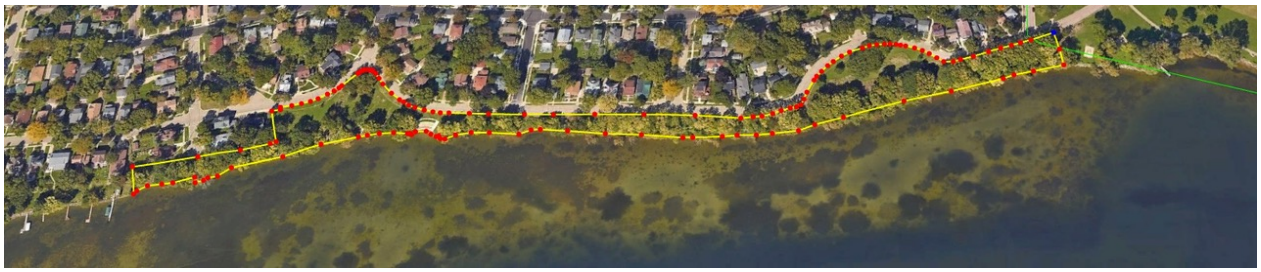
Soil Phosphorus Eutrophies Lake Monona. Soil comes from Hudson Park Steep Slopes and the North Shore of Lake Monona, Dane County

Prepared by Matthew Miller, PhD, Soil Scientist (608)-245-3995, sandpiper@edaphos.com

for Dane County Lakes & Watershed Commission
and Dane County Land & Water Resources Department, August 5, 2019



I want to bring to your attention the Hudson Park shoreline and the park's steep slopes. The shoreline has been eroding away for many years, and aside from the improvement of Hudson Beach, much of the shore is being undermined by wave action when the lake levels are normal and high. There is about 2400 feet of Lake Monona shoreline in Hudson Park.

Trees close to the shore are at continual risk of collapsing into Lake Monona if the shoreline is not repaired (for visual, see Photos 3, 4, 6, 7, 14 and 17). It would be appropriate to have Dane County shoreline people examine the shoreline when leaves are off the trees, to ascertain the severity and amount of eroded shoreline, and also determine those areas in greatest need of repair before developing a repair plan. Controlling shoreline erosion would help keep soil phosphorus and other nutrients from entering the lake (Photo 18).

Slopes, Sheet Erosion

There are approximately 1,500 linear feet of steep slopes along the Hudson Park shore. Many slopes are about 50% slope (assumed average), and slope lengths average 50 feet (Photos 8 and 11). A crude estimate for the amount of soil loss per year can be made using the USLE erosion index.

> Note that the USLE model was developed for estimating erosion caused by farming practices and was developed for uniform fields and slopes longer and less steep than exhibited at Hudson Park.

These numbers are important because they demonstrate the impact that bare soil can have on lake water quality (Photo 2). [The USLE erosion index (E.I.) estimates the predicted soil loss as if no vegetation was present]. This equation only deals with sheet erosion and not gully erosion. The equation provides a rough estimate for illustrative purposes only. For those of you mathematically inclined:

> USLE E.I. = LS x K x R where LS is slope length and steepness factor (15.5), K is the erodibility of the soil (0.43), and R is the rainfall factor (150).
>
> The USLE erosion index (LS K R) for a 50 % slope, and an area of one acre land surface (50 feet width by 870 feet along the shore) could approach an estimated 1,000 tons per acre per year (2,000,000 pounds of soil per acre per year).

Existing trees, shrubs, forbs, sedges and grasses decrease the amount of erosion. Planting additional grasses and sedges on existing bare soils (Photo 1) could greatly reduce the input of phosphorus-rich topsoil into Lake Monona. Fortunately the soil surface is not all bare (Photo 16), sedges make an excellent groundcover!

I have taken a representative sample of soil near Lakeland and Elmside Avenues. It contained 788 ppm of total phosphorus (nitric acid digest – analysis by ICP) in the soil sample.

> The soil sample also contained the following nutrients (2.88% organic matter by combustion, 0.23% total nitrogen; 2492 ppm potassium, 10619 ppm calcium, 8008 ppm magnesium, 264 ppm sulfur). The soil is 23% sand, 54% silt, and 23% clay.

In this case, every 1,000,000 pounds of soil contains 788 pounds of soil phosphorus. Thus, in our simplified example, every acre (2,000,000 pounds [one ton]) of eroded topsoil along the steep slopes could add 1576 pounds of soil to Lake Monona. If we can stop soil from getting into the lake, the lake will definitely clean up faster. It takes all the soil nutrients to feed algal and cyanobacterial blooms. We can vegetate the bare soil on the slopes under the shrubs where the soil is not presently fully vegetated (Photo 15). Costs should be minimal compared with industrialized methods of removing soil phosphorus. Better to keep the soil out of the lake than trying to clean it up after it is in.

Recent trimming along Lakeland Ave (East) removed many invasive species next to the road (Photo 15). City Parks came through and marked the trees and shrubs to cut and applied some herbicide to the stumps to prevent future sprouting. Neighbors cut the marked vegetation and hauled it to a place where it could be processed by the chipper or hauled to Olin Ave mulching site by the City.

By thinning the understory, we can create a more favorable micro-environment for the establishment of ground cover. This means selectively removing invasive understory brush such as chokecherry, honeysuckle and some of the hackberry saplings. This will allow extra light down to the soil surface for the shade tolerant grasses and the sedges to gain a foothold. Mulching over the seed with the appropriate materials will ensure a good seed set. Train High School students and others to achieve these tasks.

Accurately calculating the estimated erosion index for Hudson Park, and the amount of nutrients from sheet erosion, requires much more person-power, time, and equipment than I have as a citizen. The soil erosion people in Dane County government and the University can provide better estimates.

Even after the leaves are on the trees there is a significant amount of bare soil under the shrubs exposed to the erosive summer rains. When there are no leaves (November to April) and the bare soil on the slopes (Photos 11 and 12) is subjected to extremely large precipitation events, a large amount of soil is washed down the slopes as sheet erosion into Lake Monona.

During the leaf-off season, it is possible to see many of the effects of sheet erosion on the slopes: soil piled on the uphill side of a tree, soil removed on the downhill side of the tree, stone pillars, many bare roots (Photos 6, 11 and 12), and at places stranded tree stumps where feet of soil have been eroded underneath the stump, leaving the stump hanging in the air. Tree roots grow in soil, not in air. Exposed roots and stumps are evidence of severe soil erosion. Visit after a light snowfall.

Slope elements, gully erosion

One need only walk along the upper slope of the steep slopes along Hudson Park (Lakeland Avenue) to see that there are many gullies between the road and the shore. People wanting access to Lake Monona have formed many of the gullies over time. Tours can be arranged.

Right now (July 30, 2019) there is too much vegetation to look through to see the erosion clearly. I estimate over the whole shore length, there are more than 10 long steep gullies (Photo 13) and more than 10 short steep gullies (Photo 14) that undergo soil erosion year round and do not have ground cover. Stairs should replace several long steep gullies to provide access to lake and discourage the use of other gullies for public access.

Expert scientists with accurate equipment could measure the amount of soil that has been eroded from the gullies historically and is now in the lake up to this point in time. Only with appropriate background benchmarks would they be able to give you an estimate of gully erosion on a monthly or yearly basis going forward.

By getting more accurate estimates for the rate of shoreline erosion and the rate of soil loss from slopes for the different areas within Hudson Park, we can begin to examine where on the landscape to employ those methods of re-vegetation will most likely lead to a greater decrease in the amount of eroded soil and nutrients entering Lake Monona from Hudson Park.

Soil Test Results -- Hudson Park

Soil and Plant Analysis Lab
Univ. of Wisconsin-Madison
8452 Mineral Point Rd
Verona, WI 53593-8696

Phone (608)262-4364
Fax (608)833-1277
http://uwlab.soils.wisc.edu/

Lab No. 5055 Acct. ID Client- Matthew Miller

Re: 1 soil sample submitted March 9, 2004 (Park 2 and 3 combined)
Results emailed and mailed: March 25, 2004

Results reported on a 'dry weight' basis. Unit: 1,000 ppb = ppm = mg/kg = mg/liter. 1% = 10,000 ppm.
The UW Soil and Plant Analysis Lab QA/QC protocol includes verifying results primarily based on instrument performance, duplicate analysis and elemental recovery based on reference materials.
Please contact the lab for details or additional requests.

Nitric Acid Digest then ICP

Sample ID	P	K	Ca	Mg	S	Zn	B	Mn	Fe	Cu
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
1	788	2492	10619	8008	264	65.7	10.0	724	18976	7.37

C By Combustion — N by ?

Sample ID	Solids	Total N	Total C
	%	%	%
1	75.3	0.23	2.88

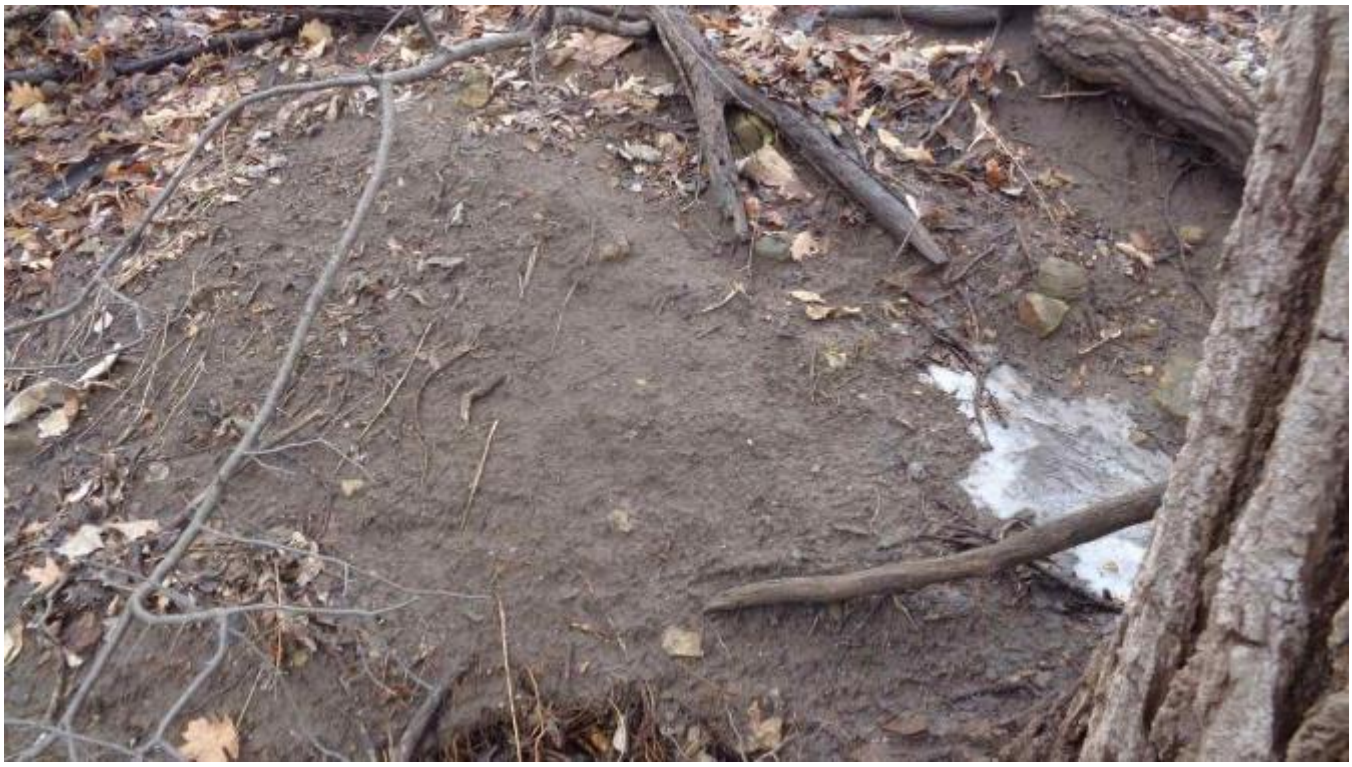
Hydrometer

Sample ID	Sand	Silt	Clay
	%	%	%
1	23	54	23

Photos of Shoreline and Steep Slopes of Hudson Park

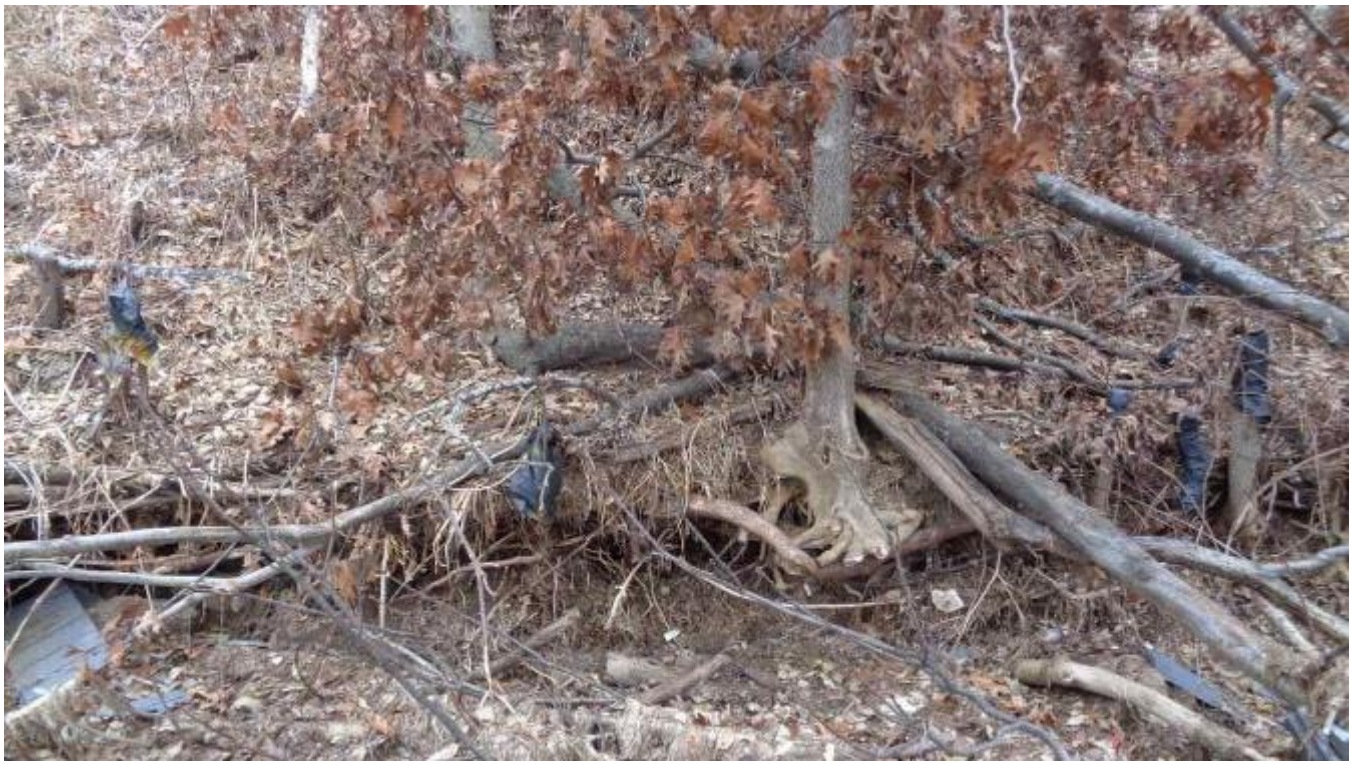
August 4, 2019 - Matthew Miller sandpiper@edaphos.com

We have a "bare soil" problem on the steep slopes in Hudson Park. We need a "no bare soil" policy for steep land next to our lakes.

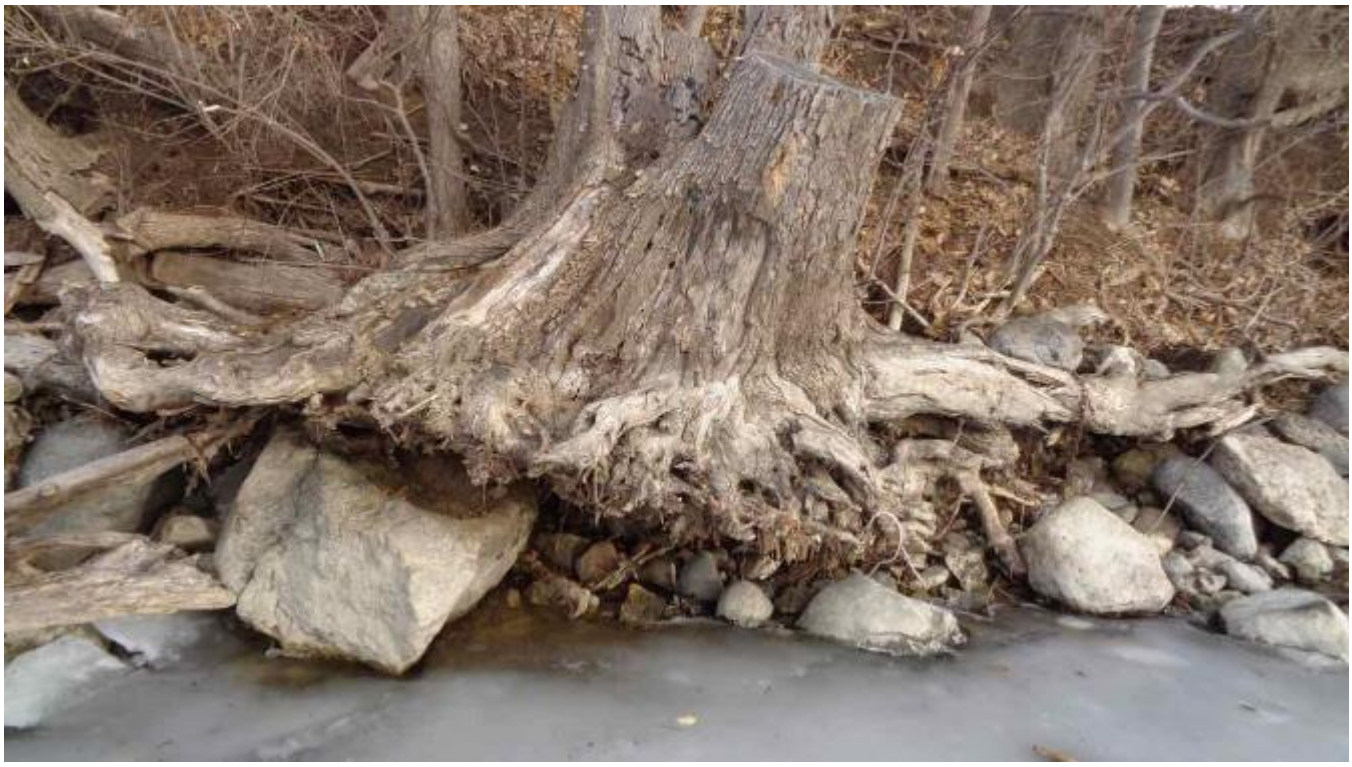


1. Along with the fall and spring lake turnover, bare soil and shoreline erosion contribute nutrients to cyanobacteria / blue-green algal blooms, this one from October 2018 at Hudson Beach.

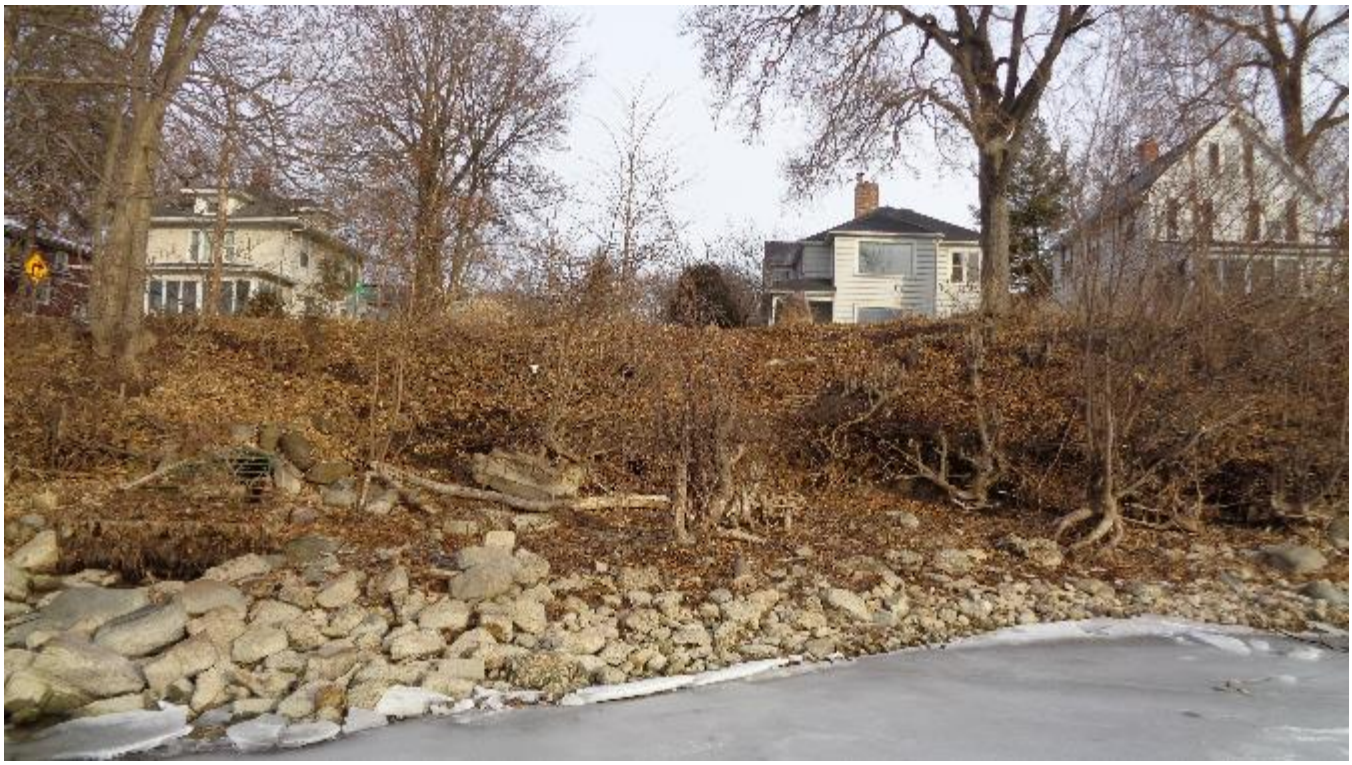
2. Normal and high lake levels undercut the shore.



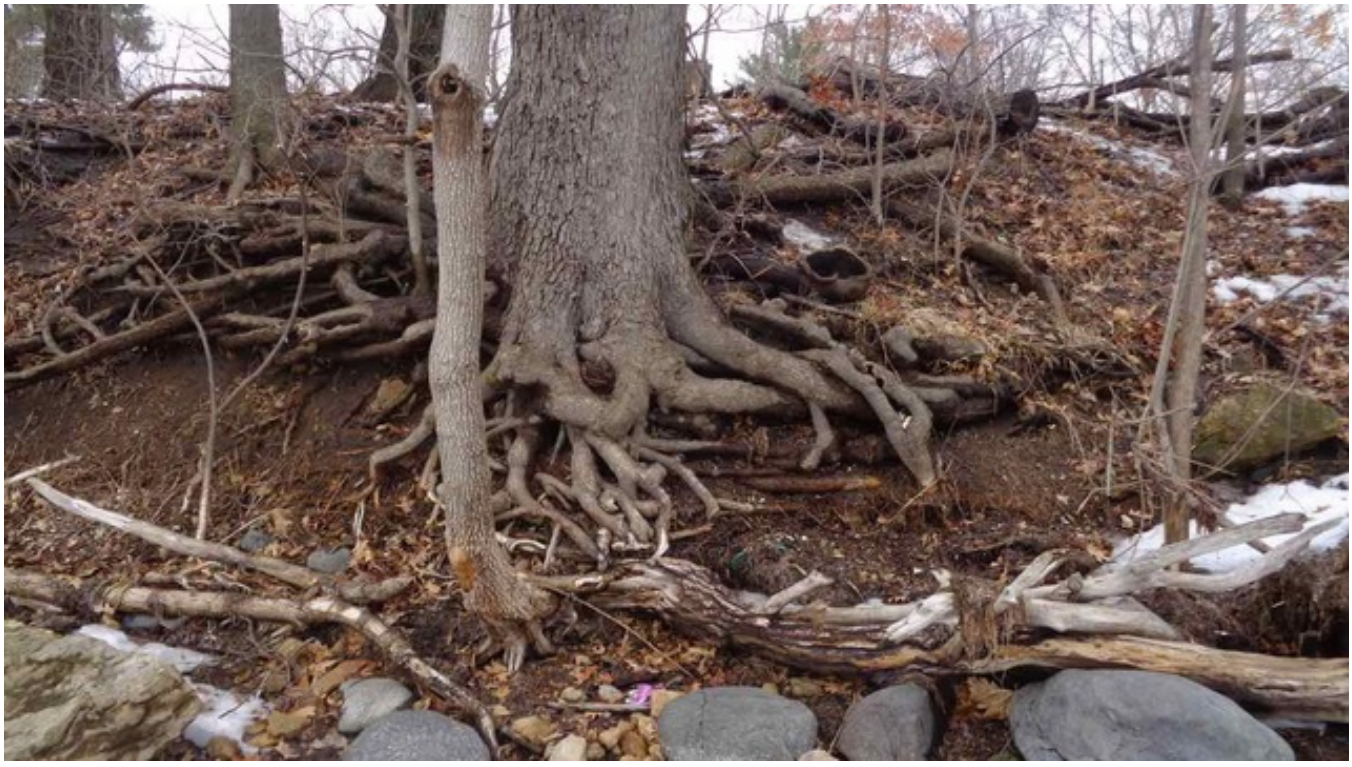
3. Undercutting the shore can lead to significant tree loss.



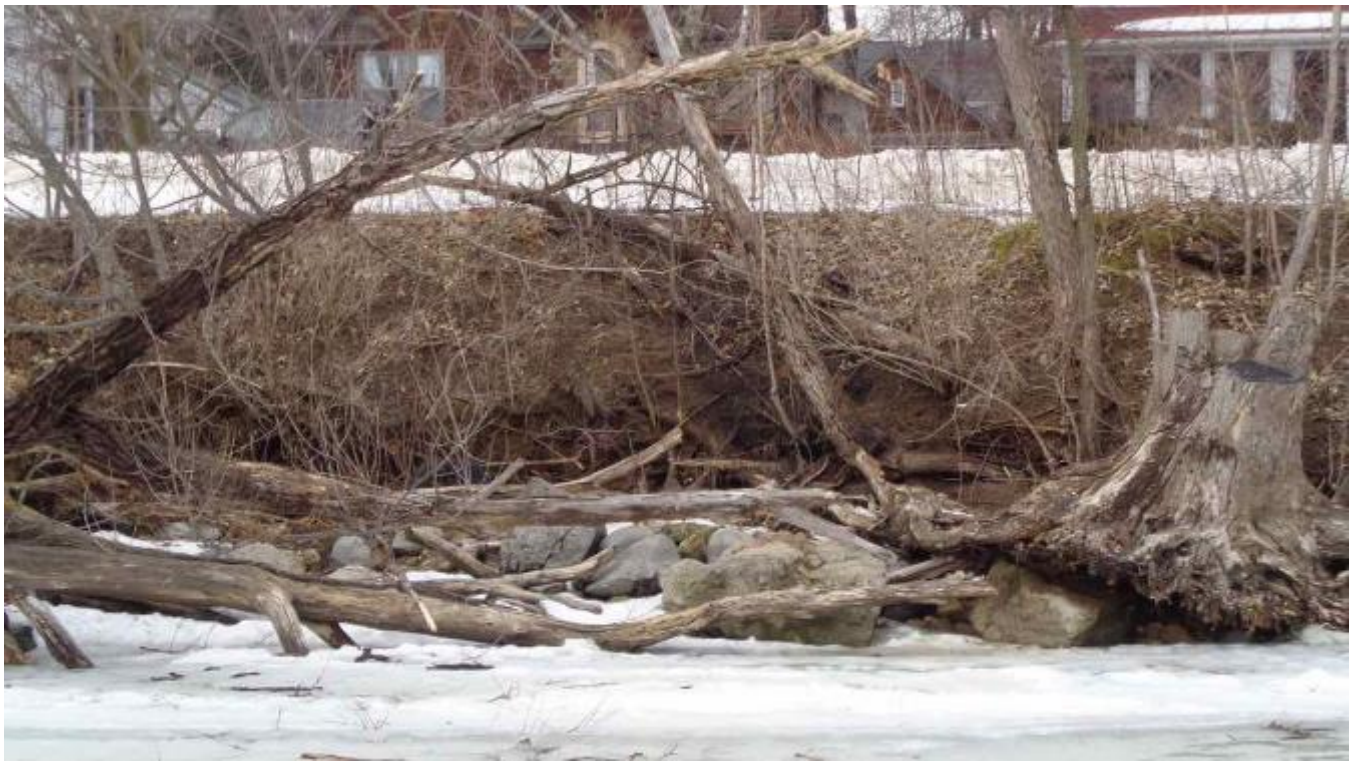
4. Shoreline at Miller and Lakeland used to be more than five feet further into the lake in the 1980s'.



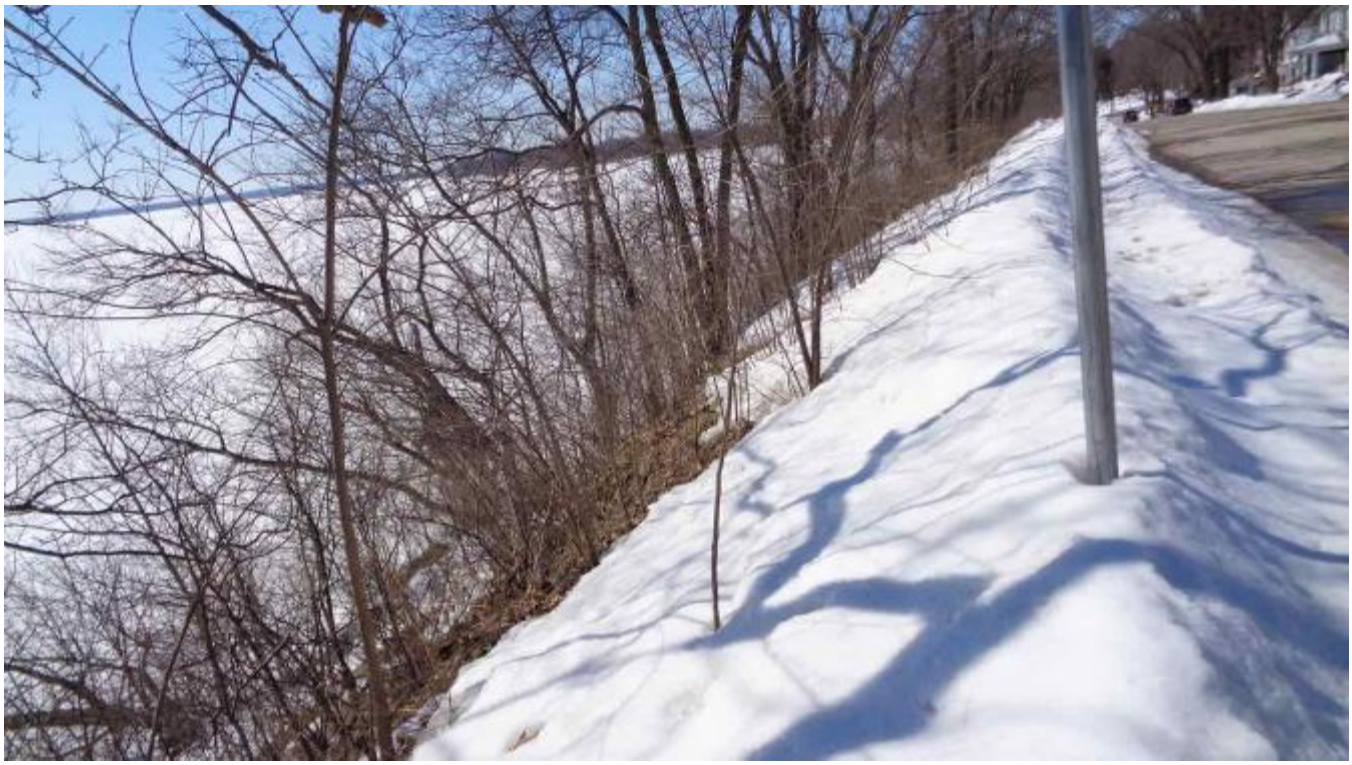
5. For some trees, it is just a matter of time before they too succumb to gravity. When the tree falls the slope will follow.



6. Example of slope collapse after trees were undercut. East of Hudson Beach.

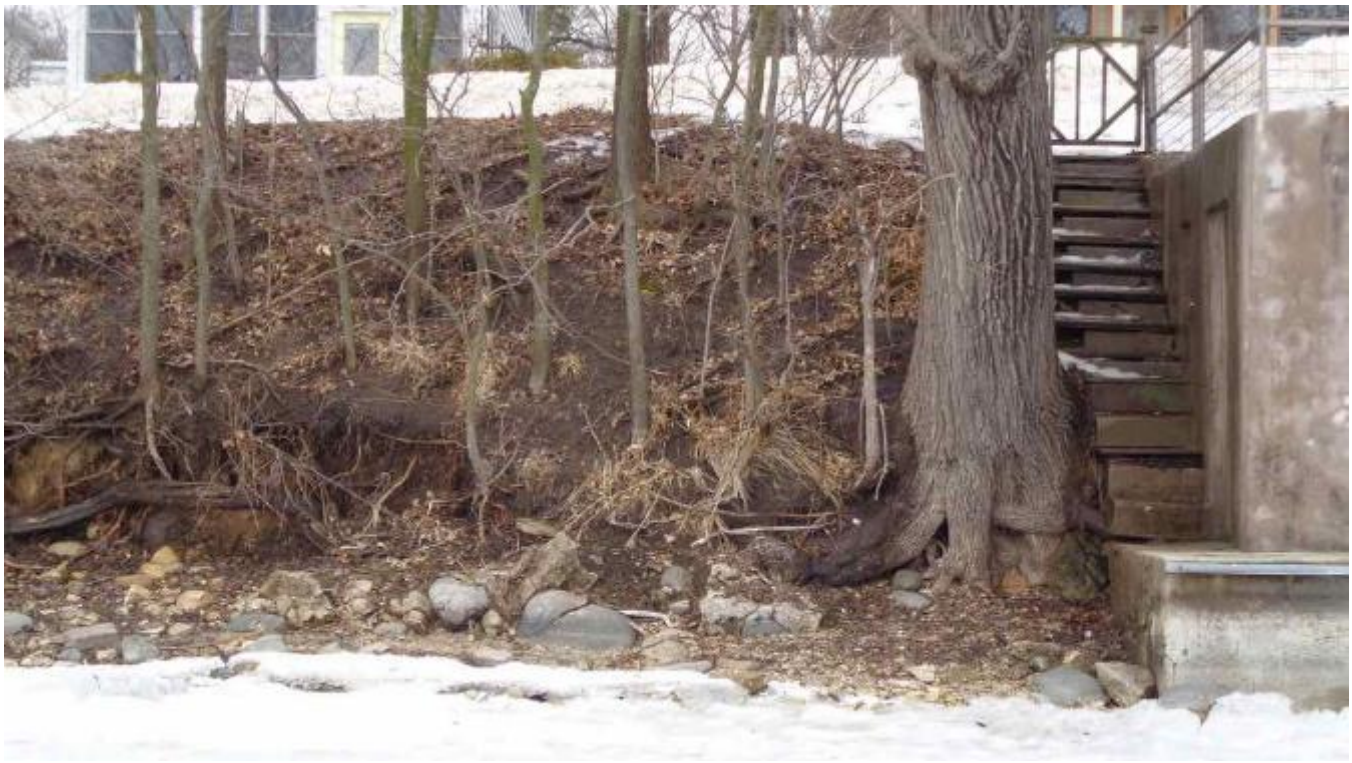


7. Steep slopes are easiest to see in winter. Slopes here exceed 50% (23 degrees).

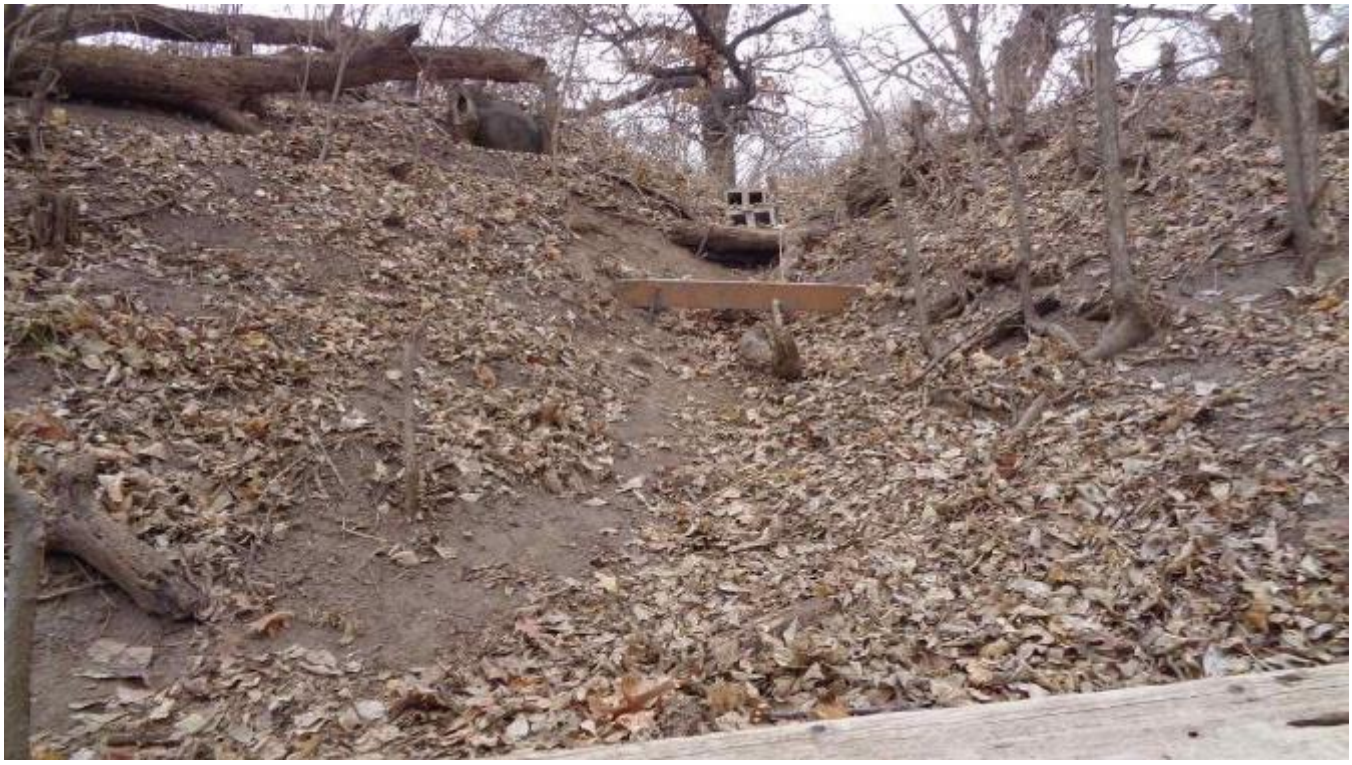


11. An example of a long steep slope. There are several characteristics of the steep slopes that can be seen when leaves are off the trees. See bare patch of soil in lower left. Note the extensive bare root system of Hackberry trees in upper left. Since roots of Hackberry will not grow in air, the roots must have grown in soil that is now in the lake.

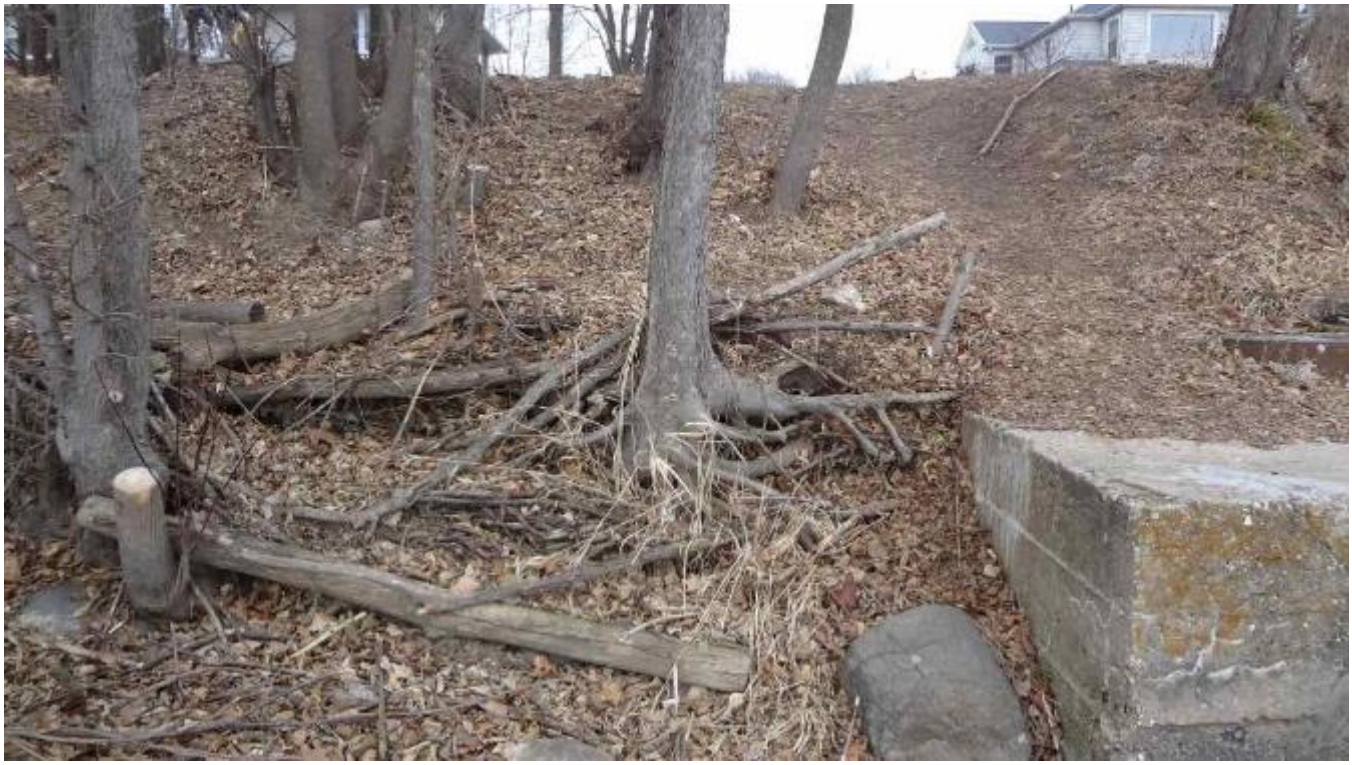
12. An example of a short steep slope, undercut shore, and bare soil exposed during winter. Solar radiation is much more intense on the south-facing steep slopes than on level ground and this extra heat input leads to rapid snowmelt after most snows. This subjects the soil to more wetting and drying cycles that can speed along the erosive forces caused by gravity.



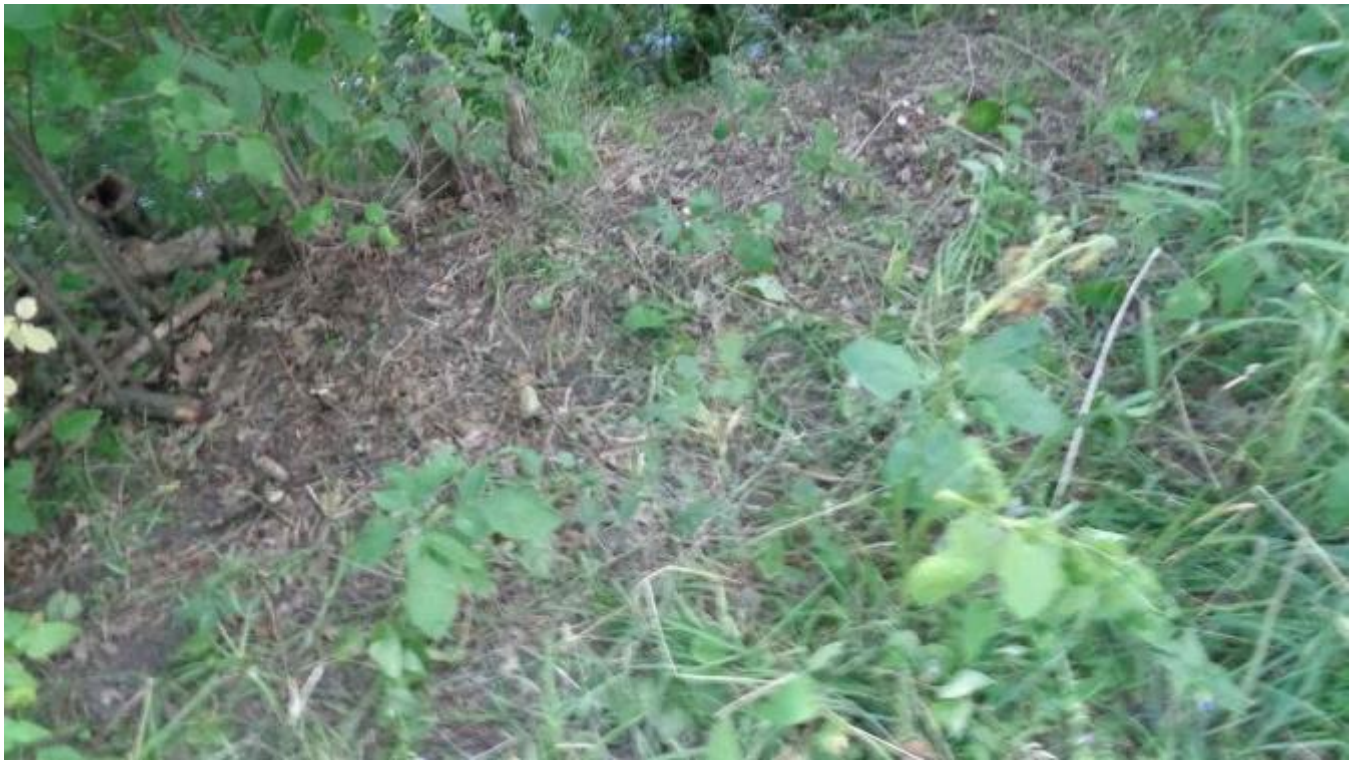
13. An example of a long steep gully used to gain access to the shore (Maple Ave). It would be instructive to calculate the volume of soil that has been lost from the gully and ended up in the lake.



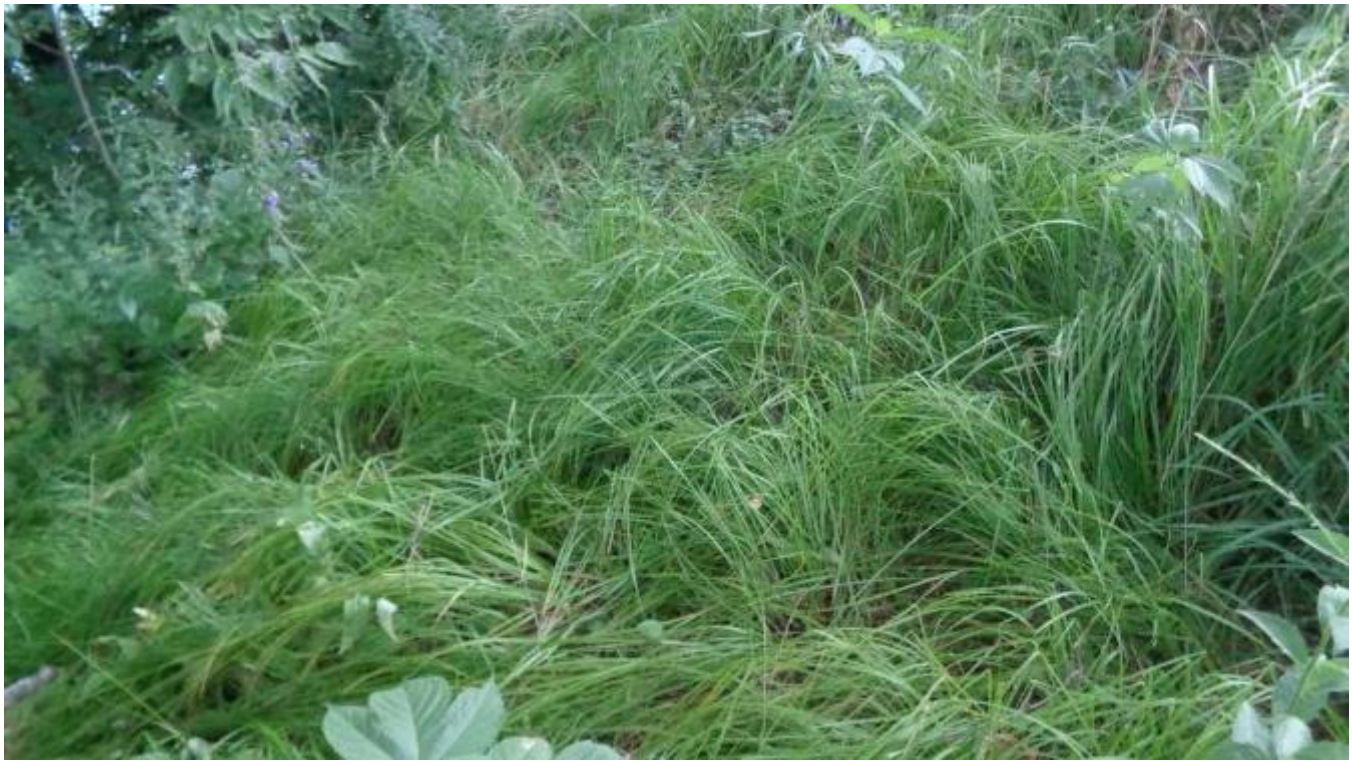
14. An example of a short steep gully; the undercut trees are along the shore at Lakeland and Miller.



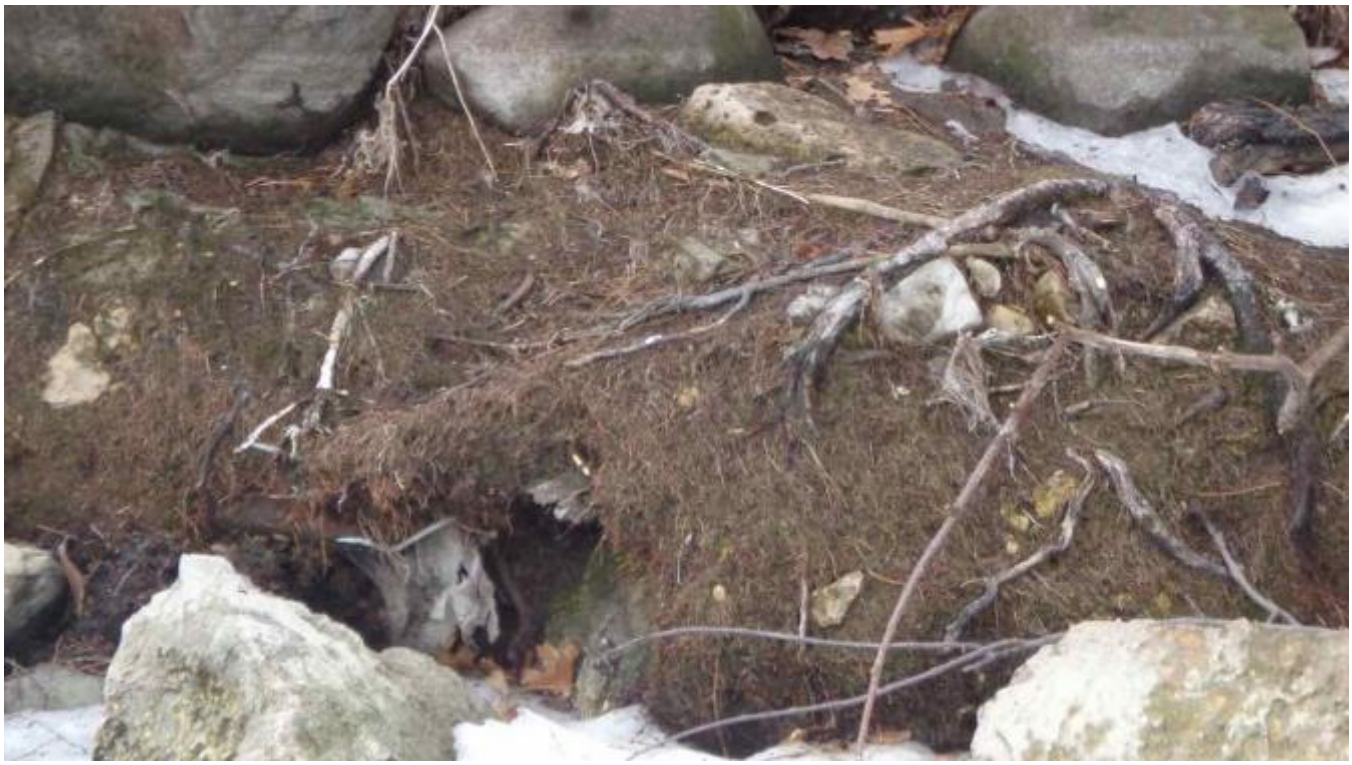
15. When pruning activities occur there is a resulting area of bare soil that is quite susceptible to erosion until the vegetation becomes established. Seeding and mulching cover crops on bare soil will control erosion.



16. Sedges provide an excellent ground cover. Some shade tolerant grasses in the mix would help. When thinning of the invasive shrubs occurs, sedge seeds and mulch could be laid on the resulting bare soil.



17. Willow roots provide some shoreline protection until the trees die and are not replaced.



18. So, let us keep the shore and slopes in good shape and keep the soil out of the water.