Analysis of Soils in Rural Southeast Michigan

Group 6: Bela Bivens, Riley Demond, Rachel Emmons

Introducing the Soil Samples:

Sample #1:

- Bela's sample
- Rural
- Holly Recreation Area
- On a walking trail
- Tan-orange color
- Clay-like texture

Introducing the Soil Samples:

Sample #2:

- Riley's sample
- Rural
- Holly Recreation Area
- ~10 feet from Wildwood Lake
- Very dark in color
- Clay-like texture

Introducing the Soil Samples:

Sample #3:

- Rachel's sample
- Rural home near Attica, MI
- Wooded area
- Thick, woody roots in sample
- Greyish-brown in color
- Silty-sand texture

Initial Hypotheses

Sample 1

- Tan-orange, sourced on walking trail, clumps together

Possible Hypothesis:
The texture might suggest some moisture or silt/clay content, but with less moisture than Sample 2. The orange color is indicative of iron oxides or the presence of sand/silt, which would provide good drainage/aeration to the soil.

Sample 2

- Dark in color, damp, sourced near lake, lots of roots/organic matter visible

Possible Hypothesis:
The dampness and dark color of this sample likely suggests a high water content. This is supported by the fact that the sample was sourced near a lake. The moisture content, along with the dark coloration, might point to a high organic/humic content.

Sample 3

- Greyish/brown in color, sourced in wooded area

Possible Hypothesis:
The grey/brown color suggests less organic matter present in the sample compared to Sample 2, but since this soil supports woodland vegetation, it will likely have a high mineral/nutrient content.

pH and Water Content

Table 8. Soil pH ranges.

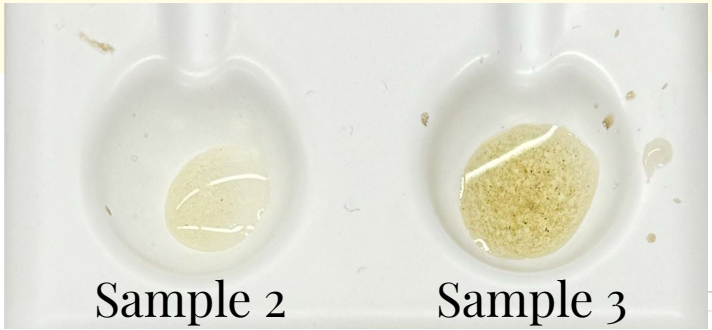
	pH	
Strongly acidic	<5.1	#3
Moderately acidic	5.2–6.0	
Slightly acidic	6.1–6.5	#1
Neutral	6.6–7.3	
Moderately alkaline	7.4–8.4	#2
Strongly alkaline	>8.5	

MSU Soil Test Interpretation: soil_test_interpretation.pdf (msu.edu)

Sample Number	pH	Mass Water Content (g)	% Water Content (water mass / dry soil mass)
#1	6.36	0.99 g	23.7%
#2	7.42	1.49 g	34.4%
#3	4.73	0.83 g	18.8%

Ammonia Nitrogen

Sample 1

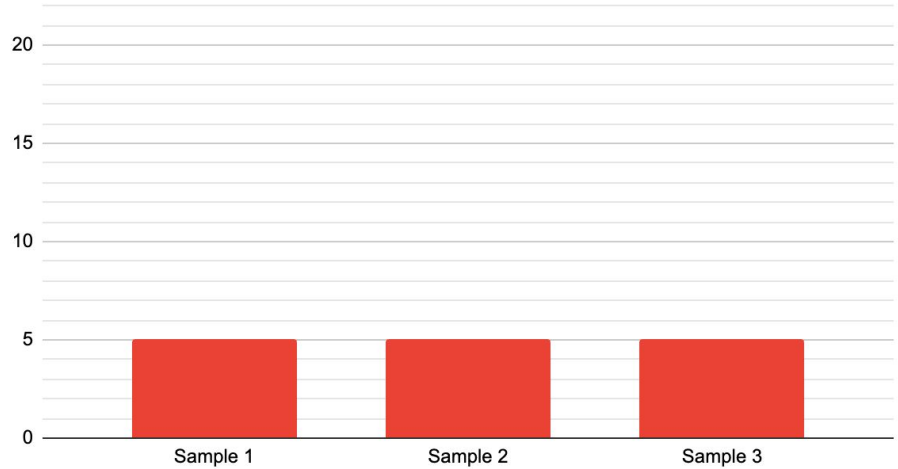


Sample 2 Sample 3

Sample 1 - very low (~5ppm)

Sample 2 - very low (~5ppm)

Sample 3 - very low (~5ppm)



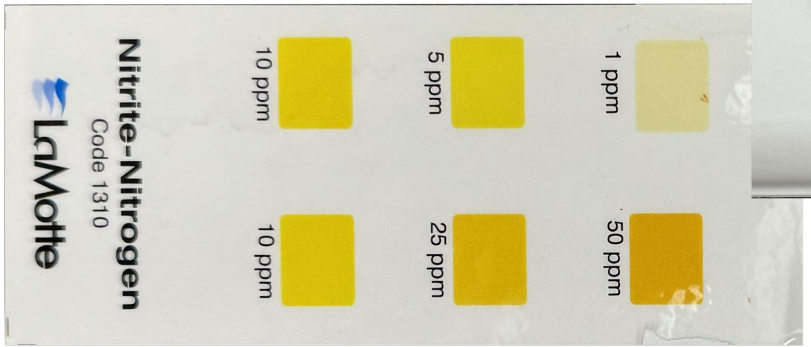
Nitrite Nitrogen

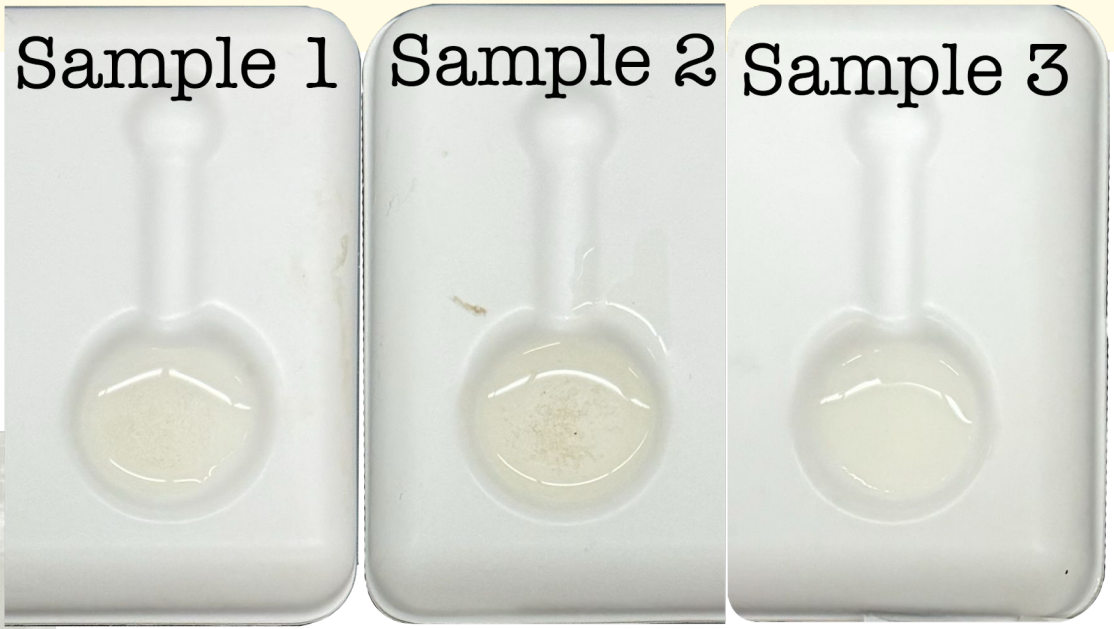
Sample 1 <1ppm

Sample 2 <1ppm

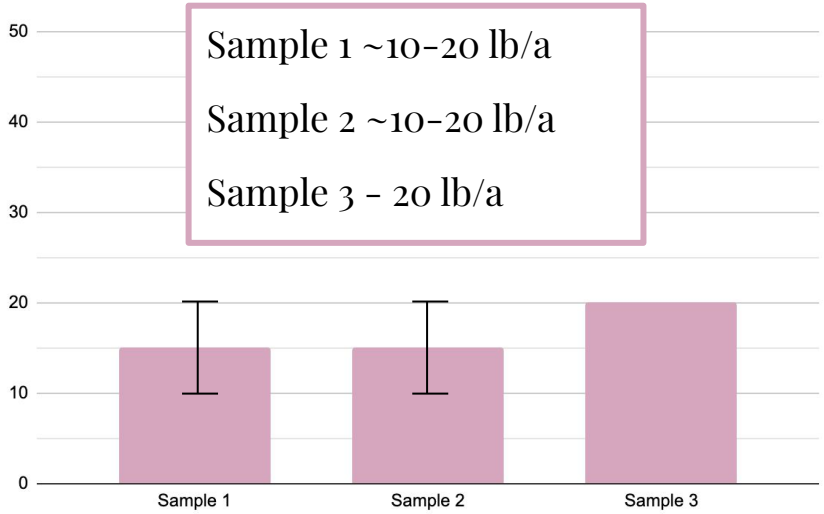
Sample 3 <1ppm

Similar results for all samples





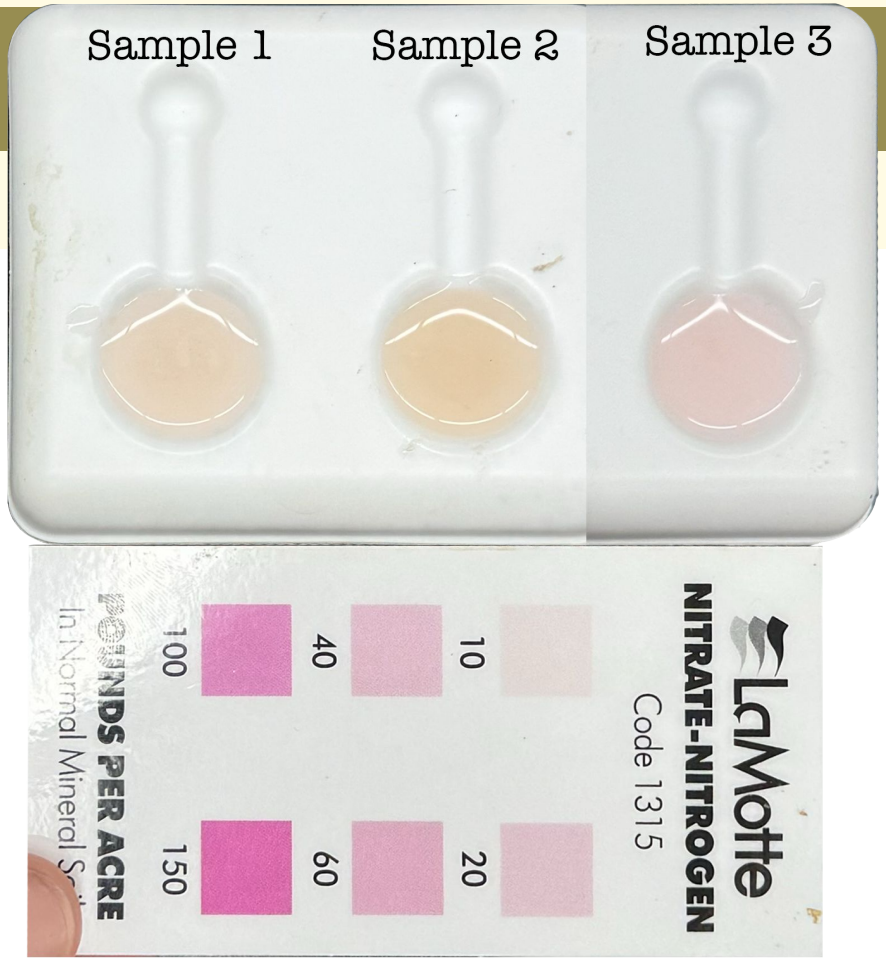
Nitrate Nitrogen



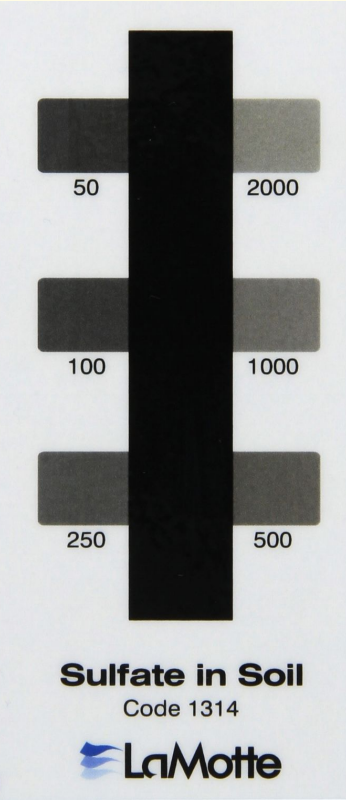
Sample 1 ~10-20 lb/a

Sample 2 ~10-20 lb/a

Sample 3 - 20 lb/a



Sulfate



Sample 1

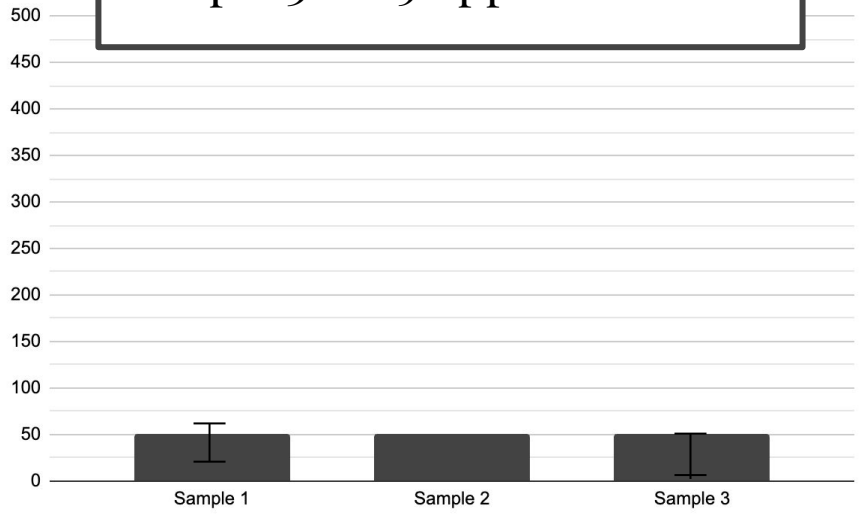
Sample 2

Sample 3

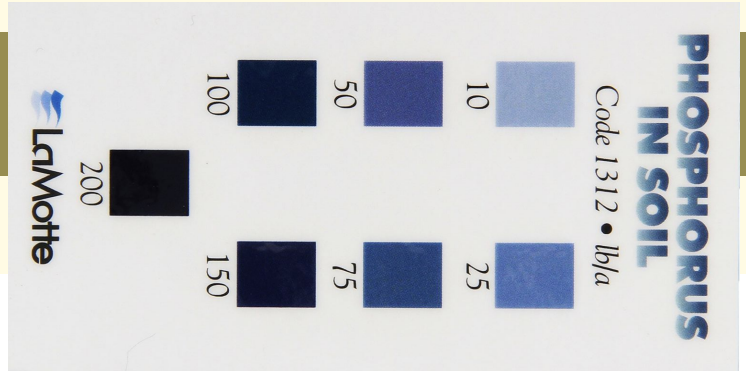
Sample 1 - ~50 ppm

Sample 2 - 50 ppm

Sample 3 - < 50 ppm



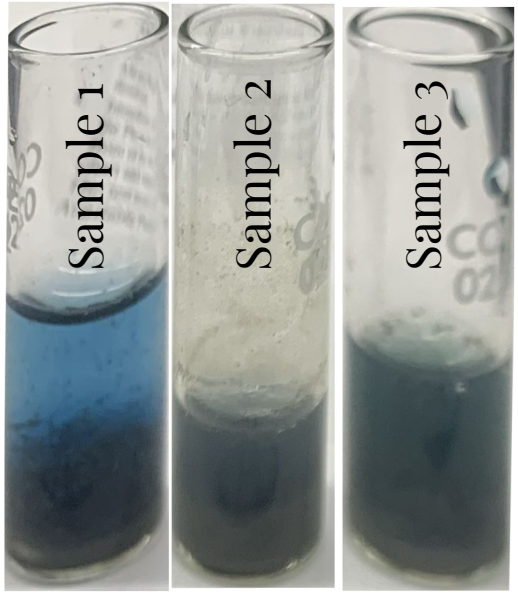
Phosphorus

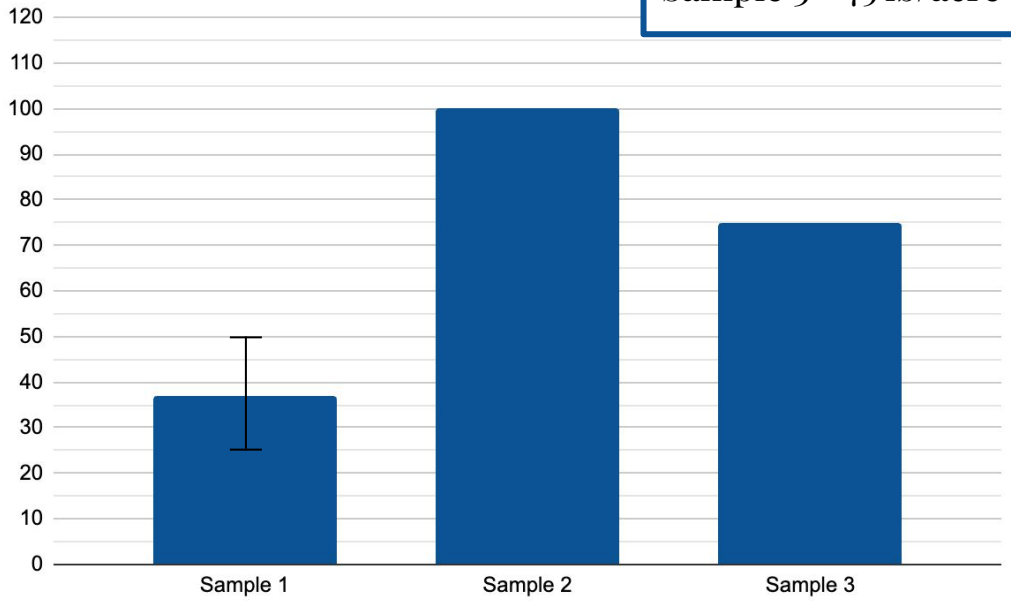


Sample 1 - 25-50 lb/acre

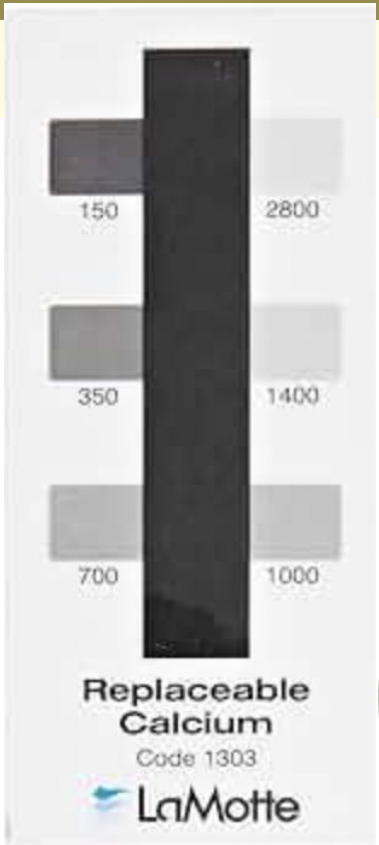
Sample 2 - 100 lb/acre

Sample 3 - 75 lb/acre





Calcium



Sample 1

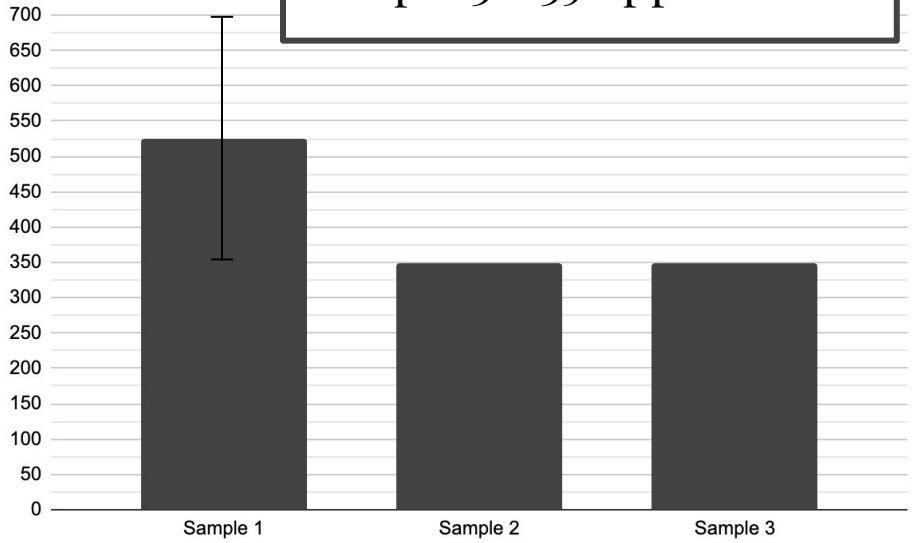
Sample 2

Sample 3

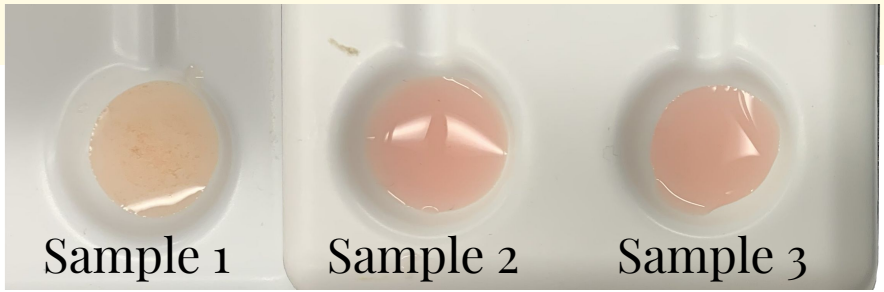
Sample 1 - 350-700 ppm

Sample 2 - 350 ppm

Sample 3 - 350 ppm



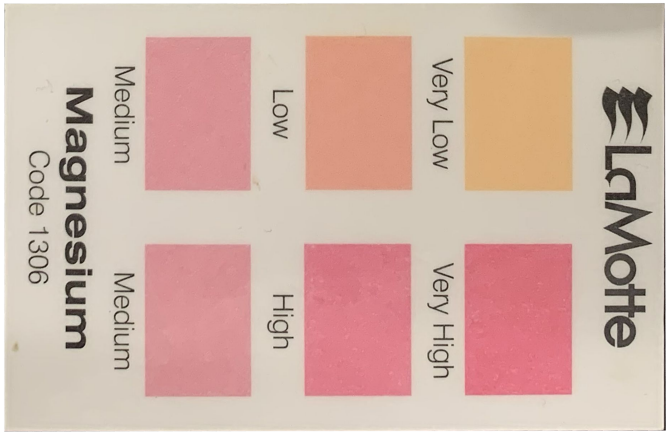
Magnesium

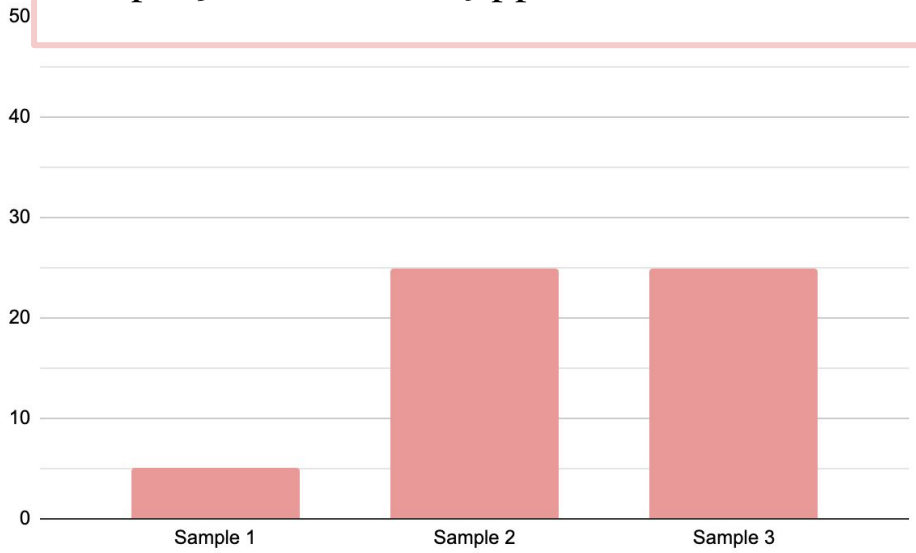


Sample 1 - very low ~5 ppm

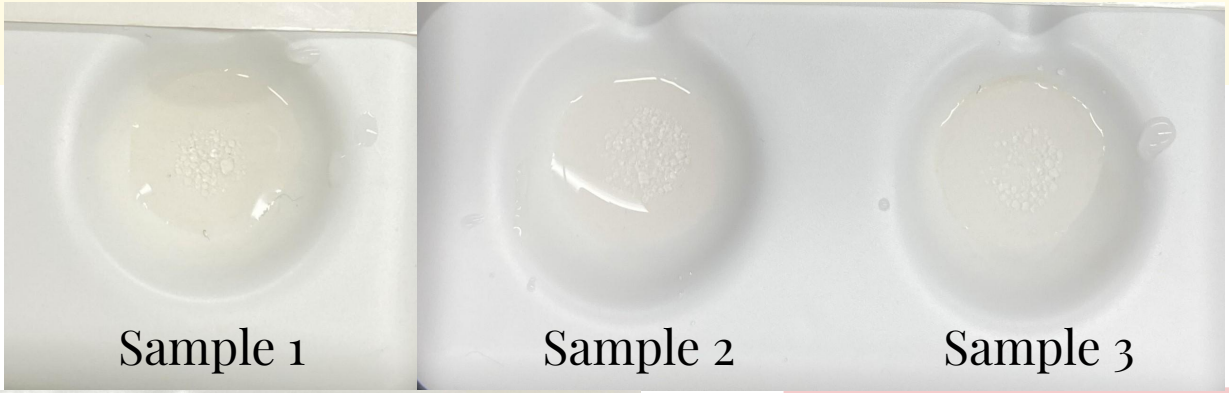
Sample 2 - medium (darker than 3) ~25ppm

Sample 3 - medium ~25 ppm





Ferric Iron



Sample 1 - Undetected/no color change

Sample 2 - Low: 5 lb/acre

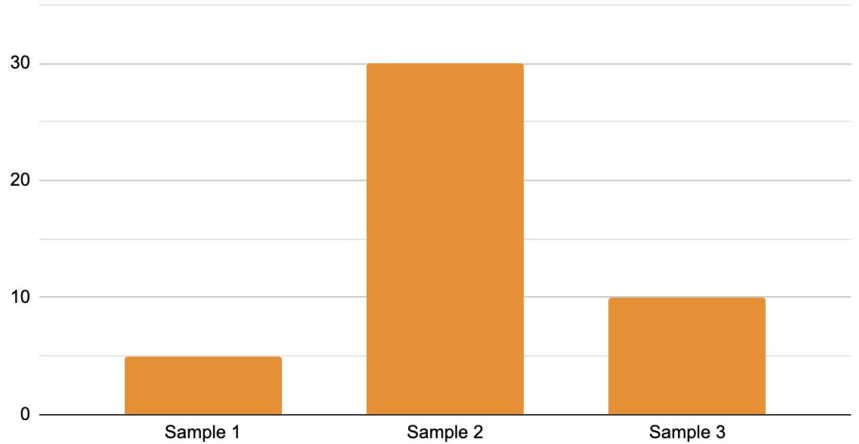
Sample 3 - Low: 5 lb/acre

Aluminum

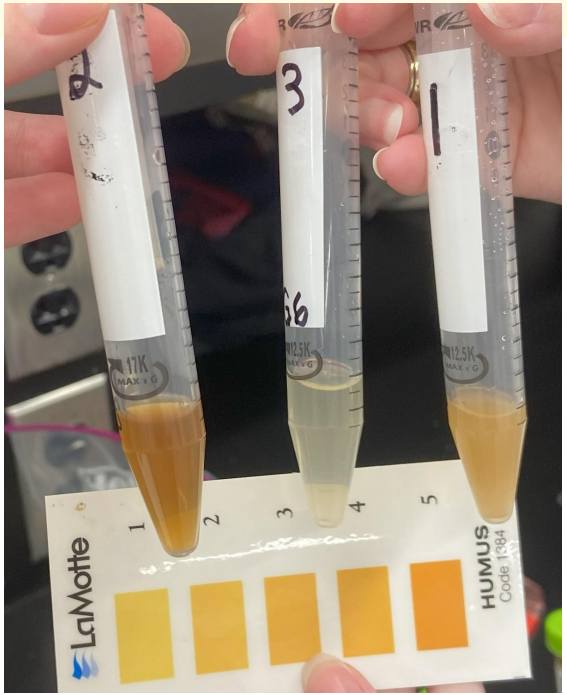
Sample 1 - Very low (~5 ppm)

Sample 2 - Medium (~30 ppm)

Sample 3 - Low (~10 ppm)



Humus



Sample 1 : 3 - All

Sample 2 : 5 - High

Sample 3 : <1 - Low

Humus or Organic Matter in Soil

Humus Reading	1 #3	2	3 #1	4	5 #2
Agricultural Soils	Low	Medium	High		
Garden Greenhouse Soils		Low	Medium	High	
Organic Soils			Low	Medium	High

Provided Soil Manual: Combination Soil Outfit

Overall Results:

Results from “Parts per Million” Samples:

Sample Number	Nitrite Nitrogen	Calcium	Sulfate
Average for Soils in Michigan	10-50 ppm	400-500 ppm	~50 ppm
1	<1 ppm	350-700 ppm	50 ppm
2	<1 ppm	350 ppm	50 ppm
3	<1 ppm	350 ppm	<50 ppm

Sources for Averages:	MSU Soil Test Interpretation: soil_test_interpretation.pdf (msu.edu)	Understanding the MSU Soil Test Report (E0015) - MSU Extension	Sulfur Fertility of Forage Crops in Michigan (msu.edu)

Overall Results:

Results from “Pounds Per Acre” Samples:

Sample Number	Nitrate Nitrogen	Phosphorus	Ferric Iron
Average for Soils in Michigan	Variable: around 10-20 lbs/acre	~106 lbs/acre (converted from ppm)	44.06-88.12 lbs/acre (converted from g/kg)
1	10-20	25-50	0
2	10-20	100	5
3	20	75	5

Sources for Averages:

MSU Soil Test Interpretation: soil_test_interpretation.pdf (msu.edu)

Nutrient Recommendations for Field Crops in Michigan (E2904) - MSU Extension

Ecological Soil Screening Soil for Iron by EPA: eco-ssl_iron.pdf (epa.gov)

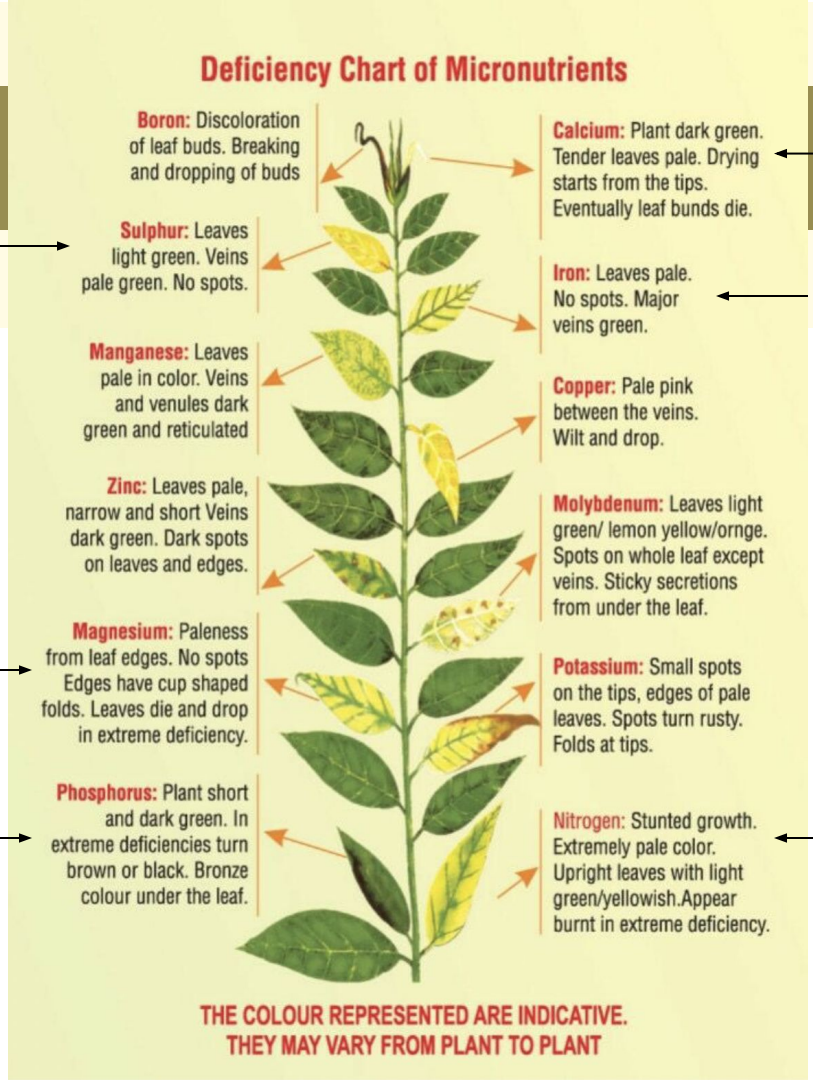
Overall Results:

Results from "Relative Amounts from Very Low to Very High" Samples:

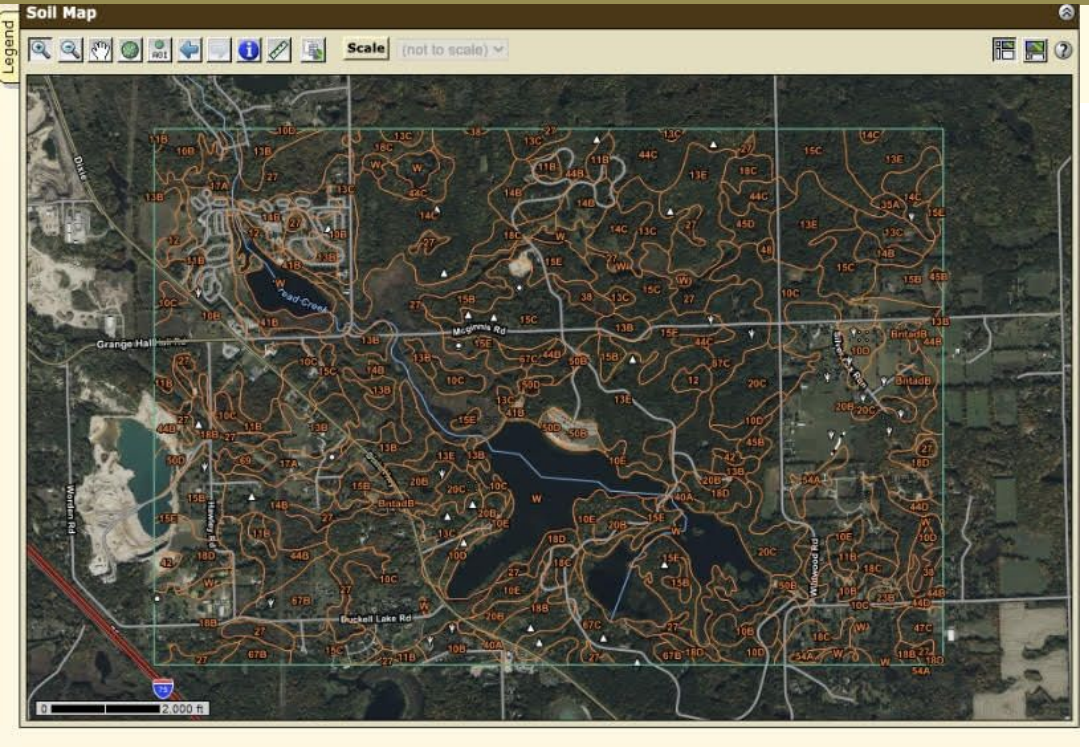
Sample Number	Ammonium Nitrogen	Magnesium	Aluminum
Average for Soils in Michigan	Very Low - Low	Less than 40 or Less than High	Variable: due to factors like precipitation, organic matter decomposition, mineral weathering, and nitrogen fertilizer
1	Very low	Very low	Very low
2	Very low	Medium	Medium
3	Very low	Medium	Low
Sources for Averages:	KBS LTER Datatable - Soil Inorganic Nitrogen (msu.edu)	Understanding the MSU Soil Test Report (E0015) - MSU Extension	Soil pH and aluminum toxicity - MSU Extension

Summary of Results

- Sample #1 had the most nutrient deficiencies out of the three collected samples.
    - Nitrogen, Ferric iron, Magnesium, and Phosphorus were all underrepresented in sample 1
- Sample #2 has the least nutrient deficiencies.
    - Nitrogen, Ferric Iron were the only underrepresented nutrients in sample 2
- Sample #3 was deficient in nitrogen and ferric iron, with little humus content
    - Plants in this soil may have yellowing on new leaves



USDA Web Soil Survey - Samples 1 & 2



HOLLY RECREATION AREA

The Holly Recreation Area, where Samples 1 & 2 were sourced, is a natural reserve that offers a variety of outdoor activities across a wide range of ecosystems, from forests to wetlands and lakes.

From a first glance at the soil map provided (USDA Natural Resources Conservation Services Soil Maps), the area seems to have a diverse range of soil types, each given a unique label. The soil maps outline different types and their abundance, and also the characteristics associated with those soils such as drainage, organic matter content, pH, and the presence of certain minerals.

Sample 1, with its moderate humus content and slightly acidic pH might be akin to soil types indicated on the map that are better drained and have less organic matter. These could be soils found in more elevated or sloped areas within the recreation area which (due to runoff) may have less OM buildup.

Sample 2, with higher water content and humus levels, might relate to soils in lower-lying areas or closer to bodies of water within the recreation area. On the soil map these would be areas with higher organic ratings and potentially finer texture (which can retain more water).

USDA Web Soil Survey

Samples 1 & 2: Organic Matter

This data suggest that Sample 1 may have come from a soil with lower organic matter ratings, such as a Marlette sandy loam or a Brookston and Colwood loam, which are rated at 2.00 for organic matter. This aligns with the moderate humus results from the lab. This idea is further supported by the fact that these soils (loam/sandy loam) are generally well-drained, as the Sample 1 results show a lower water content and possibly lower CEC than Sample 2.

Sample 2, with its higher organic matter content (humus level of 5), may have come from soil types like Capac sandy loam, which have higher organic matter ratings (but are not the highest in the given area data). The proximity to a lake would contribute to a higher water content, consistent with sandy loams like Capac that retain more moisture due to organic matter.

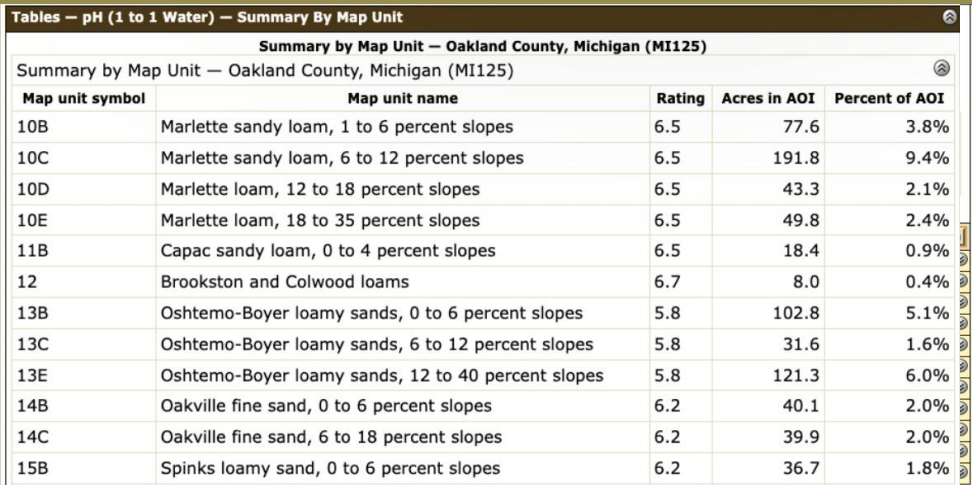
Tables — Soil Health - Organic Matter — Summary By Map Unit

Summary by Map Unit — Oakland County, Michigan (MI125)

Summary by Map Unit — Oakland County, Michigan (MI125)

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
10B	Marlette sandy loam, 1 to 6 percent slopes	2.00	77.6	3.8%
10C	Marlette sandy loam, 6 to 12 percent slopes	2.00	191.8	9.4%
10D	Marlette loam, 12 to 18 percent slopes	2.00	43.3	2.1%
10E	Marlette loam, 18 to 35 percent slopes	2.00	49.8	2.4%
11B	Capac sandy loam, 0 to 4 percent slopes	4.00	18.4	0.9%
12	Brookston and Colwood loams	4.00	8.0	0.4%
13B	Oshtemo-Boyer loamy sands, 0 to 6 percent slopes	1.75	102.8	5.1%
13C	Oshtemo-Boyer loamy sands, 6 to 12 percent slopes	1.75	31.6	1.6%
13E	Oshtemo-Boyer loamy sands, 12 to 40 percent slopes	1.75	121.3	6.0%
14B	Oakville fine sand, 0 to 6 percent slopes	1.25	40.1	2.0%
14C	Oakville fine sand, 6 to 18 percent slopes	1.25	39.9	2.0%
15B	Spinks loamy sand, 0 to 6 percent slopes	1.75	36.7	1.8%
15C	Spinks loamy sand, 6 to 12 percent slopes	1.75	122.5	6.0%
15E	Spinks loamy sand, 12 to 35 percent slopes	1.75	84.4	4.2%
17A	Wasepi sandy loam, 0 to 3 percent slopes	3.00	15.6	0.8%
18B	Fox sandy loam, till plain, 2 to 6 percent slopes	2.00	48.9	2.4%
18C	Fox sandy loam, Huron Lobe, 6 to 12 percent slopes	2.00	22.1	1.1%
18D	Fox sandy loam, Huron Lobe, 12 to 25 percent slopes	2.00	24.9	1.2%
20B	Glynwood loam, 2 to 6 percent slopes	2.00	159.7	7.8%

USDA Web Soil Survey

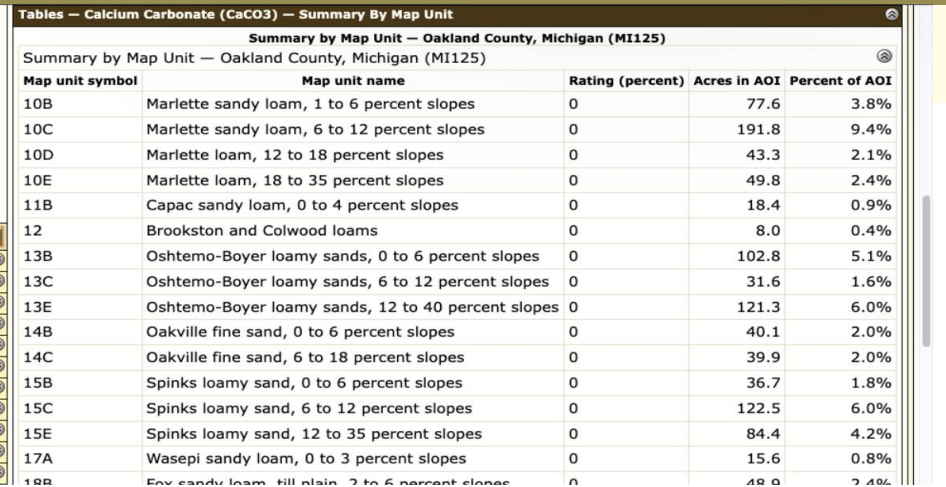


Tables — pH (1 to 1 Water) — Summary By Map Unit

Summary by Map Unit — Oakland County, Michigan (MI125)

Summary by Map Unit — Oakland County, Michigan (MI125)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10B	Marlette sandy loam, 1 to 6 percent slopes	6.5	77.6	3.8%
10C	Marlette sandy loam, 6 to 12 percent slopes	6.5	191.8	9.4%
10D	Marlette loam, 12 to 18 percent slopes	6.5	43.3	2.1%
10E	Marlette loam, 18 to 35 percent slopes	6.5	49.8	2.4%
11B	Capac sandy loam, 0 to 4 percent slopes	6.5	18.4	0.9%
12	Brookston and Colwood loams	6.7	8.0	0.4%
13B	Oshtemo-Boyer loamy sands, 0 to 6 percent slopes	5.8	102.8	5.1%
13C	Oshtemo-Boyer loamy sands, 6 to 12 percent slopes	5.8	31.6	1.6%
13E	Oshtemo-Boyer loamy sands, 12 to 40 percent slopes	5.8	121.3	6.0%
14B	Oakville fine sand, 0 to 6 percent slopes	6.2	40.1	2.0%
14C	Oakville fine sand, 6 to 18 percent slopes	6.2	39.9	2.0%
15B	Spinks loamy sand, 0 to 6 percent slopes	6.2	36.7	1.8%



Tables — Calcium Carbonate (CaCO3) — Summary By Map Unit

Summary by Map Unit — Oakland County, Michigan (MI125)

Summary by Map Unit — Oakland County, Michigan (MI125)

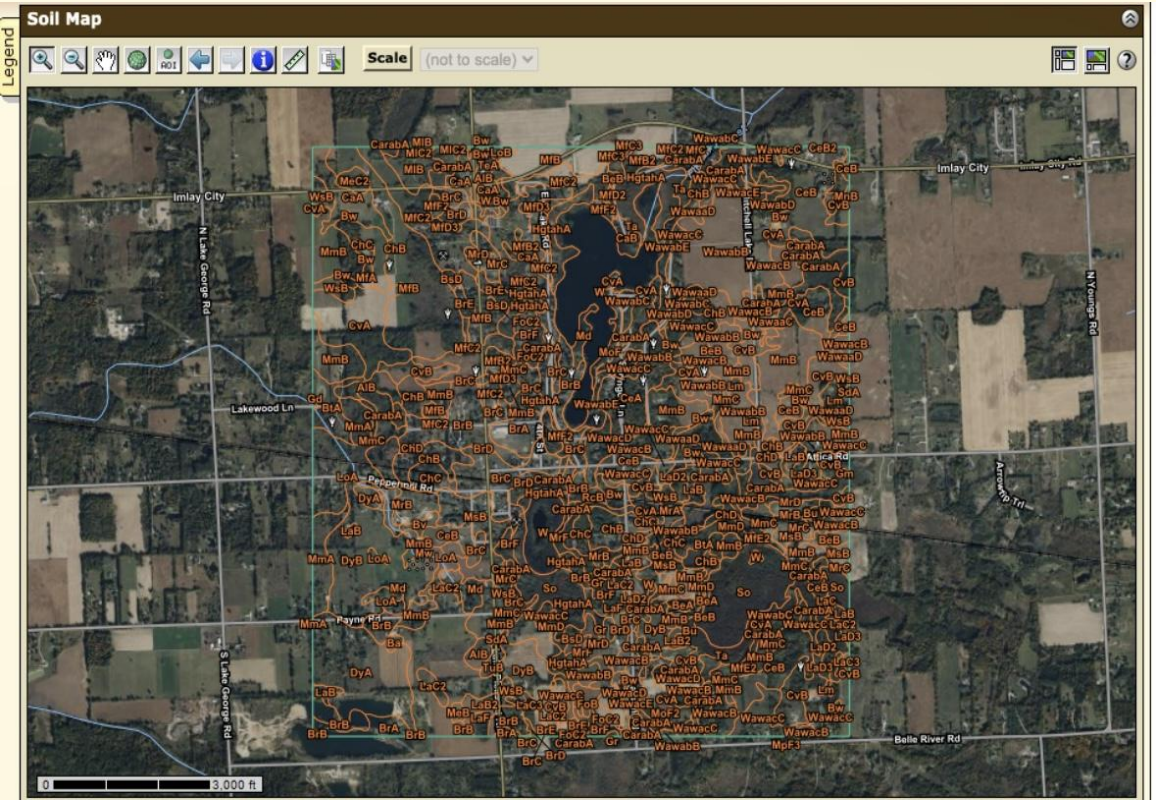
Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
10B	Marlette sandy loam, 1 to 6 percent slopes	0	77.6	3.8%
10C	Marlette sandy loam, 6 to 12 percent slopes	0	191.8	9.4%
10D	Marlette loam, 12 to 18 percent slopes	0	43.3	2.1%
10E	Marlette loam, 18 to 35 percent slopes	0	49.8	2.4%
11B	Capac sandy loam, 0 to 4 percent slopes	0	18.4	0.9%
12	Brookston and Colwood loams	0	8.0	0.4%
13B	Oshtemo-Boyer loamy sands, 0 to 6 percent slopes	0	102.8	5.1%
13C	Oshtemo-Boyer loamy sands, 6 to 12 percent slopes	0	31.6	1.6%
13E	Oshtemo-Boyer loamy sands, 12 to 40 percent slopes	0	121.3	6.0%
14B	Oakville fine sand, 0 to 6 percent slopes	0	40.1	2.0%
14C	Oakville fine sand, 6 to 18 percent slopes	0	39.9	2.0%
15B	Spinks loamy sand, 0 to 6 percent slopes	0	36.7	1.8%
15C	Spinks loamy sand, 6 to 12 percent slopes	0	122.5	6.0%
15E	Spinks loamy sand, 12 to 35 percent slopes	0	84.4	4.2%
17A	Wasepi sandy loam, 0 to 3 percent slopes	0	15.6	0.8%
18B	Fox sandy loam, till plain, 2 to 6 percent slopes	0	48.9	2.4%

Samples 1 & 2 : pH and Calcium Carbonate

The pH of Sample 1 was slightly acidic (6.36), which fits the range for the predicted soil types (loam/sandy loams), especially as they are not influenced by high levels of calcium carbonate that would raise the pH. Adversely, the higher range of Ca^{+} results in the lab for Sample 1 may imply that Sample 1 was sourced from a different type of soil, or other factors are at play.

The pH of Sample 2 is slightly basic (7.42), which could be influenced by levels of calcium carbonate in the soil– however, the USDA data shows relatively low levels of calcium carbonate in the loamy sand, suggesting that other buffering factors or inputs may be at play in maintaining a higher pH.

USDA Web Soil Survey - Sample 3



ATTICA, MI

Attica, MI, the source of Sample 3, is a rural community characterized by a mix of agricultural lands, forests, and bodies of water including streams and lakes.

Looking at the soil map provided for this area, it contains a multitude of different soil types. Such diversity might indicate a diverse terrain with varying elevations, drainage patterns, and vegetation types.

Sample 3, with its acidity, might correlate with soil types in the area that are heavily leached, or types that have a lot of forest coverage (where organic matter may increase soil acidity). Sample 3's low water content could suggest that is was taken from an area with well-drained soil, potentially sandy/loamy soils where moisture is not retained as much.

USDA Web Soil Survey

Tables — Organic Matter — Summary By Map Unit

Summary by Map Unit — Lapeer County, Michigan (MI087)

Summary by Map Unit — Lapeer County, Michigan (MI087)

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
AlB	Alcona sandy loam, 2 to 6 percent slopes	1.53	14.0	0.5%
Ba	Barry loam	2.61	1.7	0.1%
BeA	Belding sandy loam, 0 to 2 percent slopes	1.44	3.6	0.1%
BeB	Belding sandy loam, 2 to 6 percent slopes	1.44	19.4	0.7%
BrA	Boyer loamy sand, 0 to 2 percent slopes	1.31	27.6	1.1%
BrB	Boyer loamy sand, 1 to 6 percent slopes	1.40	83.3	3.2%
BrC	Boyer loamy sand, 6 to 12 percent slopes	1.40	59.3	2.3%
BrD	Boyer loamy sand, 12 to 18 percent slopes	1.15	13.7	0.5%
BrE	Boyer loamy sand, 18 to 25 percent slopes	1.29	10.5	0.4%
BrF	Boyer loamy sand, 25 to 50 percent slopes	1.29	22.4	0.9%
BsD	Boyer sandy loam, 12 to 18 percent slopes	1.35	9.7	0.4%
BtA	Brady loamy sand, 0 to 2 percent slopes	2.47	17.0	0.7%
Bu	Breckenridge sandy loam	2.22	4.3	0.2%
Bv	Brevort loamy sand	2.34	3.3	0.1%
Bw	Brookston loam	2.07	26.7	1.0%
CaA	Capac fine sandy loam, 0 to 2 percent slopes	7.38	34.3	1.3%
CaB	Capac fine sandy loam, 2 to 6 percent slopes	7.38	5.6	0.2%
CarabA	Carlisle muck, 0 to 2 percent slopes	73.53	153.9	5.9%

Sample 3: Organic Matter

Looking at the USDA data, we might be able to relate Sample 3 to some soils like Boyer loamy sand, which display a very low organic matter, as our lab data showed low humus content for this sample.

The low humus content correlates with a limited nutrient reservoir and possibly a lower CEC, which aligns with the observed nutrient deficiencies.

USDA Web Soil Survey

Tables — Soil Health - Soil Reaction (pH) — Summary By Map Unit

Summary by Map Unit — Lapeer County, Michigan (MI087)

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BeB	Belding sandy loam, 2 to 6 percent slopes	6.3	19.4	0.7%
BrA	Boyer loamy sand, 0 to 2 percent slopes	6.3	27.6	1.1%
BrB	Boyer loamy sand, 1 to 6 percent slopes	6.3	83.3	3.2%
BrC	Boyer loamy sand, 6 to 12 percent slopes	6.3	59.3	2.3%
BrD	Boyer loamy sand, 12 to 18 percent slopes	6.3	13.7	0.5%
BrE	Boyer loamy sand, 18 to 25 percent slopes	6.3	10.5	0.4%
BrF	Boyer loamy sand, 25 to 50 percent slopes	6.3	22.4	0.9%
BsD	Boyer sandy loam, 12 to 18 percent slopes	6.3	9.7	0.4%
BtA	Brady loamy sand, 0 to 2 percent slopes	5.8	17.0	0.7%
Bu	Breckenridge sandy loam	7.6	4.3	0.2%
Bv	Brevort loamy sand	6.3	3.3	0.1%
Bw	Brookston loam	6.3	26.7	1.0%
CaA	Capac fine sandy loam, 0 to 2 percent slopes	5.8	34.3	1.3%

Tables — Organic Matter — Summary By Map Unit

Summary by Map Unit — Lapeer County, Michigan (MI087)

Summary by Map Unit — Lapeer County, Michigan (MI087)

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
AlB	Alcona sandy loam, 2 to 6 percent slopes	1.53	14.0	0.5%
Ba	Barry loam	2.61	1.7	0.1%
BeA	Belding sandy loam, 0 to 2 percent slopes	1.44	3.6	0.1%
BeB	Belding sandy loam, 2 to 6 percent slopes	1.44	19.4	0.7%
BrA	Boyer loamy sand, 0 to 2 percent slopes	1.31	27.6	1.1%
BrB	Boyer loamy sand, 1 to 6 percent slopes	1.40	83.3	3.2%
BrC	Boyer loamy sand, 6 to 12 percent slopes	1.40	59.3	2.3%
BrD	Boyer loamy sand, 12 to 18 percent slopes	1.15	13.7	0.5%
BrE	Boyer loamy sand, 18 to 25 percent slopes	1.29	10.5	0.4%
BrF	Boyer loamy sand, 25 to 50 percent slopes	1.29	22.4	0.9%
BsD	Boyer sandy loam, 12 to 18 percent slopes	1.35	9.7	0.4%
BtA	Brady loamy sand, 0 to 2 percent slopes	2.47	17.0	0.7%
Bu	Breckenridge sandy loam	2.22	4.3	0.2%
Bv	Brevort loamy sand	2.34	3.3	0.1%
Bw	Brookston loam	2.07	26.7	1.0%

Sample 3: pH and Calcium Carbonate

Sample 3 is characterized by an acidic pH (4.73), and the acidity of the sample could be due to several factors including the presence of certain decomposing organics/vegetation, which may commonly be found in forested areas (like the source area of our sample). Calcium carbonate levels are typically associated with higher pH levels as it can combat/buffer acidity to some degree. Therefore, in soils where calcium carbonate is naturally low, soil tends to be more acidic. This acidic environment can impact the availability of of nutrients and nutrient uptake and lead to deficiencies, as reflected in Sample 3's low levels of nitrogen and iron.

Conclusions - Results, Final Analyses, & Thoughts

Sample 1

This sample showed significant nutrient deficiencies, particularly in nitrite, ferric iron, magnesium, and phosphorous. These deficiencies may be related to a potentially low CEC, which limits the soil's ability to hold/exchange essential nutrients. Given that the sample was sourced from a walking trail, the constant human disturbance and compaction from foot traffic may play a role in this low CEC. Furthermore, its lower water content compared to Sample 2 might correlate with a sandy/loamy texture (as supported by the USDA Soil Survey), and these types of soils typically exhibit low CEC and nutrient holding capacity.

Sample 2

Although Sample 2 is the least nutrient deficient of the three samples, this sample still exhibits lower levels of nitrogen and ferric iron. Although these nutrients are scarce/underrepresented, this soil's proximity to a lake might result in the higher nutrient cation content than Sample 1. A higher CEC may provide a buffer against rapid nutrient depletion. This sample showed the highest humus content (5), which was predicted in the initial hypothesis due to its dark color. The higher organic matter content near a lake environment might be due to the accumulation of decomposing plant material and the presence of water. This sample's source environment might support a higher microbial ecosystem than the other samples.

Sample 3

Deficiencies in nitrite, iron, and sulfate in this sample are all notable given its woodland origin. In such ecosystems, a layer of organic matter near the soil surface typically promotes a high CEC–meaning that the sample's deficiencies could be more related to something like leaching, for example, or even a naturally low baseline level of these nutrients. Despite being in an area where higher organic content is expected, the sample has low humus (<1). This could suggest that the soil has a hindered ability to break down organic matter into humus (less microbial activity, high soil acidity, etc). The low water content, while potentially beneficial in preventing nutrient leaching, also suggests that the bioavailability of nutrients could be limited (as moisture plays a role in nutrient mobility).

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