GROUNDWATER POLLUTION POTENTIAL OF BARRON COUNTY, **WISCONSIN**

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Sources of data

Barron County lies within the boundaries of two major hydrogeologic districts of Wisconsin: a small part of the northeastern area is within the Lake Superior district, and the remainder of the county lies within the west-central drift/Paleozoic district (Zaporozec and Cotter, 1985). Most of the county is covered by glacial till and by thick sequences of outwash sand and gravel, which are the major source of groundwater in Barron County (see Barron County Atlas plates, Physical Setting and Hydrogeology of Barron County, Wisconsin). Surface geology was mapped by M.D. Johnson during 1981-83 (Johnson, 1986); his map served as a basis for delineating hydrogeologic settings in Barron County.

Glacial deposits are covered by moderately to highly permeable soils that provide variable protection against surface-applied pollutants (see Barron County Atlas plate, Soils of Barron County and Their Ability to Attenuate Pollutants). The water table lies between 20 to 80 ft below the surface in most of the county, but it is shallower on the outwash plains and deeper in the southwest (see Barron County Atlas plate, Groundwater Levels in Barron County, Wisconsin). Potential sources that may pollute groundwater in the county are shown on the Barron County Atlas plate Potential Sources of Groundwater Pollution in Barron County, Wisconsin.

Evaluation system The vulnerability of groundwater in Barron County to pollution was evaluated using a modified DRASTIC system (Aller and others, 1985). The system was developed for the U.S. Environmental Protection Agency by a national committee to allow the systematic evaluation of the pollution potential of any hydrogeologic setting in the United States. The system has two major parts: the designation of mappable units, called hydrogeologic settings, and the superposition of a relative rating system

Hydrogeologic settings incorporate the major hydrogeologic factors that affect and control groundwater movement, including depth to water table, net recharge, aquifer media, soil media, topography, impact of the unsaturated zone, and hydraulic conductivity of the aquifer. These factors, which form the acronym DRASTIC, are used to assess the potential for pollutants to enter groundwater. The settings are the basis for the DRASTIC system; they are displayed on the map. Seven hydrogeologic settings were established for Barron County. Six of them were adapted from Aller and others (1985), some with slight modifications, and one was developed specifically for Barron County (7Af) on the basis of the principles used for

development of hydrogeologic settings for DRASTIC. Recharge rates were determined by Bell and Hindall (1975). Hydraulic conductivity values were estimated from textbooks on groundwater that list the ranges for different types of rocks derived from laboratory or field measurements or were taken from DRASTIC ratings developed for hydrogeologic settings similar to Barron County. Because the DRASTIC system does not include groundwater flow, areas of groundwater discharge may be slightly overrated by the system and appear on

the map as sensitive to pollution. The relative ranking scheme uses a combination of weights and ratings to produce a numerical value, or index, which helps prioritize areas with respect to groundwater pollution vulnerapility. Weights and ratings were adopted from DRASTIC (table 1). Weights were never changed, but in some cases, ratings of some DRASTIC factors were modified to reflect the physical onditions of Barron County and availability of data (marked b an asterisk). Using the index values, hydrogeologic settings were grouped into the six categories differentiated on the map.

Use of the map

This vulnerability map is designed for general and planning usage only. It shows the sensitivity of groundwater to pollution in a generalized way; local details have been generalized to fit the map scale. The map does not show areas that have been or will be polluted, or areas that cannot be polluted, and the map cannot be used for any site-specific purposes. Detailed studies of individual areas may be necessary when specific information is needed. Characteristics of individual pollutants or the likelihood of pollutant release were not taken into account when constructing the map.

Local officials can use the map to aid in determining whether or where they should study potential groundwater problems more closely. The vulnerability map can be combined with land-use maps, groundwater-quality data, and pollution-source inventory to direct available resources to the most critical areas. Such maps and information are only supplemental tools in a groundwater protection program; pollution control efforts should be concentrated on regulating land uses and on checking pollution at the source.

The DRASTIC system provides the user with information about

he hydrogeologic setting of an area and its pollution potential. (See Table 2) The symbols found on the map look like this: 7Ba1 -- defines the hydrogeologic setting 196 -- defines the index of the relative pollution potential of the groundwater in the setting.

- . Hydrogeologic setting
 1. The first number (7) refers to the major groundwater region in which the hydrogeologic setting is located, as defined by Aller and others (1985).
- 2. The letter or letters (Ba) define the hydrogeologic setting in more detail. 3. The last number (1) describes a certain set of factors that are unique to the setting. When
- factors, such as depth to water, change enough to warrant a different index but not significantly to change the hydrogeologic setting, a new set of unique characteristics is generated and another number (2) is assigned.

This number represents a relative measure of groundwater polution potential. The ranges are shown on the map legend. The darker hues indicate greater vulnerability of groundwater to

- The index has been calculated as follows: 1. Each factor has been weighted with respect to
- each other and assigned a number from 1 to 5 2. Each factor has been divided into ranges or de-
- scriptive terms and assigned associated rating from 1 to 10 (tables 1B--1H). 3. The numerical value for each factor has been
- calculated by multiplying weight and rating. 4. The individual numerical values have been

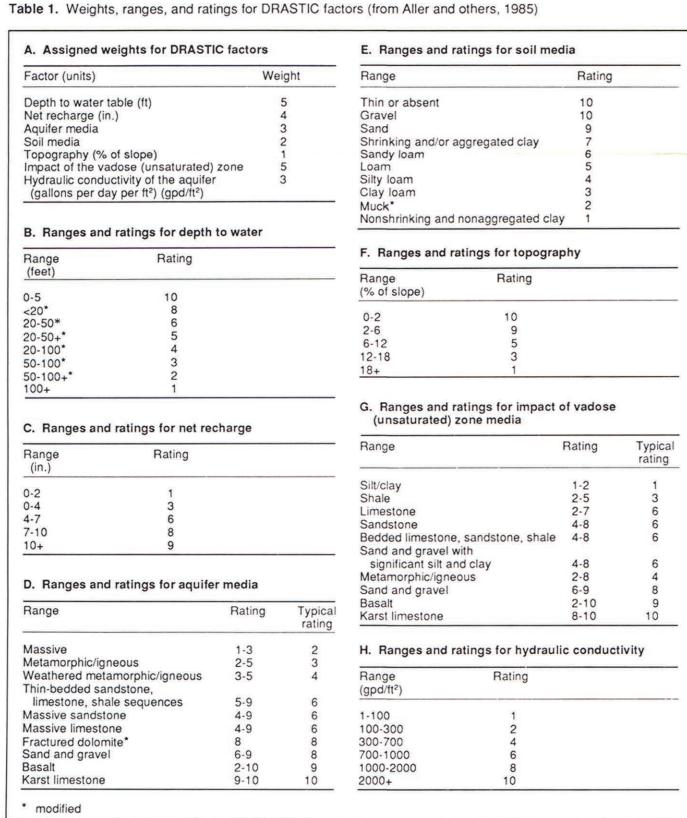
summed to obtain the DRASTIC index. The higher the index, the greater the potential for pollution. Index values range from 80 to 196 in Barron County. The numerical values are relative and have no intrinsic meaning. They are of value only with respect to other numbers generated by the same DRASTIC system and are designed for ready comparison of one setting to another.

Aller, L., Bennett, T., Lehr, J.H., and Petty, R.J., 1985, DRAS-TIC: A standardized system for evaluating ground water pollution potential using hydrogeologic settings: U.S. Environmental Protection Agency Report 600/2-85-018, 163 p.

Bell, E.A. and Hindall, S.M., 1975, The availability of ground water for irrigation in the Rice Lake-Eau Claire area, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 31, 65 p.

Johnson, M.D., 1986, Pleistocene geology of Barron County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 55, plate 1 (scale 1:100,000).

Zaporozec, A. and Cotter, R.D., 1985, Major ground-water units of Wisconsin: Wisconsin Geological and Natural History Survey Educational Series 28, 20 p.



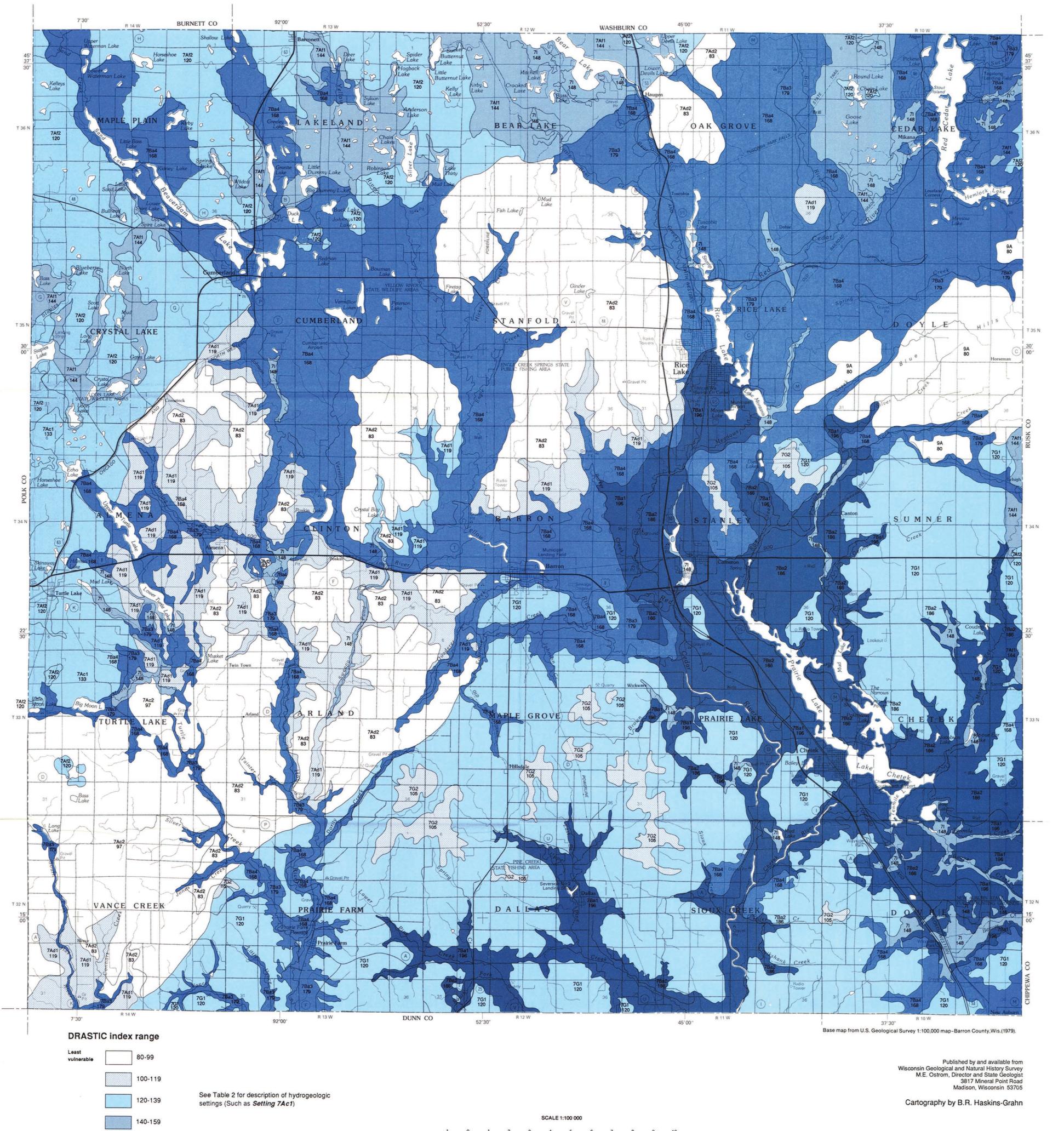


Table 2. Hydrogeologic settings and relative pollution potential index charts for Barron County, Wisconsin

West-central drift/Paleozoic district

(7Ac) Glacial deposits over dolomite (modified setting) This hydrogeologic setting is characterized by rolling to hilly to-pography and dolomite bedrock covered by till and meltwaterstream sediment that vary in thickness. Although groundwater occurs in the glacial deposits and the underlying dolomite, the dolomite serves as the principal aquifer. The till serves as a source of recharge for the underlying dolomite. Although precipitation is abundant in most of the area, recharge is moderate to moderately low because of the relatively low permeability. Depth to water table is variable; it depends partly on the thickness of the glacial till but typically is moderately deep to

Setting 7Ac1 Mixed glacial deposits over dolomite

actor	Range	Weight	Rating	Number
Depth to water	20-50+ ft	5	6*	30
Vet recharge	4-7 in.	4	6	24
Aquifer media	Fract. dolomite	3	8*	24
Soil media	Sandy loam	2	6	12
Γopography	6-12%	1	5	5
Insaturated zone	Sand/silt/clay	5	4	20
Hydraulic cond.	700-1000 gpd/ft	2 3	6	18

DRASTIC index 133

DRASTIC index 97

Setting 7Ac2 Glacial till over dolomite						
Factor	Range	Weight	Rating	N		
Depth to water	50-100 ft	5	3*			
Net recharge	2-4 in.	4	3* 3			
Aquifer media	Fract. dolomite	3	8*			
Soil media	Silty loam	2	4			
Topography	6-12%	1	5			
Unsaturated zone	Silt/clay/sand	5	3*			

* modified

Hydraulic cond. 700-1000 gpd/ft²

(7Ad) Glacial till over sandstone

This hydrogeologic setting is characterized by rolling topogra-phy and relatively flat-lying sandstone bedrock that is covered by till of varying thickness. The till consists chiefly of unsorted deposits that may be covered by loess or interbedded locally with deposits of sand and gravel. Although groundwater occurs in the glacial deposits and in the underlying bedrock, the sand and gravel interbedded within till is the principal aquifer. The till serves as a source of recharge to the underlying bedrock. Although precipitation is abundant in most of the area, recharge is moderate to moderately low because of the till and soils, which are typically loamy and silty. Depth to water table is extremely variable, depending partly on the thickness of the till and ranges between 20 and 120 ft.

Setting 7Ad1 Glacial till over sandstone

Factor	Hange	Weight	Hating	Numb
Depth to water	20-50 ft	5	6*	30
Net recharge	4-7 in.	4	6	24
Aquifer media	Sand & gravel	3	7	21
Soil media	Silty loam	2	4	8
Topography	2-6%	1	9	9
Unsaturated zone	Silt/clay/sand	5	3*	15
Hydraulic cond.	300-700 gpd/ft ²	3	4	12

DRASTIC index 119

Setting 7Ad2 Gla			W 27	4/8 12
Factor	Range	Weight	Rating	Number
Depth to water	50-100+ ft	5	2*	10
Net recharge	2-4 in.	4	3	12
Aquifer media	Sand & gravel	3	7	21
Soil media	Silty loam	2	4	8
Topography	6-12%	1	5	5
Unsaturated zone	Silt/clay/sand	5	3*	15
Hydraulic cond.	300-700 gpd/ft ²	3	4	12

* modified

(7Af) Mixed glacial deposits (new setting) This hydrogeologic setting is characterized by rolling topography and mixed glacial deposits and meltwater-stream sediments of varying thickness that overlie relatively flat-lying sandstone bedrock. Groundwater occurs in the sand and gravel interbedded within glacial till or deposited in stream-eroded glacial channels and in the narrow rims around ice-walled lakes. The centers of ice-walled lakes are composed of fine-grained clay, silt, and sand. Glacial deposits form a typical hummocky topography: isolated knobs or small hills are separated by depressions that are now filled with marshes and lakes. Precipitation is abundant throughout most of the area, and recharge is moderate to high. Water levels vary, but are usually moderately deep.

Range Weight Rating Number

DRASTIC index 120

DRASTIC index 83

Setting 7Af1 Mixed glacial deposits

Depth to water	20-50 ft	5	6*	30
Net recharge	4-7 in.	4	6	24
Aquifer media	Sand & gravel	3	7	21
Soil media	Sandy loam	2	6	12
Topography	2-6%	1	9	9
Unsaturated zone	Silt/sand & gravel	5	6	30
Hydraulic cond.	700-1000 gpd/ft ²		6	18
	DR	ASTI	C index	144

Setting 7Af2 Mixed glacial deposits

Factor	Range	Weight	Rating	Number
Depth to water	50-100 ft	5	2*	10
Net recharge	4-7 in.	4	6	24
Aquifer media	Sand & gravel	3	7	21
Soil media	Sandy loam	2	6	12
Topography	6-12%	1	5	5
Unsaturated zone	Silt/sand & grave	1 5	6	30
Hydraulic cond.	700-1000 gpd/ft ²	3	6	18

* modified

This hydrogeologic setting is characterized by nearly level to undulating topography and outwash of varying thickness that

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Wisconsin Geological and Natural History Survey Map 87-2i

A part of the Barron County Atlas

overlies sequences of sedimentary bedrock. The outwash is deposited either as thick sheet-like deposits on outwash plains or as deposits in meltwater-stream valleys. It is overlain in places by sand deposited on alluvial plains of modern streams or by organic sediment (not differentiated on the map). The outwash consists of water-washed deposits of sand and gravel that serve as the principal aquifer. These deposits are well sorted and have relatively high permeabilities. The outwash also serves as a source of recharge to the underlying bedrock aguifer. Precipitation is abundant throughout most of the area. and recharge is moderate to high. Depth to water table is relatively shallow.

Setting 7Ba1 Outwash

Factor	Range	Weight	Rating	Number
Depth to water	<20 ft	5	8*	40
Net recharge	7-10 in.	4	8	32
Aquifer media	Sand & gravel	3	9	27
Soil media	Sandy loam	2	6	12
Topography	0-2%	1	10	10
Unsaturated zone	Sand & gravel	5	9	45
Hydraulic cond.	2000+ gpd/ft ²	3	10	30
		DRAST	IC index	196

Setting 7Ba2 Outwash

Factor	Range	Weight	Rating	Number
Depth to water	20-50 ft	5	6*	30
Net recharge	7-10 in.	4	8	32
Aquifer media	Sand & gravel	3	9	27
Soil media	Sandy loam	2	6	12
Topography	0-2%	1	10	10
Unsaturated zone	Sand & gravel	5	9	45
	9			

DRASTIC index 186

DRASTIC index 179

Setting 7Ba3 Outwash

Hydraulic cond. 2000+ gpd/ft²

tor	Range	Weight	Rating	Numbe
14.	- Tungo	Troigin	rianing	11011100
th to water	<20 ft	5	8*	40
recharge	7-10 in.	4	8	32
ifer media	Sand & gravel	3	8	24
media	Silty loam	2	4	8
ography	0-2%	1	10	10
aturated zone	Sand & gravel with silt/clay	5	7	35
raulic cond.	2000+ gpd/ft ²	3	10	30

Setting 7Ba4 Outwash

or	Range	Weight	Rating	Numbe
h to water	20-50 ft	6	5*	30
echarge	7-10 in.	4	8	32
er media	Sand & gravel	3	8	24
nedia	Silty loam	2	4	8
graphy	2-6%	1	9	9
turated zone	Sand & gravel with silt/clay	5	7	35
aulic cond.	2000+ gpd/ft ²	3	10	30
		DRASTI	C index	168

(7G) Thin till over sandstone This hydrogeologic setting is characterized by rolling to hilly to-pography and deposits of thin, patchy glacial till overlying sand-stone bedrock. The till, where present, is primarily slightly grav-

elly sandy loam. The sandstone is exposed at the surface in many places in southern Barron County and serves as the principal aquifer. Precipitation is abundant in most of the area and recharge is moderate. Water levels are extremely variable, but usually are moderately deep to deep.

Setting 7G1 Thin till over sandstone

Factor	Range	Weight	Rating	Numbe
Depth to water	20-100 ft	5	4*	20
Net recharge	4-7 in.	4	6	24
Aquifer media	Sandstone	3	6	18
Soil media	Thin or absent	2	10	20
Topography	6-12%	1	5	5
Unsaturated zone	Sandstone	5	6	30
Hydraulic cond.	1-100 gpd/ft ²	3	1	3
		DDAGT	0: 1	7.000

DRASTIC index 120

Setting 7G2 Thin till over sandstone

Range	Weight	Rating	Numbe
100+ ft	5	1	5
4-7 in.	4	6	24
Sandstone	3		18
Silty loam	2		20
6-12%	1	-	5
Sandstone	5		30
300-700 gpd/ft ²		1	3
	100+ ft 4-7 in. Sandstone Silty loam 6-12% Sandstone	100+ ft 5 4-7 in. 4 Sandstone 3 Silty loam 2 6-12% 1 Sandstone 5	100+ ft 5 1 4-7 in. 4 6 Sandstone 3 6 Silty loam 2 10 6-12% 1 5 Sandstone 5 6

DRASTIC index 105

(7I) Swamp/marsh (modified setting)

This hydrogeologic setting is characterized by low topography, high water levels, and high organic silt and clay deposits overlying sand and gravel. Only larger areas on the outwash plains are shown on the map. These wetlands also occur along the courses of other floodplains and in upland areas as a result of vertically restricted drainage. Recharge is moderate in most of the area due to restriction by clayey soils. These deposits are not aquifers. Water levels are very shallow.

Setting 71 Swamp/marsh

actor	Range	Weight	Rating	Numbe
Depth to water	0-5 ft	5	10	50
Net recharge	4-7 in.	4	6	24
Aquifer media	Sand & gravel	3	8	24
Soil media	Muck/peat	2	2	4
Topography	0-2%	1	10	10
Unsaturated zone	Sand & gravel w/sig. silt/clay	5	6	30
Hydraulic cond.	100-300 gpd/ft ²	3	2	6

DRASTIC index 148 * modified

Lake Superior district (9A) Mountain slopes

This hydrogeologic setting is characterized by moderately steep to steep slopes of the Blue Hills, a thin soil or glacial till cover, and fractured Precambrian bedrock. Groundwater is obtained primarily from the fractures in the Precambrian quartzite. The fractures provide localized sources of groundwater, and well yields are typically small. Although precipitation is abundant due to the steeper slopes, thin soil cover, and small storage capacity of the fractures, runoff is significant and groundwater recharge is moderately low. Water levels are extremely variable but are commonly deep.

Setting 9A1 Mountain slopes

actor	Range	Weight	Rating	Number
epth to water	50-100+ ft	5	2*	10
et recharge	2-4 in.	4	3	12
quifer media	Quartzite	3	4	12
oil media	Thin or absent	2	10	20
pography	12-18	1	3	3
nsaturated zone	Quartzite	5	4	20
draulic cond.	1-100 gpd/ft ²	3	1	3
		DRAST	C inde	x 80