Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Illinois Geologic Quadrangle Map: IGQ Vincennes AS
William W. Shilts, Chief
2000

GENERAL AQUIFER SENSITIVITY MAP
VINCENNES QUADRANGLE
KNOX COUNTY, INDIANA AND LAWRENCE COUNTY, ILLINOIS

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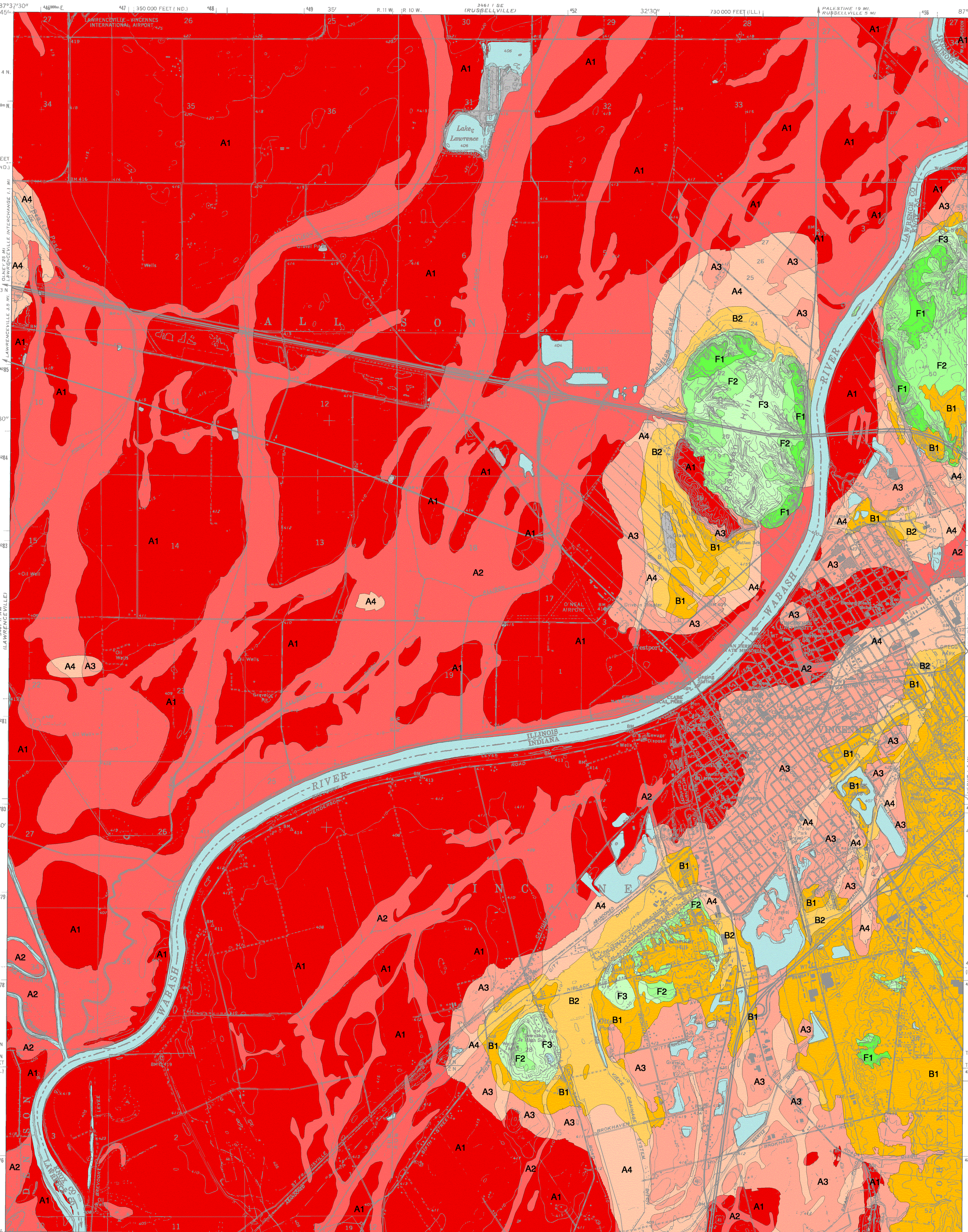

DISCLAIMER: This map was prepared for the purpose of quadrangle mapping, resource evaluation and regional planning. It is based on interpretations of available data obtained from a variety of sources. Location of geologic unit contacts are not surveyed; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist. The accuracy of the unverified data and the interpretations based upon them are not guaranteed by the Illinois State Geological Survey. The information provided on this map cannot be substituted for site-specific investigations.

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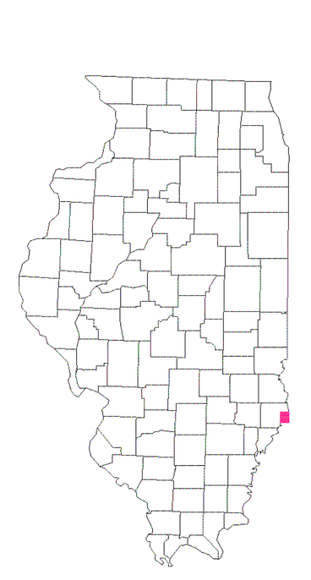
Scale 1:24,000

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

BASE MAP CONTOUR INTERVAL 10 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 projection - Zone 16



1	2	3
4		5
6	7	8

1 Birds
2 Russellville
3 Oaktown
4 Lawrenceville
5 Fritchton
6 St. Francisville
7 Decker
8 Iona

ADJOINING 7.5-MINUTE QUADRANGLES

UTM Grid North
1989 Magnetic North
1° 18 mils
0° 21′ 6 mils
declination at center of map area

Acknowledgements
We thank Robert McLeese, State Soil Scientist, Illinois (USDA-NRCS), and Tonie Endres, Soil Survey Leader, Lawrenceville, Illinois, (USDA-NRCS) for providing the recorrelation of the soils on the Vincennes Quadrangle. K. Olson (University of Illinois at Urbana-Champaign) provided access to the archival aerial photographs, which contained the original 1948 soil survey mapping. These photographs were then converted into digital form by D. Luman (ISGS) and became the base map upon which the recorrelated soils were placed and from which the parent materials and surficial geology maps were developed. We also thank the Mahrenholz, Primus and Minderman families for access to their properties for drilling and field work. J. Masters (ISGS) provided information on the sand and gravel resources, and A. Phillips (ISGS) described cores from boreholes drilled by the ISGS. D. Keefer (ISGS) and A. Phillips (ISGS) and J. Hill and B. Keith of the Indiana Geological Survey (IGS) provided review comments.

Aquifer Sensitivity to Contamination

Residents in the Vincennes Quadrangle rely completely on groundwater as their drinking-water source. Chemicals or organic compounds introduced into aquifers may present health hazards. Therefore, the potential for contamination of aquifers is a critical concern.

For this map, aquifers are defined as saturated earth materials with hydraulic conductivities (ease of water movement through a profile) that are large enough to provide sufficient water to small-diameter wells to satisfy household needs. Aquifers can be sensitive to contamination when they are shallow and, therefore, near potential sources of contamination. In the Midwest, aquifers in nonlithified materials are generally composed of well-sorted, coarse-grained sand and gravel deposits. Aquifers that occur in bedrock typically consist of highly permeable sandstone and fractured bedrock of various lithologies (Berg et al. 1984). Materials that are not considered aquifers because they are generally fine-grained and have a low saturated hydraulic conductivity include 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.

The character and thickness of materials over an aquifer and above the zone of saturation is critical to aquifer sensitivity and, therefore, a significant factor for this type of map. Where these materials possess hydraulic properties conducive to rapid downward flow, the potential for contaminants to move into the saturated portion of the aquifer is enhanced. For this reason, highly permeable unsaturated materials are mapped as part of the aquifer.

The General Aquifer Sensitivity Map to the left was partly derived from other maps developed for the Vincennes Quadrangle mapping study. These included: surficial geology (Barnhardt and Luman 2000), bedrock topography (Weibel 2000), drift thickness (Weibel 2000), and digital orthophoto map (Luman and Barnhardt 2000). Soil surveys for Lawrence County, Illinois (Fehrenbacher and Odell 1956; Endres 1997), and Knox County, Indiana (Kelly 1981), were used in mapping the upper five feet of deposits. In addition, log descriptions of 140 water-well borings, 3 test and bridge borings, and 71 borings specifically done for this mapping study helped delineate the thickness and distribution of sand and gravel deposits and non-aquifer materials. The purpose of the General Aquifer Sensitivity Map is to provide users with a 1:24,000-scale version of aquifer sensitivity conditions complete with base-map information. The map to the left is also the basis for additional specialized and smaller-scaled aquifer sensitivity maps (Maps 1, 2, 4 and 6).

The aquifer sensitivity analysis used in this assessment ranks successions of geologic materials to a depth of 100 feet according to their ability to protect groundwater in the uppermost mapped aquifer material from contamination by 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. Aquifer sensitivity maps are not based on results from either water-level measurements or water-quality analyses. Rather, they are based on generalized textural properties and assumptions about the hydraulic characteristics of geologic materials.

Aquifer Sensitivity Classes

Increasing Sensitivity

Map Unit A: High Contamination Potential

- A1 — Aquifer greater than 50 feet thick with top between 0 and 5 feet of land surface
- A2 — Aquifer greater than 50 feet thick with top between 5 and 20 feet of land surface
- A3 — Aquifer 20 to 50 feet thick with top between 0 and 5 feet of land surface
- A4 — Aquifer 20 to 50 feet thick with top between 5 and 20 feet of land surface

Map Unit B: Moderately High Contamination Potential

- B1 — Aquifer less than 20 feet thick with top between 0 and 5 feet of land surface
- B2 — Aquifer less than 20 feet thick with top between 5 and 20 feet of land surface

Map Unit F: Low Contamination Potential

- F1 — Between 50 and 100 feet of fine grained material overlying shale bedrock
- F2 — Between 20 and 50 feet of fine grained material overlying shale bedrock
- F3 — Less than 20 feet of fine grained material overlying shale bedrock

- Disturbed land
- Water

Map Units for the General Aquifer Sensitivity Assessment

The General Aquifer Sensitivity assessment (1:24,000-scale map to left) rates successions according to a decreasing sensitivity of aquifers to contamination. They range from Map Unit A (high) to Map Unit F (low). The format of this assessment is consistent with other aquifer contamination potential evaluations in Illinois (e.g., Berg et al 1984). Because conditions for Map Units C, D and E do not occur naturally in the Vincennes Quadrangle, they are not presented on these maps. Map Units C, D and E are defined as including either sand and gravel, or high permeability bedrock that is buried by at least 20 feet of fine-grained materials (C and D), or over 100 feet of fine-grained materials at land surface (E).

Map Unit A has a high potential for aquifer contamination because sand and gravel is more than 20 feet thick (commonly more than 50 feet thick) and lies within 20 feet of land surface. In these areas, a contaminant from any source can move rapidly to wells through sand and gravel deposits. Map Unit A covers 94% of the Illinois portion of the quadrangle and 73% of the Indiana portion. Sand and gravel in Map Unit A is commonly used as an aquifer.

Map Unit B has a moderately high potential for aquifer contamination because sand and gravel deposits less than 20 feet thick lie within 20 feet of land surface. Groundwater within these thin sand and gravel deposits is not commonly utilized. 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 B occurs extensively on uplands in the southeastern portion of the quadrangle in Indiana, where a thin veneer of wind-blown sand overlies diamicton or bedrock. It also resides at the base of slopes or in low-lying areas where bedrock is near the surface.

Map Unit F has a low potential for aquifer contamination because there is no sand and gravel mapped as occurring within 100 feet of land surface. In these areas, fine-grained lacustrine deposits, loess or silty alluvium overlie shale. Map Unit F occurs on Robeson Hills in Illinois, east of Robeson Hills in Indiana, on Bunker Hill on the south side of Vincennes, and in scattered locations in the southeastern portion of the quadrangle.

Historic water-quality samples from large-diameter wells indicate that shallow groundwater in these fine-grained materials can be contaminated by means of flow through fractures and through thin unmapped sands. The presence of these fractures and thin sand deposits suggests that land-use practices like farming, landfilling of wastes, and using septic tanks can result in contamination of shallow groundwater, and, therefore, drinking water.

Inset Maps

Map 1. *Aquifer sensitivity to municipal and hazardous waste*

A land use with a significant potential to contaminate aquifers is municipal and hazardous waste disposal. Map 1 may be used as a generalized guide to evaluate aquifer sensitivity to contamination at existing disposal sites and to evaluate locales where the likelihood of finding suitable sites is greatest.

Map Units A and B (on 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 1 shows that 93% of the quadrangle has a high potential for aquifer contamination from municipal and hazardous waste disposal.

Map Unit F (on the General Aquifer Sensitivity Map) has a low potential for aquifer contamination because there are no aquifers mapped in the upper 100 feet. Bedrock aquifers may be present beneath the upper shale unit in Illinois, or beneath the upper shale or sandstone unit in Indiana. It is usually politically, and sometimes environmentally, wise not to locate any waste disposal facility over aquifer materials regardless of depth. Waste disposal facilities should always be located according to site-specific criteria and be carefully designed, constructed and monitored to ensure that leaks are identified before significant contamination occurs.

Map 2. *Aquifer sensitivity to septic leachate*

Principal considerations in the evaluation of land areas for suitability of septic systems are soil drainage and the hydraulic conductivity of geologic materials. Soils with drainage classified as "very poor," "poor," "somewhat poor" and "moderately well" often can have restricted downward movement of water and effluent from septic tanks to underlying aquifers. Reduced downward movement of effluent results in a reduced sensitivity of underlying aquifers to contamination.

Map 2 shows areas from most (shown as red) to least (shown as green) conducive to aquifer contamination from septic systems. Soils with "well," "somewhat excessive," and "excessively well" drained profiles (derived from Fehrenbacher and Odell 1956; Kelly 1981; Endres 1997) are shown with a stippled pattern overprinted onto the geologic conditions. In the stippled areas, septic systems can operate properly; however, there is a large potential for infiltration of contaminants to underlying aquifers. The most common contaminants in septic effluent include bacteria, nitrate and detergents.

Map Units A and B (on the General Aquifer Sensitivity Map) have "excessively high" and "high" potential, respectively for aquifer contamination, particularly where sand and gravel is within 5 feet of land surface (Units A1, A3 and B1) and where well-drained soils occur. Because sand and gravel is thin in B areas, contaminants are likely to migrate along any contact with underlying finer grained materials and may then discharge into nearby lakes, rivers and streams.

Map Unit F (on the General Aquifer Sensitivity Map) has 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. However, in the poorly-drained geologic settings, effluents have a greater potential to seep to the surface creating health and odor problems and contaminate surface-water supplies or storm sewers.

Maps 3, 4, 5, and 6. *Aquifer sensitivity to nitrate and pesticide leaching and other surface activities*

Keefer (1995) suggests that from a regional perspective, 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 classes of soils (Map 3) is primarily based upon the hydraulic conductivity and drainage class of the soils. Using these two parameters, soil series are grouped into five nitrate leaching classes according to the relative probability of nitrate movement through their profiles. They are ranked in order of the probability of leaching.

Nitrate leaching classes (Map 3) were combined (Table 1) with the General Aquifer Sensitivity Map (showing depth to aquifers) to produce Map 4, which shows aquifer sensitivity to contamination by nitrate leaching. The most sensitive areas on Map 4 primarily occur on river terraces composed of sand and gravel (floodplain) or on eolian (wind-deposited) sand that comprises part of the upland (southeastern part of the quadrangle in Indiana and the southern part of Robeson Hills in Illinois). The map can also be used to evaluate the sensitivity of aquifers to nitrate contamination from surface application of sewage sludge, septage, and waste from animal confinement facilities, and from salts and other road de-icers.

The map showing soil pesticide leaching classes (Map 5) groups soils according to the relative probability of pesticide movement through their profiles. Five pesticide leaching classes are ranked in order of the probability of pesticide leaching.

Pesticide leaching classes (Map 5) were combined (Table 2) with the General Aquifer Sensitivity Map (showing depth to aquifers) to produce Map 6, which shows aquifer sensitivity to contamination by pesticide leaching. Map 6 is similar to the nitrate sensitivity map (Map 4) except that the aquifer sensitivity is less for pesticides than for nitrates (shown by less red and more orange and yellow on the map). This is because the amount of organic matter in the soils is a factor for determining aquifer sensitivity from pesticides, but not for nitrates. The map can also be used to estimate the sensitivity of aquifers to contamination by other diffuse, or nonpoint sources of organic chemicals, such as from land application of contaminated soil.

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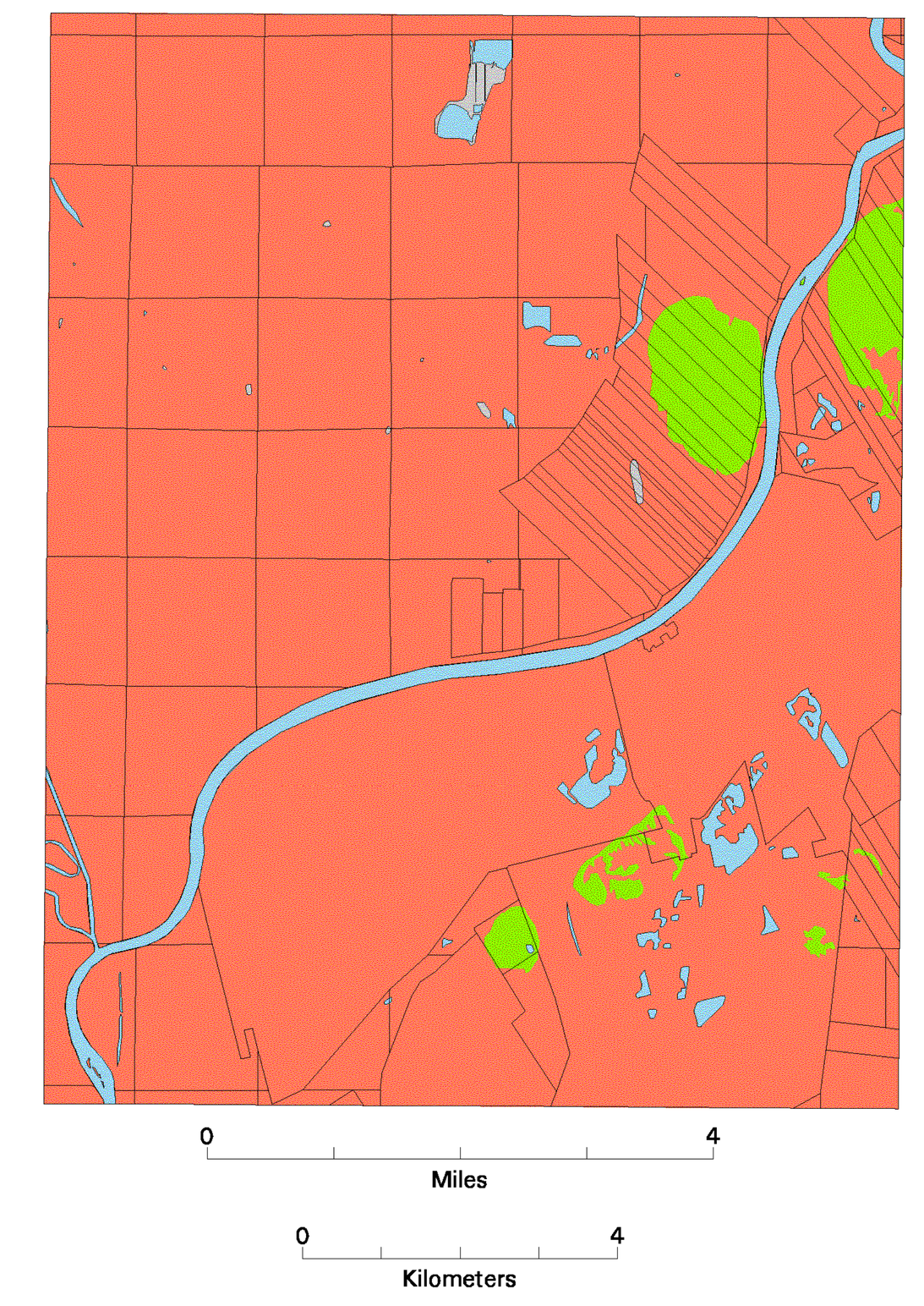
Map 1. Aquifer Sensitivity to Municipal or Hazardous Waste



Map 2. Aquifer Sensitivity to Septic Leachate

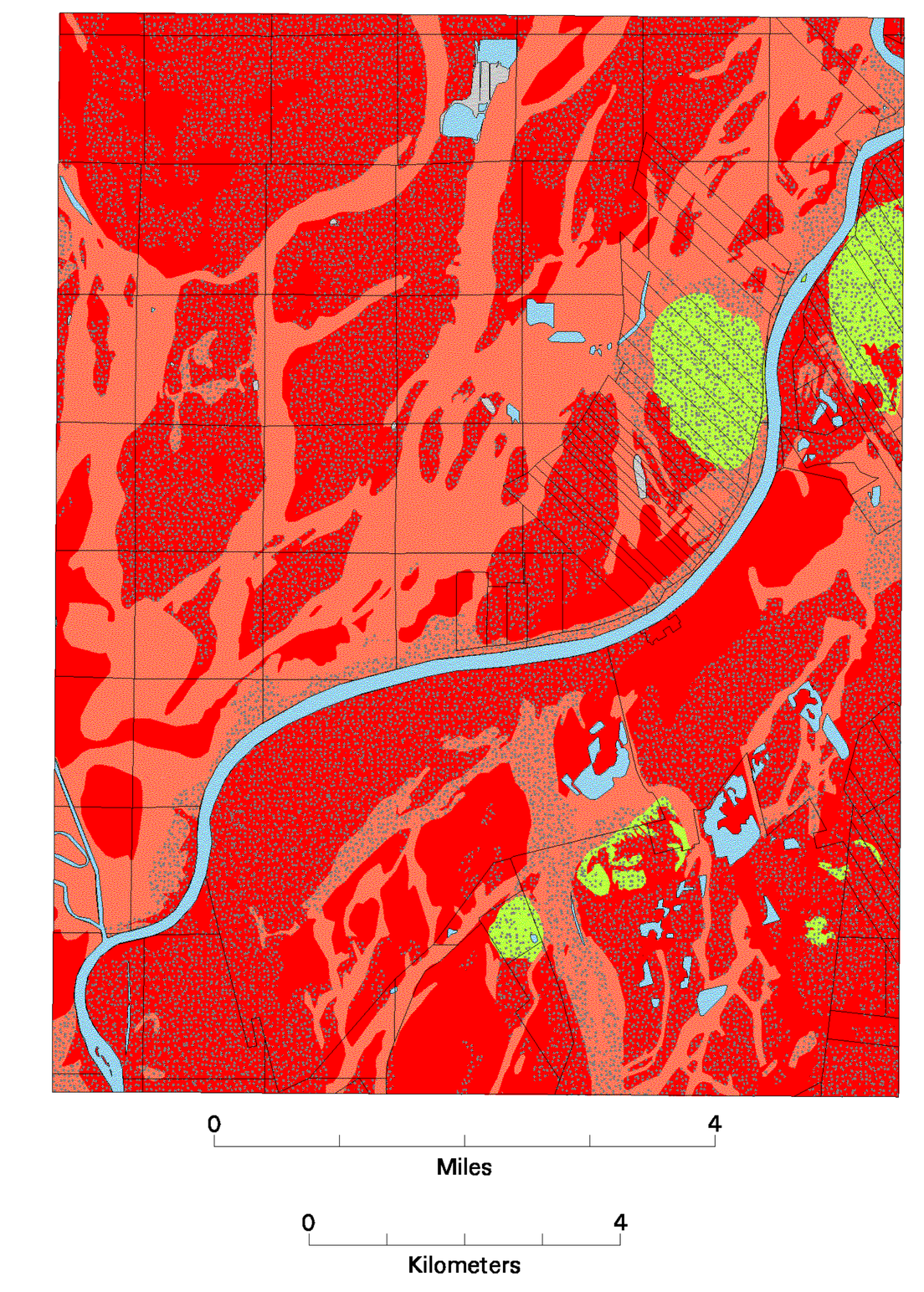
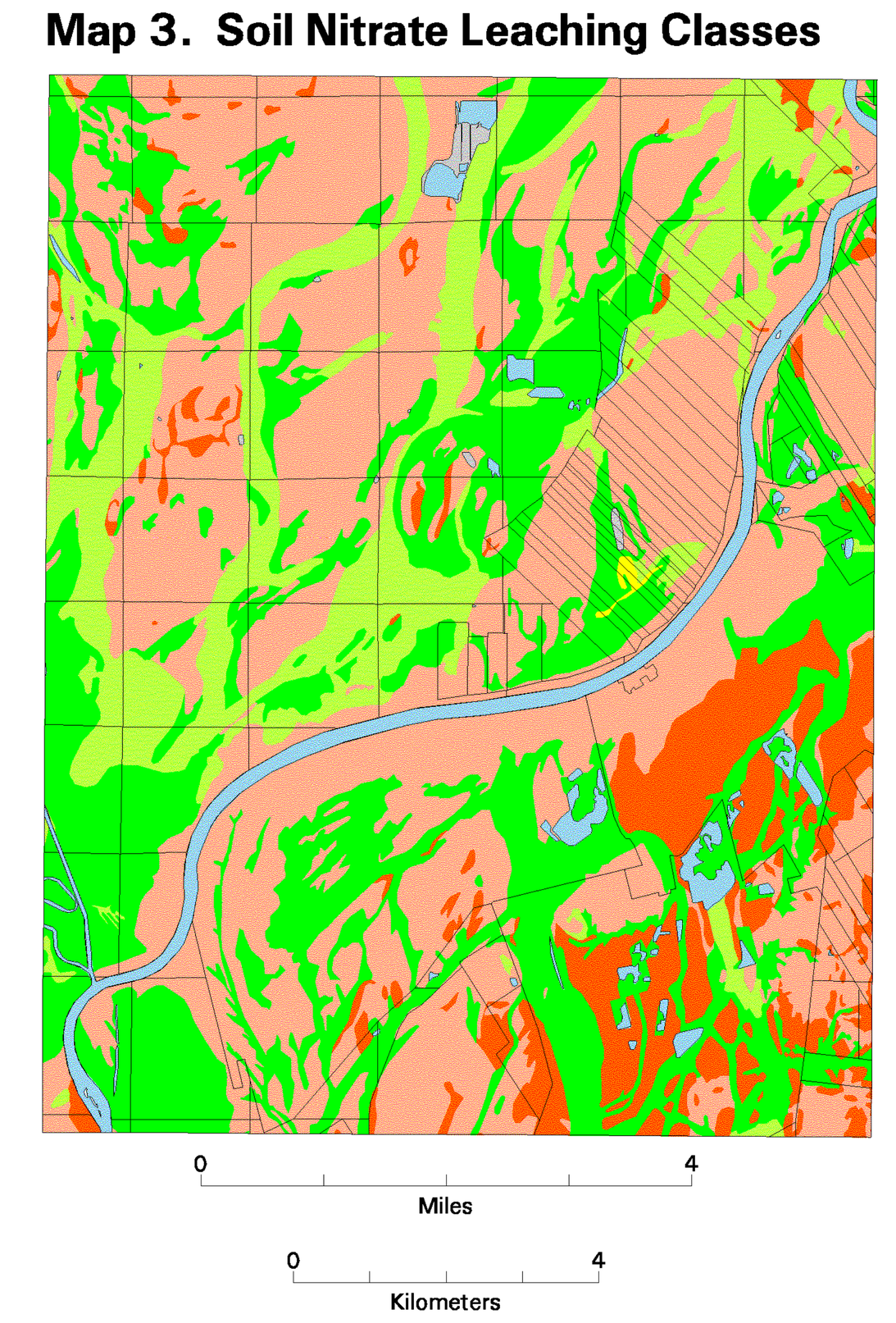


Table 1: Aquifer sensitivity to contamination by nitrate leaching

Depth to Upper Aquifer	General Sensitivity Class	Nitrate Leaching Class (Map 3)	Aquifer Sensitivity (Map 4)
< 20 feet	A/B	Excessive to moderate*	Very high
< 20 feet	A/B	Limited	High
< 20 feet	A/B	Very Limited	Moderate
> 100 feet	F	Excessive to very limited**	Very low

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

Map 3. Soil Nitrate Leaching Classes



Map 4. Aquifer Sensitivity to Nitrate Leaching

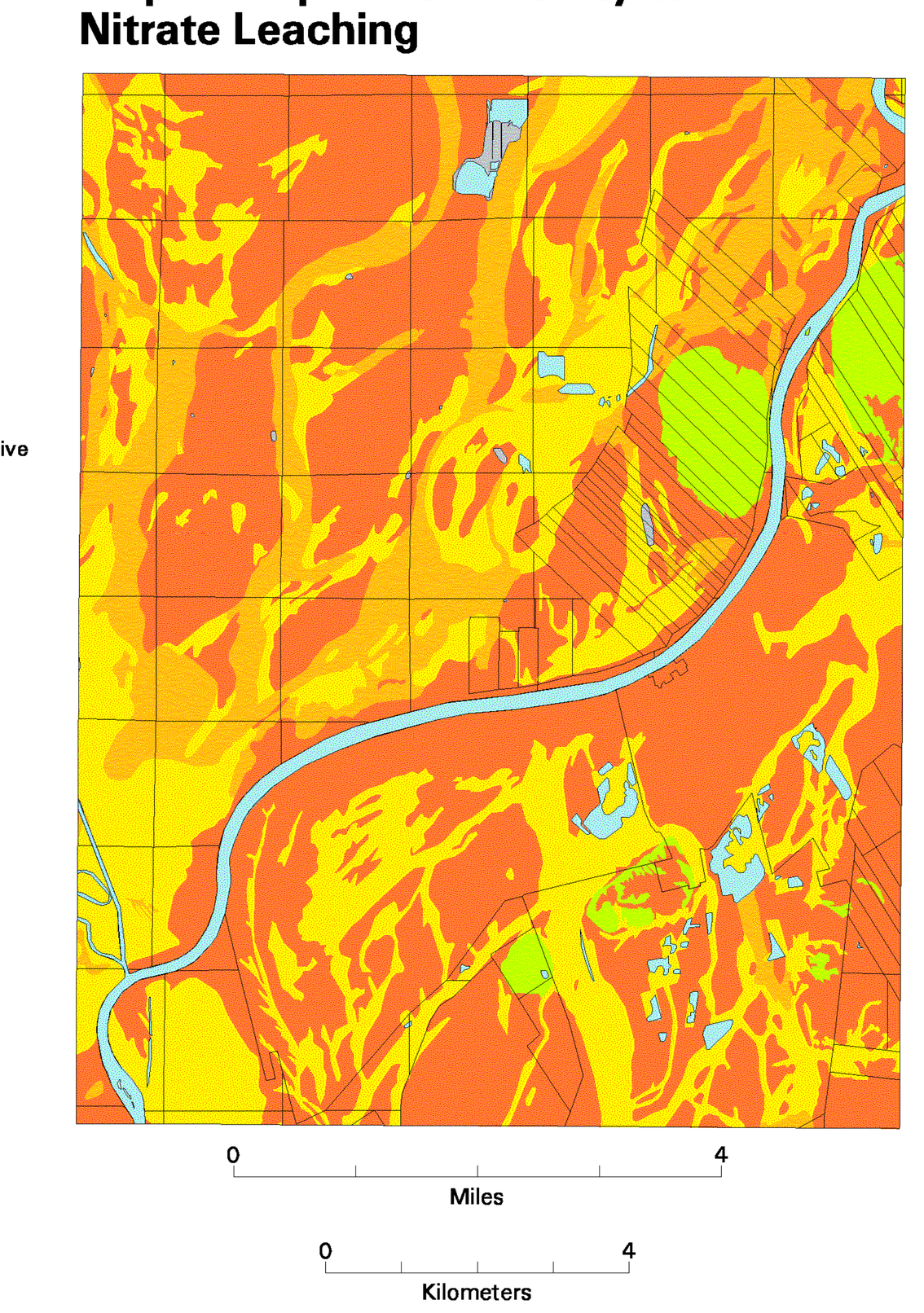
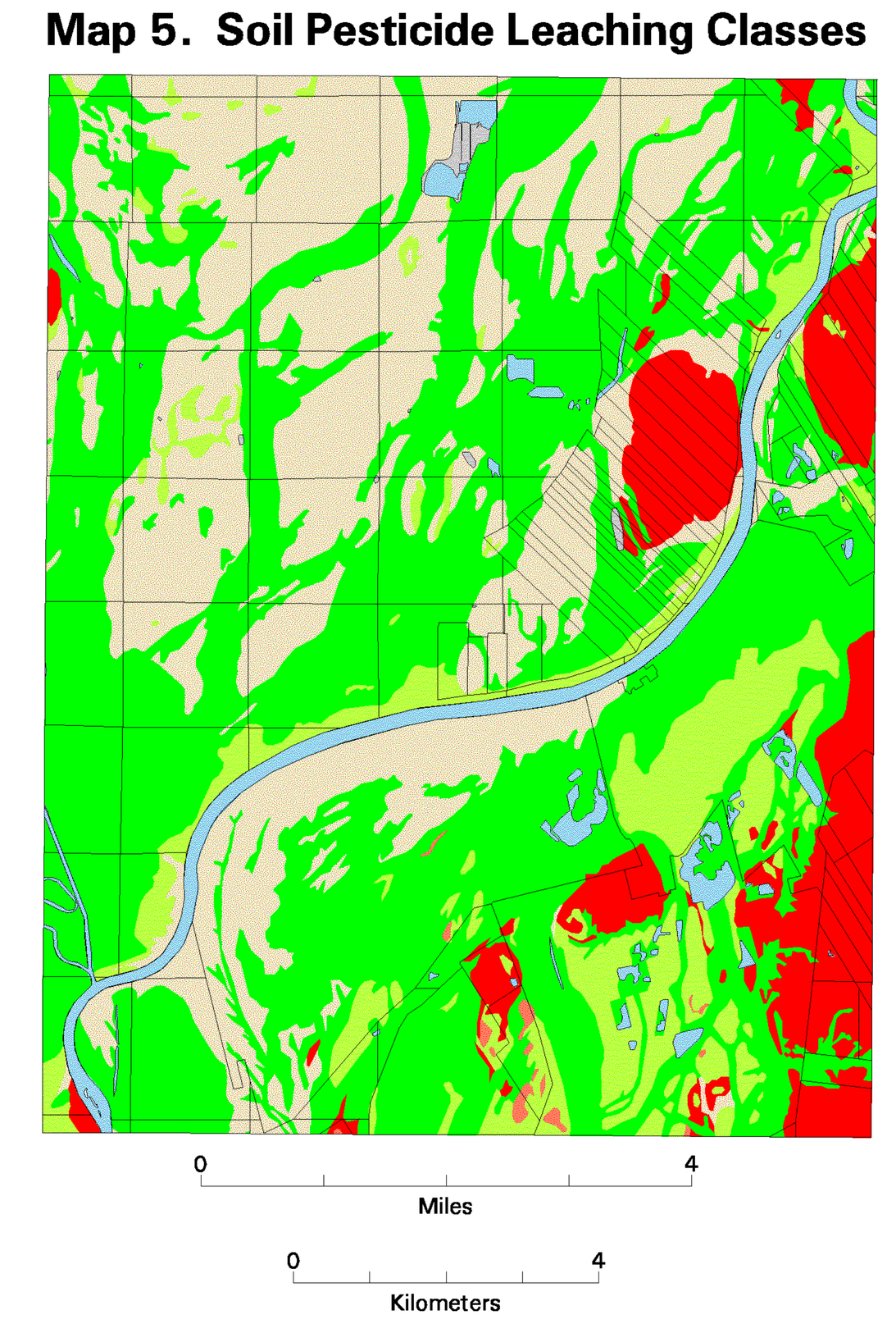


Table 2: Aquifer sensitivity to contamination by pesticide leaching

Depth to Upper Aquifer	General Sensitivity Class	Pesticide Leaching Class (Map 5)	Aquifer Sensitivity (Map 6)
< 20 feet	A/B	Excessive or high	Very high
< 20 feet	A/B	Somewhat limited or limited	High
< 20 feet	A/B	Very limited	Moderate
> 100 feet	F	Excessive to very limited*	Very low

* includes all pesticide leaching classes

Map 5. Soil Pesticide Leaching Classes



Map 6. Aquifer Sensitivity to Pesticide Leaching