Soil-attenuation-potential map of Langlade County, Wisconsin

J.A. Gassen and F.W. Madison, 1990

Introduction

Soils usually compose only 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 (thickness, texture, rock type, 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 and type of vegetation will, in conjunction with the soil and parent material, 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, drainage, and the time that the soil has had to form. In Langlade County the modern landscape was most strongly influenced by the last glaciers, which invaded the county about 15,000 years ago from the northeast and southeast, covering all but the southwest part of the county, where deposits of earlier glaciations are found. The glaciers eroded the land and left behind characteristic deposits of till (a poorly sorted mixture of sand, silt, and boulders) and outwash (sand and gravel carried away from the ice by meltwater). Following the disappearance of the ice, loess (wind-deposited silt) was deposited on part of the land surface; coniferous and deciduous forests reappeared; depressions in the till and outwash filled with organic material. Organic soils (Histosols) occupy about 90,000 acres or 16 percent of the land area of the county. Glacial material is generally thick; bedrock is found within 5 feet of the surface in less than 1 percent of the land area of the county.

The flat-lying outwash plains in the county are intensively farmed. Because of the coarse texture of the subsurface material, agrichemical inputs must be carefully managed to avoid groundwater contamination. Threats to groundwater also may be posed by improperly installed or leaking septic systems or overuse of chemicals on lawns and gardens.

Nearly 64 percent of the land area of Langlade County is forested. This, combined with the approximately 10,000 acres of water in the county, forms the basis for a strong recreation and tourism industry. Land uses associated with forested areas are fairly benign environmentally; however, improperly managed timber harvesting can create surface-water problems.

Most groundwater used in Langlade County comes from the sand and gravel aquifer (that is, the glaciofluvial sediment and till) that overlies the bedrock, which consists of igneous and metamorphic rock of Precambrian age. Although the bedrock contains water, it does not generally yield water sufficient for domestic use unless a well happens to hit a large fissure or crack. This makes preservation of the quality of the water in the sand and gravel aquifer extremely important: if the groundwater in the sand and gravel aquifer becomes contaminated, alternative sources of water for the county are limited.

Capacity of soils to attenuate contaminants

Attenuation is a series of complex processes, none of which are 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 natural purification capacity of the soil, like that of any other natural resource is limited, and sometimes soils can become contaminated. Cleaning contaminated soil can be as difficult as cleaning contaminated groundwater.

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 was developed to assess those soil properties that play a role in the attenuation of potential groundwater contaminants resulting from land-use activities.

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. The soil-potential map presented here 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 Langlade 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 Langlade County soil survey. All soil series mapped in the county were ranked on the basis of their physical and chemical characteristics in a natural state. Man-induced changes, such as tiling and ditching in areas of agricultural activity, may 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 assessed in the field.

Soil-attenuation potential

The soils of Langlade County are fairly equally distributed among the four contaminant attenuation associations (table 2). Antigo soils, which have formed in as much as 3 feet of loess over outwash, cover nearly 120,000 acres or 21 percent of the land area of the county. Contaminant attenuation in soils is greatly affected by the contact between percolating water, which contains contaminants, and mineral and organic soil particles. In medium-textured soils like the Antigo silt loam, well aggregated surface horizons allow water to infiltrate (enter) the soil easily; water percolates (moves) through the soil reasonably slowly and contact between the percolating water and soil particles is maximized. Antigo soils are the only ones in Langlade County that have the **best** potential to attenuate contaminants.

However, the outwash that underlies the Antigo soils has a limited ability to attenuate contaminants. Because of the coarse texture of the outwash, water moves through it rapidly; contact between the water and outwash particles is brief and attenuation is slight. Many of the Antigo soils are farmed intensively; chemical inputs, including nutrients and pesticides, must be carefully managed because of the coarse-textured material that underlies them; contaminants not used for crop growth or contained with the loess move rapidly to the groundwater.

Soils with good potential are dominated by those formed in thin loess (<15 inches) over sandy loam and loamy sand till (Kennan and Amery). In Langlade County, attenuation potential in these soils classified as good instead of best because the loess mantle is thin and the underlying tills are coarse textured. In Freeon soils, the loess is somewhat thicker and the till, although coarse textured, is tightly packed and water moves through it slowly. The remaining soilns in this association are formed in 20 to 40 inches of loess (Crystal Lake and Langlade) or loamy material (Scott Lake) over outwash sand and gravel. These soils can attenuate contaminants fairly well but the subsurface material cannot.

Soils in Langlade County with marginal potential to attenuate contaminants are primarily those formed in 15 to 40 inches of loess over till (Magnor) or over outwash (Comstock) or in the same thickness of loamy material over outwash (Oesterle). In contrast to those soils with good attenuation potential, these soils are considered to be somewhat poorly drained, which means that 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.

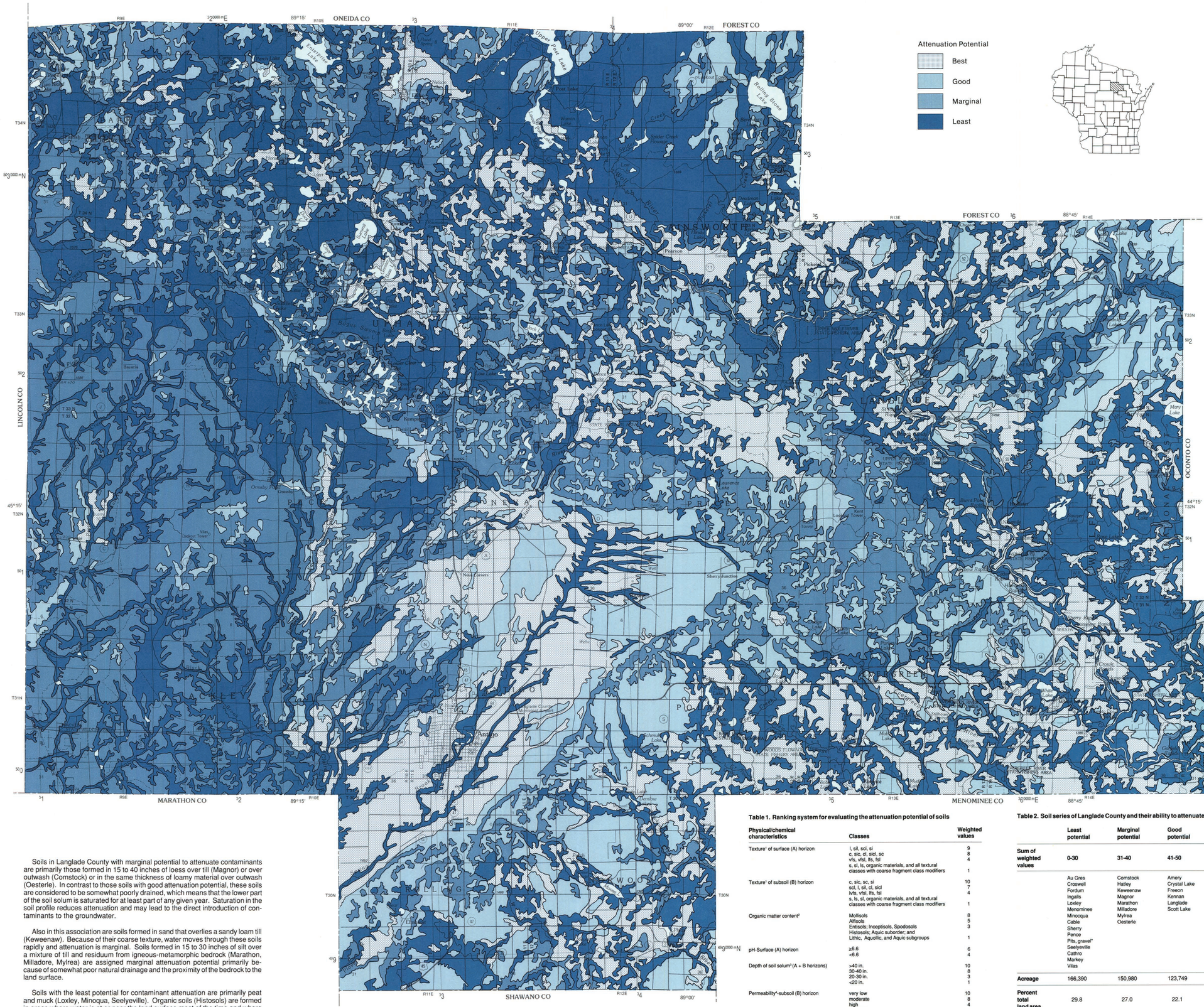
Also in this association are soils formed in sand that overlies a sandy loam till (Keweenaw). Because of their coarse texture, water moves through these soils rapidly and attenuation is marginal. Soils formed in 15 to 30 inches of silt over a mixture of till and residuum from igneous-metamorphic bedrock (Marathon, Milladore, Mylrea) are assigned marginal attenuation potential primarily because of somewhat poor natural drainage and the proximity of the bedrock to the land surface.

Soils with the least potential for contaminant attenuation are primarily peat and muck (Loxley, Minoqua, Seelyeville). Organic soils (Histosols) are formed in areas where water is at or near the land surface most of the time and where organic matter accumulates more rapidly than it decomposes. These soils may play an important role in preventing sediment and nutrients from entering surface water; however, they generally occur in areas of groundwater discharge, so their role in attenuating contaminants destined for groundwater is limited. Other soils in this association are sands (Au Gres, Vilas, Pence), which, because of their coarse texture, do not attenuate potential contaminants.

References

Mickelson, D.M., 1986, Glacial and related deposits of Langlade County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 52, 30 p.

Soil Conservation Service, 1986, Soil Survey of Langlade County, Wisconsin: U.S. Department of Agriculture, 167 p. plus maps (scale 1:20,000).



Cartography by M.S. Humke and G.A. Isler

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
	vfs, 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	≥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; 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] 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 of Langlade County and their ability to attenuate contaminants

	Least potential	Marginal potential	Good potential	Best potential
Sum of weighted values	**0-30**	**31-40**	**41-50**	**51***
	Au Gres	Comstock	Amery	Antigo
	Croswell	Hatley	Crystal Lake	
	Fordum	Keweenaw	Freeon	
	Ingalls	Magnor	Kennan	
	Loxley	Marathon	Langlade	
	Menominee	Milladore	Scott Lake	
	Minocqua	Mylrea		
	Cable	Oesterle		
	Sherry			
	Pence			
	Pits, gravel*			
	Seelyeville			
	Cathro			
	Markey			
	Vilas			
Acreage	166,390	150,980	123,749	117,870
Percent total land area	29.8	27.0	22.1	21.1

*map unit

University of Wisconsin-Extension

Published by and available from
Geological and Natural History Survey
Ronald Hennings, Acting Director and State Geologist
3817 Mineral Point Road, Madison, Wisconsin 53705

Soil Map 11