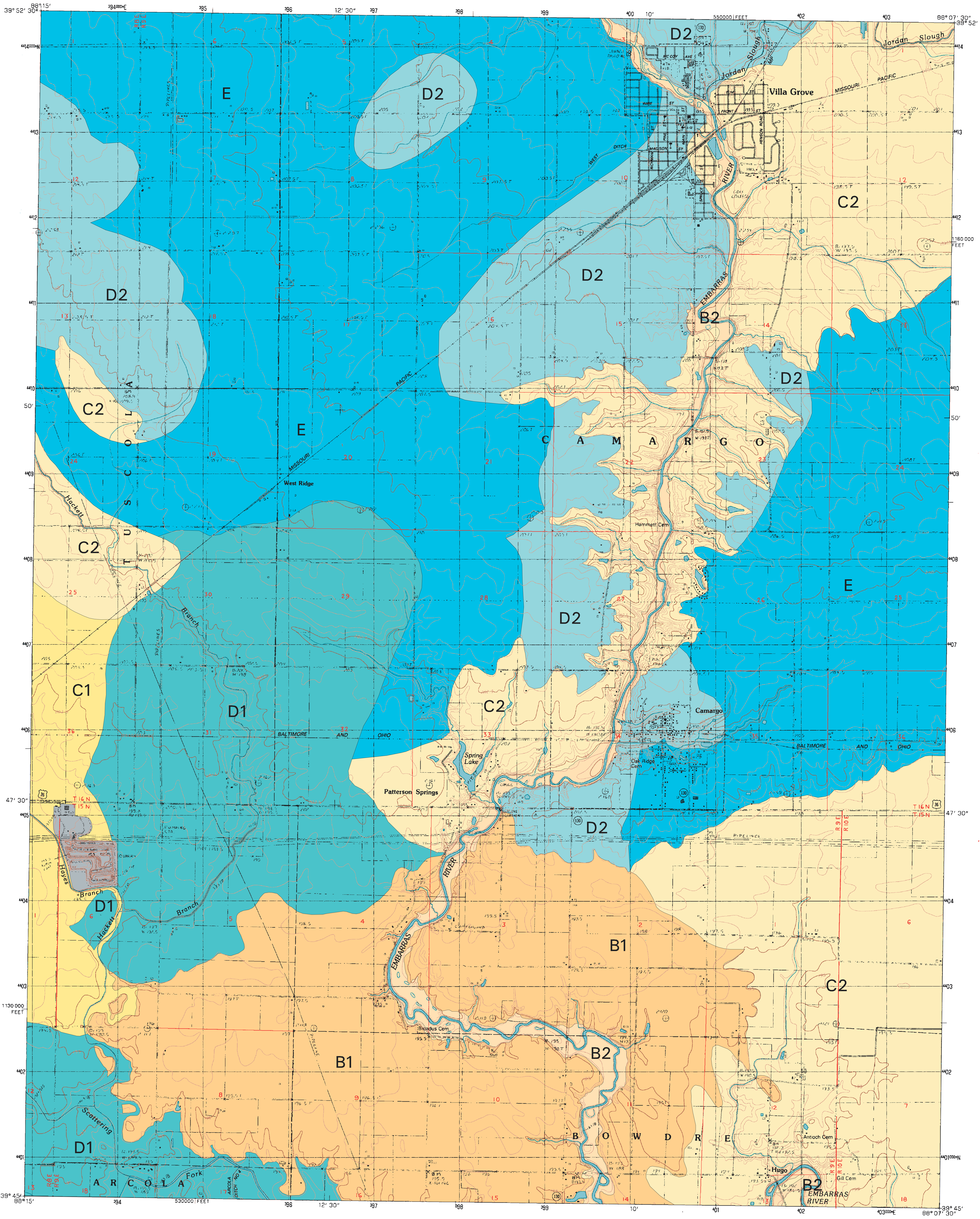
Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Illinois Geologic Quadrangle Map: IGQ Villa Grove-AS
William W. Shilts, Chief
1999

GENERAL AQUIFER SENSITIVITY MAP

Villa Grove Quadrangle, Douglas County, Illinois

Richard C. Berg, Curtis C. Abert



Scale 1:24,000

0 — 2 miles
0 — 2 kilometers
0 — 2000 feet

DISCLAIMER: This map was prepared for the purpose of quadrangle mapping, resource evaluation, and regional planning. It is based on interpretations of available data obtained from a variety of sources. Certain locations may not have been field-verified or the data were not rigorously reviewed. The accuracy of the unverified data and the interpretations based upon them are not guaranteed by the Illinois State Geological Survey.

Base map compiled at the Illinois State Geological Survey (ISGS) from Digital Raster Graphic data (1982) provided by the U.S. Geological Survey.
1927 North American datum
Universal Transverse Mercator projection - Zone 16

1	2	3
4		5
6	7	8

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

NORTH

ADJOINING 7.5-MINUTE QUADRANGLES

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Aquifer Sensitivity to Contamination

The potential for contamination of groundwater in aquifers is a critical concern in Illinois and in the Villa Grove Quadrangle because chemicals or organic compounds introduced into aquifers may present potential health hazards. Residents in the Villa Grove Quadrangle rely completely on groundwater for a drinking water source.

For this map, aquifers are defined as saturated earth materials with large hydraulic conductivities (a measure of the ease of water movement through a material) that provide enough water to small-diameter wells for household needs. Aquifers can be sensitive to contamination because their hydraulic properties allow contaminants to travel rapidly. In Illinois, aquifers are generally composed of unlithified well-sorted sand and gravel deposits, or bedrock units composed of porous sandstone, or fractured carbonate bedrock (Berg et al., 1984). Silty and clayey river and lake sediment, diamicton (a mixture of gravel, sand, silt, and clay commonly called "till"), windblown silt (loess), shale, unfractured carbonate, and cemented sandstone are not considered aquifers because they are generally fine-grained and their saturated hydraulic conductivities are small.

Also important in this interpretation was consideration of aquifer materials above the water table. These deposits are not saturated, but still possess hydraulic properties conducive to downward flow of potential contaminants to the saturated portion of the aquifer; therefore, they are mapped as part of the aquifer. Subsurface aquifer materials containing thin (less than 10 feet) sand and gravel deposits were also considered. They presently may not be used as an aquifer; however, they potentially can yield small amounts of water to residential wells.

The General Aquifer Sensitivity Map to the left was partly derived from other maps developed for the Villa Grove mapping study: Quaternary deposits (Hansel et al., 1999), bedrock geology (Weibel and Lasemi, 1999), and drift thickness (Weibel and Abert, 1999) maps. In addition, descriptions of earth materials from 124 water-well borings and 27 test and bridge borings helped delineate the thickness and distribution of subsurface diamictons and sand and gravel deposits. The units of this map show depth-to-aquifer information, which is the basis for additional specialized aquifer sensitivity maps (Maps A, B, D, and F).

The aquifer sensitivity analysis used in this assessment ranks sequences of geologic materials to a depth of 100 feet according to their ability to protect groundwater in the uppermost mapped aquifer material from potential contamination from a variety of sources. Because of limitations in available data, mapping generalizations, and inability to address specific types of contaminants, this map should not be used as a substitute for evaluation of individual sites. Also, aquifer sensitivity maps are based on generalized textural properties and assumptions about hydraulic characteristics of geologic materials, but not results from water-quality samples or groundwater flow.

Map Units for the General Aquifer Sensitivity Assessment

The general aquifer sensitivity assessment rates sequences from Map Unit B to Map Unit E according to a decreasing sensitivity of aquifers to contamination. For consistency with other aquifer contamination potential evaluations in Illinois (e.g., Berg et al,, 1984), Map Unit A is restricted to sand and gravel or high-permeability bedrock at land surface. This condition does not naturally occur in the Villa Grove Quadrangle.

Map Unit B has a moderately high potential for aquifer contamination because sand and gravel deposits less than 20 feet thick are within 20 feet of land surface. Groundwater within these thin sand and gravel deposits is not commonly tapped. However, there is a potential for migration of contaminants within the sand and gravel and eventual discharge along slopes or into surface-water bodies.

Map Unit C has a moderate potential for aquifer contamination because sand and gravel or high-permeability bedrock are buried by 20 to 50 feet of fine-grained deposits.

Map Unit D has a moderately low potential for aquifer contamination because sand and gravel or high-permeability bedrock are buried beneath 50 to 100 feet of fine-grained deposits.

Map Unit E has a low potential for aquifer contamination because neither sand and gravel nor high-permeability bedrock are present within 100 feet of land surface. Some areas within unit E are underlain by non-aquifer Pennsylvanian rocks at depths of less than 100 feet. Exisiting data show that there are no aquifers in this area. Future drilling may discover additional aquifer resources.

Although aquifer sensitivity decreases as the thickness of overlying fine-grained materials increases, historic water-quality samples from large-diameter wells indicate that shallow groundwater in the fine-grained materials can be contaminated by means of flow through fractures (Schock et al., 1992). The presence of these fractures means that land-use practices like farming, landfilling of wastes, and using septic tanks can result in unexpected contamination in these large-diameter wells.

Aquifer Sensitivity Classes

- B1 — Aquifer within 5 feet of land surface and less than 20 feet thick
- B2 — Aquifer between 5 and 20 feet of land surface and less than 20 feet thick
- C1 — Aquifer between 20 and 50 feet of land surface and greater than 20 feet thick
- C2 — Aquifer between 20 and 50 feet of land surface and less than 20 feet thick
- D1 — Aquifer between 50 and 100 feet of land surface and greater than 20 feet thick
- D2 — Aquifer between 50 and 100 feet of land surface and less than 20 feet thick
- E — Aquifer not present within 100 feet of land surface
- Disturbed land
- Water

Inset Maps

A. Aquifer sensitivity from municipal and hazardous waste disposal

Perhaps the land use with the greatest potential to contaminate aquifers is municipal and hazardous waste disposal sites. Map A can be used to preliminarily assess existing sites and more importantly to screen the quadrangle for regions where the likelihood of finding suitable sites is highest.

Map Units B and C of the General Aquifer Sensitivity map have a high potential for aquifer contamination because waste buried in a pit or trench as deep as 50 feet may be placed in direct contact with an aquifer. Therefore, there is little or no natural protection by overlying finer-grained materials.

Map Unit D has a moderate potential for aquifer contamination, but should not be used for waste disposal because aquifers can be as shallow as 50 feet beneath land surface.

Map Unit E has a low potential for aquifer contamination because of a lack of aquifers in the upper 100 feet. However, it is usually politically and sometimes environmentally wise not to locate any waste-disposal facility over aquifer materials at any depth. Waste-disposal facilities must always be located according to site-specific criteria and carefully designed, constructed, and monitored.

An area of disturbed land shown on the General Aquifer Sensitivity Map exposes bedrock at a quarry in the southwestern portion of the quadrangle. The aquifer material being extracted is porous and highly-permeable Devonian and Silurian dolomites about 160 feet below land surface and exposed at the bottom of the quarry. This situation, however, poses little threat as a contamination source as long as normal quarry operations are in place and land use at the quarry does not change. For example, a contamination hazard could be created if the quarry were used for waste disposal or if a major chemical or fuel spill occurred.

B. Aquifer sensitivity from septic systems

Principal considerations in ranking land areas on their suitability for septic systems are soil drainage and the hydraulic conductivity of geologic materials. Soils with "very poor," "poor," "somewhat poor," and "moderately well" soil drainage conditions, and those with steep slopes and difficulties with septic tank installation were classified by Hallbick and Fehrenbacher (1971) as having "moderate" and "severe" limitations for septic tank disposal fields.

Map B shows soils as a shaded pattern, where "slight" limitations exist for septic tank disposal fields, overprinted onto the geologic conditions most and least conducive to aquifer contamination from septic systems. Soils with slight limitations occur mostly in well-drained areas where septic systems can operate properly; however, the potential exists for downward flow of contaminants to underlying aquifers. The most common wastes in septic effluent include bacteria, nitrate, and detergents.

Map Unit B has a high potential for aquifer contamination particularly where sand and gravel is within 5 feet of land surface (Unit B1) and where well-drained soils occur. Areas with poor soil drainage lessen the potential for aquifer contamination mainly because downward contaminant flow is restricted. Because sand and gravel is thin in these areas, contaminants can also migrate along a contact with underlying finer-grained materials and enter lakes, rivers, and streams with relative ease.

Map Units C, D, and E have a low potential for aquifer contamination because septic systems, installed in the upper 3 to 5 feet are underlain by fine-grained deposits more than 20 feet thick. The fine-grained sediments provide considerable protection to the aquifer from effluents even when overlain by well-drained soils. However, when poorly-drained soils overlie the fine-grained deposits, effluents have a greater potential to seep to the land surface and contaminate surface-water supplies.

C, D, E, F. Aquifer sensitivity from agricultural chemicals and other surface activities

Maps C and E were constructed by classifying soil series in the quadrangle (Hallbick and Fehrenbacher, 1971) according to nitrate and pesticide soil leaching classes (Keefer, 1995). The main factors that affect the probability of nitrates and pesticides moving through soil profiles and into aquifers are soil drainage, soil hydraulic conductivity, and amount of organic matter.

The map showing nitrate leaching characteristics of soils (Map C) primarily considers the hydraulic conductivity and drainage class of the soils. Five nitrate leaching classes group soil series according to the relative probability of nitrate movement through their profiles. They are ranked in order of the probability of leaching.

Map C, showing nitrate leaching classes, was combined with the General Aquifer Sensitivity Map showing depth to aquifers. The resultant map, Map D, shows that the highest sensitivity areas are primarily in the south-central portion of the quadrangle and along the Embarras River. The map can also be used to evaluate sensitivity to nitrates from surface application of sewage sludge and septage as well as waste from large animal confinement facilities, and sensitivity to salts from road de-icers.

The map showing pesticide leaching classes (Map E) groups soils according to the relative probability of pesticide movement through their profiles. There are five pesticide leaching classes. Map units are ranked in order of the probability of pesticide leaching.

Map E, showing pesticide leaching classes, was combined with the General Aquifer Sensitivity Map showing depth to aquifers. The resultant map, Map F, is similar to the nitrate sensitivity map, except that aquifer sensitivity is lower for pesticides than for nitrates because the amount of organic matter is not a factor for determining aquifer sensitivity from nitrates. The map can also be used to evaluate sensitivity to other organic chemicals.

References

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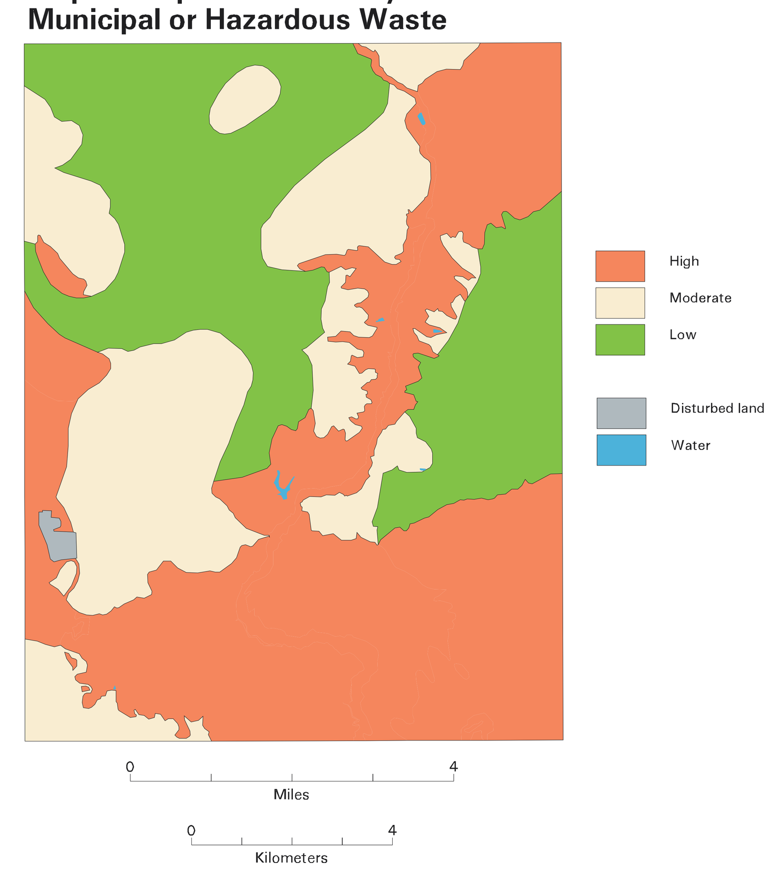
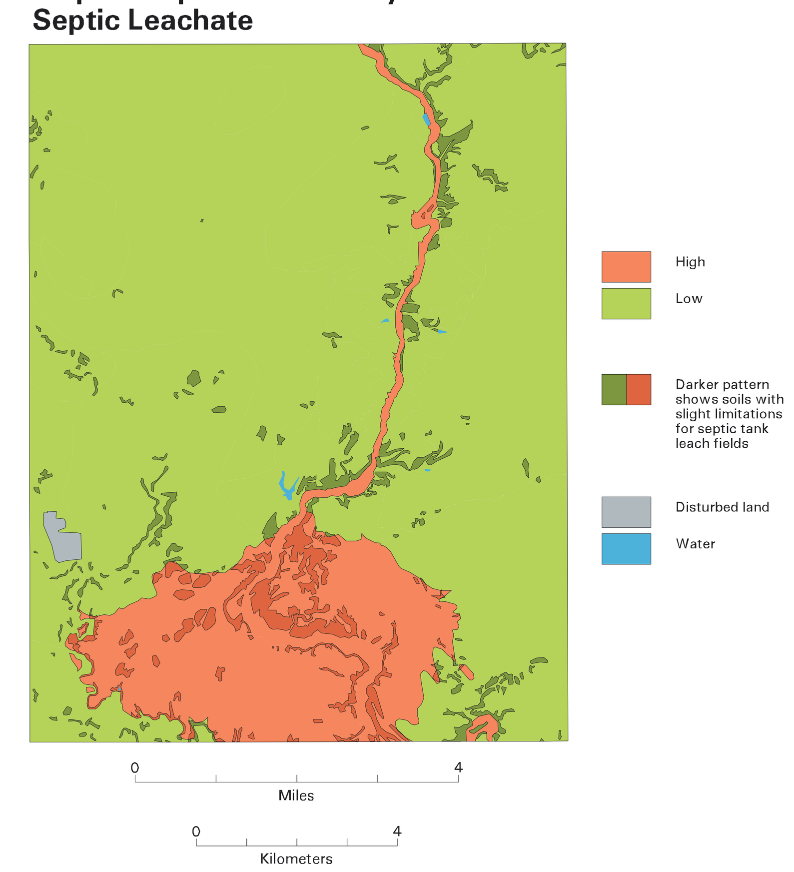
Map A. Aquifer Sensitivity to Municipal or Hazardous Waste



Map B. Aquifer Sensitivity to Septic Leachate

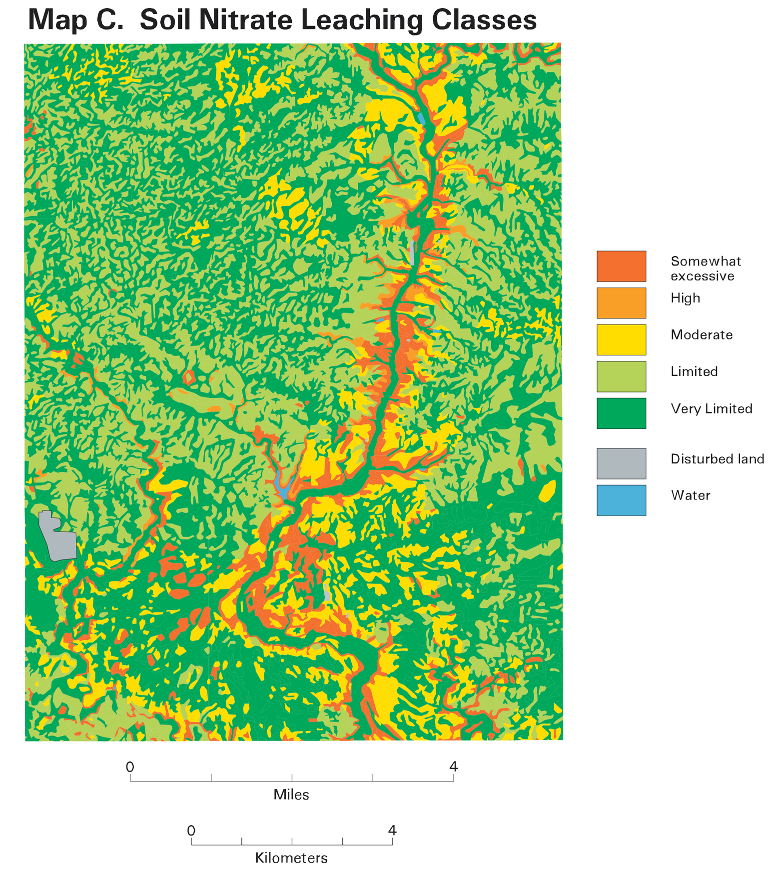


Aquifer sensitivity to contamination by nitrate leaching

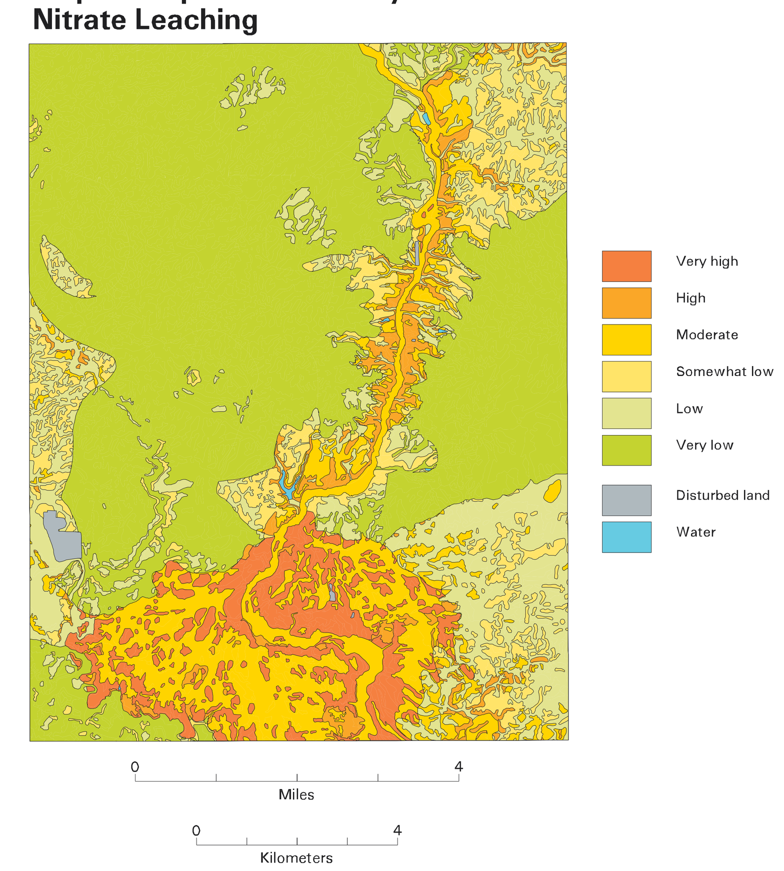
Aquifer sensitivity	Nitrate leaching class	Depth to upper aquifer	General sensitivity class
Very high	Somewhat excessive to moderate*	< 20 feet	B
High	Limited Somewhat excessive	< 20 feet 20 - 50 feet	B C
Moderate	Very limited High or moderate	< 20 feet 20 - 50 feet	B C
Somewhat low	Limited Somewhat excessive	20 - 50 feet 50 - 100 feet	C D
Low	Very limited High or moderate	20 - 50 feet 50 - 100 feet	C D
Very low	Limited or very limited Somewhat excessive to very limited**	50 - 100 feet > 100 feet	D E

* includes somewhat excessive, high, and moderate soil leaching classes
** includes all nitrate leaching classes

Map C. Soil Nitrate Leaching Classes



Map D. Aquifer Sensitivity to Nitrate Leaching

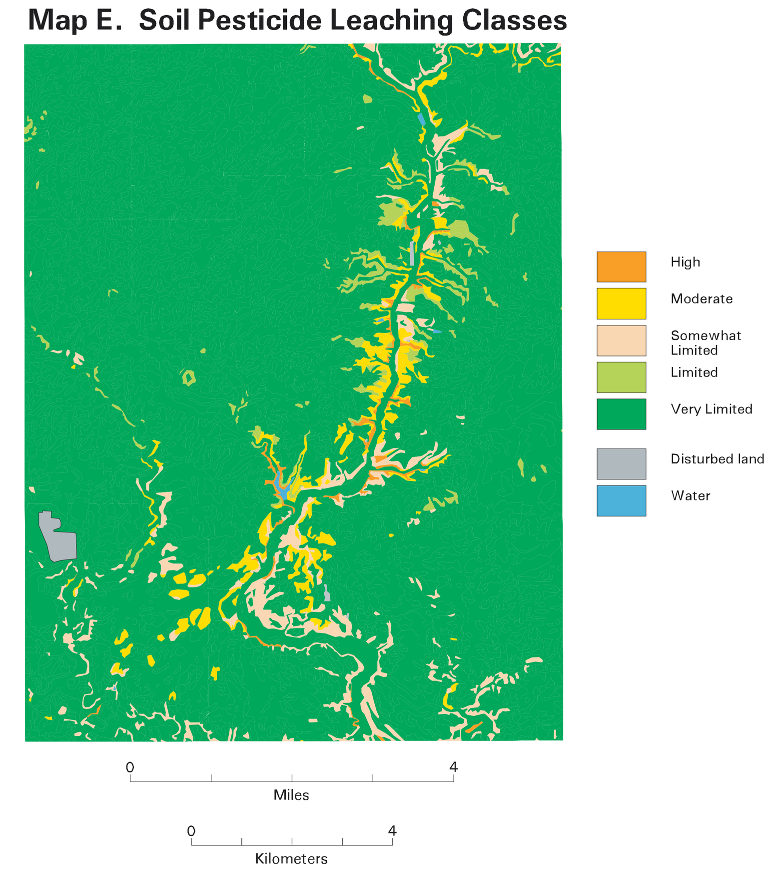


Aquifer sensitivity to contamination by pesticide leaching

Aquifer sensitivity	Pesticide leaching class	Depth to upper aquifer	General sensitivity class
Very high	High or moderate	< 20 feet	B
High	Somewhat limited	< 20 feet	B
Moderate	Very limited High or moderate	< 20 feet 20 - 50 feet	B C
Somewhat low	Somewhat limited to very limited*	20 - 50 feet	C
Low	High	50 - 100 feet	D
Very low	Moderate to very limited** High to very limited***	50 - 100 feet > 100 feet	D E

* includes somewhat limited, limited, and very limited soil leaching classes
** includes moderate, somewhat limited, limited, and very limited soil leaching classes
*** includes all pesticide leaching classes

Map E. Soil Pesticide Leaching Classes



Map F. Aquifer Sensitivity to Pesticide Leaching