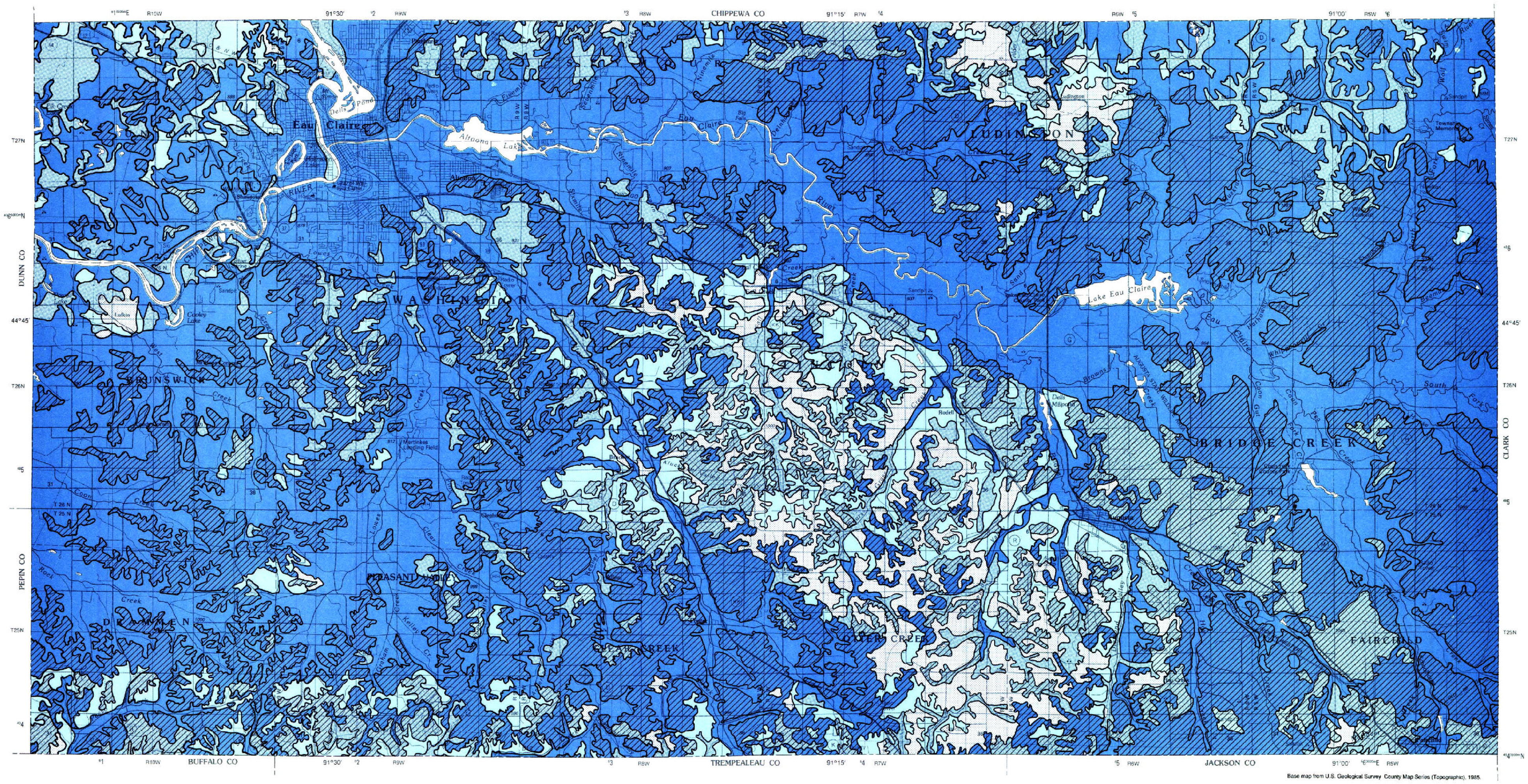
SOILS OF EAU CLAIRE COUNTY, WISCONSIN, AND THEIR ABILITY TO ATTENUATE CONTAMINANTS



Base map from U.S. Geological Survey County Map Series (Topographic), 1985.

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Introduction

Soils usually compose only the upper 2 to 4 feet of unconsolidated materials at the earth's surface. Soils are the basis of agricultural production; they provide the foundation for buildings and roads; if properly used, they aid in the treatment and recycling of wastes from homes, from the production of livestock and poultry, and from municipal and industrial sewage treatment plants. Soil characteristics (depth, texture, and permeability) are among the most significant factors that determine the rate and extent of groundwater recharge and the degree of natural protection against contamination. Land characteristics such as slope, vegetation type, and type of rock will, in conjunction with the soil, determine the overall potential of the environment to protect groundwater.

Glaciers moved across most of Eau Claire County tens or hundreds of thousands of years ago, leaving behind characteristic deposits of till (a poorly sorted mixture of sand, silt, clay, and boulders) and outwash (sand and gravel carried off the ice by meltwaters). Subsequent erosion and other geomorphic processes have removed many of these deposits; consequently, evidence of these early glaciations is sparse at the modern land surface, except in the northeastern part of the county where soils are formed in glacial till.

Although the last glacier to invade Wisconsin terminated north and northeast of Eau Claire County, its influence on the modern landscape was significant. Water from the melting ice moved through the county, following the Chippewa River drainage system and leaving behind extensive coarse-textured (sand-sized) alluvial deposits. Fine, silt-sized particles were carried great distances until the flow of the water slowed enough to allow deposition of these materials. Following the disappearance of the ice, these fine particles were picked up by the wind and deposited to varying depths on the land surface. Many of the modern soils in Eau Claire County formed in this silty material, which is called loess.

Many factors influence the type of soil that develops in an area: the parent material from which the soil formed, relief, climate, natural vegetation, drainage, and the time that the soil has had to form. Although the early glaciers modified the landscape in the county, relatively steep areas are common and soil erosion is a continuing problem. In some parts of Eau Claire County, the loess has been eroded and soils formed in residuum of the sandstone bedrock. Bedrock, either sandstone or shale, is within 5 feet of the land surface over about 164,000 acres (nearly 40% of the county).

For mapping, classification, and interpretive purposes, soils are grouped into soil series on the basis of similar physical and chemical characteristics, type of parent material, and arrangement of horizons or layers. A grouping of individual soils based solely on physical and chemical characteristics is required to evaluate the potential of soils for attenuating contaminants. An evaluation system was developed to assess those soil properties that play a role in the attenuation of potential groundwater contaminants resulting from land-use activities.

Capacity of soils to attenuate contaminants

Attenuation is a series of complex processes, all of which are not clearly understood. During attenuation, the soil holds essential plant nutrients for uptake by agronomic crops, immobilizes metals that might be contained in municipal sewage sludge, or removes bacteria contained in animal or human wastes. The soil is an integral part of the natural protection of groundwater from surface-applied contaminants.

However, the natural purification capacity of the soil, like that of any other natural resource, is limited; sometimes soils that retain contaminants become contaminated. Cleaning contaminated soil can be as difficult as cleaning contaminated groundwater. The evaluation system presented here must be looked upon as a supplemental planning tool only, as a time- and cost-saving guide for preliminary screening of the county for areas sensitive to the impact of normal land-use activities. This soil-potential map does not replace the need for detailed on-site investigations. It does, however, reduce the number of areas to be studied in detail by identifying the areas of best and least attenuation potential. Local details have been generalized to fit the mapping scale, which cannot accommodate small, local variations in soil characteristics.

This system evaluates the ability of the soil solum (the A and B horizons) to attenuate potential contaminants resulting from activities above or within the soil zone. The soil-attenuation capacity is considered here only in general terms and is not contaminant-specific. Different contaminants may behave differently--some may be completely eliminated by soil organisms, some may be used by plants, some may be adsorbed on soil particles, and some may eventually pass through the soil solum unchanged.

Physical and chemical characteristics to establish soil ratings

For assessing soil potential for attenuation of contaminants in Eau Claire County, seven physical and chemical characteristics were selected for each soil series and were given weighted values (table 1). Values assigned to each characteristic were determined subjectively, with 1 being the poorest and 10 the best attenuation potential. These values were summed, and soils with total point scores within certain ranges were grouped into four soil associations, which, in turn, reflect different attenuation potentials (table 2). Soil associations consist of two or more dissimilar series that occur on the landscape in a regularly repeating pattern.

Information needed for this assessment was taken entirely from the Eau Claire County soil survey. All soil series mapped in the county were ranked on the basis of their characteristics in a natural state. Man-induced changes, such as tiling and ditching, may affect the attenuation potential of a particular soil. In those instances where alteration has been extensive, a reassessment may be required. Areas in the county where the bedrock is within 5 feet of the surface are indicated on the map. Even though the rock may be covered with 2 to 4 feet of soil materials that have good capacity for contaminant attenuation, the proximity of the bedrock to the land surface still limits subsurface and surface land-use activities.

Soil attenuation potential

Slightly more than 72 percent of the land area (298,940 acres) in Eau Claire County is covered with soils that have the least potential for contaminant attenuation. Even though they are well drained, the coarse texture of deep, sandy soils such as Menahga and Plainfield series allows water to move through them very rapidly, thus minimizing contact between the percolating waters and soil particles and reducing contaminant attenuation. Boone and Plainbo soils form in 20 to 40 inches of sandy residuum from sandstone bedrock; Elkmound soils have 10 to 20 inches of loamy materials over platy sandstone. Ludington and Humbird soils develop in residuum from interbedded sandstones and shales. Many of these shallow, residual soils form on steep slopes and are not well suited for any type of land use.

Soils with marginal potential for contaminant attenuation include those formed in up to 30 inches of silty materials over sandstone (Veedum, Norden, Gale) and in similar thicknesses of loamy materials over sandstone (Hixton, Northfield) or outwash (Meridian, Lows, Dells). In their subsurface horizons, some of these soils display morphological features that indicate periods of saturation. Presence of a saturated zone within the soil solum interrupts the attenuation processes and may allow contaminants to be introduced into the groundwater.

Soils with good potential to attenuate contaminants cover 33,310 acres (about 8% of the county). These soils have formed in 20 to 40 inches of loess over sandstone (Gale) or loess over outwash (Meridian). Seaton soils have developed in deep silt (>48 inches) and normally would be considered to have the best attenuation potential. However, in Eau Claire County Seaton soils that occur on steep slopes and have been moderately or severely eroded are ranked as having only good attenuation potential. Erosion removes the topsoil, thus affecting infiltration of water into the soil--a key part of the attenuation process. These soils are well suited for a variety of land uses, including agriculture, but must be managed carefully to control erosion.

About 25,000 acres in the county are covered with soils having the best potential for contaminant attenuation. These are soils such as Seaton and Mt. Carroll, which are formed in deep silt (>48 inches). Maximum attenuation occurs when water percolates slowly through the soil solum and contact between contaminants and soil particles is maximized. Well structured, medium-textured surface horizons that enhance infiltration and deep, finer-textured subsoils are characteristic of the soils in this association. These soils are well suited to all types of land-use activities.

This map shows the distribution of soils in Eau Claire County on the basis of their potentials for contaminant attenuation. Soils with bedrock within 5 feet of the land surface are found throughout the county. Soils with special management requirements dominate the county. Deep, flat-lying sandy soils lend themselves well to irrigated agriculture but, because of their limited ability to attenuate contaminants, must be carefully managed to avoid nutrient and pesticide movement to the groundwater. Soils on steep slopes are often shallow and are not suited to land uses other than forestry. Deeper soils on steep slopes can be used in a variety of ways but must be carefully managed to reduce erosion.

Table 1. Ranking system for evaluating the attenuation potential of soils

Physical/chemical characteristics	Classes	Weighted values
Texture[1] of surface (A) horizon	l, sil, scl, si	9
	c, sic, cl, sicl, sc	8
	lvfs, vfsl, lfs, fsl	4
	s, ls, sl, organic materials, and all textural classes with coarse fragment class modifiers	1
Texture[1] of subsoil (B) horizon	c, sic, sc, si	10
	scl, l, sil, cl, sicl	7
	lvfs, vfsl, lfs, fsl	4
	s, ls, sl, organic materials, and all textural classes with coarse fragment class modifiers	1
Organic matter content[2]	Mollisols	8
	Alfisols	5
	Entisols; Inceptisols, Spodosols	3
	Histosols; Aquic suborder; and Lithic, Aquollic, and Aquic subgroups	1
pH-Surface (A) horizon	≥6.6	6
	<6.6	4
Depth of soil solum (A + B horizons)	>40 in.	10
	30-40 in.	8
	20-30 in.	3
	<20 in.	1
Permeability[3]-subsoil (B) horizon	very low	10
	moderate	8
	high	4
	very high	1
Soil drainage class	well drained	10
	well to moderately well drained	7
	moderately well drained	4
	somewhat poorly, poorly, and very poorly drained; and excessively well drained	1

[1] Soil textural classes: l = loam, sil = silt loam, scl = sandy clay loam, si = silt, c = clay, sic = silty clay, cl = clay loam, sicl = silty clay loam, sc = sandy clay, lvfs = loamy very fine sand, vfsl = very fine sandy loam, lfs = loamy fine sand, fsl = fine sandy loam, s = sand, ls = loamy sand, sl = sandy loam.

[2] Based on the ordinal, subordinal, or subgroup levels of the soil classification system; soils are assigned a lower number if they are wet or less than 20 inches thick over bedrock; see county soil survey report.

[3] Based on the particle-size class at the family level of the soil classification system, type, and grade of structure, and consistence; see soil profile descriptions and classification table in county soil survey report.

Attenuation Potential

- Best
- Good
- Marginal
- Least
- Bedrock within 5 feet of surface

SCALE 1:100 000

1 0 1 2 3 4 5 KILOMETRES

1 0 1 2 MILES

Wisconsin Geological and Natural History Survey Map 89-6

Cartography by K. Campbell Roushar

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Table 2. Soil series in Eau Claire County listed by attenuation potential

	Least potential	Marginal potential	Good potential	Best potential
Sum of weighted values	0-30	31-40	41-50	51+
	Adrian Alluvial land, sandy* Alluvial land, wet* Arland, eroded† Au Gres Billett Boone-Plainbo complex Burkhardt Chetek Eleva Elkmound Elm Lake Fairchild-Merrillan complex Fall Creek Friendship Gotham Houghton Ludington-Humbird complex Markey Menahga Morocco Newson Northfield, eroded* Northfield, steep† Plainbo Plainfield River wash* Sparta Terrace escarpments, sandy* Trempe Urne Vilas	Arland Cable Caryville Curran Dells Dunnville Ettrick Gale, eroded† Gale, steep† Hiles Hiles-Kert complex Hixton, eroded† Kert Lows Marshan Meridian, eroded† Meridian, moderately well drained† Norden Northfield Orion Otter Shiffer Veedum Vesper	Arenzville Dakota Fall Creek, moderately well drained variant Gale Hixton Meridian Seaton, steep, eroded† Seaton, moderately well drained† Tell	Mt. Carroll Otterholt Pillot Seaton Seaton, eroded† Seaton, benches† Whitehall, deep variant
Acreage	298,940	57,290	33,310	24,742
Percent of total land area	72.2	13.8	8.0	6.0

* Undifferentiated land type
† Soil phase