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AQUIFER SENSITIVITY MAP, JO DAVIESS COUNTY, ILLINOIS

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INTRODUCTION

This map classifies areas within Jo Daviess County according to the potential for aquifers to become contaminated from surface disposal of municipal waste. For this study, an aquifer is defined as a geologic material that readily supplies useful volumes of water rapidly to small diameter wells or to streams. Coarse- grained unlithified materials and very porous or fractured bedrock are considered aquifer materials. Fine- grained unlithified materials and low permeability bedrock are not considered aquifers.

AQUIFER MATERIALS (high permeability)	NON- AQUIFER MATERIALS (low permeability)
well sorted fine- sand	lake silt and clay
sand and gravel	loess (wind- blown silt)
fractured dolomite and limestone	silty river deposits
sandstone	clay- rich bedrock soils
	glacial till
	shale

PRINCIPLES OF AQUIFER SENSITIVITY

Aquifer sensitivity is defined (USEPA 1993) as the relative ease with which a contaminant of any kind applied on or near the land surface can migrate to an aquifer. It is a function of the characteristics of geologic materials, and is not dependent on land use or contaminant characteristics. Studies have shown that the properties of geologic materials overlying an aquifer directly influence the potential for aquifer contamination (Berg and Kempton 1984; Keefer and Berg 1990; Berg and Abert 1994). The thickness and character of these deposits are important factors when determining aquifer sensitivity in the manner described by Soller and Berg (1992). Several of the assumptions used to produce this aquifer sensitivity map are similar to those used by Berg and Abert (1994), as well as McGarry and Grimley (1997) in adjoining Carroll County. They include:

1. Aquifer materials have a high sensitivity to contamination and non- aquifer materials have low sensitivity.
2. In areas where bedrock aquifer materials are at the bedrock surface, thinner unconsolidated materials increase the potential for contamination of bedrock aquifers because contaminant travel time to bedrock is shorter through thin unconsolidated materials than through thick unconsolidated materials. (e.g., sensitivity classification A1 > A3 > C > D)
3. Where the aquifer is fractured dolomite or sandstone and the surficial bedrock unit is shale, thinner unlithified materials overlying the shale decreases the potential for contamination of unknown sand and gravel aquifers. This is due to the decreased likelihood that a large sand and gravel aquifer exists with decreasing thickness of unlithified materials overlying the shale. (Soller and Berg 1992). (e.g., sensitivity classification E3 < E2 < E1)
4. Coarse- grained unlithified aquifer materials (e.g., sand and gravel) may act as groundwater conduits to underlying fractured dolomite or sandstone. Although water wells may not be screened in these units, contaminants may rapidly pass through these materials and enter the underlying bedrock. Fine- grained unconsolidated non- aquifer materials (e.g., silt and clay) are less likely to rapidly transmit contaminants to the underlying bedrock. However, fractures in fine- grained drift (e.g., till) can increase contaminant travel time to the bedrock aquifers by several orders of magnitude. The degree of fracturing of subsurface materials must be evaluated in site- specific investigations prior to landfill siting or for permitting. other activities that could adversely impact groundwater quality. (e.g., sensitivity classification A2, A4 > C, D)
5. Thicker sand and gravel deposits have a greater groundwater resource potential and can supply a larger population than thin sand and gravel deposits. Therefore, areas with thick aquifer materials have a higher sensitivity category than areas with thin aquifer materials. (e.g., sensitivity classification A2 > A5 or A5 > B1)

Many other data can be used to determine aquifer sensitivity, but were not used for the sake of model simplicity. These data include field measurements for hydraulic conductivity of bedrock and unconsolidated deposits, determination of groundwater flow direction, piezometric surface mapping, surface slope, textural variations of geologic materials, organic carbon content of soils, soil permeability, land use activity, recharge rates, thickness of shale, and orientation and connectivity of the fracture networks within the bedrock. The incorporation of such data would improve the usefulness of the model for site specific studies.

METHODOLOGY

Information used to map aquifer sensitivity in Jo Daviess County came from the following maps: bedrock geology (McGarry 2000), surficial geology (Riggs 2000), and thickness of Quaternary deposits (Riggs and McGarry 2000). Mapped units were ranked according to the sensitivity of aquifer materials to be contaminated by leakage from a municipal waste site. Criteria used to determine the relative aquifer sensitivity rank were the depth to the uppermost aquifer material, and the thickness and type of aquifer materials. Depth to sand and gravel aquifers and thickness of aquifer materials were determined from maps of Quaternary deposits. In areas where the uppermost aquifer is located in bedrock, the map of thickness of Quaternary deposits was used to determine depth of the aquifer. The type of aquifer was determined from the maps of the surficial geology and the bedrock geology (see inset maps).

Examples of specific map areas within aquifer sensitivity rating classes are:

A1: In side slopes in the central portion of the county (e.g., between Hell's Branch and Apple River): fractured dolomite is very near the land surface.
A2: In the Mississippi River valley (e.g., near the Savanna Army Depot): coarse- grained sand and gravel outwash (Henry Fm.) is very near the land surface.
A3: Across broad areas in the uplands of the county (e.g., near East Dubuque and Menominee): loess covers fractured dolomite.
A4: South of Hanover: loess overlies sand and gravel outwash and fractured dolomite.
A5: In the Apple River valley, south of Hanover: thin alluvium and loess overlie thick glacial outwash and shale.
B1: Areas west of Hanover: thin eolian sand (Parkland sand facies of the Henry Formation) overlies shale.
B2: Along the base of the Camp Creek valley: thin buried sand is overlain by fine- grained alluvium and underlain by shale. This sensitivity class is similar to A4, but the surface sediments are underlain by shale.
C: Areas east of Stockton: loess and Ogle Member till (25 to 50 ft. thick) overlie sand and gravel and/or fractured dolomite.
D: Areas east of Stockton: loess and thicker Ogle Member till (greater than 50 ft. thick) overlie sand and gravel and/or fractured dolomite.
E1: Areas east of Stockton: loess and thicker Ogle Member till (greater than 50 ft. thick) overlie shale.
E2: Broad areas along US Highway 20 west of Galena: loess (10 to 50 ft. thick) overlies shale.
E3: Areas surrounding Scales Mound: shale is very near the land surface.

AQUIFER SENSTITVITY TO CONTAMINATION FROM MUNICIPAL SOLID WASTE SITES

Map Units A, B, and C: High potential for aquifer contamination from waste disposal facilities. Regions designated as A, B, and C, which all contain sand and gravel and/or bedrock aquifer materials within 50 feet of land surface, are extremely sensitive to potential contamination from waste disposal facilities. Waste buried in a pit or trench up to 50 feet deep may be placed in direct contact with sand and gravel deposits or bedrock aquifers. Therefore, there is little or no natural protection of an aquifer by overlying finer- grained materials. Trench depths of 50 feet are now fairly common (and some up to 100 feet have been proposed) because operators desire to maximize landfill capacities because of the difficulties in obtaining permits for new facilities. In Map Unit B, thin sand and gravel is underlain by fine- grained deposits. Therefore it may be possible to remove the sand and gravel to the top of the fine- grained deposit, however caution must be taken to prevent waste and effluent from coming in contact with sand and gravel exposed at the sides of the trench.

Map Unit D: Moderate potential for aquifer contamination from waste disposal facilities. This unit includes areas of sand and gravel and/or bedrock aquifers that are overlain by more than 50 feet of fine- grained deposits. Although the aquifer sensitivity is relatively low because fine- grained materials separate the aquifer from land surface, aquifer materials can be as shallow as 50 feet below the land surface. Areas mapped as D should not be used for hazardous waste disposal. Municipal waste disposal may be acceptable if site- specific investigations indicate that the aquifer is closer to a 100- foot depth (Berg 1994). At least 50 feet of undisturbed fine- grained sediment should separate the bottom of the landfill trench from the top of the aquifer material.

Map Unit E: Low potential for aquifer contamination from waste disposal facilities. This unit occurs where bedrock aquifers are overlain by shale, which is overlain by fine- grained sediments. The potential for contamination of aquifers from waste disposal facilities is low because of the lack of aquifer materials at or near the land surface. Such areas have a low potential to suffer groundwater contamination from municipal or, perhaps, hazardous wastes. Waste disposal facilities must always be designed, constructed, and carefully monitored to minimize their potential for groundwater contamination.

Significant parts of Map Units D and E areas may have poor surface drainage or have a seasonally high water table. Although thick, fine- grained deposits reduce the potential for aquifers to become contaminated, a higher potential for surface water contamination exists because of overland flow of water to a lake, river or stream, especially in areas of high relief. In addition, landfill design, engineering, and operation may be problematic in poorly- drained areas. The soil survey of Jo Daviess County (Tegeler 1996) provides delineation of poorly- drained soils and should be consulted when siting a municipal waste disposal facility. In addition, detailed site- specific investigations must be conducted to verify the absence of aquifer materials in these map areas.

SUMMARY

Much of Jo Daviess County, Illinois has a very high aquifer sensitivity because fractured dolomite bedrock aquifers lie beneath thin glacial drift or loess. Areas where dolomite bedrock is exposed are most sensitive. In addition, a high potential for contamination exists where thick coarse- grained unconsolidated sediments occur. In contrast, areas underlain by shale bedrock have a low sensitivity to aquifer contamination. A more moderate sensitivity to aquifer contamination exists in areas where fine- grained unconsolidated deposits overlie dolomite bedrock (such as till- covered landscapes in the east- central portion of the county) or where thin coarse- grained unconsolidated deposits overlie shale.

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EXPLANATION

- US Highway
- State Highway
- Other Roads
- Railroad
- Streams
- Disturbed Land
- Water
- Municipality
- State Park

Color Symbol	Category	Depth to Aquifer[1]	Aquifer Type[2]	Total Aquifer Thickness
VERY HIGH SENSITIVITY				THICK AQUIFER NEAR SURFACE
	A1	0-5 ft.	Bedrock	>50 ft.
	A2	0-5 ft.	Sand & gravel[3] and/or bedrock	>50 ft.
	A3	5-25 ft.[3]	Bedrock	>50 ft.
	A4	5-25 ft.	Sand & gravel[4] and/or bedrock	>50 ft.
	A5	0-25 ft.	Sand & gravel[5]	25-50 ft.
HIGH SENSITIVITY				THIN AQUIFER NEAR SURFACE
	B1	0-5 ft.	Sand & gravel[5]	5-25 ft.
	B2	5-25 ft.	Sand & gravel[4]	5-25 ft.
MODERATELY HIGH SENSITIVITY				AQUIFER AT DEPTH (25-50 FT.)
	C	25-50 ft.	Sand & gravel[4] and/or bedrock	>50 ft.
MODERATE SENSITIVITY				AQUIFER AT DEPTH (>50 FT.)
	D	>50 ft.	Sand & gravel[4] and/or bedrock	>50 ft.
LOW SENSITIVITY				AQUIFER BELOW SHALE
	E1	>50 ft. + shale[6]	Bedrock	>50 ft.
	E2	10-50 ft. + shale[6]	Bedrock	>50 ft.
	E3	0-10 ft. +shale[6]	Bedrock	>50 ft.

1. Fine-grained sediment above aquifers include uniform silt (loess), diamicton (till), and stratified silt and clay (lake sediments).
2. Bedrock aquifers are primarily dolomite; some sandstone in the far northwest.
3. Depth to aquifer may be up to 40 ft. in a few areas in western Jo Daviess County where loess is thick.
4. Sand and gravel aquifers directly overlie bedrock aquifers in most areas.
5. Underlain by shale.
6. Thickness of shale varies from 5-200 ft., typically greater than 50 ft.

REFERENCES

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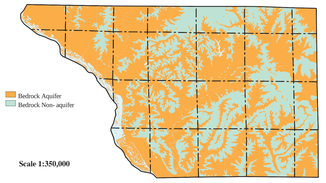
Scale 1:62,500
1 inch equals approximately 1 mile
Lambert Conformal Conic Projection

MAP COMPONENTS

Bedrock Aquifers at the Bedrock Surface of Jo Daviess County, Illinois

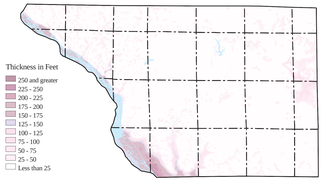


Scale 1:350,000

from McGarry (2000)

This map was used to determine the presence of bedrock aquifers within a given area. Dolomite and sandstone are considered aquifers; shale is considered a non- aquifer.

Thickness of Quaternary Deposits of Jo Daviess County, Illinois

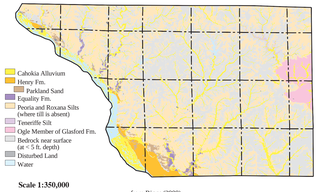


Scale 1:350,000

from Riggs and McGarry (2000)

This map was used to determine the depth to aquifers (either bedrock or drift) and thickness of unconsolidated materials (both aquifer and non- aquifer).

Surficial Geology of Jo Daviess County, Illinois



Scale 1:350,000

from Riggs (2000)

This map was used to determine the presence of drift aquifers and thickness of unconsolidated materials (both aquifer and non- aquifer).

This map was prepared by the Illinois State Geological Survey, in cooperation with the Illinois Department of Commerce and Community Affairs and the Jo Daviess County Board. It is part of a suite of maps created to assist local government in addressing geologic questions concerning capable sites for landfill development. Maps produced for this study are intended for regional land use planning purposes. More detailed mapping is needed for site- specific considerations. This map has been reviewed for scientific accuracy and edited to meet the quality standards of maps in the ISGS Map Series.