SOILS OF PORTAGE COUNTY AND THEIR ABILITY TO ATTENUATE CONTAMINANTS

L. Ward Good and F.W. Madison

1987

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; 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 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.

The modern landscape in Portage County has been shaped by deposits from the last major ice sheet to invade southern Wisconsin. That ice, which was moving generally from east to west, pushed about one-third of the way across the county. Behind its terminal moraines, soils are formed in coarse-textured tills (poorly sorted deposits of sand, silt, and boulders).

As the glacial ice melted, tremendous volumes of water carried off gravel, sand, silt, and clay, which were deposited in streams or lakes or, in the case of the finest particles, transported many miles away by the moving water. Much of the western part of Portage County was a large lake basin that filled with sand-sized materials. Following the final disappearance of the glacier, the land surface became stabilized by vegetation. Much of that surface was reworked by wind, which left sandy and loamy coverings on upland surfaces and a landscape rippled with sand dunes.

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. Over much of Portage County, soils are formed in sands that were either deposited by water or wind. Major groups of soils also developed in till and in organic materials (muck). In the northwestern part of the county, soils are formed in a medium- to fine-textured residuum derived from the weathering of igneous and metamorphic rocks. These materials have been reworked by water and have been shifted around in the landscape by mass movement and related geomorphic processes.

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 evaluative 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 pollutants

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, and sometimes soils that retain contaminants may themselves 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. Contaminants may behave in various 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.

Physical and chemical characteristics to establish soil ratings

For assessing soil potential for attenuation of contaminants in Portage 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 Portage County soil survey report. 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. The majority of the soils in the county are formed in deep, unconsolidated glacial materials or weathered residuum; bedrock is within 5 feet of the surface in only about 7 percent of its land area.

Soil attenuation potential

Contaminant attenuation in soils depends on water moving through the soil solum at a rate that ensures maximum contact between the percolating water that contains contaminants and the soil particles. Deep (>35 in.), medium- and fine-textured soils are best. In contrast, water moves through coarse-textured materials very rapidly; contact between contaminants and soil particles is minimal and attenuation is significantly reduced.

Soils that have the **least** potential for attenuation include deep sands, like Plainfield or Meehan, that are excessively drained (water moves through the soil solum very rapidly) or poorly drained (water stands in the soil solum). The presence of free water in the soil solum during part or all of the year interrupts attenuation and often allows contaminants to be introduced into the groundwater.

Organic soil materials, which accumulate only when the water is at or very near the land surface, are widely distributed in Portage County. Roscommon soils have less than 10 in. of organic materials over sands; Markey soils form in 15 to 50 in. of organic deposits. Seelyeville soils form in deep organics (>50 in.). Although organic materials have many desirable properties for contaminant attenuation, in their natural, undrained state their ability to reduce contaminant loadings is severely restricted by the presence of the water table.

Soils with the least potential for contaminant attenuation cover more than 64 percent of the total land area of Portage County. This suggests that all land-use activities should be carefully monitored. Sandy soils are naturally droughty; the availability of abundant groundwater, however, makes irrigated agriculture possible in many areas of the county. Intensive agricultural production may increase the risk of groundwater contamination.

Soils with **marginal** potential for contaminant attenuation include those formed in 20 to 40 in. of loamy materials over coarse-textured till (Wyocena) or outwash (Billett), in shallow, medium-textured materials over residuum (Meadland), and in 20 to 40 in. of loamy materials over interbedded sandstones and shales (Kert).

Altdorf and Dolph soils form in up to 30 in. of silts over fine-textured residuum and have **good** potential for contaminant attenuation. Similar potential is exhibited by Rosholt soils, which form in up to 40 in. of loamy materials over sand and gravel. No soil series mapped in Portage County was ranked as having the **best** potential for attenuation.

This map of Portage County illustrates the dominance of soils that have marginal or less potential for attenuating contaminants. Because of the relative proximity of the water table to the land surface in much of the county, most land-use activities must be carefully managed to ensure protection of the groundwater resource.

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

Physical/chemical characteristics	Classes	Weighted values
Texture[1]—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]—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 consistency; see county soil survey report.

Table 2. Soil series in Portage County listed by attenuation potential

	Least potential	Marginal potential	Good potential	Best potential
Sum of weighted values	0-30	31-40	41-50	51+
	Alluvial land*	Billett	Altdorf	
	wet	Dunnville	Dolph	
	Cathro	Kert	Norgo	
	Coloma	Meadland	Rosholt	
	Dancy	Mecan	Rozellville	
	Dunnville, mottled subsoil variant	Mosinee		
	Friendship	Oesterle, silty subsoil variant		
	Kranski	Richford		
	Leola	Rosholt, eroded		
	Lupton	Sherry		
	Markey	Vesper		
	Marsh*	Wyocena		
	Meehan			
	Meehan, sandstone substratum			
	Oesterle			
	Pearl			
	Plainbo			
	Plainfield			
	Plainfield and Kranski			
	Plainfield, gravelly variant			
	Plainfield, granite substratum			
	Point			
	Rockers			
	Rock land*			
	Roscommon			
	Roscommon-Meehan complex			
	Roscommon, loamy variant			
	Rosholt			
	Seelyeville			
Acreage	331,670	145,700	38,400	- - - -
Percent of total land area	64.3%	28.3%	7.4%	0.0%

*Undifferentiated land type

WLEX University of Wisconsin—Extension

Published by and available from
Wisconsin Geological and Natural History Survey
M.E. Ostrom, Director and State Geologist
3817 Mineral Point Road, Madison, Wisconsin 53705

SCALE 1:100 000

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

MILES 1 0 1 2 3 4 5

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

Cartography by D.L. Patterson

Map 87-8