1.58	-	-	-	9	38.7	42.3	19	-	-	-
	n	6	-	-	-	8	8	8	8	-	-	-
	R	12-20	-	-	-	1-30	-	26-64	21-63	-	-	-
Wedron Formation Wadsworth Till Member (ww)	$\bar{X}$	33.3	7.2	18.8	-	2.9	9.2	38.2	50.6	9.3	72.6	17
	n	71	126	120	-	138	138	138	138	76	76	76
	R	5-70	1.1-1.8	11-30	-	0-10	0-22	17-69	21-81	4-15	68-82	9-22
Wadsworth Till -lacustrine	$\bar{X}$	16.1	2.5	18.1	-	3.4	19.4	51	29.4	8.9	74.5	16.6
	n	9	4	6	-	19	19	19	19	15	15	15
	R	10-25	1-4.2	16-21	-	0-21	0-67	21-78	11-68	3-15	66-89	8-20

Explanation of Symbols:

$\bar{X}$ = mean
n = number of tests
R = range of data: low value - high value
N = number of blows per foot (Standard Penetration Test)
qu = unconfined compressive strength in tons per square foot
w = natural moisture content in percent
δd = dry density in pounds per cubic foot
Gvl = percent of gravel in total sample
Sd
St } = percent of sand, silt and clay, respectively, in < 2mm fraction of sample
Cl
M = percent montmorillonite and expandables in clay fraction
I = percent illite in clay fraction
C-K = percent chlorite plus kaolinite in clay fraction

Data for several mapped units are not available for samples in Lake County.

Wedron Formation

Wadsworth Till Member (ww). The Wadsworth Till Member underlies the entire county, except under small areas in the extreme western portion, and it forms the conspicuous Valparaiso and Lake Border Moraines (fig. 1). The Valpariso Morainic System is a 10 mile wide complex of low ridges and hills, interspersed with lakes and peat bogs, and covering almost the entire western half of the county. Along the western edge of the Valparaiso Moraine, the Wadsworth Till is thin, but it thickens rapidly towards the east so that in the highest part of the moraine, slightly west of the center of the county, it is more than 250 feet (76 meters) thick in several areas. The Lake Border Moraines are east of the Des Plaines River and form long, narrow ridges paralleling the Lake Michigan shore. In Lake Border Moraines, the Wadsworth Till ranges from 100 to 200 feet (30 to 60 meters) thick.

The Wadsworth till is a silty clay till, gray when unaltered; when oxidized, it varies from yellow to olive brown. It usually contains a small quantity of dolomite pebbles and black shale fragments. It also contains many discontinuous silt and sand lenses of lacustrine origin (ww-1). Some variation in the silt and clay percentages occurs in the Wadsworth Till but this appears to have little stratigraphic significance as the variations are minor and slight shifts in the sand-silt-clay ratio seem to be characteristic of this till. For example, the till immediately west of the Des Plaines River (where it roughly corresponds to the Tinley Moraine) contains a slightly higher percentage of silt and sand than the till to the west of it. The till of the Lake Border Moraines contains silt and clay in nearly equal amounts, but in the Valparaiso Moraine the clay is usually of higher percentage than the silt. In the Lake Border Moraines sand is a relatively minor component and usually only a trace of gravel is present.

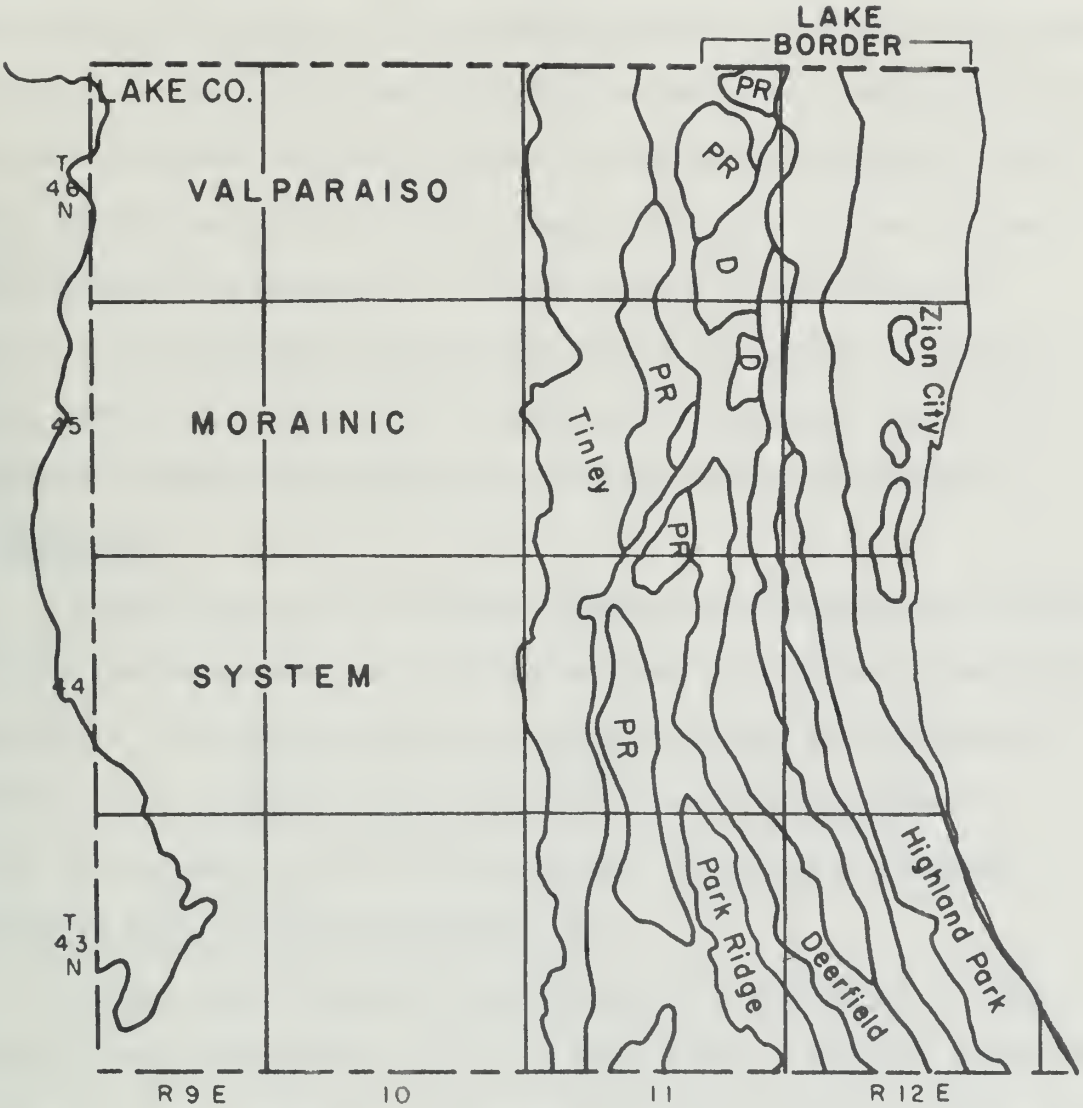

Fig. 1 - Moraines in Lake County (after Willman and Frye, 1970).

Glacial Sand and Gravel

Although most of the sand and gravel outwash is assigned to the Henry Formation, some of the sand and gravel outwash deposits of Lake County can be stratigraphically and mineralogically associated with given till units. Pro-glacial outwash deposits are the Haeger outwash (wh-o) and the buried Wadsworth outwash (ww-o). Along the western edge of the county, outwash associated with the Haeger Till occurs at land surface or buried under thin Haeger Till. In the cross sections (plate 5), additional sand and gravel deposits are shown to be present in the subsurface. These outwashes cannot be related to a particular till, but are generally categorized as Wedron or Winnebago Formation outwash.

Henry Formation

Great quantities of surficial material were transported by meltwater from wasting glacial ice. Different types of surficial outwash are recognized in Lake County according to their lithology and mechanism of deposition. The surficial outwash deposits, other than the Haeger outwash, are assigned to one of three members of the Henry Formation.

Valley Train Deposits (Mackinaw Member, hm)

Clean, medium-textured sand and gravel of the Mackinaw Member occupies the Des Plaines River valley in Lake County. Deposits average 25 to 30 feet (7.5 to 9 meters) in thickness and are generally recognized by their topographic and stratigraphic expression. Minor quantities of valley train outwash also occur in the Fox River Valley.

Outwash Plains (Batavia Member, hb)

The Batavia Member consists of clean sand and gravel deposited by meltwater on broad plains in front of glaciers. Compared to the extensive outwash plains in McHenry County to the west, the occurence of the Batavia Member in Lake County is very limited. The principal outwash plain in Lake

County is found along the western border. Here a plain of sand and gravel 20 to 30 feet (6 to 9 meters) thick is dotted with numerous lakes, peat bogs, and lacustrine deposits formed in depressions left by melting blocks of detached glacier ice. Other minor deposits of the Batavia Member occur in the central and southcentral portions of the county. In the North Mill Creek valley along the northern boundary of Lake County, Batavia Member sand and gravel deposits grade into Mackinaw Member deposits.

Kames (Wasco Member, hw)

Hills, mounds, and knobs of poorly sorted sand and gravel are called kames and are assigned to the Wasco Member of the Henry Formation. Such deposits occur in and near the Fox River Valley along the western edge of the county. The largest areas occur in a north-south belt in the vicinity of the Chain O'Lakes. These deposits form high steep slopes, particularly west of the Fox River in the northwest corner of the county.

Glacial Lake and Windblown Deposits

The surficial materials of Lake County include sediments deposited in glacial lakes. Silts and clays occurring in such quiet-water environments are assigned to the Carmi Member of the Equality Formation. They are yellow-gray to gray, faintly bedded, and uniformly fine-grained in texture. In Lake County, their thickness does not exceed 15 feet (4.5 meters). Coarse-grained beach and bar deposits of sand, gravel and silt found in nearshore environments, are assigned to the Dolton Member of the Equality Formation.

In the northwestern part of Lake County, Carmi Member deposits fill depressions in the outwash plain bordering the Fox River. Other similar lake deposits are widely scattered throughout other portions of western Lake County. Beach deposits of the Dolton Member surround the small lakes in the western half of the county but are too limited in areal

extent to map. Glacial lake deposits of both the Carmi and Dolton Members of the Equality Formation are present adjacent to the shoreline bordering Lake Michigan. These deposits resulted from former high levels in an ice marginal glacial lake (Lake Chicago) which occupied the Lake Michigan basin. Immediately adjacent to the shoreline in the northern portion of the county are modern sand and gravel beach deposits. These are assigned to the Ravinia Member of the Lake Michigan Formation (lmr). Thickness of the combined modern and ancient beach deposits averages (about) 25 feet (7.5 meters).

Wind-blown deposits in Lake County are limited to a thin veneer of Richland Loess (ri) which is present over much of the county. Since the loess is generally less than three feet thick in the county, it was not mapped for this study.

Other Sediments

In addition to glacial sediments, other recent surficial geologic materials are present in Lake County. Alluvial deposits, mapped collectively as Cahokia Alluvium (c), may contain some organic material, silt, clay, sand, and sometimes gravel. It is found in the Des Plaines River Valley and in most other stream valleys in Lake County. Recent sediments are also found in shallow, poorly-drained depressions. These are referred to as accretion gley (ag). Fine textured materials occurring along stream valleys where they accumulated as a result of slopewash and downslope gravity movement are called Peyton Colluvium (py). Accretion gley and Peyton Colluvium may grade into organic peat or muck deposits which are classified as Grayslake Peat (gl).

The Grayslake Peat was named for exposures of peat in the pit of the Grayslake Peat Company one mile south of Grayslake. Deposits of peat and muck are probably more abundant in Lake County than in any other area of Illinois. Significant areas of peat in the County include the bog

area area surrounding Grass Lake, much of which is incorporated into Chain O'Lakes State Park, Volo Bog (McComas et al, 1972) and the large bog area behind the present Lake Michigan beach ridge in northwestern Lake County (Hester and Fraser, 1973). Many smaller bogs and marshes containing at least some Grayslake Peat are scattered over the entire surface of the Valparaiso Moraine System and in low areas between kames along the western side of the county.

TERRAINS

The landscape in Lake County is mainly comprised of a complex series of north-south trending morainic ridges which form the Valparaiso, Tinley and Lake Boarder Morainic Systems (fig. 1). These broad, undulating ridges are underlain by thick sequences (100-300 feet, 30 to 90 meters) of glacial till on an easterly sloping bedrock surface. In general, the landscape in Lake County is higher in the western portion and slopes toward the lake to the east. In and among the morainic areas there are numerous undrained depressions forming small lakes, marshes and peaty, poorly drained soils. The western edge of Lake County contains a complex of ice-contact deposits. Some of these ridges and mounds are as much as 75 feet higher than the surrounding land surface. The shoreline of Lake Michigan, on the eastern edge of the county, has been modified by lake processes which have deposited a range of materials and formed various landforms such as sandy beaches, gravel areas, dunes, lake sediments and steep-sloped, wave-cut cliffs.

For this study the landscape in Lake County has been subdivided into three basic terrains: uplands, plains and lowlands, listed as A, B, and C, respectively, on plate 2. These terrains were identified on the basis of relative elevation, slope characteristics, and sequence and character of the underlying material, and can be considered somewhat arbitrary in Lake County.

There is one area mapped as uplands (A) in the southwestern portion of the county. These uplands form the western edge of the Valparaiso morainic system (Fox Lake Moraine). It is underlain by the silty clay Wadsworth Till. This area, although considerably lower than some of the high morainic areas in McHenry and Kane Counties to the west, has the highest elevations in Lake County, in excess of 900 feet (272 meters) just north of Lake Zurich.

Plains areas, area B on plate 2, comprise about 75 percent of Lake County. With the exception of the lake shoreline, major river valleys, and a small portion of higher morainic uplands (area A), all of Lake County has a plain type of terrain. These plains have an intermediate elevation ranging from 650 feet to 800 feet (195 to 240 meters). In Lake County the plains are underlain mainly by the silty clay Wadsworth Till. Geomorphically, these areas comprise the series of broad morainic ridges of the Valparaiso, Tinley and Lake Border Moraines.

The lowlands areas (area C) are essentially the principal river valleys of the county: Fox River, the Des Plaines River, the North Branch of the Chicago River, and their tributaries. These river systems trend north-south parallel to the trend of the moraines, and once served as drainageways for glacial meltwaters.

The Fox River, located along the western edge of the county, is a unique system of poorly-integrated drainageways in and among the numerous lakes in the area called the Chain O'Lakes. The resulting drainage pattern was first developed by meltwaters channeling through the ice and ice-contact debris. The debris still locally forms steep-sided slopes on the valley walls in the Fox River Valley.

The Des Plaines River and its tributaries drain a large area of the central portion of the county. The Des Plaines River lowlands range

from 640 to 700 feet (192 to 210 meters) in elevation and are considerably lower than the Fox River lowlands, which range from 730 to 800 feet (219 to 240 meters) in elevation. The North Branch of the Chicago River and its tributaries drain the southeastern portion of Lake County. The eastern edge of Lake County is drained by a number of short entrenched, intermittent streams, many with very steep gradients, which flow into Lake Michigan.

NATURAL AND ARTIFICIAL RECHARGE

In Lake County the predominant geologic material is the silty clay Wadsworth Till normally with high water table conditions and the predominant terrain mapped is plains. On the basis of these considerations one might conclude that there is only limited natural recharge of rainfall to the ground-water system. However, based on the hydrogeologic principles and potential regional ground-water flow systems described in volume 1 of this series, much of the area included as upland and plain in Lake County (pl. 2) may be contributing significantly to regional natural recharge of the shallow aquifer systems.

The preliminary evaluation of the six county metropolitan region suggests that the areas mapped as upland terrains in Kane and McHenry Counties, particularly those underlain by sand and gravel at shallow depth, may contribute most to natural recharge regionally. It is likely that many of the areas mapped as uplands and plains on the terrain map (pl. 2) in Lake County may be considered as potentially contributing significant natural recharge to the shallow aquifer, at least locally in Lake and Northern Cook Counties. Therefore, the area mapped as a plain between the Des Plaines River lowland and Lake Michigan may in fact act as a local recharge area to the surface sand and gravel aquifers along the Des Plaines Valley and easterly to the buried shallow aquifers in the

area immediately adjacent to Lake Michigan. From a regional standpoint, however, the area may not be as significant as other areas to the west.

The lowlands (terrain C), particularly those associated with the Des Plaines River and the Fox River are underlain by varying amounts of sand and gravel. These areas may be suitable for artificial recharge locally, especially in areas of extensive ground-water development.

The significance of each terrain within Lake County with respect to both natural and artificial recharge cannot be finalized until the entire northeastern Illinois region has been evaluated.

DRAINAGE

The soil drainage conditions of an area are a major consideration in the interpretations of geologic materials for planning. There are many factors which influence soil drainage in Lake County, such as: depth to and fluctuations of the top of the zone of saturation (water table), permeability of the underlying materials, local and regional slope characteristics, and position with respect to local and regional ground-water flow systems, streams and drainageways.

Plate 3 shows areas of poorly drained soils in Lake County. These were interpreted from existing soil reference and areas prone to flooding were taken from USGS flood hazard maps (U. S. Geological Survey Hydrologic Atlas Series). Poorly drained areas have deloped in Lake County in distinct regions with specific mappable characteristics. Poorly drained areas of the Fox River-Chain O'Lakes basin occupy areas where the soil's parent materials are peat or organic sediments and have formed in filled or partially filled lakes. These poorly drained soils are produced by the melting of buried and detached ice blocks during ablation of the ice sheet forming depressions. Poorly drained areas are common on the hummocky terrain of the Valparaiso Morainic System, west of

the Des Plaines River. Here, small shallow depressions on the relatively impermeable clayey Wadsworth Till have filled with organic materials. In addition, poorly drained marshy areas occur on the abandoned high level lake plains of the Zion Beach Ridge Complex. The areas of poorly drained soils also include the many small or large drainageways which are local or regional discharge areas and are subject to periodic flooding (U. S. Geological Survey Hydrologic Atlas Series).

INTERPRETATION FOR PLANNING

Waste Disposal and Pollution Potential

Five waste disposal and/or pollution potential maps are presented for Lake County which evaluate conditions relative to:

(1) land burial of wastes (plate 4a)

(2) surface spreading of wastes (plate 4b)

(3) waste disposal by septic systems (plate 4c)

(4) application of fertilizers and soil additives (plate 4d)

(5) application of herbicides and insecticides (plate 4e)

For waste disposal, these maps only indicate a probability of finding suitable or unsuitable sites within Lake County, and they cannot be considered a replacement for individual site evaluation. A detailed discussion of the factors involved and limitations in the mapping has been presented in volume 1 of this report.

Land Burial of Wastes (including sanitary landfills)

This map (plate 4a) differentiates areas for the burial of all types of waste products in the ground. We have not distinguished the state of the waste product; that is, whether it is solid, semisolid, or liquid. We have included in this map considerations of the burial of both domestic refuse and industrial chemical waste, some of which may be toxic. Areas A through E are listed in ascending order of their capacity to provide pro-

tection from pollution of both ground water and surface waters. The basic assumptions are: 1) burial in a trench 20 feet deep and 2) contact with ground water.

Most of Lake County is underlain by greater than 50 feet (15 meters) of silty clay till (Wadsworth Till). This fine grained till has a low hydraulic conductivity and moderate cation exchange capacity and attenuation characteristics. Areas of till have varying drainage characteristics depending upon their position in the landscape, surrounding topography, and variations in local materials. Fair to well drained areas of thick Wadsworth Till are mapped as area E and are potentially good areas for land burial of wastes. Poorly drained areas of thick Wadsworth Till are mapped as areas E'. Poor drainage may cause pollutants to return to the surface causing surface water pollution problems where there is insufficient dilution, but it also decreases the potential for pollution of the ground water.

The lowland areas of Lake County are principally underlain (at or within 20 feet, i.e., 6 meters of the land surface) by sand and gravel aquifers (Areas B and B') and are suitable for land burial of non-polluting wastes under controlled conditions. These areas mainly include the Lake Michigan shoreline, Des Plaines River Valley and the Fox River Valley. Small areas of B occur locally within lower morainic areas. Poorly drained areas in B usually occur where there has been some deposition of fine grained material at the surface by lakes, streams and slopewash and are mapped as area B'. In the western portion of the county, the till thins and is underlain by sand and gravel. In these areas detailed control was not available to differentiate all areas where the surficial till were greater or less than 25 feet (7.5 meters) thick. Therefore, where information was not available and surrounding areas suggested that sand and gravel was present, the area was mapped as B and B'. Areas where sand and gravel may be within

25 to 50 feet (7.5-15 meters) of the surface (areas D or D') are generally restricted to the western margin of the county.

In Lake County, the bedrock surface does not come within 50 feet (15 meters) of the land surface. Therefore the units A and C for Land Burial of Wastes do not pertain.

Surface Spreading of Wastes

Plate 4b differentiates areas where there may be pollution problems resulting from the spreading of wastes on the land surface or in the top soil. It is to be used primarily for the placement of industrial and sewage wastes, by any method, on the land surface.

In Lake County, the factors that were considered in mapping include depth to sand and gravel aquifers, terrain and drainage conditions,and soil characteristics,particularly hydraulic conductivity.

A major portion of Lake County, underlain by thick Wadsworth Till, is mapped as area C due to the low hydraulic conductivity of the tills, poor drainage of the surficial material,or steep slopes. Acceptance below the surface soil may potentially be a problem in these areas.

In lowland areas, where sand and gravel occurs at or near the surface, there is a potential for ground water and surficial aquifer pollution. These areas, principally in Fox River and Des Plaines River Valleys and locally on lower morainic areas, are mapped as area B.

Lake County does not have any areas for surface spreading of wastes without limitations (criteria E).

Waste Disposal by Septic Systems

Plate 4c shows areas of potential pollution by septic systems in Lake County. The mapping criteria and procedures have been discussed in detail in volume one of this report.

Lake County has no areas where there are no limitations for

septic systems. A large majority of the county, underlain by 20 feet (6 meters) of Wadsworth Till is mapped as area D. The only limitations in this area are due to the poor acceptance and low hydraulic conductivity of the till.

Poorly drained areas, uplands with steep slopes and, areas of ground water discharge may also cause acceptance problems. In Lake County these areas (Areas C) are found along the Lake Michigan shoreline in poorly drained former lake deposits, locally poorly drained and discharge areas on the moraines especially in the western half of the county, and in upland areas of terraine A.

The principal areas for potential pollution from the use of septic systems in Lake County are underlain by sand and gravel at or within 20 feet (6 meters) of the land surface (Areas A and B). These areas occur along major drainageways of the Fox River and Des Plaines River.

Application of Fertilizer and Soil Additives

Conditions for Application of Fertilizers and Soil Additives in Lake County are mapped on Plate 4d. Only two of the units, A and C, apply to the conditions found in Lake County owing to the occurrence of a single surficial till unit, the Wadsworth Till, and a deep bedrock surface.

Areas mapped C, which are principally underlain by Wadsworth Till, are fine-grained, sometimes poorly drained materials (i.e. lake and stream sediments, muck, peat, etc.), and found over the majority of Lake County. These areas may have surface runoff problems owing to the low hydraulic conductivity of the materials and/or steep terrains or ground water discharge.

Areas mapped A, have large potential for pollution of shallow groundwater systems due to the occurrence of sand and gravel at the surface. In Lake County, these areas lie principally along the shoreline of Lake Michigan, along the Fox River and Des Plaines River Systems, and locally on the broad morainic areas in the northwest portion of the county.

Application of Insecticides and Herbicides

Conditions for application of insecticides and herbicides, mapped on plate 4e, are very similar to conditions for application of fertilizers and soil additives in Lake County. There are no areas mapped without limitations for application of insecticides and herbicides (criteria C).

In Lake County, areas A and B, conditions for application of insecticides and herbicides (plate 4e), correspond respectively in map unit and criteria to areas A and C, conditions for application of fertilizers and soil additives (plate 4d). This is due to their similar application at or near the ground surface, actions by the same natural processes of precipitation, runoff, etc., and similar criteria for each map unit.

LAND UTILIZATION MAPPING

Material properties such as texture and bearing capacity, and terrain characteristics such as drainage and depth to zone of saturation, affect the suitability of land for different uses. Two maps were prepared (plates 7a and 7b) to evaluate both terrain and material characteristics for two specific types of land use - community development and roadway construction. These maps should be used in conjunction with the USGS flood hazard maps and the poorly drained soils map (plate 3).

Certain differences between the maps prepared for this study (pl. 7a and 7b) and plate 4 of Larsen (1973) are due mainly to updated mapping techniques, new data and the use of terrains in making the interpretations in this study. Some of the differences are due to the significance attached to given deposits on data by individual mappers. In plates 7a-7b, a rigid classification of areas (i.e., good, marginal, poor) was purposely avoided; rather, these interpretive maps should be used as one

source of technical input for planning decisions along with other types of nongeologic data. It is assumed that specific construction projects will include an adequate subsurface investigation program.

<u>Construction Conditions for Community Development</u>

Plate 7a indicates construction conditions in order of decreasing restraints for community residential development. Major problems encountered in community development in Lake County, as in much of northeastern Illinois, include poor surface drainage, flooding along rivers and streams, and the presence of deposits which have a low-bearing capacity such as peat or accretion gley.

These conditions are most likely to cause severe problems in areas A and D on plate 7a. These areas include the lowlands along the western border of the county along Fox River, and the lowland areas of predominantly outwash along the Des Plaines River Valley. Caving of excavations and flooding of basements are some of the problems likely to be encountered in lowland areas.

Areas of intermediate and upland terrain (areas E and F, plate 7a) where problems of drainage and flooding are more localized, occur throughout the county. Bearing strengths are generally adequate for single family residences and surficial materials can be easily excavated for foundations and utility lines. Acceptance problems for septic systems may be encountered frequently throughout the county where high water table and poor surface drainage occurs in the Wadsworth till and in lacustrine deposits.

Of considerable local significance to construction in Lake County are two particular geologic hazzards - shoreline erosion along the Lake Michigan bluffs and areas of peat. Other hazards include flooding along the Des Plaines River and other rivers and streams. These hazards are discussed in more detail in the section on Geologic Hazards.

Construction Conditions for Roadways

Plate 7b indicates construction conditions in order of decreasing restraints for roadways. In general, roadway planners are concerned with locating areas of poor drainage, low-bearing capacity materials, and areas subject to seasonal flooding, in determining the amount of material to be excavated or replaced in cuts or fills, and locating potential sources of borrow that are close to the proposed construction. Roadway construction in area A lowlands (plate 7b) may require removal of soft materials, construction of embankments to required grades, and construction of structures over waterways.

In areas C and D cuts and fills may be needed, and material from cuts should be suitable for common backfill.

RESOURCES

Ground-Water Resources

For many years, the aquifers underlying Lake County have supplied the overall water needs of the residents of the county. Larsen (1973) has presented a discussion of the overall ground-water conditions in Lake County. A summary of that information is presented here along with some specific relationships pertinent to the overall purposes of this study. The principal water-yielding units in Lake County are the deep sandstone aquifers, the shallow dolomite aquifers and the glacial drift aquifers. A general description of these units can be found in Volume 1 of the series.

The two aquifers closest to the surface, the shallow dolomite aquifer (Silurian) and the glacial drift aquifers, form a shallow system. Water is recharged to these aquifers by local rainfall. Some of the aquifers in the shallow systems are in direct contact with each other. Others are separated by a few tens of feet of non-water yielding tills.

Bedrock Aquifers

The Silurian dolomite forms the shallow bedrock aquifer and lies directly below the glacial drift. In the southern part of the Des Plaines River Valley, it is only about 75 feet (23 meters) below the surface. Elsewhere, it underlies up to 200 feet (60 meters) or more of drift. The water yields of the Silurian vary from moderate to large, depending on the size, number and continuity of fractures, crevices and solution cavities present. These features usually occur in the upper part of the dolomite.

The deep sandstone aquifers are present in all areas of the county, constituting a dependable, though deep, source of ground water. Detailed information on the bedrock aquifers in Lake County can be found also in Suter, et. al. (1960) and Hughes, et. al. (1966).

Sand and Gravel Aquifers

Sand and gravel deposits are the main aquifers within the glacial drift. For this study they are categorized as surficial aquifers and buried aquifers as mapped by Larsen (1973). Plate 5, a series of cross sections modified from Larsen (1973, pl. 2B), shows the regional continuity, thickness and relationship of the surficial and buried sand and gravel aquifers to other glacial materials and the bedrock. Plate 6, buried sand and gravel aquifers, is also taken from Larsen (1973, plate 2 D). In order to be mapped as an aquifer, the sand and gravel must be at least 15 feet (4.5 meters) thick and occupy at least a half a square mile (1.3 Km^2) in area.

Surficial Sand and Gravel Aquifers

Surficial sand and gravel aquifers are shown by Larsen (1973, pl 2 C) and can be generally inferred from plate 1 of this report as those areas directly underlain by Henry Formation, principally Batavia (hb) or Mackinaw (hm) Members or Haeger outwash (wh-o), which generally fit the above stated criteria. The Wasco Member (hw), Henry Formation may also be an aquifer,

but in certain areas, such as in the northwestern corner of the county, it lies in a position above the adjacent Fox River lowlands and may locally be naturally drained as may other sand and gravel deposits in similar topographic settings.

Surficial sand and gravel aquifers are extremely limited in Lake County and are mainly restricted to a relatively narrow band in the Fox River Valley in the westernmost part of the county. The thin deposits along the Des Plaines River Valley may locally yield small ground-water supplies.

Buried Sand and Gravel Aquifers

Buried sand and gravel aquifers in Lake County occur principally at two specific stratigraphic horizons within the glacial drift (pl. 5). A buried sand and gravel aquifer is a body of sand and gravel with the size and thickness of surficial sand and gravel aquifers, but also covered by 10 feet (3 meters) or more of fine-grained deposits. The cross sections and map (pl. 5 and 6) show two thick extensive buried sand and gravel aquifers occurring in the western third of Lake County, with their continuity and thickness generally decreasing eastward. Plate 6 does not include buried aquifers that may appear at the landsurface or are connected to the surficial aquifers. This type of relationship is particularly significant along the western margin of the county where the upper of these aquifers is at the surface. Locally in this area, no till separates the two aquifers so that sand and gravel may be continuous from land surface to the top of bedrock. In this area, the aquifers appear to be highly permeable and have the best potential for developing large quantities of water from the drift.

Sand and Gravel Resources

For years Lake County has been one of the major producers of sand and gravel in the state of Illinois. The sand and gravel deposits in the Des Plaines River Valley have been worked extensively as the material is clean, usually has less than 10 feet of cover, and is at least 20 feet thick.

The kames and outwash plains along the western edge of the county are also sources of commercial sand and gravel, although the deposits vary in texture. See Larsen (1973) for additional discussion and a sand and gravel resources map, and Ekblaw and Lamar (1964).

Peat Resources

Three peat companies are presently operating in Lake County, excavating, drying and shredding the material for agricultural and horticultural uses. Many other of the dozens of peat deposits in Lake County could be worked if the demand for it arose. At present, Lake County is the second largest peat-producing county in Illinois (Hester and Lamar, 1969).

Clay Resources

The Wadsworth Till was formerly used as a source of clay in the manufacture of common brick of the Chicago type. A large brickyard was in operation on County Line Road in Deerfield, but ceased manufacturing a number of years ago when the market for paving brick disappeared. If ever in the future there is an expanded market for brick, Lake County has abundant and ubiquitous clay resources from the Wadsworth Till. Therefore clay resources are not significant consideration for regional planning in Lake County.

Dolomite Resources

There are no bedrock outcrops in Lake County as the glacial overburden is, at its thinnest, at least 75 feet thick (22.5 m) and averages

more than 100 feet thick. There are numerous areas in other parts of northeastern Illinois where the overburden is thin. Therefore, it is not anticipated that dolomite will be considered a resource in Lake County.

GEOLOGIC HAZARDS

Geologic processes which are spectacular and regionally destructive such as severe earthquakes and volcanic activity are not common to northeastern Illinois due to the lack of geologic conditions which produce such events. Nevertheless, there are certain processes operating and conditions present in Lake County of which special mention should be made. These include shoreline erosion along Lake Michigan, river valley flooding and poor upland drainage, in addition to rather widespread occurrence of unstable materials, principally peat, but also organic silts, marl, silts, etc. All of these conditions significantly affect man's activities in certain areas of the county.

Lake Michigan Shoreline Erosion

In recent years, there has been no other single natural event in northeastern Illinois which has generated more discussion, interest and concern than the recent period of high water level and resultant erosion along the shoreline of Lake Michigan. Larsen (1973, p. 30-33) has summarized the principal factors which cause shoreline erosion and the results of this erosion. A number of studies are currently being carried on to discover the cause and affect relationships and find ways to mitigate the damaging results of wave action along the shoreline. Berg and Collinson (1976) have summarized some of the results of the geological studies to date on bluff erosion. The geology of the bluffs and foundation characteristics are discussed by DuMontelle, Stoffel and Brossman (1975). Fraser and Hester (1974) have discussed the effects of erosion on the beach area of northeastern Lake County and methods of replenishing beach sand lost to wave erosion. These studies have focused on identifying the areas which have been particularly

vulnerable to erosion and the geologic conditions and processes which make these areas more susceptible to erosion. These studies should be consulted for specific information on this problem.

The results of these studies are in large part aimed at understanding the processes so others may find ways of protecting the shoreline from erosion, and thereby save countless homes and other valuable property from eventual destruction. However, it should be realized that damage to property by wave erosion occurs as a result of a natural process which is difficult and expensive to control and at best is often inadequate. It has been suggested by Larsen (1973, p. 33) that possibly the most feasible way to prevent extensive loss of property along the shoreline is to establish an adequate buffer zone between man's zone of habitation and the shoreline.

Flooding

The hazards of flooding along major drainageways are generally recognized and many studies have been made to identify flood hazard areas and recommend methods of preventing flooding or minimize flood damages to areas developed in flood plains. For this study, the areas identified as the principal flood hazard areas particularly along the Des Plaines River and its tributaries have been incorporated into the interpretations for community development (pl. 7a) and roadway construction (pl. 7b).

In addition to the more obvious flood-prone areas, there are many smaller flood-prone areas throughout Lake County which are not as obvious. These are areas which, during periods of heavy rainfall or long-term wet periods, may flood locally and cause considerable damage to property. These areas may appear "high and dry" but may on occasion develop standing water due to periodic high water table, poor natural drainage conditions and relatively impermeable materials in the subsurface. Although many such areas have been identified on plates 3, 7a and 76, some areas may be too small to show at the scale of mapping. In some instances the county soils

maps (Paschke and Alexander, 1970) indicate such areas. Site investigations including historical data on local conditions may save considerable cost and inconvenience.

As in the case with shoreline erosion, flooding is a natural process for which costly damage can best be minimized by recognizing flood-prone or poorly drained areas prior to any future development.

Unstable Materials

Peat and associated organic silt and marl deposits are spongy, highly compressible materials which retain large quantities of water. Most if not all of the significant peat deposits have been identified on plate 1 as Grayslake Peat (gl) and have been considered in the interpretations for community development (pl. 7a) and roadway construction (pl. 7b). Such areas cause serious problems for many types of construction. If these areas are developed, the cost is great particularly if the peat must be removed and the excavation filled with noncompressible material. The cost may be justified for major projects, but is normally prohibitive for home or subdivision construction.

Although most of the larger areas of peat are readily identified, numerous small areas may go unrecognized, and even if identified during this study, some are too small to show at the scale of the maps produced. In most cases, these areas should be shown by the county soils maps. All areas of peat are within areas that are also poorly drained and therefore susceptible to flooding during long wet periods.

UNIQUE GEOLOGICAL FEATURES IN LAKE COUNTY

1. Volo Bog: (Sec. 28-45N-9E). Volo Bog is the only remaining acid bog in Illinois which has a floating mat of vegetation. This bog, in the late stages of filling, presents a unique opportunity to view the entire sequence of vegetal encroachment in a bog that has been developing since the melting of the last continental glaciers. (See McComas, et. al., 1972)

2. Peat bogs: Three different geological environments give rise to peat bogs in Lake County; in sandy areas behind the present Lake Michigan beach ridge (46N-12E), in hummocky morainic topography (e.g. 44N-10E), and in the Chain O'Lakes lowland of the Fox River, where the largest bog in the state encircles Grass Lake (46N-0E).

3. Chain O'Lakes: (46N-9E). The Chain O'Lakes region occupies a northeast-southwest trend of fluvial-glacial drainageways. Large ice blocks became detached from the retreating glacier and stood throughout the area. Meltwaters channeled their way through the ice and surrounding glacial debris. Subsequent melting of the ice blocks produced huge depressions which the lakes occupy today.

4. Valparaiso Morainic System: A series of closely spaced moraines comprise the Valparaiso System. Abundant knobs, kettles, swamps and lakes compose the hummocky terrain. From the crest of the morainic system at Fairfield (Sec. 10-44N-10E), Lake Michigan can be seen nearly 15 miles to the east.

5. Lake Border Morainic System: This system is composed of five moraines separated throughout much of their length by parallel valleys -- the Des Plaines River and tributaries of the Chicago River. Uniform gray silty clay till comprises these moraines which are of considerably less relief and gentler slopes than the Valparaiso Morainic System.

6. Ice Contact Features: (46N to 44N-9E). Any east-west road going from Lake County into McHenry County encounters ice-contact features. These prominent ridges and slopes were formed at the margins of the Haeger and Wadsworth Tills and are thought to represent interlobate deposits.

7. Des Plaines River Valley: The Des Plaines River Valley was a major drainageway for glacial meltwater. Today, thick sequences of sand and gravel in the valley are a major resource for ground water and materials.

8. Zion Beach Ridge Complex: This beach ridge complex trends north-south along the Lake Michigan shoreline from Kenosha, Wisconsin to Waukegan. It is bounded on the west by a similar north-south trending till bluff. The complex consists of several environments; beach ridges, dunes, marshes, and modern beaches. It is the result of former high level lakes which occupied the Lake Michigan basin. The beach ridge complex is transitory, with erosion occurring in some areas and aggradation in others at the present time. (See Hester and Fraser, 1973)

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