George H. Ryan, Governor

Department of Natural Resources
Brent Manning, Director
ILLINOIS STATE GEOLOGICAL SURVEY
Illinois Geologic Quadrangle Map: IGQ Villa Grove-CC
William W. Shilts, Chief
2001

CONSTRUCTION CONDITIONS
Natural Hazards Map

Villa Grove Quadrangle, Douglas County, Illinois

Christopher J. Stohr

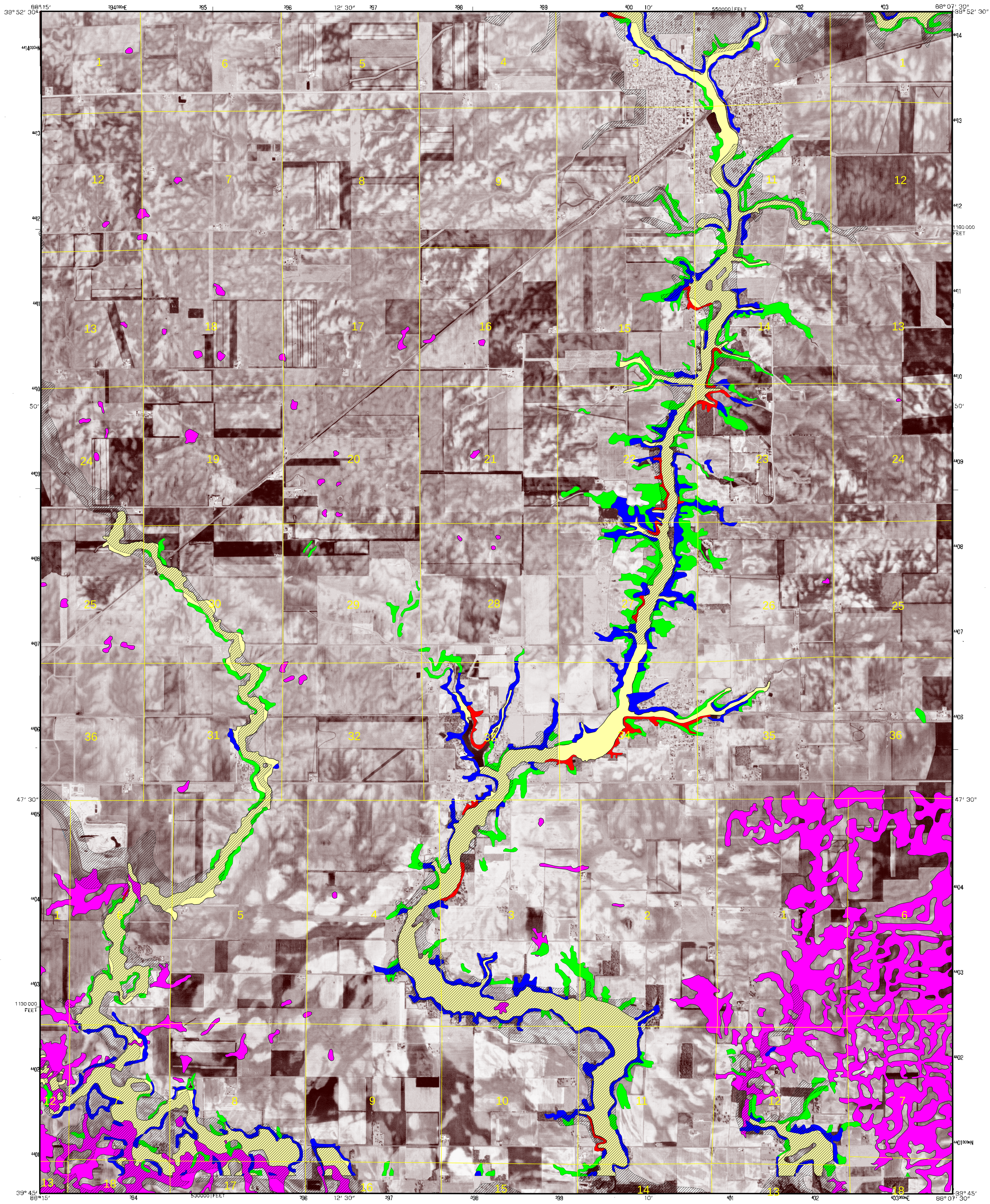

Table 1 Geotechnical engineering data from laboratory testing provided by S. Robinson, Illinois Department of Transportation District 5, Paris, IL; D. Hambley and J. Nelson, Graef, Analt, Schloemer, Chicago IL; and D. Kerns, Hanson Engineers, Incorporated, Springfield, IL.

	Classification		Atterberg Limits					Strength		Moisture-Density Std Compaction		Hydraulic Conductivity cm/sec
	USCS	AASHTO (Group Index)	w %	PL	LL	PI	N	Qu TSF	P TSF	Max. Dry Density PCF	Optimum Moisture Content %	remolded cm/sec
Peoria Silt	CL	A-6 (11)		19	38	19						
Peoria Silt	CL	A-6(4)		15	27	12						
Peoria Silt	CL	A-7,6(15)		24	42	18				103	19	
Diamicton(till) Brown sandy clay Batestown Member	CL	A-6(8)	18	18	32	14	31	8.73	4.5+	124.4	12.3	0.11×10^{-07}
Diamicton (till) Brown silty clay Batestown Member	CL	A-6(12)	24	21	43	22	12	3.30	3.8	121.2	11.4	7.7×10^{-07}
Diamicton (till) Gray silty clay Batestown Member	CL	A-6(10)	13	16	29	13	13	2.33	2.3	134.1	8.5	4.5×10^{-07}
Diamicton (till) Gray silty clay + c. sand Batestown Member	CL-ML	A-4(0)	13	15	19	4	31	12.02	4.5+	125.8	10.7	

USDA - United States Department of Agriculture
USCS - Unified soil classification system
AASHTO - American Association of State Highway and Transportation Officials
Qu - Unconfined compression test
P - Pocket penetrometer test
TSF -Tons per Square Foot
PL - Plastic Limit
LL - Liquid Limit
PI - Plastic Index
N - Standard Penetration Test blow counts
PCF - Pounds per Cubic Foot

Table 2 Particle size and classification data provided by S. Robinson, Illinois Department of Transportation District 5, Paris, IL; D. Hambley and J. Nelson, Graef, Anhalt, Schloemer, Chicago, IL; and D. Kerns, Hanson Engineers, Incorporated, Springfield, IL.

	Classification			Particle Size, % retained upon U.S. Standard Sieve Mesh #											
	USDA	USCS	AASHTO	4	10	16	20	40	50	60	100	200	230		
			(Group	millimeters			micrometers								
			Index)	4.75	2	1.19	840	420	300	250	149	74	62.5		
				GRAVEL	SAND									SILT	CLAY
Peoria Silt (loess)	SiC	CL	A-6 (11)	0.8	0.7			3.5			7.6	1.0		53	3
Peoria Silt (loess)	SiCL	CL	A-7,6(15)	0	0						6	10		59	25
Diamicton (till) Brown sandy clay Batestown Member	SC	CL	A-6(8)	3	1.2	0.7			8.8		9.8	6.5		30.7	38.7
Diamicton (till) Brown silty clay Batestown Member	SiC	CL	A-6(12)				1.4	2.5			6.3	2.1		50.0	37.8
Diamicton (till) Gray silty clay Batestown Member	SiC	CL	A-6(10)				2.9	3.8			9.2	4.5		39.8	39.8
Diamicton (till) Gray silty clay + sand Batestown Member	SiC	CL-ML	A-4(0)	0	2.9			8.5			12.3	9.2		36.5	30.6

Figure 1 Engineering Materials Map

Sand thickness (ft)
1-2
3-4
5-6
7-10

Erosion class (see text)
2
3

General parent material types
River sediment (alluvium)
Deltaic sediment
Diamicton (till)
Till plain
End moraine
Lake sediments

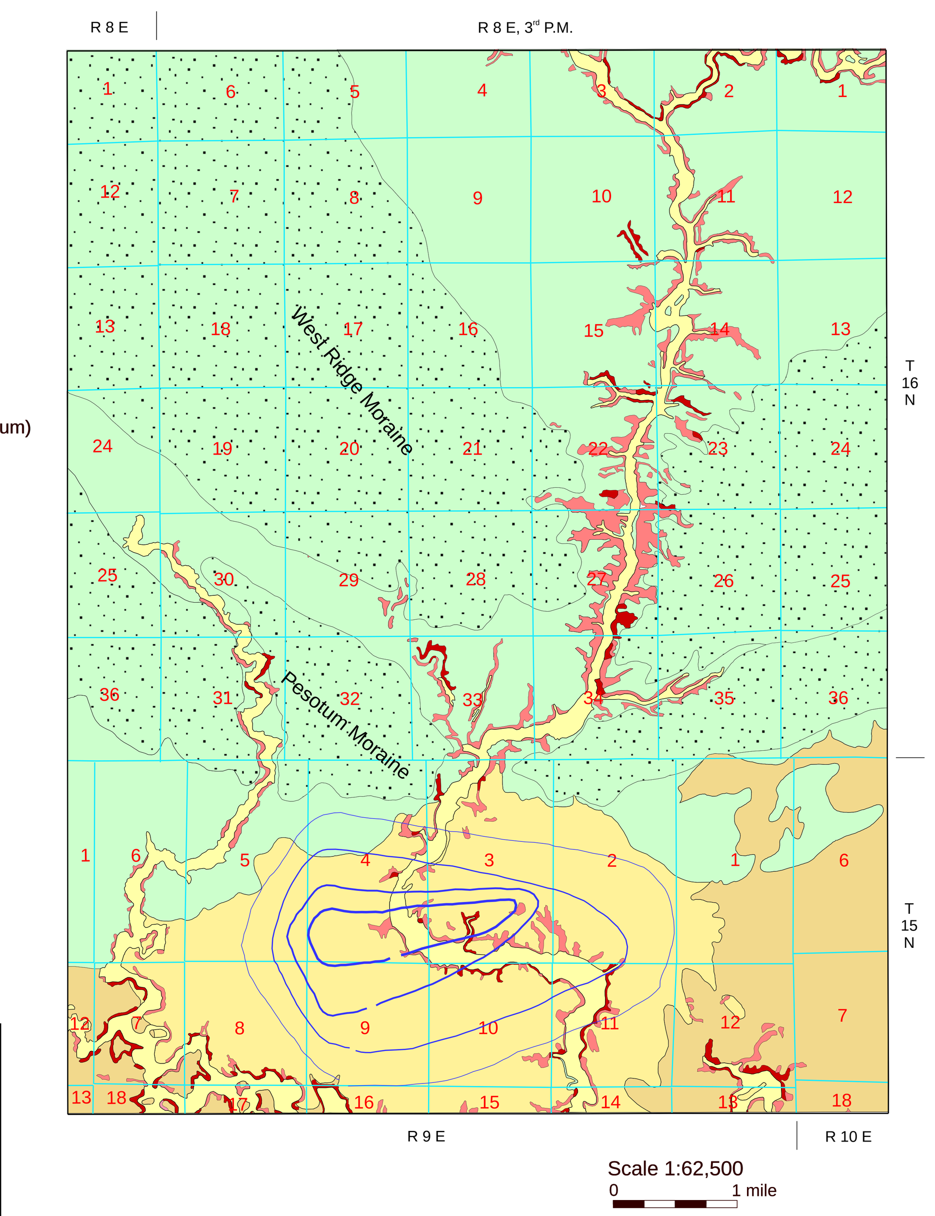

Table 3 Particle size and clay mineralogy of the samples from Villa Grove 3 boring. Clay mineralogy percentages from X-ray diffraction according to method described in Hughes and Warren (1987).

	Depth, (ft)	g/s/s/c	Expandable Minerals	Illite	K + C
Peoria Silt	2	0.4/12/55.6/32.4	81	12	6
Batestown Member (oxidized)	7	0.6/25.8/51.8/22.4	7	81	11
Batestown Member (unoxidized)	12.5	2/27.2/50.8/22	5	75	19
Batestown Member (unoxidized)	16.5	0.8/27.6/51/21.4	4	75	20

g/s/s/c - gravel, sand, silt, clay
K+C - kaolinite and chlorite undifferentiated.

Natural Hazards, Construction Conditions and Materials of the Villa Grove Quadrangle

The primary concern for interpreting soils and geology for conditions related to construction are the presence of natural hazards and the suitability of materials for support of light construction generally involving 1- and 2-story buildings with shallow foundations and relatively low loads transmitted to footings. Ease of excavation for basements or utilities, adequate bearing strengths to support structures, and drainage conditions are the major concerns of builders. Because physical properties and terrain characteristics of some geologic units are similar, several geologic units shown on the surficial geologic map (Hansel, et al., 1999) were combined and shown as one unit on the Engineering Materials map (Fig. 1).

Because the type of soil can significantly influence geologic conditions at a specific site, the detailed information on soils that is available from the Soil Survey of Douglas County (Hallbick and Fehrenbacher, 1971) should be used in conjunction with data from this report. The measurements and descriptions referred to in this section are intended for information only and should not be used for design purposes.

The ideal site for most structures (1) is not susceptible to flooding; (2) has thick, well-drained soil materials having a high bearing capacity; (3) can be excavated with minimum difficulty; and (4) has no known natural hazards. Because few ideal sites exist, remedial work or special design and construction techniques may be necessary. The Natural Hazards (left) and the Engineering Materials Maps (Fig. 1) should be used in conjunction with the General Aquifer Sensitivity Map (Berg and Abert, 1999) for preliminary evaluations prior to site development.

The following conditions are considered to be most critical to general construction.

Thickness of surficial materials. Drift thickness ranges from 25 to 275 feet (Weibel and Abert, 1999). The unlithified material is thickest in a buried bedrock valley in the eastern and northeastern part of the quadrangle, and thinnest in the southwest. Drift thickness increases in the Pesotum and West Ridge Moraines shown as a stipple pattern on the Engineering Materials map. Loess, wind-blown silt, is about 3 to 5 feet thick in the quadrangle (Fehrenbacher et al., 1986).

Internal drainage characteristics. Surface runoff and infiltration characteristics of surficial materials affect soil drainage. Well-drained soils are considered to be more desirable for construction than are poorly drained soils. Soils in the Villa Grove Quadrangle tend to be moderately to poorly drained at the surface and are subject to seasonally high water tables.

Bearing capacity and ease of excavation. The bearing capacity of earth materials depends on many factors, including loading history, material types, drainage characteristics, and moisture content. Bedrock, till, outwash, and dune sand have the highest bearing capacities; bearing capacities are considerably lower for alluvium, lake sediments, loess, colluvium (slope sediments), peat, and muck.

Table 1 presents values obtained from a few available boring records and tests for various bearing capacity tests (standard penetration, pocket penetrometer, and unconfined uniaxial compression). The table does not show the landscape position of the borings, geologic sequence of materials, consolidation history, or other factors that influence bearing capacity.

Although the ease of excavation at a particular site depends partly on human factors (operator efficiency and machinery used) and on weather, ease of excavation is related primarily to the geologic materials being excavated and their position on the landscape. Outwash gravel and sand, and loess are easy to excavate; lacustrine silts and clays are subject to flooding and high water table; and tills and bedrock are moderately to very difficult to excavate.

Private Sewage Disposal Suitability

New innovative methods increase the effectiveness and suitability of mechanical and passive types of on-site, private sewage disposal with leach fields for areas rated as having moderate to severe limitations. For specific residential and commercial sites and related activities on-site disposal design should refer to manufacturers specifications, recommendations of the Douglas County Soil Survey, and on-site tests such as Guelph Permeameter and double-ring infiltrometer. For evaluating the sensitivity of an aquifer to leachate see Berg and Abert (1999).

Natural Hazards

In the Villa Grove Quadrangle, natural hazards include flooding, poorly drained lake deposits, unstable slopes, high susceptibility to frost, and adverse shrink-swell characteristics.

Flooding of the Embarras River is a particular problem for theVillage of Villa Grove and vicinity. Although the greatest hazard tends to be seasonal, the chance of flooding and flash flooding is prevalent throughout the year. Areas susceptible to flooding lie within the 500- and 100-year floodplain. The outline of the 100-year flood boundary digitized by the Illinois State Water Survey from 1:24,000-scale Flood Insurance Rate Maps and Flood Hazard Boundary Maps (FEMA, 1985) prepared for the National Flood Insurance Program is shown on the Natural Hazards map (left). The area shown as susceptible to flooding is for insurance purposes and may not represent all of the areas subject to flooding. Conservative design would consider the mapped alluvium as potentially flood-prone where not otherwise designated within the 100-year floodplain.

A USDA-NRCS study of flooding shows a higher flood elevation and larger affected area (Upper Embarras River Basin Planning Committee, 1996 and Embarras River Basin resource management plan, 1996). For further information contact the Illinois State Water Survey (217/333-5482).

Unstable slopes occur at cutbanks, steep or overhanging slopes recently eroded along the outside of a meander of the Embarras River and tributaries. Additional slope instability may occur where deep excavations have been constructed for quarrying rock. Colluvium mapped along the Embarras River, Scattering Fork, and Hackett Branch delineates slopewash and ancient landslides where cutbanks have collapsed as streams erode material from the toe of the slope. Stream banks are also the most susceptible to erosion. Numerous examples can be found along banks of rivers and streams.

The Natural Hazards Map shows where slopes exceed 4% and are eroded, indicating the potential for slope instability. Cut banks along the Embarras River are the steepest and most susceptible. On-site investigation is needed where these areas would be considered for construction.

Lake silts and clays occur primarily in the floodplain of the Embarras River and in the southern part of the map area. These materials can cause significant construction problems because variations in types of expandable clay minerals and soil drainage allow differential settlement to occur in structures founded on these materials. Excavations in lake deposits fill with water because of the poor drainage, low relief, and high water table; therefore, a basement type construction may exhibit buoyancy if groundwater is not drained or pumped to lower the water table. Construction of basements is not desirable in such a setting unless special building techniques are used. Position on the landscape is critical in siting small structures on lake sediments; slightly elevated sites are desirable. The Douglas County Soil Survey maps (Hallbick and Fehrenbacher, 1971), used in conjunction with these maps, should be helpful for locating suitable construction sites in lake materials.

Shrinkage and swelling of soils can cause damage to building foundations, driveways, and roads. Heaving of the ground surface can result from expansion as a result of water absorption. Settlement can occur from dessication through plants or by evaporation. Clay mineralogy influences shrinkage and swelling of a sediment in proportion to its clay content (Hughes and Warren, 1987). The Peoria Silt in which the topsoil and subsoil are formed, contains a relatively high proportion of expandable clay minerals which can lead to problems associated with shrinking and swelling soils (Table 3) . The underlying Batestown Member shown as diamicton in Figure 2, contains relatively low percentage of expandables and is much less susceptible to shrinking and swelling (Table 3). The Soil Survey of Douglas County shows that upland surface soils have moderate shrink-swell susceptibility, areas near major drainage tend to have low susceptibility, and soil derived from loess and lacustrine silts found in the southeast and southwest are most susceptible to the shrinking and swelling resulting from changes in water content.

Frost heaving susceptibility is the potential for upward heaving or lateral movement from expansion caused by the freezing of soil water causing damage to building foundations, driveways, and roads. Based upon measurements taken at sod-covered ground during 1980–96, the earliest ground frost was on 10 December and the latest ground frost was on 15 March. The deepest frost penetration measured was 46 cm (18 inches) during 1981–82, the 9th coldest winter of record and the coldest during the 1980–96 interval. The mean frost penetration is about 10 cm (4 inches) (Wendland, 1998). Depth of freezing can vary, based on many factors, including antecedent moisture, ground cover, vegetation, and soil type; however, bare soil tends to freeze deeper than sod-covered ground.

The Soil Survey of Douglas County shows that most of the soils have moderate to high susceptibility to formation of ice lenses, which could result in heaving. According to the Soil Survey Handbook (Soil Survey Staff,1999), the design freezing index value is estimated to be about 750. The design freezing index value is the cumulative degree-days of air temperature below 32°F for the coldest year in a ten-year cycle or the average of the three coldest years in a 30-year cycle.

Amplification of earthquake-induced ground motion has not been measured directly in Illinois. The nearest earthquake epicenter having a magnitude greater than or equal to 5 occurred at Lawrenceville, Illinois in June 1987. Although the quadrangle lies close to the Wabash Valley Fault Zone and the New Madrid Seismic Zone (Heigold and Larson, 1990), the effect of earthquake ground motion from those seismic areas would not be likely to severely affect most well-built and maintained buildings. Poorly maintained chimneys, masonry, unsecured interior objects, and sensitive electronic components of computers and instruments would be the most affected. Ground motion would probably be amplified in alluvial and saturated materials. Although the design of critical facilities should consider earthquake ground motion, structures on upland diamicton areas are less likely to be affected. Seismic analysis for low-level radioactive waste depository structures in nearby Clark County was performed by the Battelle Memorial Institute and Hanson Engineers, Inc. (1990a and b) as part of investigations for the Martinsville Alternative Site.

Regional Construction Materials

In general, surficial materials have been mapped as loess (topsoil and subsoil); till, silt, and clay; and sand and gravel. Particle size distribution by mechanical analysis and hydrometer is shown in Table 2.

Topsoil and Subsoil are commonly developed in the upper 3 to 5 feet of surficial materials. Prairie soils in this area tend to be developed in loess and weathered diamicton. Mollisols and Alfisols are typical surface soils.

Silt and Clay intermixed with layers of fine sand compose the lake sediment area in the southern part of the quadrangle. Excavation will be hampered by poor drainage and a high water table.

Diamicton (till) is composed of a well-graded mixture of silt, sand, clay and gravel with sand layers and lenses. It is suitable for most construction fill materials and as a foundation for small structures. Till is dense and is usually excavated with moderate difficulty.

Sand and Gravel can be found in limited quantities along the Embarras River and at the south end of the quadrangle in a deltaic deposit. The delta contains up to 10 feet of sand beneath 3 feet of silt. Contours on Figure 1 show the thickness of the sand, which is composed of progressively lesser proportion of fines with depth (Lasemi et al., in press; Hansel et al., 1999; Fraser and Steinmetz, 1971).

Limestone/dolomite can be obtained from the Tuscola Stone Company east of Tuscola on U.S. Route 36. Crushed dolomite is available for concrete and bituminous aggregate and roadbed materials (Lasemi et al., in press).

Regional Construction Conditions

The entire quadrangle area is covered with three to five feet of silt loam soil. Although superb for cultivated crops, the silt is a fair to poor subgrade for roads and has moderate to high shrink-swell potential. Depending upon topographic position, the material is very poorly to moderately well drained.

River (alluvium) and Slope (colluvium) Sediments. These areas tend to be subject to flooding and landslides. Conservative design practice requires avoidance or special design consideration. Permits from the U.S. Army Corps of Engineers Louisville, Kentucky, office may be required for construction or channel modification in these areas.

Delta Sediments. Although artificial drainage is recommended for crops, underlying well-drained sand makes this area difficult for pond and lake construction. The slope of the sandy deltaic deposits will pose problems in the excavation and construction of structures allowing water to drain by gravity into a downslope excavation. Furthermore, an excavated basement can act as a subsurface impoundment (obstacle) to flow, subjecting the structure to hydraulic pressures, leakage, and possibly piping. Shallow groundwater head and volume of subsurface flow should be considered in the design of structures in the area marked as deltaic sediments.

Diamicton (till). The dense nature of the till yields adequate foundation support for most light construction. Till has low primary permeability (CL and CL-ML, Table 1) through the matrix but allows low to moderate secondary permeability through joints and fractures. Consequently, the loess-till interface tends to restrict vertical drainage, and a water table is often developed at that surface.

Lake Sediment. Composed of thin layers of silt, clay, and fine sand, the lake sediment area tends to be poorly drained and subject to flooding or long-standing water. Abundance of expandable clay minerals contributes to adverse shrink-swell and frost susceptibility. Conservative design practice requires construction avoidance or special design consideration.

Erosion

Susceptibility of soils to erosion (Fig. 1) should be considered in planning excavation and site grading to reduce runoff. The Soil Survey of Douglas County offers a guide for assessing areas where erosion from wind and water is accelerated. The Survey (Soil Survey Division Staff, 1993) classifies erosion into four classes:

Class 1. Soils having a few rills, accumulation at base of slope, plowing of lower than expected material, and widely spaced, deep rills or shallow gullies without measurable reduction in thickness. This erosion class is mostly found in alluvial areas of the Villa Grove Quadrangle.

Class 2. Soils exposing underlying B horizon. This erosion class is found on steep slopes.

Class 3. Obvious gully erosion occurs on steep slopes.

Class 4. Soils exposing parent material. There is no Class 4 erosion in the Villa Grove Quadrangle.

Problems with erosion are likely to be confined to steep slopes along the Embarras River. Routine precautions and attention to local slopes and grading during earthmoving activities in upland and shallow sloped areas should be sufficient for most construction.

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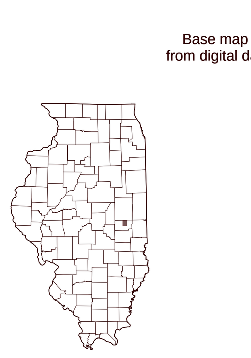
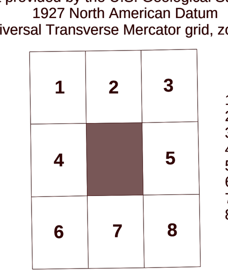
Scale 1:24,000
0 2 miles
0 2 kilometers
0 2000 feet

Base map compiled at the Illinois State Geological Survey (ISGS) from digital data provided by the U.S. Geological Survey and the ISGS
1927 North American Datum
Universal Transverse Mercator grid, zone 16





1 Tolono
2 Villa Grove NW
3 Longview
4 Tuscola
5 Murdock
6 Arcola
7 Hindsboro
8 Oakland

ADJOINING 7.5-MINUTE QUADRANGLES

NORTH

FEMA Flooding Recurrence
100 yr flood

Potentially flood-prone
alluvium

Shrink-swell susceptibility
High to very high

Percent Slope
4-7
7-12
18-40

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For further information about this map contact:
ILLINOIS STATE GEOLOGICAL SURVEY
615 East Peabody
Champaign Illinois 61820-6964

(217)333-4747

http://www.isgs.uiuc.edu

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