SOILS OF PIERCE COUNTY AND THEIR ABILITY TO ATTENUATE CONTAMINANTS

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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 KILOMETRES

1 0 1 2 3 4 5 MILES

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

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.

Many thousands of years ago, glaciers moved across Pierce County, leaving behind characteristic deposits of till (an unsorted assemblage of sand, silt, clay, and stones) and outwash (a mixture primarily of sand and gravel deposited by glacial meltwater). Over the intervening years, much of the evidence of these early glaciations has been removed from the landscape by erosion, solufluction and other geomorphic processes. Although the last glacier to invade Wisconsin did not move into the county, materials derived from it significantly affected the modern landscape.

Meltwaters moving away from that ice sheet carried fine, silt-sized particles great distances until waters 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. Most of the modern soils in Pierce County are formed in this 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 glaciers modified the landscape in the county to a limited degree, relatively steep areas are still common and soil erosion is a continuing problem. Nearly 25 percent of the land area (around 95,000 acres) has slopes greater than 12 percent and many soils are mapped as either moderately or severely eroded. Bedrock (either limestone, sandstone, or shale) is within 5 feet of the surface over about 67,000 acres in Pierce 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 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 Pierce 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 for this assessment was taken entirely from the Pierce 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. Those areas in Pierce County where bedrock is within 5 feet of the land 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 surface still limits subsurface and surface land-use activities.

Soil attenuation potential

More than half of Pierce County is covered with soils that have the **best** potential for attenuating contaminants. These soils have formed in greater than 40 inches of silts (Seaton) or have developed in silts over medium-textured tills (Otterholt and Renova). These soils are naturally well drained and are effective at contaminant removal because they are deep and medium-textured, so water carrying contaminants percolates through them slowly. This rate of movement maximizes the contact between the water and the soil particles, thus increasing attenuation.

Typical of soils with **good** potential for contaminant removal are the Whalan or Dubuque series, which have developed in 20 to 30 inches of silts over till and limestone or over residuum and limestone. Vlasaty soils have formed in somewhat deeper silts (30 to 40 in.), but in lower subsoil horizons display morphological features that indicate periods of saturation. Presence of the saturated zone within the soil solum interrupts the attenuation process and may allow contaminants to be introduced into the groundwater.

Sargeant soils, like the Vlasaty series, have formed in 30 to 40 inches of silt over till, but have only **marginal** potential for contaminant attenuation because their natural drainage is poor and water stands in the soil solum for a significant part of the year. Soils developed in less than 20 inches of silty or loamy material over limestone or sandstone (Dunbarton or Gale) are rated as marginal because of the thinness of the soil solum and the proximity of the bedrock to the land surface. If the bedrock is limestone that is fractured and/or contains solution pits (karst), contaminants can be introduced directly into the groundwater. Erosion of these soils exacerbates contamination problems by removing the soil coverings which have, at best, limited attenuation ability.

Soils with the **least** potential for contaminant removal include two undifferentiated land types: steep stony and rocky land and alluvial land. As its name implies, steep stony and rocky land is mapped in areas of steep slopes where the soil cover is extremely thin and rock outcrops are common. Many of the places in which these areas occur are forested, which provides important protection from erosion; generally, they are not suited for any other land uses.

Alluvial soils occur in the valley bottoms along perennially or intermittently flowing streams and are often made up of soil materials eroded from the surrounding uplands. Some are coarse textured and almost all have extremely poor natural soil drainage. Other soils in Pierce County that have the least potential for contaminant attenuation include those formed in deep sands, such as Plainfield and Sparta. Water moves through coarse-textured materials very rapidly; contact between contaminants and soil particles is minimal and attenuation is significantly reduced.

As the accompanying map shows, soils with the best potential for contaminant attenuation are well distributed throughout the county. These soils offer good protection for the groundwater systems from potential contaminants generated by normal land-use activities. Soil erosion, however, is a significant problem because it removes the protective soil cover. Land uses, particularly in areas of moderate to steep slopes, must be carefully managed in order to reduce soil losses.

Table 1. Ranking system for evaluating the attenuation potential of soils in Pierce 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; 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 Pierce 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	Auburndale	Almena	Dakota
	Alluvial land, loamy, nearly level*	Clyde	Antigo	Dakota, rock substratum variant
	Alluvial land, loamy, gently sloping*	Dickinson	Arenzville	Downs
	Alluvial land, sandy*	Dunbarton complex	Arland	Fayette
	Alluvial land, wet*	Freeon	Chaseburg	Hixton
	Boone	Freer	Derinda	Onamia (Rosholt)‡
	Burkhardt	Gale, thin solum variant	Dubuque	Ostrander
	Chetek	Halder	Dunbarton	Otterholt
	Edith (Elderon)‡	Lamont	Floyd	Port Byron
	Edith (Elderon)‡-Wykoff Soils†	Lawler	Gale	Racine
	Plainfield	Orion	Hesch	Renova
	Riverwash*	Sargeant	Meridian	Rockton complex
	Sogn-Rockton loams†		Renova, sandy variant	Santiago
	Sparta		Rozetta	Seaton
	Steep stony and rocky land*		Sable	Spencer
	Terrace escarpments, loamy*		Schapville	Tell
	Terrace escarpments, sandy*		Stronghurst	Terril
			Vlasaty	Waukegan
			Whalan	Worthen
				Wykoff
Acreage	61,935	28,248	73,326	214,731
Percent of total land area	16.4%	7.5%	19.4%	56.7%

*Undifferentiated land type
†Soil association
‡Modern soil series name

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