Soil-attenuation-potential map of Trempealeau County, Wisconsin

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Introduction

Soils usually develop in the upper 2 to 4 feet of unlithified material at the earth's surface; they are underlain by their parent materials, which may be rock or unlithified materials that can extend to great depths. Soils and their parent materials are the basis of agricultural production; they provide the foundation for buildings and roads; and, 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 and parent-material characteristics (including thickness, texture, rock types, and permeability) are among those natural factors that help determine the rate and extent of groundwater recharge and the degree of natural protection against groundwater contamination. Land characteristics such as slope and type of vegetation will, in conjunction with soil and parent-material characteristics, determine the overall potential of the environment to protect groundwater.

Many factors influence the type of soil that develops in an area: the parent material from which the soil formed, relief, climate, natural vegetation, and the time that the soil has had to form. The glacier that entered Wisconsin during the late Pleistocene (between 25,000 and 10,000 years ago) terminated north and east of the county and did not directly influence Trempealeau County's present landscape. However, many thousands, or perhaps even millions, of years ago, a glacier moved across Trempealeau County, but erosion has removed most of the glacial deposits from the land surface.

As it moved across the land surface, the glacier ground the rock underneath it into silt-sized particles called rock flour. Meltwater streams discharging from the glacier deposited these particles along streambeds. As meltwater levels fell, this material was exposed, and the prevailing westerly winds then picked up the silt and re-deposited it on the land surface as loess. This loess still covers much of Trempealeau County. Because the county was not overridden by ice during the late Pleistocene, the landscape consists of well defined drainage basins with either broad, flat upland surfaces in areas underlain by dolomite or rounded, narrow uplands in areas underlain by sandstone. Valley walls tend to be steep; valley bottoms are broad, flat, and filled with material eroded from surrounding uplands.

About 55 percent of the land in the county is moderately steep to steep; erosion, particularly that associated with land-disturbing activities such as agriculture or timber harvesting, can be a serious problem. Not only does soil erosion contribute to the degradation of the county's surface-water resources but it also strips away the soil mantle, which provides some protection for groundwater. In nearly 46 percent of the county, bedrock (sandstone or dolomite) is within 5 feet of the land surface.

Capacity of soils to attenuate contaminants

Attenuation is a series of complex physical, chemical, and biological processes, many of which are not fully 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 purification capacity of the soil, like that of many other natural resources, is limited, and sometimes soil can become contaminated. Restoring it can be as difficult as restoring any contaminated resource.

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. An evaluative system that groups individual soils solely on the basis of physical and chemical characteristics has been developed to assess those soil properties that play a role in the attenuation of potential groundwater contaminants resulting from land-use activities.

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. Soil-attenuation capacity is considered here only in general terms and is not contaminant specific. Different types of contaminants move throught the environment in different ways: 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.

The evaluation system presented here must be looked upon as a supplemental planning tool only—a time- and cost-saving guide for preliminary screening of the county for areas sensitive to the impact of normal land-use activities. The soil-attenuation-potential map presented here does not replace the need for detailed site investigations. It does, however, reduce the number of areas that need to be studied in detail by identifying the areas of best, good, marginal, and least attenuation potential. Local details have been generalized to fit the mapping scale, which cannot accommodate small variations in soil characteristics.

Physical and chemical characteristics to establish soil ratings

For assessing the soil potential for attenuation of contaminants in Trempealeau 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 soil series that occur on the landscape in a regularly repeating pattern.

Information needed for this assessment was taken entirely from the Trempealeau County Soil Survey (Soil Conservation Service, 1977). All soil series, and some phases of those series, mapped in the county were ranked on the basis of their physical and chemical characteristics; significant changes in soils due to erosion were taken into account in the evaluations. Other human-induced changes, such as tiling and ditching in areas of agricultural activity, may also affect the attenuation potential of a particular soil or soils. In those instances where alteration has been extensive, a reassessment may be required; the effects of these changes cannot be determined from the soil survey report but must be evaluated in the field.

Soil-attenuation potential

Approximately 17 percent of the land area of Trempealeau County is covered with soil having the best potential for contaminant attenuation. Downs, Fayette, and Seaton soils have formed in silt greater than 48 inches thick. Contaminant attenuation in soil is greatly affected by the contact between percolating (moving) water, which may contain contaminants, and the mineral and organic soil particles. In medium-textured soils such as Seaton, Fayette, or Downs, well structured surface horizons allow water to infiltrate (enter) the soil easily; water percolates through the soil relatively slowly and contact between the percolating water and soil particles is maximized. In areas where these deep, silty soils cover the land surface, the potential for reducing or eliminating contaminants resulting from land-use activities is best.

Port Byron soils are similar to Seaton soils, except that they formed under prairie grasses and forbes rather than under hardwood-forest vegetation. Worthen and Huntsville soils developed in deep silts that have accumulated in depressions, in valley bottoms, or on terraces.

Soils with good potential to attenuate contaminants are those formed in 20 to 40 inches of silt over sandstone (Gale, Hixton, LaFarge) or over unlithified sand (Pillot, Whitehall). Because of the coarse texture of the materials underlying these soils, water moves through them very rapidly; contact between the percolating water and the sand particles is brief and attenuation is minimal. In areas where these soils are farmed intensively, chemical inputs, including nutrients and pesticides, must be carefully managed; chemicals and nutrients not used for crop production or attenuated by the finer-textured material at the surface will move rapidly through the unlithified sand and may contaminate groundwater.

Also included in this association are Fayette soils that have been eroded. Soil erosion reduces the thickness of the silty material that overlies the sandstone and thus limits the ability of the soil to reduce contaminant movement.

Soils that have marginal potential to attenuate contaminants are primarily those formed in thin silt (less than 24 inches) over sandstone (Urne, Norden). Hixton soils that have been eroded are also included in this association. In these soils, the protective silt mantle is thin and coarse-textured material that has only limited ability to reduce contaminants is close to the land surface. Somewhat poorly drained (Boaz) and poorly drained (Ettick) soils are also included in this association because the lower part of the soil solum is saturated for at least part of any given year. Saturation in the soil profile reduces attenuation and may lead to the direct introduction of contaminants to the groundwater.

Soils that have the least potential to attenuate contaminants are either formed in transported sand (Sparta, Gotham, Morocco) or in sand weathered from sandstone (Boone, Eleva, Gale). In these soils, the soil solum is thin and the coarse-textured materials that compose them have limited attenuation potential. Also included is a miscellaneous land type (stony and rocky land); the steepness of slopes results in soils being eroded as rapidly as they form, which effectively eliminates the protective soil mantle.

Reference

Soil Conservation Service, 1977, Soil Survey of Trempealeau County, Wisconsin: U.S. Department of Agriculture, 121 p. plus maps (scale 1:15,840)

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, sl, ls, 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	$\geq$6.6	6
	<6.6	4
Depth of soil solum[3] (A + B horizons)	>40 in.	10
	30-40 in.	8
	20-30 in.	3
	<20 in.	1
Permeability[4]-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; 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] Assign next lower value if bedrock is within 30 to 40 inches of the soil surface; this takes into account erosion that may have decreased soil depth. See descriptions of soil map units in county soil survey report.

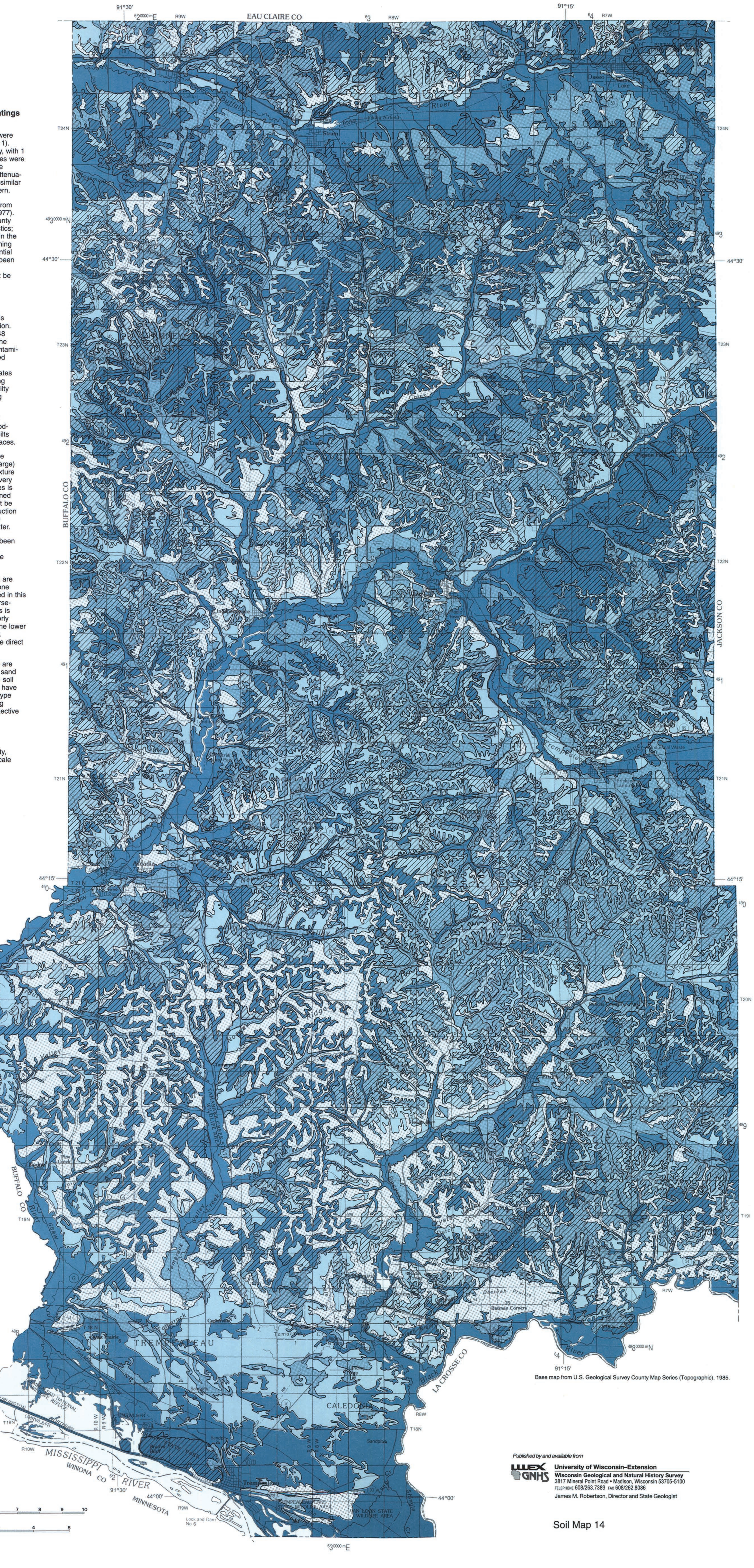
[4] Based on the particle-size class at the family level of the soil classification system, type, and grade of structure, and consistence; with strongly contrasting particle-size classes, the most permeable size class should be used. See soil profile descriptions and classification table in county soil survey report.

Table 2. Soil series in Trempealeau County, listed by attenuation potential

	Least potential	Marginal potential	Good potential	Best potential
Sum of weighted values	0–30	31–40	41–50	>51
	Boone Eleva Eleva-Boone complex Eleva-Gale complex Gotham Gotham-Sparta loamy fine sands, 12 to 20 percent slopes+ Gullied land* Houghton Kato variant sandy loam Loamy alluvial land* Loamy terrace escarpments* Marsh* Morocco Palms Sandy alluvial land* Sandy terrace escarpments* Shiffer Sparta Stony and rocky land* Trempe Trempealeau, mottled subsoil variant Urne Wallkill Wet alluvial land*	Billett Boaz Ettrick Hixton, steep slope, eroded+ Kato Meridian Trempealeau Urne Urne-Norden complex Lawson slopes, eroded+	Denrock Dickinson Dunnville Ettrick, clayey subsoil variant Fayette, eroded and severely eroded+ Gale Hixton loam, 2 to 6 percent slopes, eroded+ La Farge Port Byron Muscatine Norden Pillot silt loam, 6 to 12 percent slopes Whitehall	Downs Fayette silt loam, 2 to 6 percent slopes+ Fayette silt loam, 6 to 12 percent slopes+ Fayette silt loam, 12 to 20 percent slopes+ Fayette silt loam, 20 to 30 percent slopes+ Huntsville Palsgrove Pillot Seaton Worthen
Acreage	183,890	92,330	115,820	78,300
Percent of total land area	39.1	19.6	24.6	16.7

*miscellaneous land type
+soil phase

1986 magnetic declination (MN) at center of map



Attenuation Potential

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

Scale 1:100,000

1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

1 0 1 2 3 4 5 MILES

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

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