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Caves and karst of the Niagara Escarpment: A caver's perspective

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Carolyn's Caverns

ABSTRACT

The Silurian bedrock of northeastern Wisconsin has been modified by glaciers, erosion, and dissolution over a long period of time. Three classes or types of caves—littoral (sea), block creep, and solutional—are found along the Niagara Escarpment, and this article describes examples of each. Other karst features such as enlarged joints and sinkholes are of interest for study and a potential cause for concern because of the pollution danger that they pose for groundwater. Caves in the area are not large or long by national or international standards, but are important to wildlife and to our health and safety.

GEOLOGY

The Niagara Escarpment is formed of dolostone bedrock. This sedimentary rock layer is mostly flat, but is slightly higher in elevation in the west than the east. In some areas along the western edge of its extent, the rock appears as a bluff or escarpment, while in other places it is covered by soil and rocks deposited by the glaciers that covered this part of the state, the last of which melted away roughly 10,000 years ago. In some places in eastern Wisconsin, as little as 6 to 12 inches of glacial debris covers the bedrock; elsewhere, more than 100 feet of material was deposited.

The dolostone bedrock was formed in the Silurian Period, between 443 and 417 million years ago, when this area was covered by shallow, tropical oceans (Dott and Attig, 2004). The limey sediment was deposited on the sea floor by algae, corals, and other marine organisms, and became limestone over time and with pressure and recrystallization. Historically, this type of rock was called limestone, even though it is not truly limestone: pure limestone is calcium carbonate. Scientists are not sure how or when, but magnesium replaced some of the calcium in the limestone here, possibly when mineral-rich water migrated upward through the rock (Dott and Attig, 2004). More recently and accurately it is now called dolomite or dolostone. The exact chemistry of the rock likely varies from place to place—in some localities, the rock seems to dissolve more readily in the weak acids found in nature, leading to enlarged joints, sinkholes, and caves. The Silurian-age formations lie above the Ordovician Maquoketa Formation, which can be seen in some areas at the base of the western bluff and along the Green Bay shore.

Karst terrain

Solution-formed features such as enlarged joints, sinkholes, and caves are typical of a karst terrain (Luczaj, 2013). In areas with karst, there are few surface streams because water easily drains through openings in the bedrock, and surface streams may lose water to underground drainage. For example, Logan Creek in Door County connects spring-fed Lost Lake to Clark Lake. In spring or during a wet fall, water typically flows along the entire length of the creek. During a dry summer, water seeps into the creek bed before it reaches Clark Lake. This is known as a "losing" stream.

With surface drainage rapidly reaching the water table, there is a significant risk of well pollution in a karst terrain. In rural areas, septic systems and barnyards as well as field-spreading of manure and septic wastes can and do pollute groundwater that supplies drinking water.

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Glaciers

Continental glaciers covered much of Wisconsin during the Pleistocene Epoch. While the southwestern corner of Wisconsin (known as the Driftless Area) escaped glaciation, its topography has been altered by precipitation and erosion. There have been a number of advances of glaciers into northeastern Wisconsin, but the Late Wisconsin glaciation, which started about 26,000 years ago, erased most evidence of previous advances (Dott and Attig, 2004). Ice flowed southward from central Canada as far as the Ohio River. The concept of ice flowing may be difficult to imagine, but over time very thick ice can flow over and around obstacles much like water in a river. A hill that is composed of harder stone may resist the ice, or a sharp point may deflect the moving glacier. An example of a hill that resisted the glacier's advance is one just south of Chilton, home to the Carolyn's Caverns System (described later).

Scientists have estimated that the glaciers were as much as 1 mile thick. Computer modeling estimates that the sheer weight of the glacier tilted eastern Wisconsin downward at least 100 m (330 ft) (Dutch, 2009). This weight fractured the bedrock or modified pre-existing fractures, and these joints contribute to the presence of caves in the Niagara Escarpment. Careful measurements have shown that the area is still rising as the land rebounds from the loss of the glacier's weight. That upward movement likely opens cracks that were produced by the weight of the glaciers.

As the climate warmed, the glaciers began to melt away faster than they had advanced. This melting process began about 16,000 years ago, but there were colder periods where they advanced again. The glaciers did not completely retreat from the area until 10,000 years ago. As they melted, Glacial Lake Oshkosh was formed. This glacial lake was an enormous body of water that encompassed the current Fox River Valley and Lake Winnebago. Drainage to the north was blocked by the retreating glacier. Over time, water found varying outlets to Lake Michigan. One outlet was the path of the Neshota and West Twin Rivers near Maribel, Wisconsin. The water from this drainage greatly affected the

Eric Fowle

Figure 1. *Eagle Cave, a littoral cave in Peninsula State Park.*

formation of caves that were in the area, first enlarging the caves and, later, partially filling them with water-washed sediment.

CAVES

Caves of the Niagara Escarpment fall into three classes: solution, littoral (sea), and block creep. Solution caves are the most common type, but they are not evenly distributed across the landscape. Glaciers likely crushed some caves, scraped the top off others, and filled still more with sediment and stones. Much of northeastern Wisconsin is covered by many feet of glacial drift and likely contains buried caves.

Littoral (sea) caves

Littoral, or sea, caves are formed by wave action. Well-known examples occur at Cave Point County Park in Door County along the Lake Michigan shore. Most of these are best seen from the water. These types of caves are formed as wave action erodes and loosens stone along joints; frost action probably also help to enlarge caves. Generally, sea caves follow the direction of joints or faults in the bedrock. At Cave Point most of the entrances are at water level and are roughly perpendicular to the shoreline, although there are examples of other entrance formations: one cave has three entrances and runs about 100 ft (30 m) parallel to the shore. Peninsula State Park on Green Bay has a number of sea caves in the Eagle Bluff area. All are well above current water level and were formed before glacial rebound, when water level was much higher relative to the land. **Eagle Cave** at Peninsula Park (fig. 1) is tens of feet above current water level. Potawatomi State Park near Sturgeon Bay also has some small sea caves.

Littoral caves are not common or widely distributed in Wisconsin. A rocky bluff must be near the shore of a sufficiently large body of water (Lake Michigan) for wave action to be violent enough to erode and loosen rock from the bluff.

Block creep caves

Block creep caves are usually found very near the edge of a bluff where the dolostone has a major joint or fault parallel to the bluff edge. These caves form when a sizable block of bedrock slides outward from the bluff, possibly helped by slipping on the underlying Maquoketa shale and by frost wedging. Many of these widened joints are open to the surface and may fill with soil, boulders, and organic matter. If a top layer of rock does not split off the bluff, a cave remains and is less likely to fill with debris.

On the bluff above Oakfield, Wisconsin, there is a block creep cave several hundred feet long. **Oakfield Crevice Cave** (fig. 2) is generally 2 to 6 ft (0.6 to 1.8 m) wide and varies in height from barely crawling height to 20 ft (6 m) tall in places. The cave is just a few feet

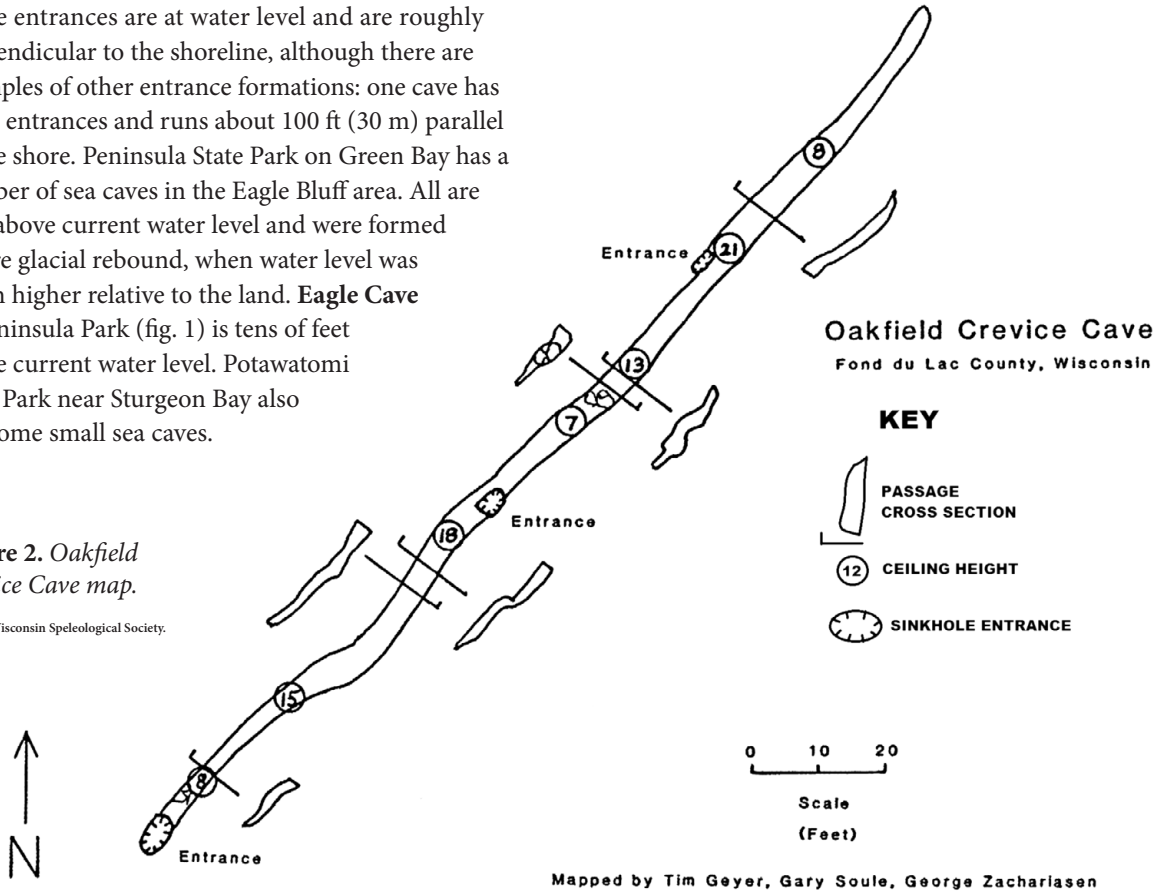

Figure 2. *Oakfield Crevice Cave map.*

Source: Wisconsin Speleological Society.

from the edge of the bluff and the bluff-side wall of the cave matches the contour of the other side very well in many places. Some stones have broken from the covering layer of bedrock, leaving four entrances and some keystones bridging the passage.

> "One end of this cave extends under the original part of the nursing home which had no basement."

In Sturgeon Bay, Wisconsin, basement excavation for an addition to a nursing home encountered a cave that appears to be of block creep origin. Excavation had destroyed the middle part of the cave, but local caver Gary K. Soule was able to convince the builders to modify the foundation of the addition to preserve access to the remaining two portions of the cave.

One end of this cave extends under the original part of the nursing home which had no basement. This portion is very dry. It contains walking-height passage several feet wide. In some areas, fossils have been eroded out of the walls. The other end of the cave tends to be wetter, and extends under a busy street. This cave is located on the side of a gently sloping hill. There is no obvious reason for the block to have moved downhill, leaving a solid roof over the cave. The distance from the cave ceiling to the surface is likely not more than about 10 ft (3 m), but there was no evidence of the cave's existence before the basement excavation.

Solution caves

Solution caves are formed by the slow dissolution of the bedrock by water. The dolostone of the Niagara Escarpment is not very soluble in pure water, but when carbon dioxide is dissolved in water, carbonic acid is formed that more easily dissolves the rock. Acidic water running through joints and bedding plane surfaces enlarges the opening. Over long periods of time this can create passages large enough for people to fit through. Caves that have been formed by relatively still water below the water table are considered to be phreatic, meaning the limestone has dissolved in all directions, while those caused by flowing water are formed by vadose action, creating a trench in the floor. There are examples of both types in northeastern Wisconsin. The dolostone is less soluble than the limestones found in other parts of the country where caves can be much larger.

Once a cave has formed it might be filled by sediment such as sand, breakdown rocks, and sometimes dripstone formations. As a cave drains of water, loose rocks may fall from the ceiling because they weigh more in air than when under water. Frost action may also loosen rocks near the entrance to a cave. Flowing water may carry silt, sand, and gravel into a cave, building up impressive deposits that can fill or nearly fill cave passages.

Al Schema

Figure 3. *Sediment profile of Maribel New Hope Cave. Samples were obtained at numbered locations for age dating. Note the cut-off layers at sample location 2.*


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Figure 4. *Hikers in an un-roofed cave passage, Maribel Area.*

Glaciers traveling over northeastern Wisconsin collapsed some caves, and filled others with large amounts of sediment. Melting glaciers supplied large amounts of water that flowed through and enlarged some caves.

Members of the Wisconsin Speleological Society have excavated fill from several caves over a period of years. At Cherney Maribel Caves County Park in northern Manitowoc County, sandy sediments several feet deep in **Maribel New Hope Cave** show cross-bedding from many different depositional events (fig. 3). Sediment filled cave passages nearly to the ceiling in many places (Luczaj and Stieglitz, 2008). Soil samples were taken in the hope of age-dating the sediment layers. Water continues to seep through the fill. A short distance from this cave is a perennial spring which, years ago, was used as a source of mineral drinking water. Sinkholes in the surrounding farmland to the west may be the source of this water.

Also at Cherney Maribel Caves County Park, a recent excavation project connected two separate nearby crawlway caves into one cave, the **Tartarus Cave System**. This project was completed in 2012 and received a considerable amount of press coverage. Digging continues at both Tartarus and Maribel New Hope Cave attempting to find more unknown passages. Public tours are held on schedule during summer weekends.

The caves at Cherney Maribel Caves County Park are located on a bluff overlooking the valley of the West Twin River, which carried meltwater as the glaciers wasted. As mentioned previously, Glacial Lake Oshkosh formed in the Green Bay-Fox Valley lowland and drained through several different routes as the ice retreated. At some point, the water escaped through the Neshota and West Twin Rivers. This large flow of water excavated the valley, exposing the existing caves (Dott and Attig, 2004).

There are numerous small cave remnants and a large un-roofed cave segment or canyon on private land nearby (fig. 4). This canyon is some tens of feet wide in places, and lower portions of the wall show scallops, indicating this was a cave passage with a significant flow of water in the past. It appears that 3 to 4 ft (0.9 to 1.2 m) of ceiling rock collapsed, partially filling the canyon with broken stone. A few small sections of cave remain off the canyon. Other small sections of cave can be

found in the woods nearby, showing that this was once an extensive cave system.

Ledge View Nature Center is located a few miles south of Chilton in Calumet County, and was established on a hill of dolostone where a small cave in the woods had been known for many years. The small cave, called **Montgomery Cave,** had been used as a dumpsite for refuse from a nearby rendering plant, but has since been cleaned up. In 1986, cavers from the Wisconsin Speleological Society exploring the nearby woods found a shallow sinkhole and began excavating dirt, stones, and cattle bones. They unearthed a small, shallow cave room which led to a lower shallow room. They called these caves **Carolyn's Caverns**. Over many years, more fill has been removed, and the now-extensive cave network is called the Carolyn's Caverns System (fig. 5). There are easy walking passages where only low crawlways or completely filled passages previously existed (fig. 6). Because the entrances to the cave system are near the top of the hill, it is clear that glacial meltwater provided most, if not all, of the fill. The excavation project is continuing, so it is yet unknown how large the full system is. Tours of the cave system are available through the Nature Center, which also houses excellent educational exhibits.

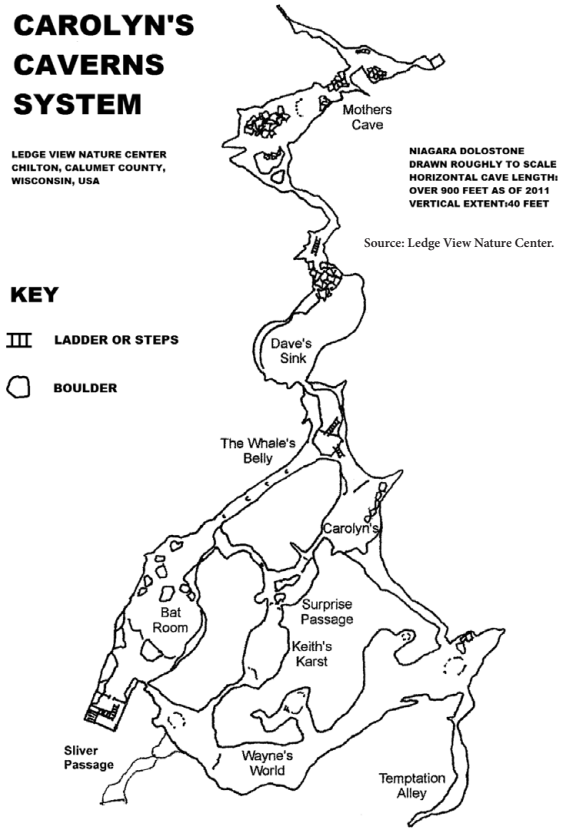

Figure 5. *Carolyn's Caverns System map.*

Ledge View Nature Center

Figure 6. *Passage in Carolyn's Caverns.*

Horseshoe Bay Cave is one of the longest caves in northeastern Wisconsin, and is located near the shore of Green Bay in Door County. This cave's existence has been known since at least 1896, when two hunters noticed water emerging from the bluff. From 1959 to 1963, cavers explored and mapped 1,740 ft (530 m) of passage, much of it low, wet, and cold. In 1978 cavers dug through a sand and gravel filled crawlway at the end of the mapped passage and entered a watery stream crawlway leading to about another thousand feet of passage. Cave divers have gone even farther.

The cave is unusual in Wisconsin for containing flowing water—most Wisconsin caves are high above the current water table and developed before valleys were formed by erosion. The Horseshoe Bay Cave map looks like a sinuous river and the cave was likely formed by flowing water (fig. 7). Many "rooms" are formed along the passage by solutionally enlarged joints. Occasionally water flows out of the cave, when snow melts rapidly enough. In 1986 water flowed out of the entrance for several days, and in September 2014 heavy rain again caused the entrance to flood (fig. 8). In the 1920s, Plum Bottom, a large, shallow closed valley just inland from the cave, flooded with water up to 6 ft (1.8 m) deep (Door County Advocate, 1982). Children attending

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Figure 8. *Water flooding from the entrance of Horseshoe Bay Cave in 2014.*

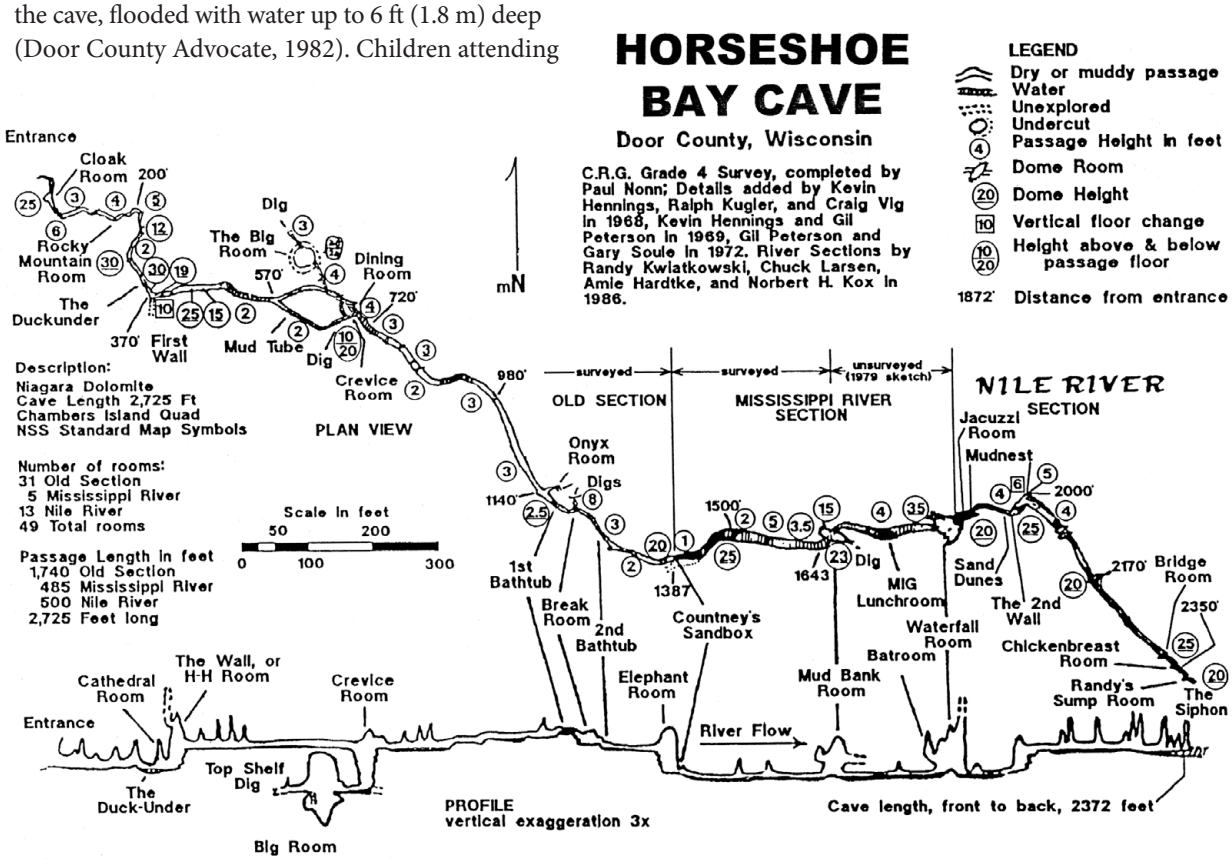

Figure 7. *Horseshoe Bay Cave map. Source: Wisconsin Speleological Society.*

school on the other side of the valley were rowed across the pond. One day a sinkhole opened up, taking water in, and a few hours later water was observed flowing out of Horseshoe Bay Cave. The whole valley drained during the day, according to witnesses at the time (G.K. Soule, personal communication). This is an unusual event, but during many years, snowmelt water flows through Plum Bottom and disappears into the ground in a farm field with no visible sinkhole. Whether that water flows directly to Horseshoe Bay Cave or to other discharge points along the escarpment to the west has not been documented. Many other small sinkholes are known in the area.

The entrance portion of Horseshoe Bay Cave has been obtained by Door County as a part of a larger county parks expansion project. Use of the cave for educational visits by school groups and the public is included as a desired function of a cave management plan. Much of the rest of the cave, not under county ownership, extends under an adjacent golf course. The cave entrance now has a bat-friendly gate, and access policies are being formulated with the Door County Parks Department.

THE IMPORTANCE OF CAVES AND KARST

Caves and karst play an extremely important role in the quality of the region's groundwater. In northeastern Wisconsin, the majority of the population gets their drinking water from wells. Many people think that the earth filters their well water adequately and they don't have to worry about its safety; however, the many fractures and joints in the bedrock and occasional cave passages allow water to travel into the water table rapidly without the filtering of harmful bacteria and chemicals that would naturally occur as water percolates slowly through soil, sand, and organic matter.

A testing project by the Wisconsin Geological and Natural History Survey in northern Door County from 1986 to 1990 (Bradbury and Muldoon, 1992) had some interesting results. A series of test wells were drilled in a pattern and tested for many parameters. A camera lowered into one bore hole showed fractures and areas that had been dissolved at different levels. At about 150 ft (45 m) below the surface, the rock had a dissolved or "Swiss cheese" appearance rather than discrete fractures. In drilling the wells, voids or holes were encountered and drilling fluids were lost at several levels. In one case, water was "forcefully rejected" at a well drilled 200 ft (60 m) away, showing a very open underground connection.

A test which introduced a tracer element at one test well and measured its arrival at a neighboring test well showed a groundwater flow rate of 55 ft (16.8 m) per day, which certainly allows little chance for filtering of contaminants. In September of 1987, contamination occurred that suggested an even faster flow rate: construction at a farm about a half mile from the test site caused farm wastes and blasting residue to flush into an exposed fracture system, and high nitrate levels were measured in a down-gradient test well the next time samples were obtained. There were 2 weeks between tests, so the precise flow rate cannot be determined, but it was at least 210 ft (64 m) per day. To a different test well farther away, the flow rate was at least 380 ft (116 m) per day. There are no previously known cave passages in this area, only the intersecting network of vertical and horizontal fractures revealed by the research of Bradbury and Muldoon (1992).

"A test…showed a groundwater flow rate of 55 ft (16.8 m) per day, which certainly allows little chance for filtering of contaminants."

The author's personal experience also highlights this rapid flow of groundwater pollution. Several years ago manure was spread on a snow-covered farm field about ⅛ mi (200 m) from our well in the Plum Bottom area of Door County. Shortly after the snow rapidly melted, our tap water turned brown and tested positive for coliform bacteria for months afterward. The well had been recently drilled over 300 ft (91 m) deep and was properly cased, but was polluted anyway. Neighbors reported that their well water regularly turned brown in spring and they were in the habit of using bottled water during that time. About a year later a small sinkhole opened up at the low end of the farm field and a narrow crack was open at least 20 ft (6 m) deep. This may have been the source of well pollution. Later that summer the sinkhole was filled in again with soil.

CONCLUSION

Caves and their associated features are interesting and important features of the landscape on the Niagara Escarpment. Caves at Ledge View Nature Center near Chilton and Cherney Maribel Caves County Park have interpretive tours for the public and school groups. Caves provide habitat for animals large and small, from raccoons and bats to microscopic organisms. Caves, sinkholes, and underground water drainage are important to drinking water safety and public health.

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Note: For more information on the caves mentioned, visit the following websites:

Wisconsin Speleological Society (wisconsincaves.org),

Ledge View Nature Center (ledgeviewnaturecenter.org),

and Maribel Caves (maribelcaves.com).

Caves are a delicate and potentially dangerous environment and it is not recommended to visit them without trained leadership.