

Special Meeting

Drinking Water Study Results



Wednesday, October 29, 6:00 – 7:00 pm

In Person:

Dunn Town Hall
7979 E Lake Lizzie Rd
Pelican Rapids, MN 56572

Online:

Microsoft Teams
[Join the meeting now](#)
Meeting ID: 252 293 469 789 3
Passcode: Dn9gX3Tk

By Phone

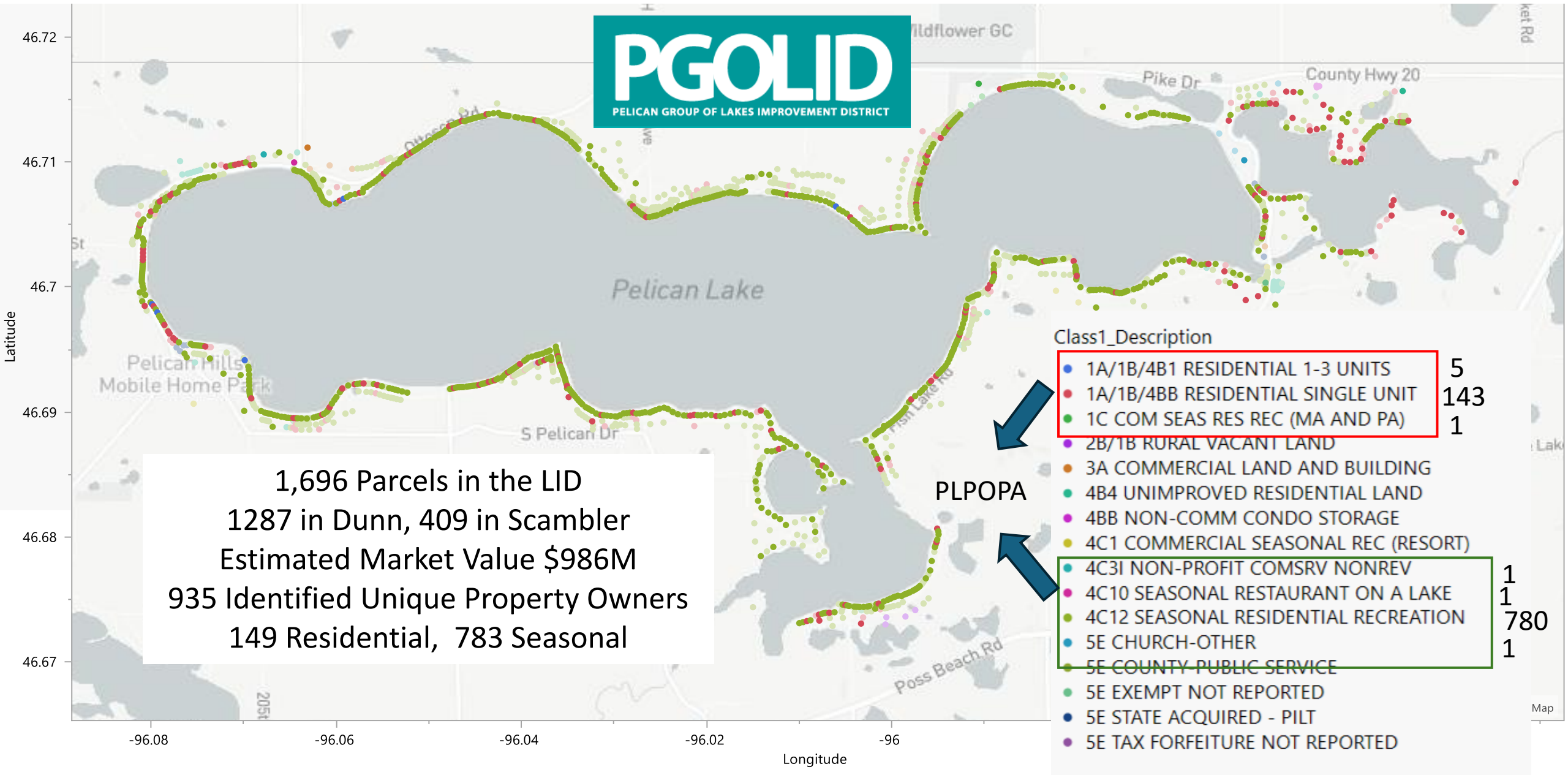
218-302-5994
Phone conference ID:
432 914 971#

AGENDA

1. Present study and results (20-30 minutes)
2. Question and Answer Discussion (30 minutes)

Presenting:
Dr. Adrian Lund
Moriya Rufer

The Pelican Group of Lakes Improvement District



2025 PGOLID Drinking Water Study

Who? Pelican Group of Lakes Improvement District

What? The PGOLID board has initiated a study of the drinking water quality in the LID this summer.

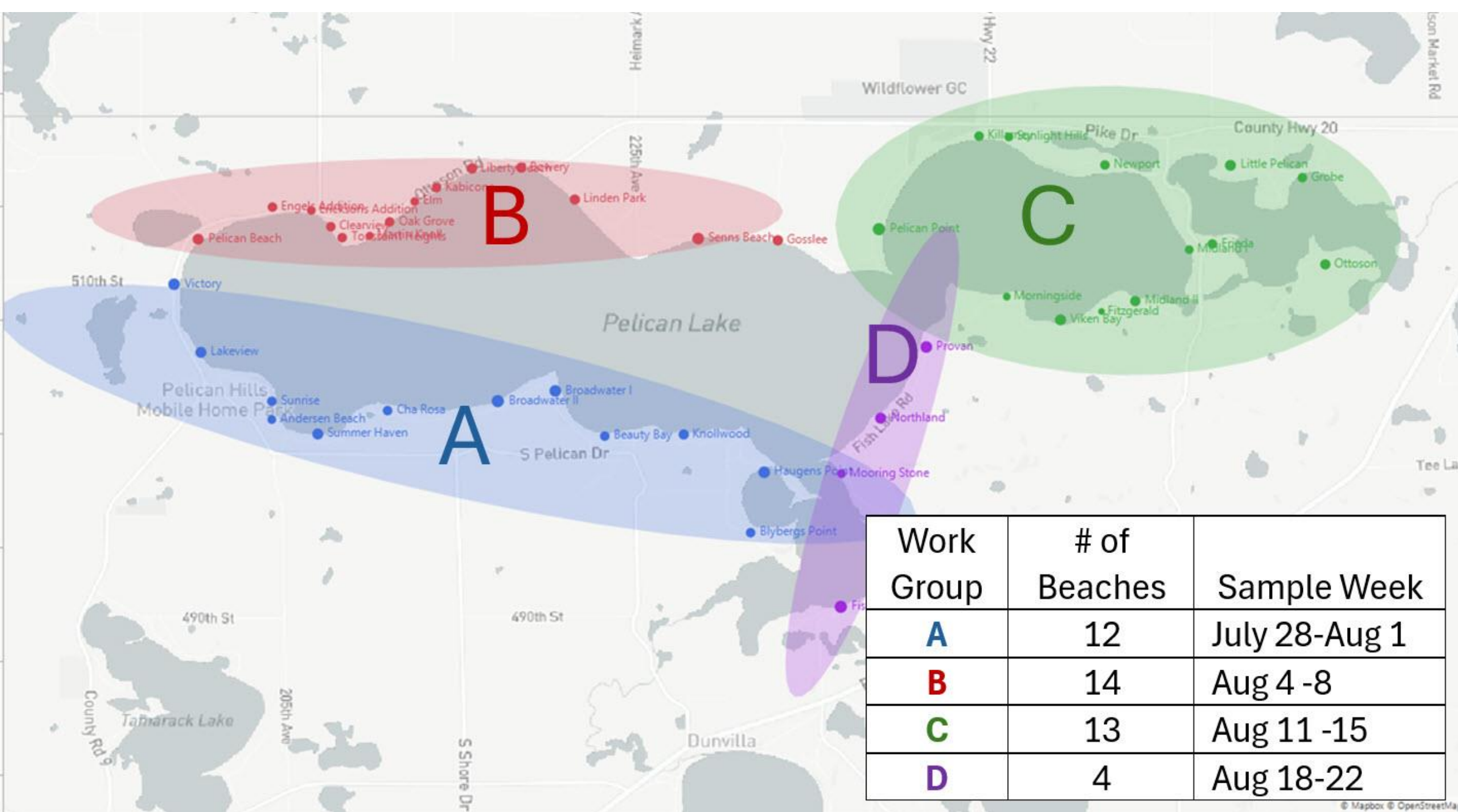
Why? There are several water and sewer – related projects that are being considered and having good data on the current drinking water quality of the LID area is critical in understanding the need for these projects.

Where? Our plan is to randomly select 250 of the 1500 or so properties in the LID to offer a voluntary water test valued at \$250 which will be paid for by PGOLID.

When? Properties that have been selected at random will be contacted shortly to see if they are willing to participate in the study. You cannot opt-in, only opt-out.

How? If you are contacted and agree to allow sampling, a professional from RMB labs will set up a time in July to take a sample from your well. The sample will be analyzed and the data sent to you directly from RMB. The study team will also get the data for analysis. Your water data will not be made public or shared with any agency. We will make a report at the lake and beach level only and the individual well data anonymized.

Who can I ask questions to? Moriya Rufer is the PGOLID Lake Coordinator with Houston Engineering. She can be contacted at (218) 396-1169 or email at mrufer@houstoneng.com



Work Group	# of Beaches	Sample Week
A	12	July 28-Aug 1
B	14	Aug 4 -8
C	13	Aug 11 -15
D	4	Aug 18-22

July 28, 2025

1) Line Flushing



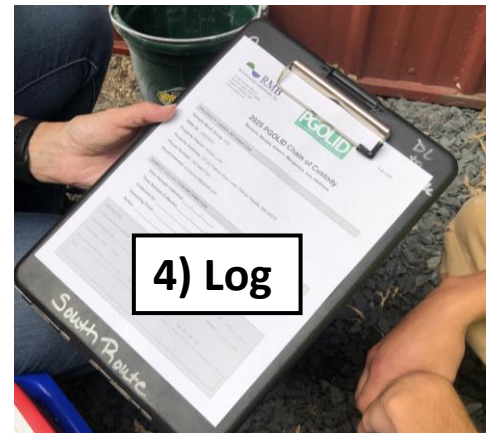
2) Sanitize



3) Sample



4) Log

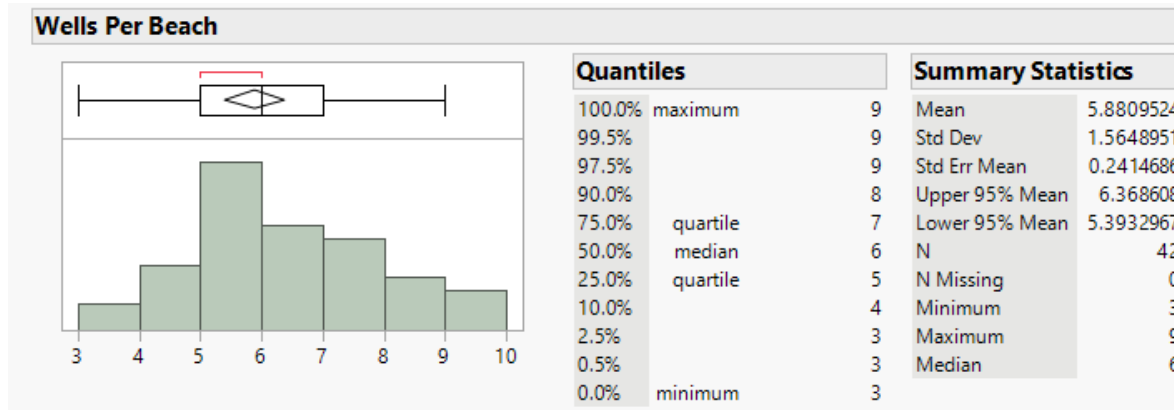


5) Transport



DW Study Sampling

- Target was to collect 252, we got 247.
- Zero samples from Robinswood
- To keep $n \geq 3$, we merged Fitzgerald data merged with Midland II
-

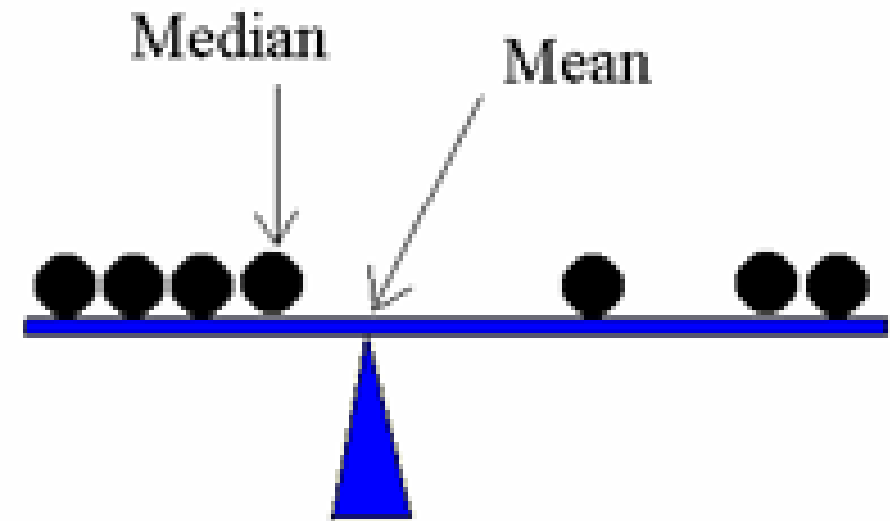


AREA	BNR	Beach	PLPOA Members	LIPOLAMs	SqRT n	Target Samples	Actual	Diff	Sample Work Group
1	30	Blybergs Point	12	12	4	5	5		A
1	31	Haugens Point	33	32	6	7	8	1	A
1	32	Knollw ood	23	23	5	6	6		A
1	33	Beauty Bay	16	16	4	5	5		A
1	34	Broadw ater I	48	43	7	8	8		A
1	35	Broadw ater II	53	51	8	9	9		A
2	1	Lakeview	30	30	6	7	7		A
2	2	Victory	34	33	6	7	7		A
2	37	Cha Rosa	16	13	4	5	5		A
2	38	Summer Haven	34	34	6	7	7		A
2	39	Andersen Beach	35	6	3	4	4		A
2	40	Sunrise	10	10	4	5	5		A
3	3	Pelican Beach	29	29	6	7	7		B
3	4	Engels Addition	11	11	4	5	5		B
3	5	Ericksons Addition	5	5	3	4	4		B
3	6	Clearview	13	13	4	5	5		B
3	7	Toussaint Heights	11	11	4	5	5		B
3	8	Martin Knoll	4	4	2	3	3		B
3	9	Oak Grove	14	14	4	5	5		B
3	10	Elm	7	7	3	4	4		B
3	11	Kabicona	19	14	4	5	5		B
3	12	Liberty Beach	22	19	5	6	6		B
4a	13	Bow ery	19	18	5	6	6		B
4a	14	Linden Park	26	24	5	6	6		B
4a	15	Senns Beach	48	46	7	8	8		B
4b	16	Gosslee	24	24	5	6	6		B
5	21	Robinsw ood	3	3	2	3	0	-3	C
5	22	Midland I	17	15	4	5	4	-1	C
5	23	Midland II	24	20	5	6	6		C
5	24	Fitzgerald	4	4	2	3	2	-1	C
5	25	Viken Bay	35	31	6	7	7		C
5	26	Morningside	8	8	3	4	3	-1	C
7	41	Little Pelican	37	31	6	7	7		C
7	41A	Grobe	21	16	4	5	5		C
7	41B	Ottoson	23	17	5	6	6		C
7	41C	Frieda	14	13	4	5	5		C
4b	17	Pelican Point	62	60	8	9	9		C
4c	18	Killarney	16	15	4	5	5		C
4c	19	Sunlight Hills	8	8	3	4	4		C
4c	20	New port	14	14	4	5	5		C
6	27	Provan	46	45	7	8	8		D
6	28	Northland	32	32	6	7	7		D
6	29	Mooring Stone	9	8	3	4	4		D
8	42	Fish Lake	61	53	8	9	9		D
		TOTALs	1030	935	208	252	247	-5	

But first, a short discussion of statistics



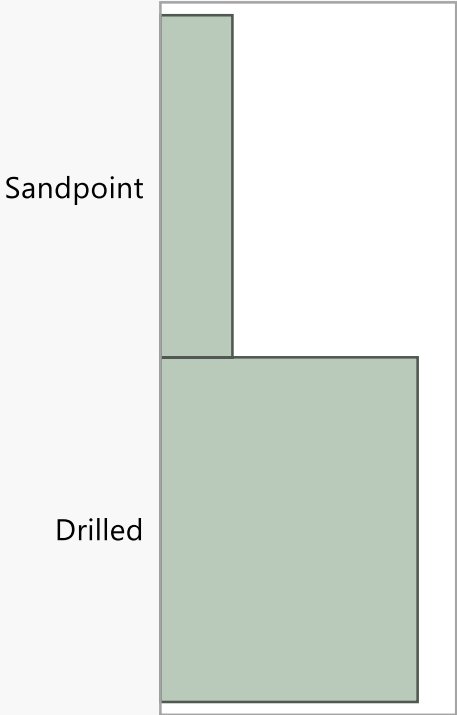
- The Mean (weighted Average) of a data set is the sum of all values divided by the number of values.
 - The mean of 3, 4, 6, 7, 8, 10, 15 is about 7.57 ($53/7$).
 - The mean of 3, 4, 6, 7, 8, 10, 150 is about 26.86 ($188/7$).
- The median is the “middle value” of a data set of either data set is 7. Or another way, there are as many values equal to it or below it as above it.
- When looking at data sets with large outliers or non-uniform distributions, **median** is often more informative than **mean**. But both have value.



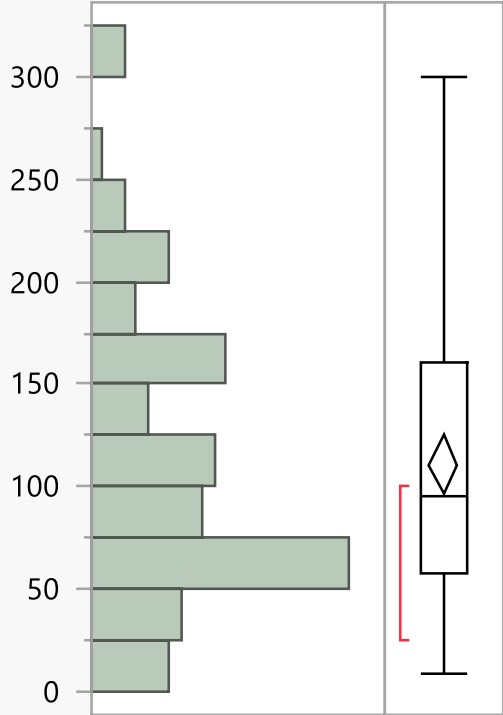
<https://online.stat.psu.edu/stat504/lesson/measures-central-tendency>

Distributions

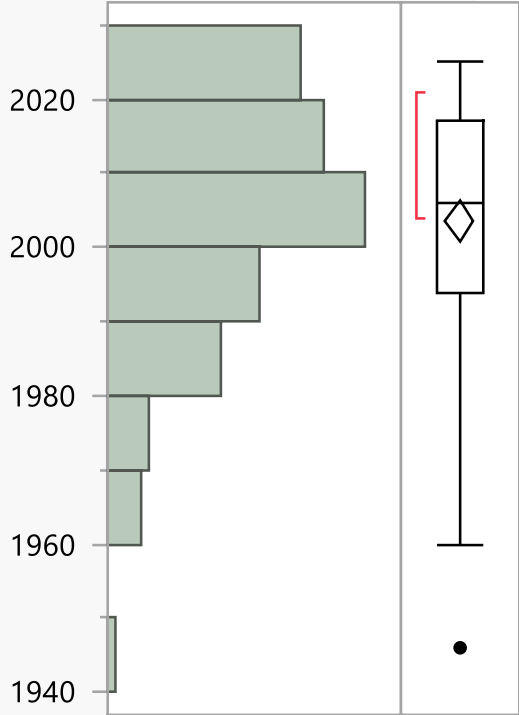
Well Type



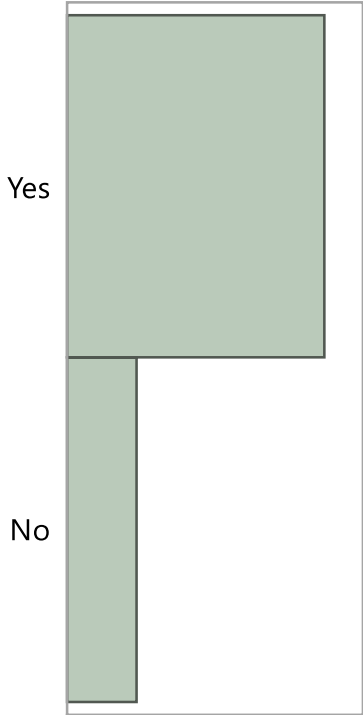
Well Depth (ft)



Well Installed year.



Satisfied with Water?



Frequencies

Level	Count	Prob
Drilled	155	0.78283
Sandpoint	43	0.21717
Total	198	1.00000
N Missing	49	
2 Levels		

Summary Statistics

Mean	110.81915
Std Dev	71.084678
N	94
N Missing	153
Minimum	9
Maximum	300
Median	95.5

Summary Statistics

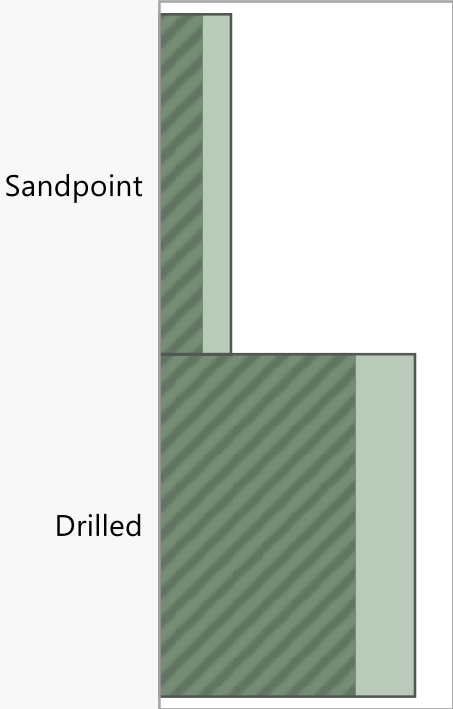
Mean	2003.627
Std Dev	15.949788
N	126
N Missing	121
Minimum	1946
Maximum	2025
Median	2006

Frequencies

Level	Count	Prob
No	46	0.21198
Yes	171	0.78802
Total	217	1.00000
N Missing	30	
2 Levels		

Distributions (Satisfied with Water = Yes)

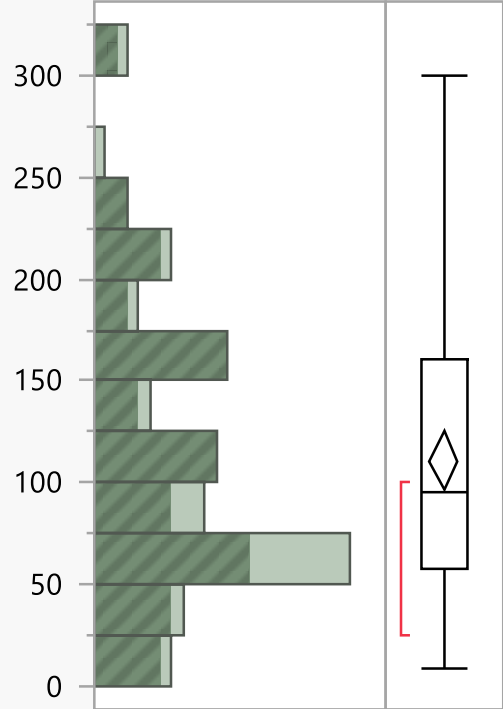
Well Type



Frequencies

Level	Count	Prob
Drilled	155	0.78283
Sandpoint	43	0.21717
Total	198	1.00000
N Missing 49		
2 Levels		

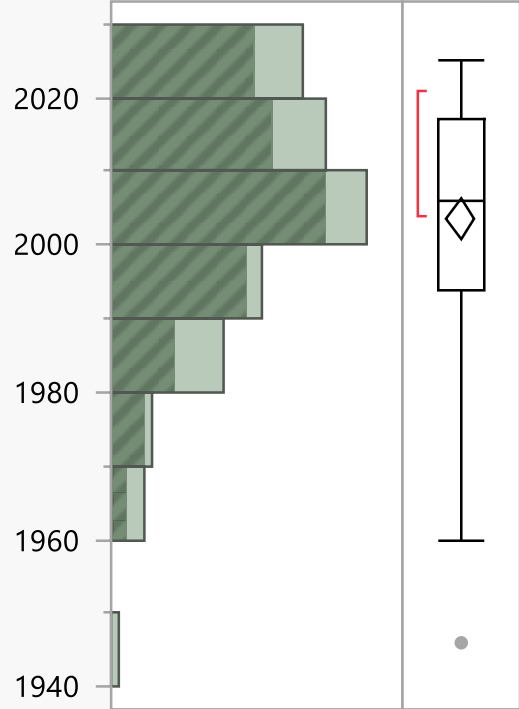
Well Depth (ft)



Summary Statistics

Mean	110.81915
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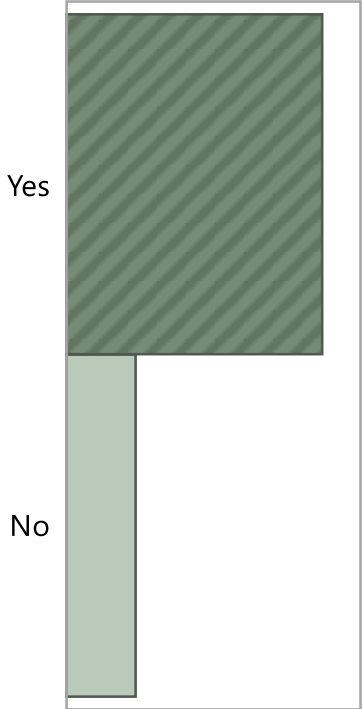
Well Installed year.



Summary Statistics

Mean	2003.627
Std Dev	15.949788
N	126
N Missing	121
Minimum	1946
Maximum	2025
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Satisfied with Water?

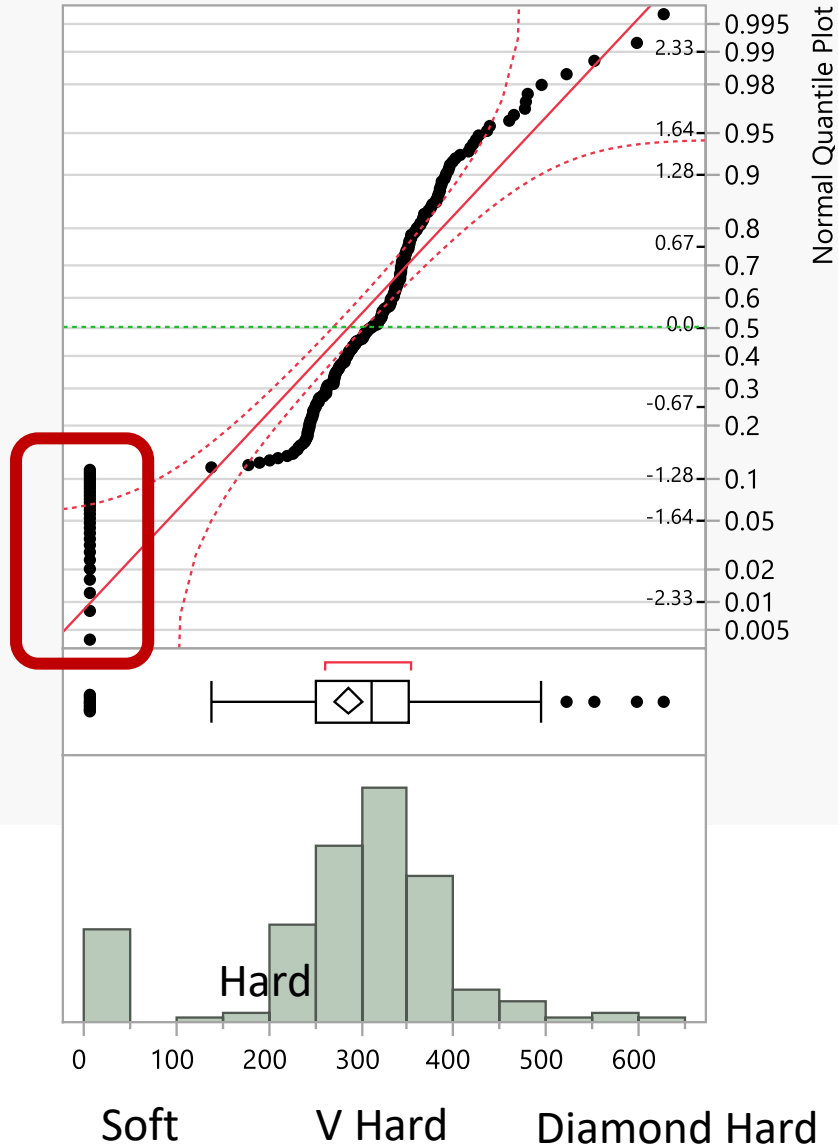


Frequencies

Level	Count	Prob
No	46	0.21198
Yes	171	0.78802
Total	217	1.00000
N Missing 30		
2 Levels		

But first, some data cleanup

Total Hardness (mg/mL) [LOD = 6.62]



Quantiles

100.0%	maximum	627
99.5%		620.04
97.5%		479.6
90.0%		391.2
75.0%	quartile	351
50.0%	median	312
25.0%	quartile	251
10.0%		6.62
2.5%		6.62
0.5%		6.62
0.0%	minimum	6.62

Summary Statistics

Mean	286.85571
Std Dev	119.71216
Std Err Mean	7.6171023
Upper 95% Mean	301.85877
Lower 95% Mean	271.85265
N	247
N Missing	0

- Distribution analysis of the Hardness data indicates that 28 of the 247 (11%) water samples had been softened.
- These 28 samples were removed* from the well water data set.

*but prove useful later



Let's Look at my Results!



- Of the 28 that were found to be soft, 27 were from outside spigots.
- If Total Hardness is **<6.62** then **your water sample was after the softener**, and all your results do not represent your raw well water data!



RMB
Environmental Laboratories, Inc.
www.rmbel.com

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501 Highway 13 East Suite 104
Burnsville, MN 55337
952-456-8470

Detroit Lakes
22796 County Highway 6
Detroit Lakes, MN 56501
218-846-1465

Virginia
110 1/2 S 15th Avenue W
Virginia, MN 55792
218-440-2043

Laboratory Results
August 02, 2025

Report To: PGOLID - Drinking Water
PO Box 336
Pelican Rapids, MN, 56572

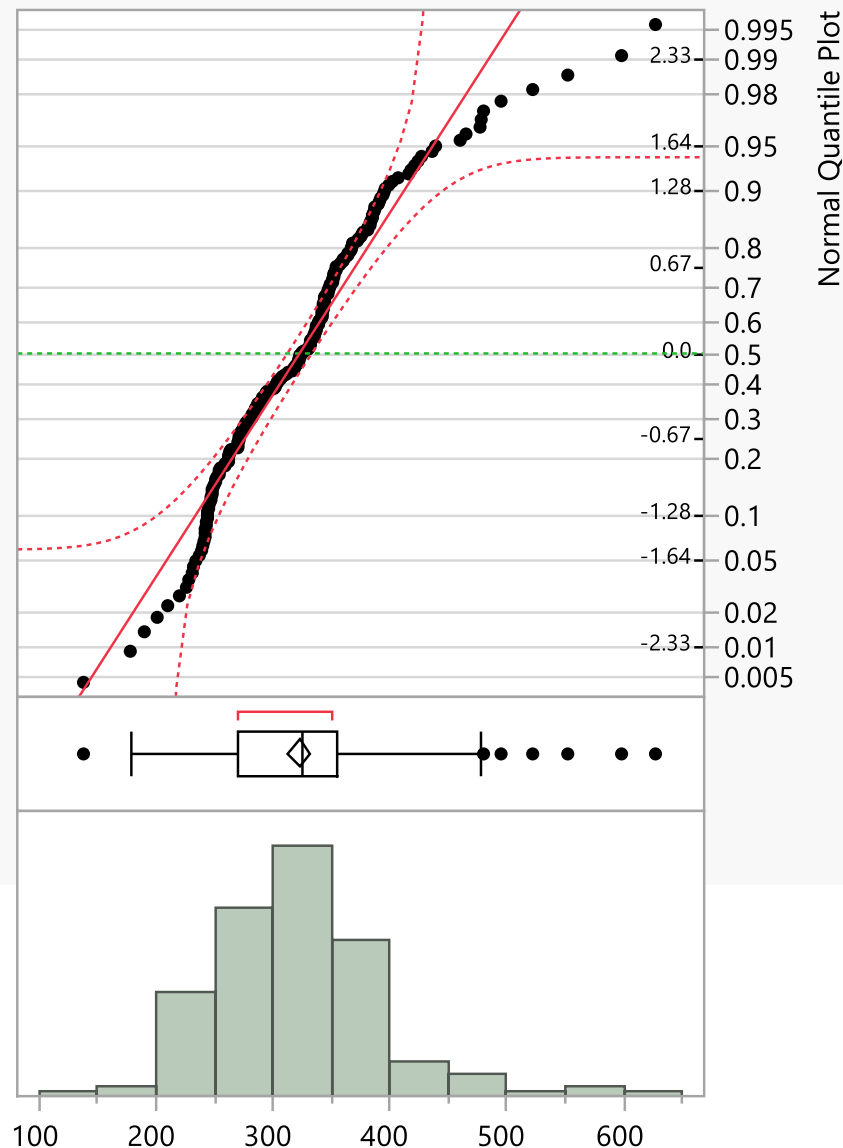
Bill To: PGOLID - Drinking Water
PO Box 336
Pelican Rapids, MN, 56572

Lab Code: D077984-01
Matrix: Water
Date/Time Sampled: 07/28/2025 08:30
Date/Time Received: 07/28/2025 10:00
Samplers: Tracy Borash, RMB Tec
Sample Receipt Temperature °C: 14.8

Sample Description: 23122 Pelican Bass Lane, Pelican Rapids, MN 56572
Property Owner Name: Adrian Lund
Sampling Point: Outside Spigot
Unique Well ID: 25823587
Sample Receipt Information: Samples received same day as collected.

Analyte	Result	Units	Analyte Qualifiers	RL	DF	Allowable Limit	Analysis Method	Preparation Method	Analyzed	Facility
Chemistry Parameters										
Nitrate as N	< 0.0300	mg/L		0.0300	1	10	EPA 353.2 (calc.)		07/29/25 14:00	DL
Laboratory Interpretation: The Nitrate as N result MEETS the primary drinking water standards set by the US Environmental Protection Agency.										
Metals (Total) by ICP-MS										
Arsenic	12.7	ug/L		1.00	1	10	EPA 200.8	EPA 200.8	07/30/25 22:35	DL
Laboratory Interpretation: The Arsenic result DOES NOT MEET the primary drinking water standards set by the US Environmental Protection Agency.										
Metals (Total) by ICP										
Total Hardness	364	mg/L as CaCO3		6.62	1	-	SM2340 B-2011		07/31/25 16:57	DL
Iron	7.06	mg/L		0.05	1	-	EPA 200.7	EPA 200.7	07/31/25 16:57	DL
Manganese	0.51	mg/L		0.01	1	0.05	EPA 200.7	EPA 200.7	07/31/25 16:57	DL
Laboratory Interpretation: The Manganese result DOES NOT MEET the secondary drinking water standards set by the US Environmental Protection Agency.										
Microbiological										
Total Coliform Bacteria MPN	< 1.0	MPN/100 mL		1.0	1	< 1.0	SM9223B-2004	Colilert	07/28/25 15:27	DL
Laboratory Interpretation: The Total Coliform result MEETS the primary drinking water standards set by the US Environmental Protection Agency.										
E. Coli Bacteria MPN	< 1.0	MPN/100 mL		1.0	1	< 1.0	SM9223B-2004	Colilert	07/28/25 15:27	DL
Laboratory Interpretation: The E. Coli result MEETS the primary drinking water standards set by the US Environmental Protection Agency.										
Qualifiers and Definitions										
Item	Definition									
RL	Reporting Limit									
DF	Dilution Factor									
DL	Indicates test performed by RMB Environmental Laboratories - Detroit Lakes.									

Total Hardness (mg/mL) [LOD = 6.62] (Softened Samples Removed)

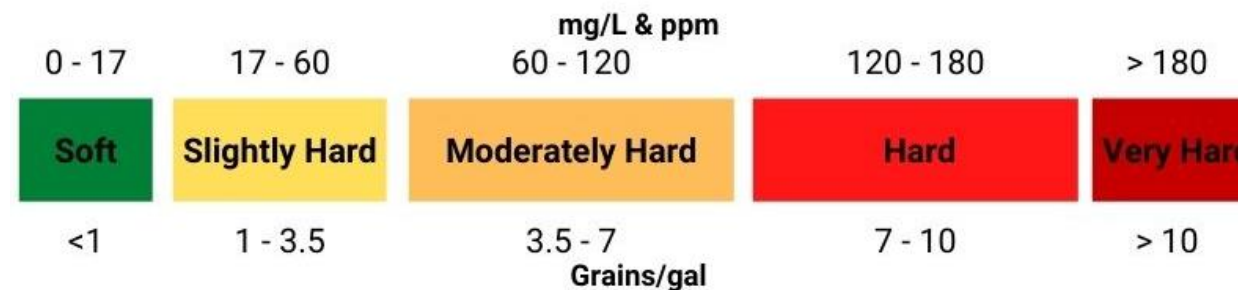


Quantiles		
100.0%	maximum	627
99.5%		624.1
97.5%		487.5
90.0%		395
75.0%	quartile	354
50.0%	median	325
25.0%	quartile	271
10.0%		244
2.5%		215
0.5%		142
0.0%	minimum	138

Summary Statistics	
Mean	322.68493
Std Dev	69.24863
Std Err Mean	4.6793888
Upper 95% Mean	331.90757
Lower 95% Mean	313.4623
N	219
N Missing	0
Minimum	138
Maximum	627
Median	325

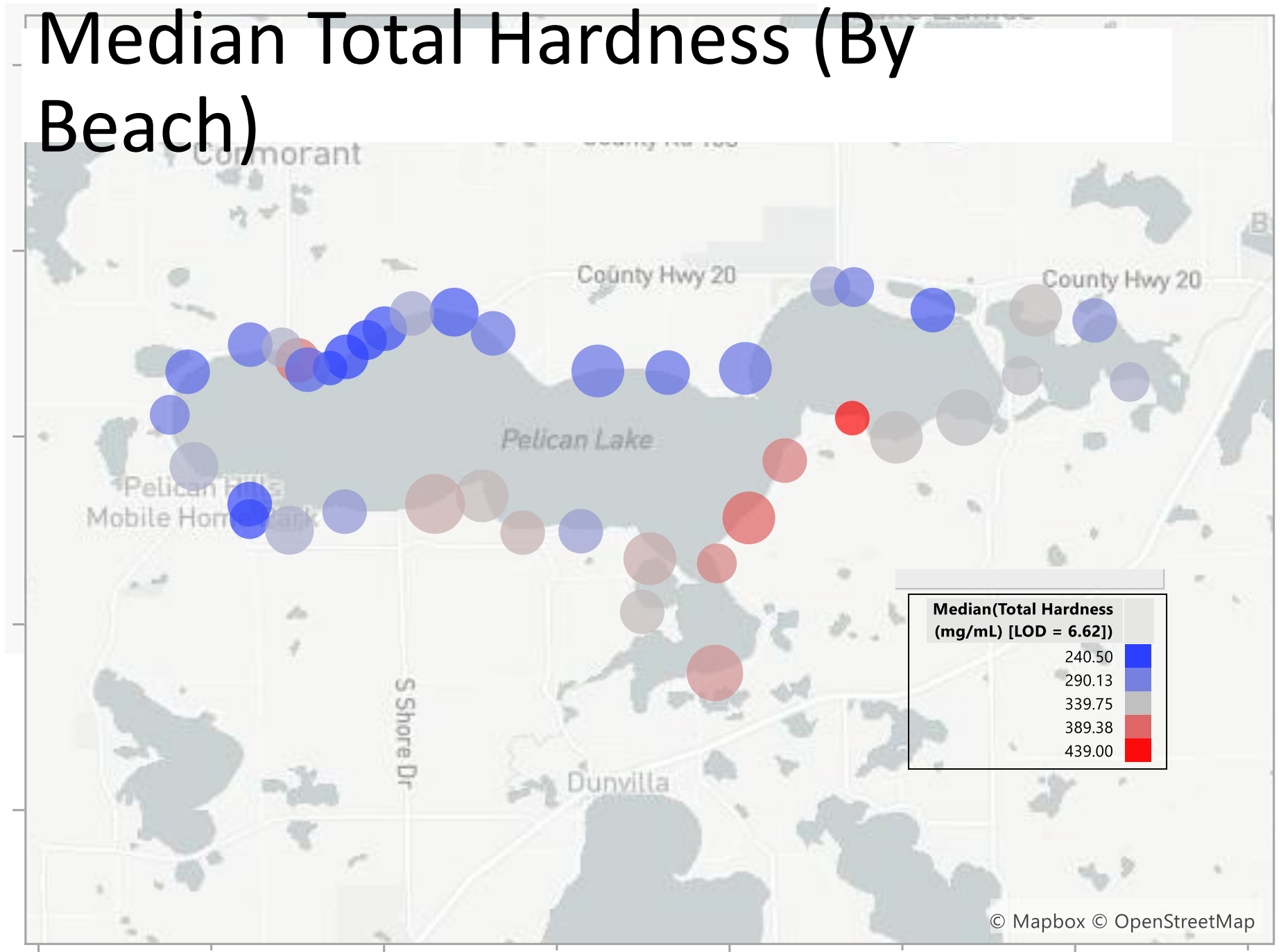


- With softened samples removed, mean hardness from remaining 219 samples was 322 mg/L (19 grains per gallon)



Median Total Hardness (By Beach)

Beach Name	Well Samples	Median Total Hardness (mg/mL) [LOD = 6.62]
Morningside	3	439
Northland	7	392
Clearview	5	381
Provan	5	377
Mooring Stone	4	374.5
Fish Lake	8	365.5
Broadwater II	9	351
Haugens Point	7	351
Beauty Bay	5	348
Broadwater I	7	344
Blybergs Point	5	343
Viken Bay	7	342
Little Pelican	7	342
Midlands F&RW	8	338.5
Frieda	4	337
Lakeview	6	327.5
Ericksons Addition	4	327.5
Ottoson	4	327
Summer Haven	6	324
Liberty Beach	5	319
Killarney	4	318
Knollwood	5	313
Cha Rosa	5	308
Grobe	5	304
Sunlight Hills	4	287
Victory	4	286.5
Linden Park	5	283
Pelican Point	7	282
Senns Beach	7	280
Gosslee	5	277
Engels Addition	5	276
Pelican Beach	5	273
Toussaint Heights	5	271
New port	5	262
Bowery	6	260.5
Kabicona	5	254
Sunrise	5	250
Martin Knoll	3	248
Andersen Beach	4	247.5
Oak Grove	5	243
Elm	4	240.5



Arsenic

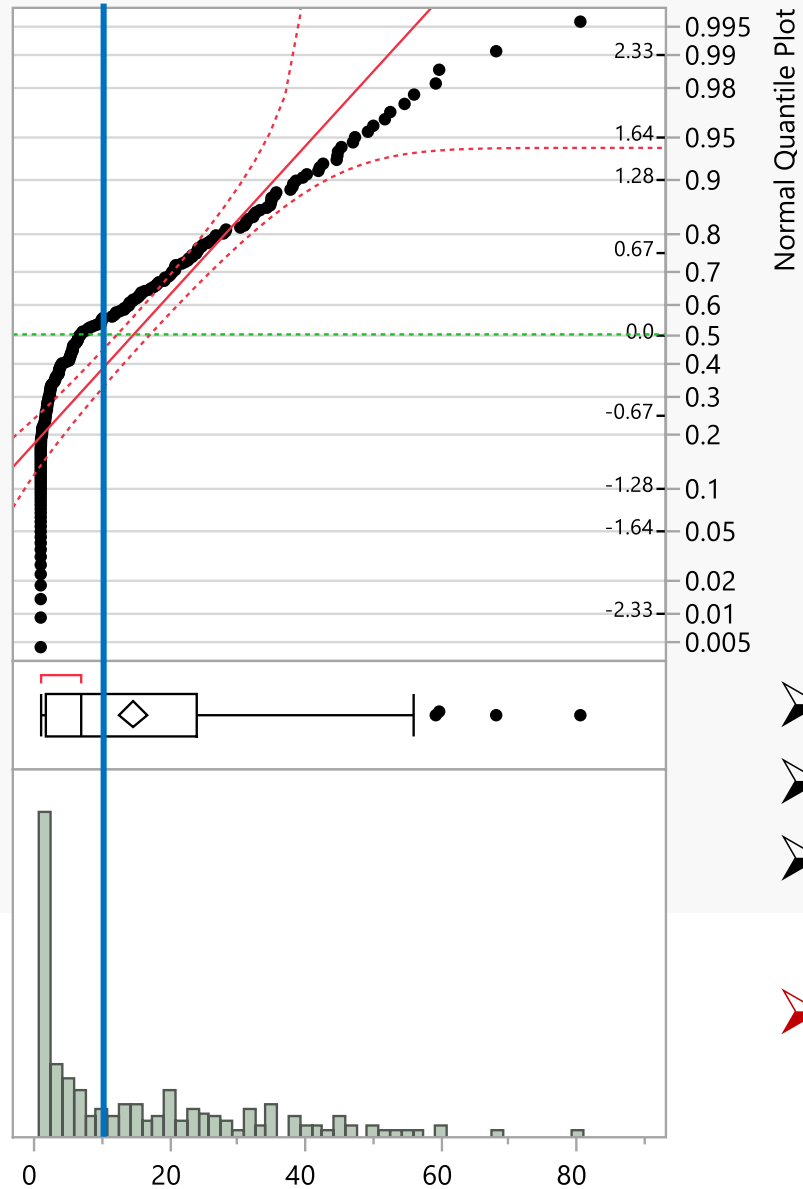
- Occurs naturally in rocks and soil across MN
- Dissolves into groundwater
- Health Risks: low levels over time are associated with cancer, skin problems, and child health affects
- EPA Standard is 10 $\mu\text{g}/\text{L}$, but levels lower than that can still affect you
- EPA goal is 0 $\mu\text{g}/\text{L}$

Periodic Table of the Elements

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Hydrogen 1.008 1																		Helium 4.003 2																		Lithium 6.94 3																		Beryllium 9.01 4																		Boron 10.81 5																		Carbon 12.01 6																		Nitrogen 14.01 7																		Oxygen 16.00 8																		Fluorine 18.99 9																		Neon 20.18 10																		Sodium 22.99 11																		Magnesium 24.31 12																		Aluminum 26.98 13																		Silicon 28.09 14																		Phosphorus 30.97 15																		Sulfur 32.06 16																		Chlorine 35.45 17																		Argon 39.95 18																		Potassium 39.10 19																		Calcium 40.08 20																		Scandium 44.96 21																		Titanium 47.88 22																		Vanadium 50.94 23																		Chromium 51.99 24																		Manganese 54.94 25																		Iron 55.85 26																		Cobalt 58.93 27																		Nickel 58.69 28																		Copper 63.55 29																		Zinc 65.38 30																		Gallium 69.72 31																		Germanium 72.64 32																		Arsenic 74.92 33																		Selenium 78.96 34																		Bromine 79.90 35																		Krypton 83.80 36																		Rubidium 85.47 37																		Strontium 87.62 38																		Yttrium 88.91 39																		Zirconium 91.22 40																		Niobium 92.91 41																		Molybdenum 95.94 42																		Technetium 98.01 43																		Ruthenium 101.07 44																		Rhodium 102.91 45																		Palladium 106.42 46																		Silver 107.87 47																		Cadmium 112.41 48																		Indium 114.82 49																		Tin 118.71 50																		Antimony 121.76 51																		Tellurium 127.60 52																		Iodine 126.91 53																		Xenon 131.29 54																		Cesium 132.91 55																		Barium 137.33 56																		Lanthanum 138.91 57																		Cerium 140.12 58																		Praseodymium 140.91 59																		Neodymium 144.24 60																		Promethium 145 61																		Samarium 150.36 62																		Europium 151.96 63																		Gadolinium 157.25 64																		Terbium 158.93 65																		Dysprosium 162.50 66																		Holmium 164.93 67																		Erbium 167.26 68																		Thulium 168.93 69																		Ytterbium 173.05 70																		Lutetium 174.97 71																		Actinium 227 87																		Thorium 232.04 88																		Protactinium 231.04 89																		Uranium 238.03 90																		Neptunium 237.05 91																		Plutonium 244 92																		Americium 243 93																		Curium 247 94																		Berkelium 247 95																		Californium 251 96																		Einsteinium 252 97																		Fermium 257 98																		Mendelevium 258 99																		Nobelium 259 100																		Lawrencium 262 101																	
Atomic Number →																		← Symbol																		Name →																		← Atomic Weight																		Electrons per shell →																		State of matter (color of name) GAS LIQUID SOLID UNKNOWN																		Subcategory in the metal-metalloid-nonmetal trend (color of background) Alkali metals Alkaline earth metals Transition metals Lanthanides Actinides Post-transition metals Metalloids Reactive nonmetals Noble gases Unknown chemical properties																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															

Pelican Lake has 238 billion pounds of water in it.
1 $\mu\text{g} / \text{L}$ would be like 5 gallons of pure arsenic dissolved in it

Arsenic (µg/L) [LOD = 1]



Quantiles

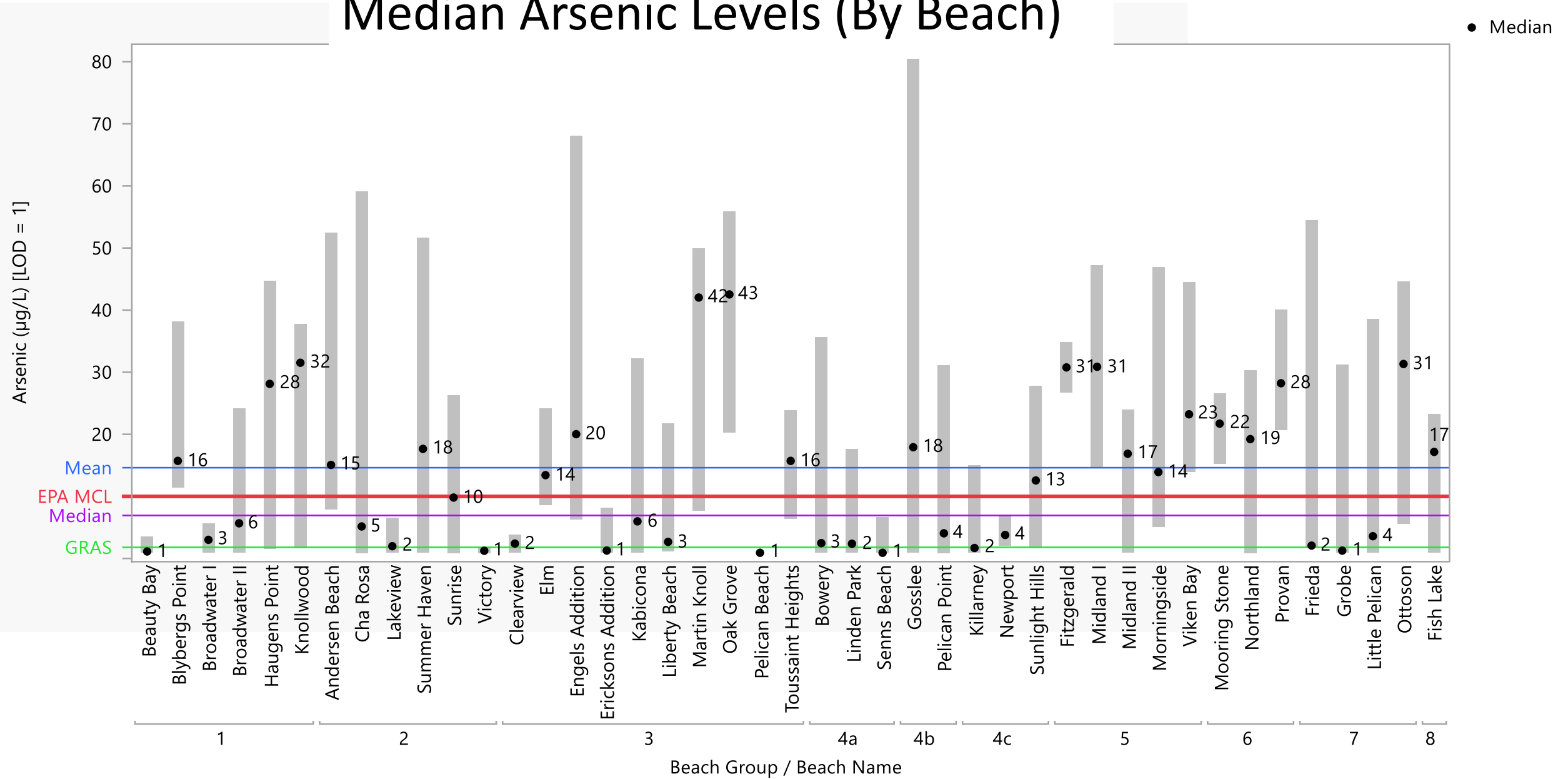
100.0%	maximum	80.5
99.5%		79.26
97.5%		55.3
90.0%		38.6
75.0%	quartile	23.9
50.0%	median	6.89
25.0%	quartile	1.73
10.0%		1
2.5%		1
0.5%		1
0.0%	minimum	1

Summary Statistics

Mean	14.705434
Std Dev	16.093319
Std Err Mean	1.0874857
Upper 95% Mean	16.848765
Lower 95% Mean	12.562102
N	219
Median	6.89

- 62 out of 218 (28%) samples were below 2 µg/L
- 58 out of 218 (27%) samples were between 2 and 10 µg/L
- 98 out of 218 (45%) of samples were >10 µg/L
- 72% of wells sampled in the LID should likely be remediated for Arsenic.

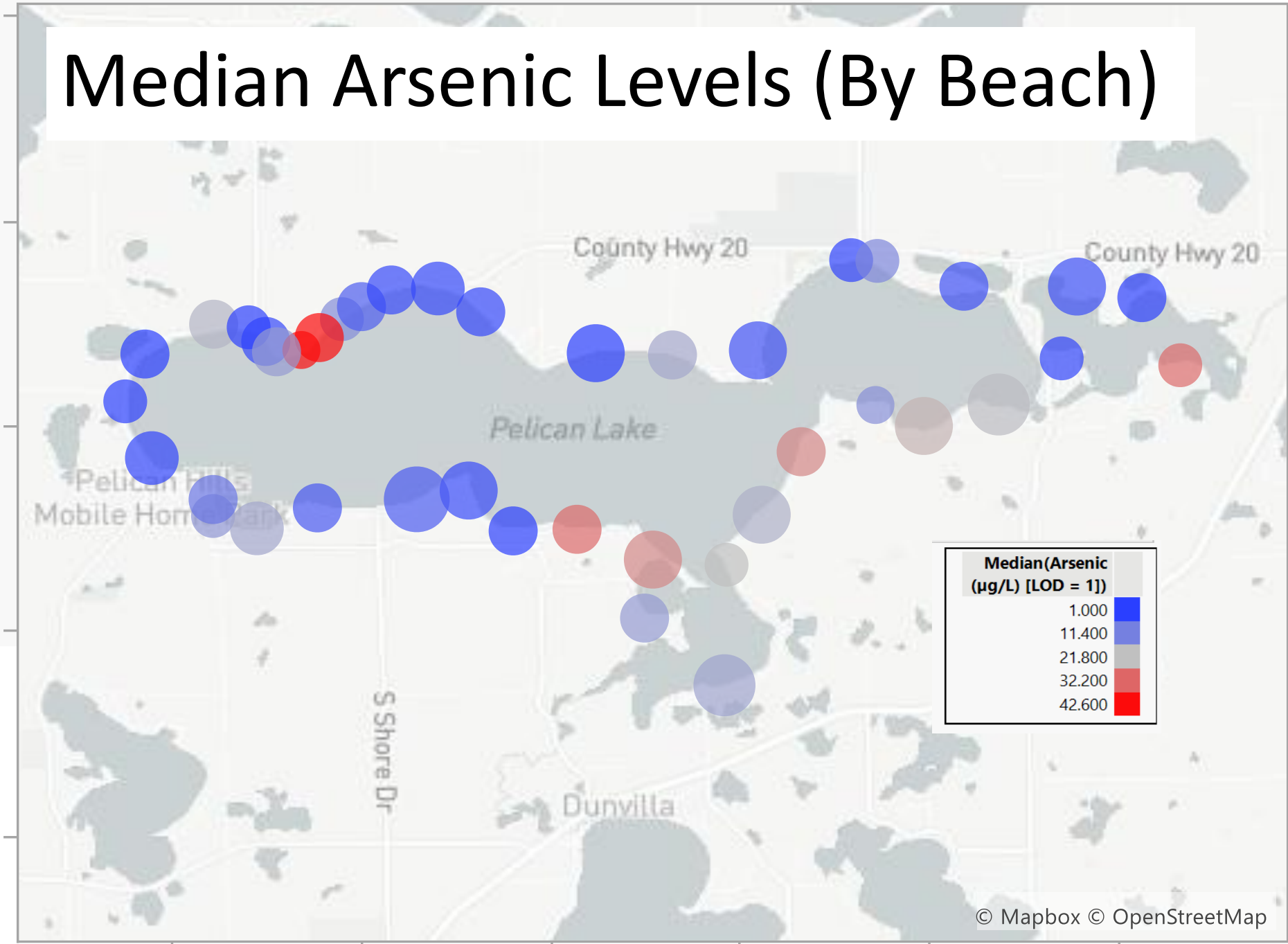
Median Arsenic Levels (By Beach)



Where(28 rows excluded)
Error band is constructed using the minimum and maximum of the data.

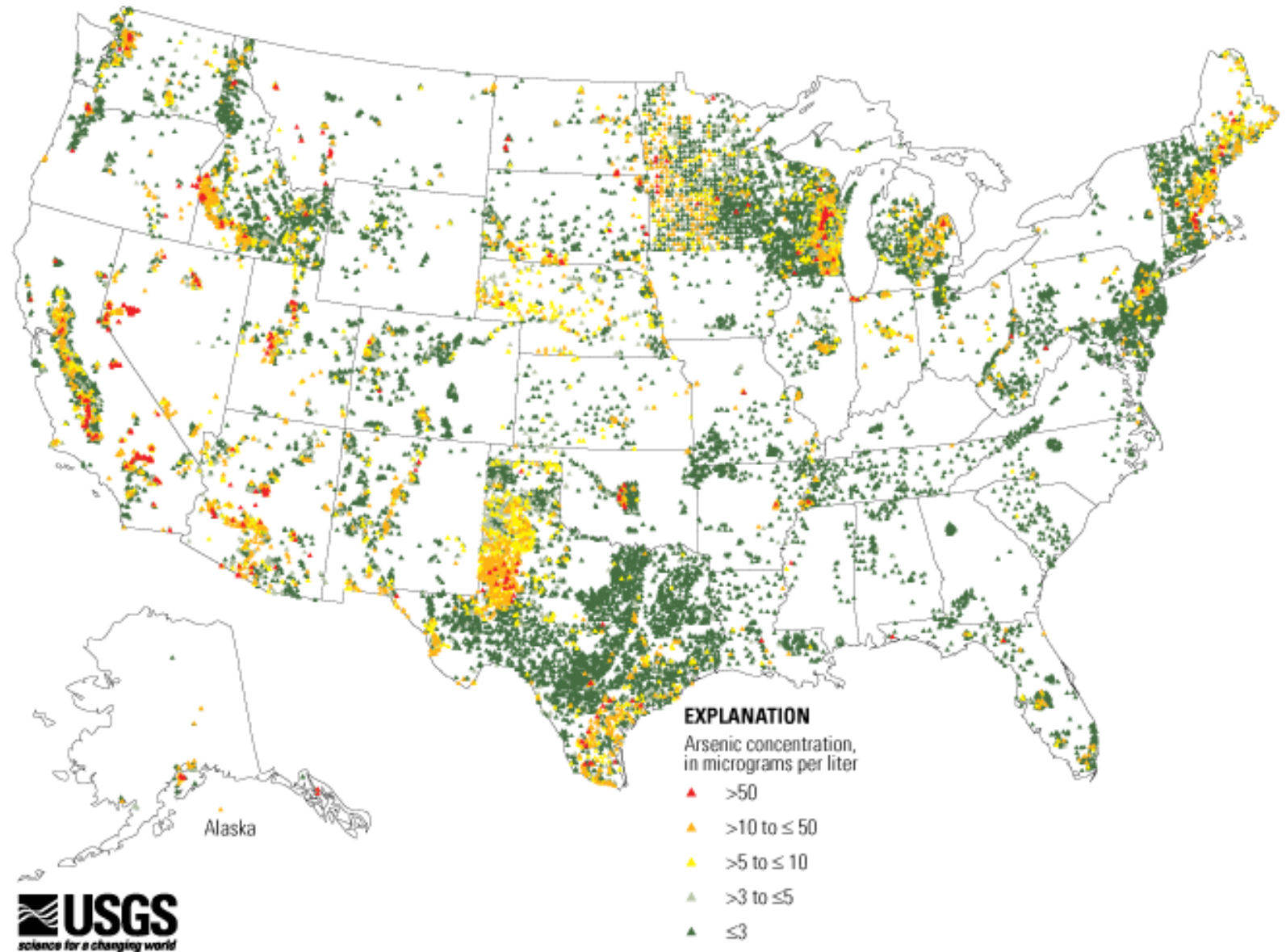
Beach Name	Well Samples	Median Arsenic (µg/L) [LOD = 1]
Oak Grove	5	42.6
Martin Knoll	3	42.1
Knollwood	5	31.6
Ottoson	4	31.4
Provan	5	28.3
Haugens Point	7	28.2
Viken Bay	7	23.3
Mooring Stone	4	21.8
Midlands F&RW	8	21.2
Engels Addition	5	20.1
Northland	7	19.3
Gosslee	5	18.0
Summer Haven	6	17.7
Fish Lake	8	17.3
Blybergs Point	5	15.8
Toussaint Heights	5	15.8
Andersen Beach	4	15.2
Morningside	3	14.0
Elm	4	13.5
Sunlight Hills	4	12.7
Sunrise	5	9.9
Kabicona	5	6.1
Broadwater II	9	5.8
Cha Rosa	5	5.2
Pelican Point	7	4.1
New port	5	3.9
Little Pelican	7	3.7
Broadwater I	7	3.1
Liberty Beach	5	2.8
Bowery	6	2.6
Clearview	5	2.5
Linden Park	5	2.5
Frieda	4	2.2
Lakeview	6	2.1
Killarney	4	1.8
Ericksons Addition	4	1.4
Grobe	5	1.4
Victory	4	1.3
Beauty Bay	5	1.2
Pelican Beach	5	1.0
Senns Beach	7	1.0

Median Arsenic Levels (By Beach)



We are not alone

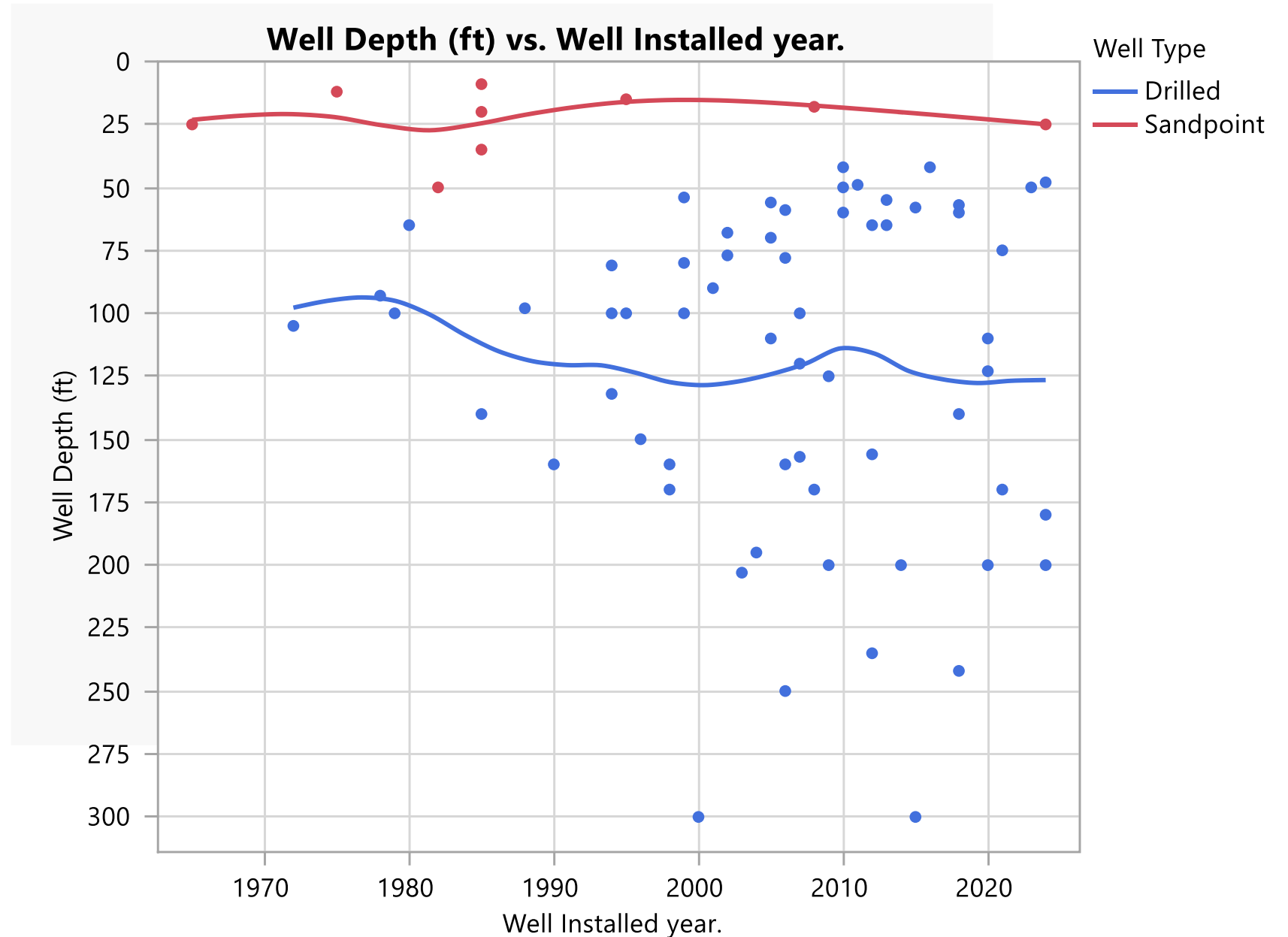
- The U.S. Geological Survey (USGS) has analyzed water samples from more than 5,000 wells across the United States and determined that **at least 7 percent of the wells had arsenic levels above the current EPA standard of 10 ppb.**
- They estimate that about **2.1 million** people in the U.S. may be getting their drinking water from private domestic wells considered to have high concentrations of arsenic.



USEPA Arsenic drinking water standard is 10 micrograms per liter

Well depth and age

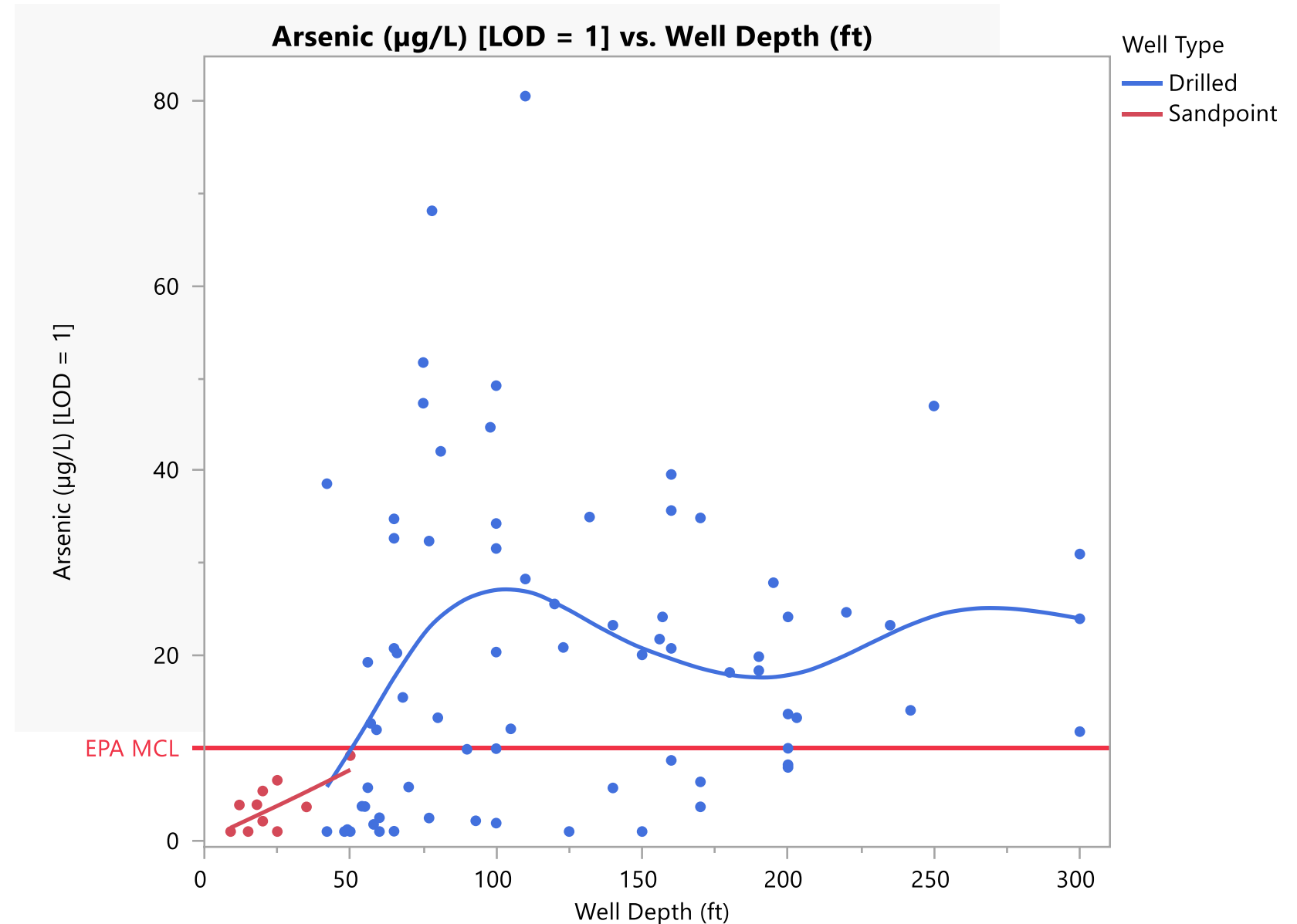
- Many participants reported their well depth, date of installation and type.
- You can see that while sandpoints are less common, they are still being installed.
- Also drilled well depth varies greatly.



Where(28 rows excluded)

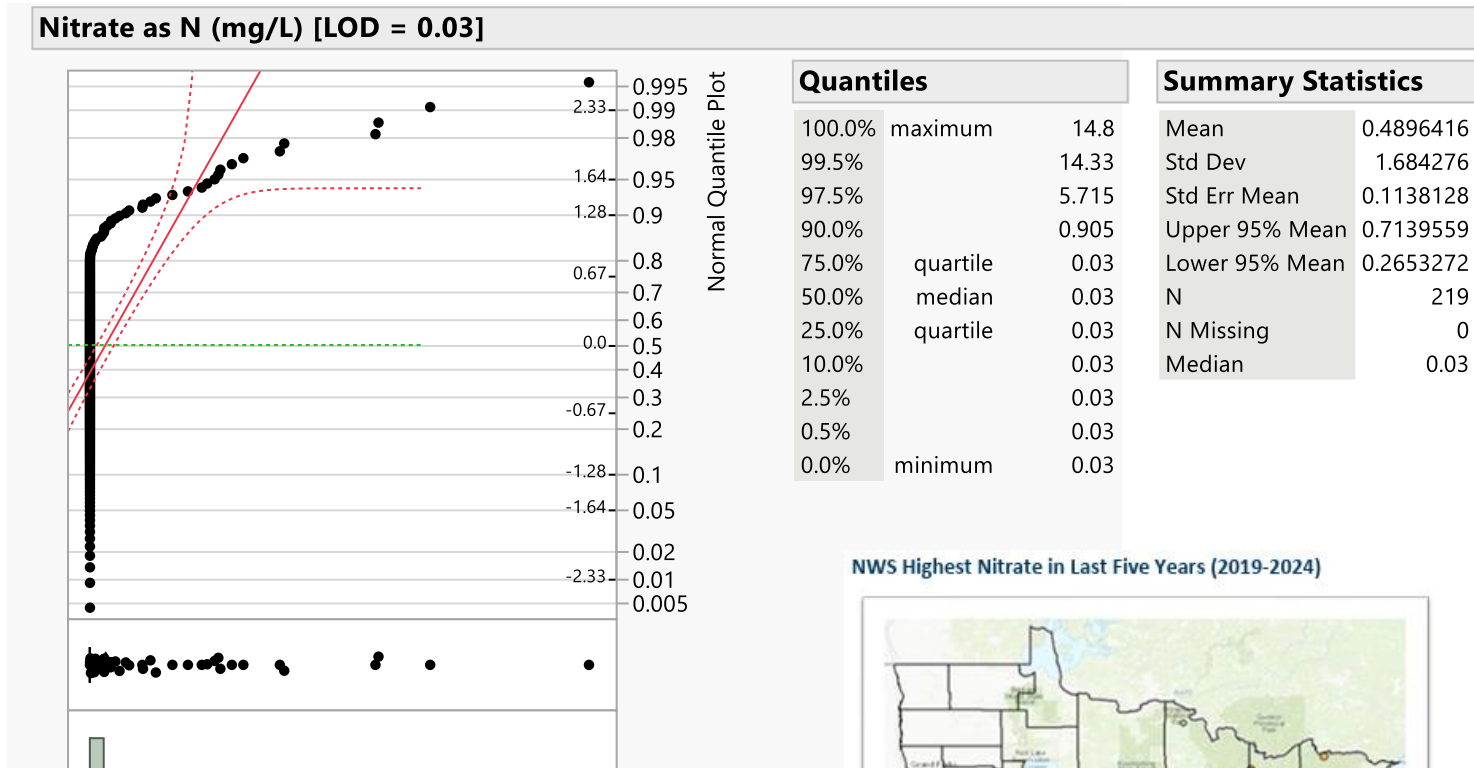
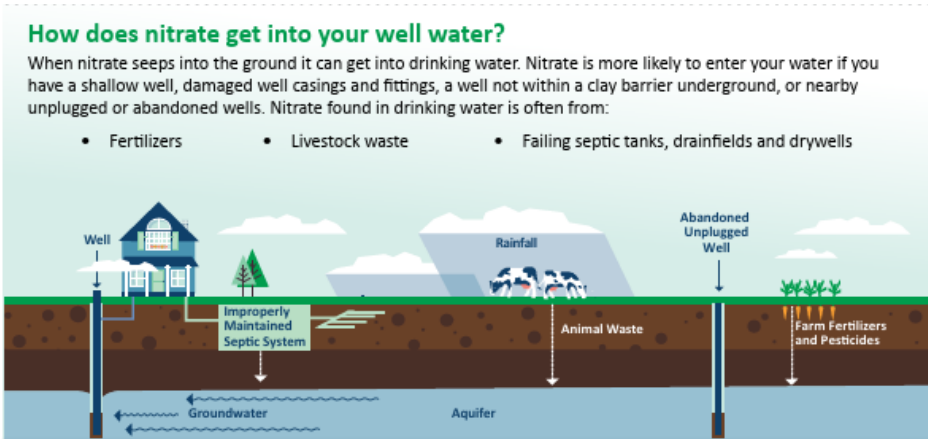
Arsenic vs well depth

- The fact that sandpoints are in the “newer” surface ground water, it is not surprising that they have generally lower As levels.
- For drilled wells, deeper does not mean necessarily higher As levels.

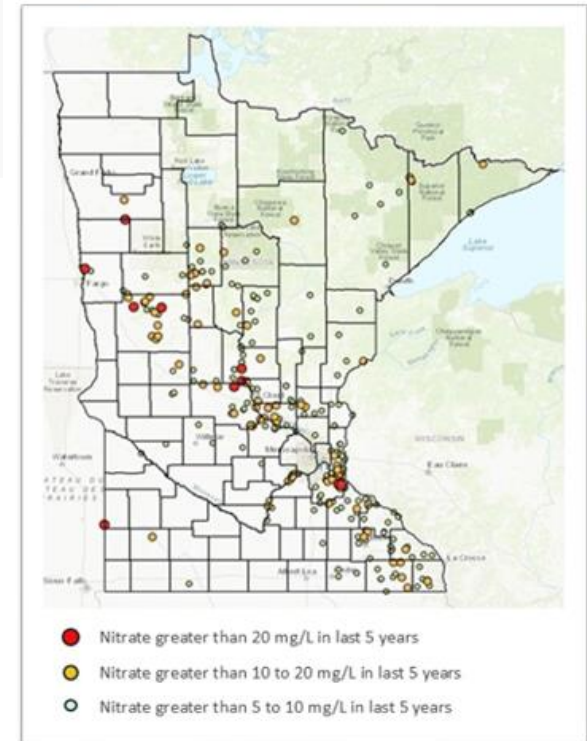


Nitrate

- Nitrate is a regulated drinking water contaminant. MCL = 10 mg/L < 3 is ideal
- It comes from surface sources.
- 2 / 219 wells tested >10 mg/L
- 11 / 219 (5%) wells tested between 3 and 10 mg/L
- 176 / 219 (80%) of wells tested nitrate was not detected above LOD
- High levels of nitrate in drinking water can cause a condition called "blue baby syndrome" (methemoglobinemia), which can be fatal in severe cases.

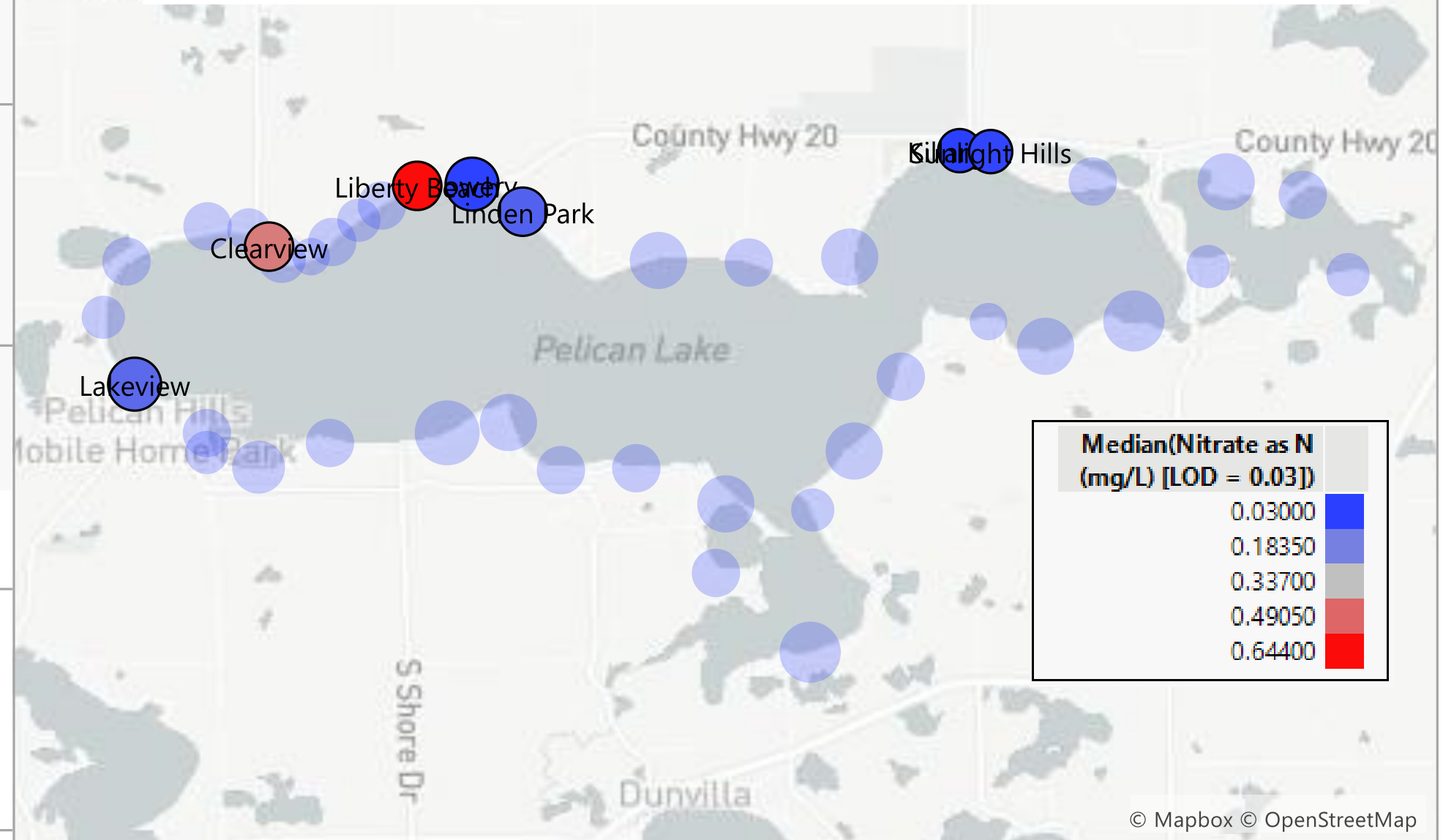


NWS Highest Nitrate in Last Five Years (2019-2024)



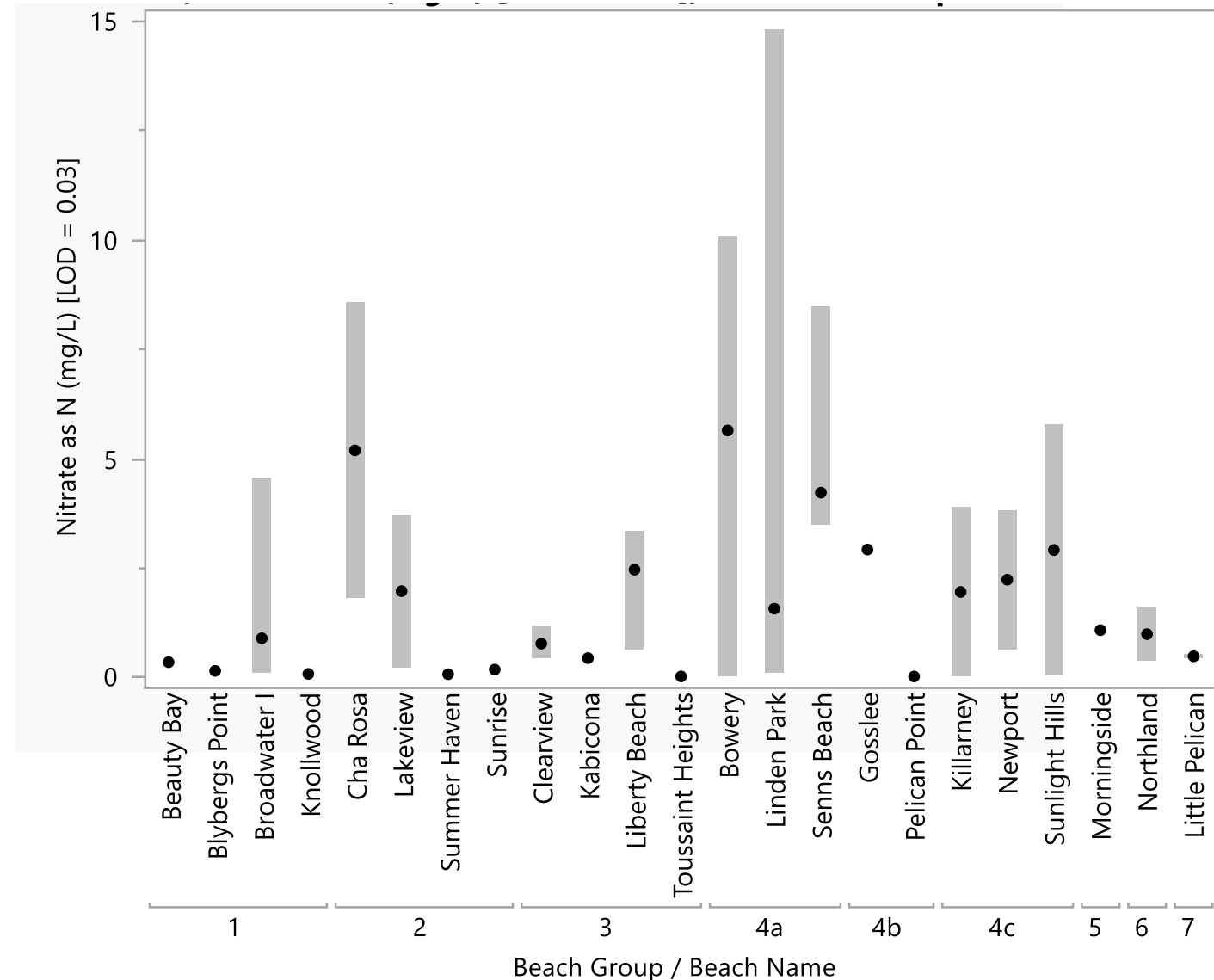
Beach Group	Beach Name	Well Samples	Median Nitrate as N (mg/L) [LOD = 0.03]
3	Liberty Beach	5	0.644
3	Clearview	5	0.454
2	Lakeview	6	0.13
4a	Linden Park	5	0.113
4c	Sunlight Hills	4	0.0444
4a	Bowery	6	0.0371
4c	Killarney	4	0.0323
5	Morningside	3	0.03
6	Northland	7	0.03
6	Provan	5	0.03
6	Mooring Stone	4	0.03
8	Fish Lake	8	0.03
1	Broadwater II	9	0.03
1	Haugens Point	7	0.03
1	Beauty Bay	5	0.03
1	Broadwater I	7	0.03
1	Blybergs Point	5	0.03
5	Viken Bay	7	0.03
7	Little Pelican	7	0.03
5	Midlands F&RW	8	0.03
7	Frieda	4	0.03
3	Ericksons Addition	4	0.03
7	Ottoson	4	0.03
2	Summer Haven	6	0.03
1	Knollwood	5	0.03
2	Cha Rosa	5	0.03
7	Grobe	5	0.03
2	Victory	4	0.03
4b	Pelican Point	7	0.03
4a	Senns Beach	7	0.03
4b	Gosslee	5	0.03
3	Engels Addition	5	0.03
3	Pelican Beach	5	0.03
3	Toussaint Heights	5	0.03
4c	New port	5	0.03
3	Kabicona	5	0.03
2	Sunrise	5	0.03
3	Martin Knoll	3	0.03
2	Andersen Beach	4	0.03
3	Oak Grove	5	0.03
3	Elm	4	0.03

Median Nitrate as N (By Beach)



Median Nitrate as N (By Beach) (176 @ LOD removed)

- Median isn't always the best tool for looking at data.
- In this case, the 80% “zeros” were hiding the signal.
- If we remove the 176 “zeros” (0.03mg/l) values we see definite nitrate “hotspots” on the lake.



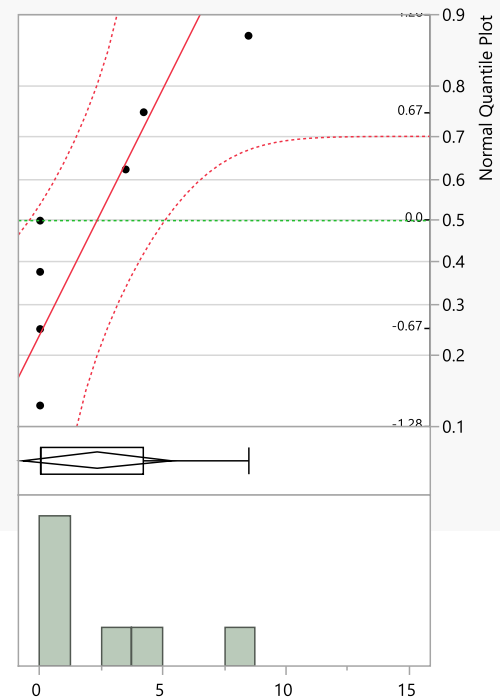
Where(176 rows excluded)

Error band is constructed using the minimum and maximum of the data.

There are beaches with clear trends of higher nitrate levels.

Beach Name=Senns Beach

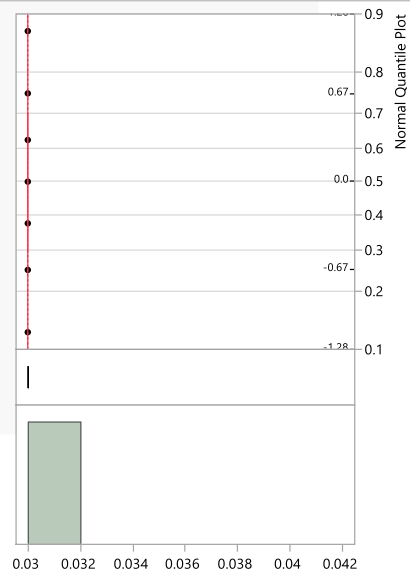
Nitrate as N (mg/L) [LOD = 0.03]



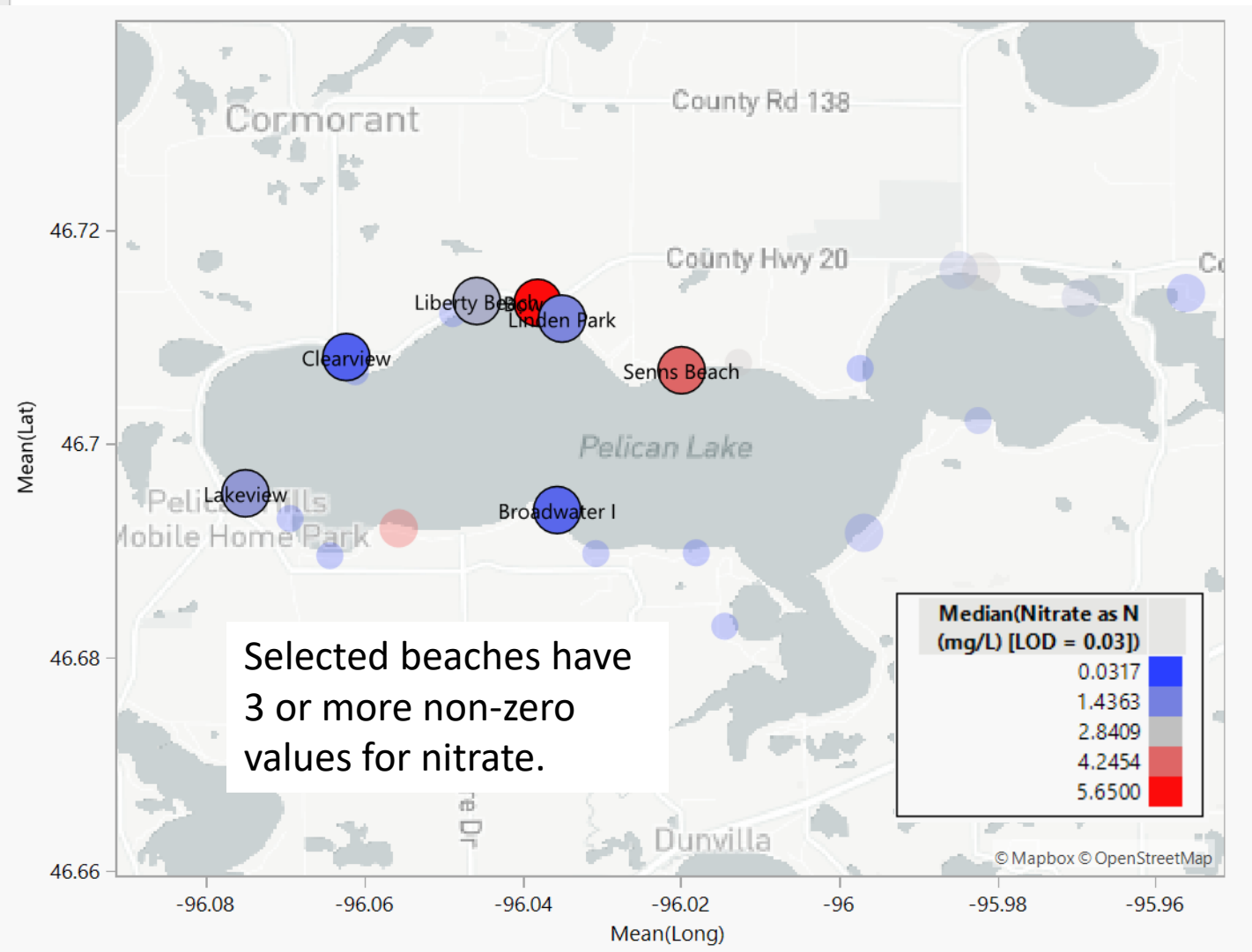
Quantiles			Summary Statistics	
100.0%	maximum	8.48	Mean	2.3328571
99.5%		8.48	Std Dev	3.2649998
97.5%		8.48	Std Err Mean	1.2340539
90.0%		8.48	Upper 95% Mean	5.3524783
75.0%	quartile	4.23	Lower 95% Mean	-0.686764
50.0%	median	0.03	N	7
25.0%	quartile	0.03	N Missing	0
10.0%		0.03		
2.5%		0.03		
0.5%		0.03		
0.0%	minimum	0.03		

Beach Name=Haugens Point

Nitrate as N (mg/L) [LOD = 0.03]

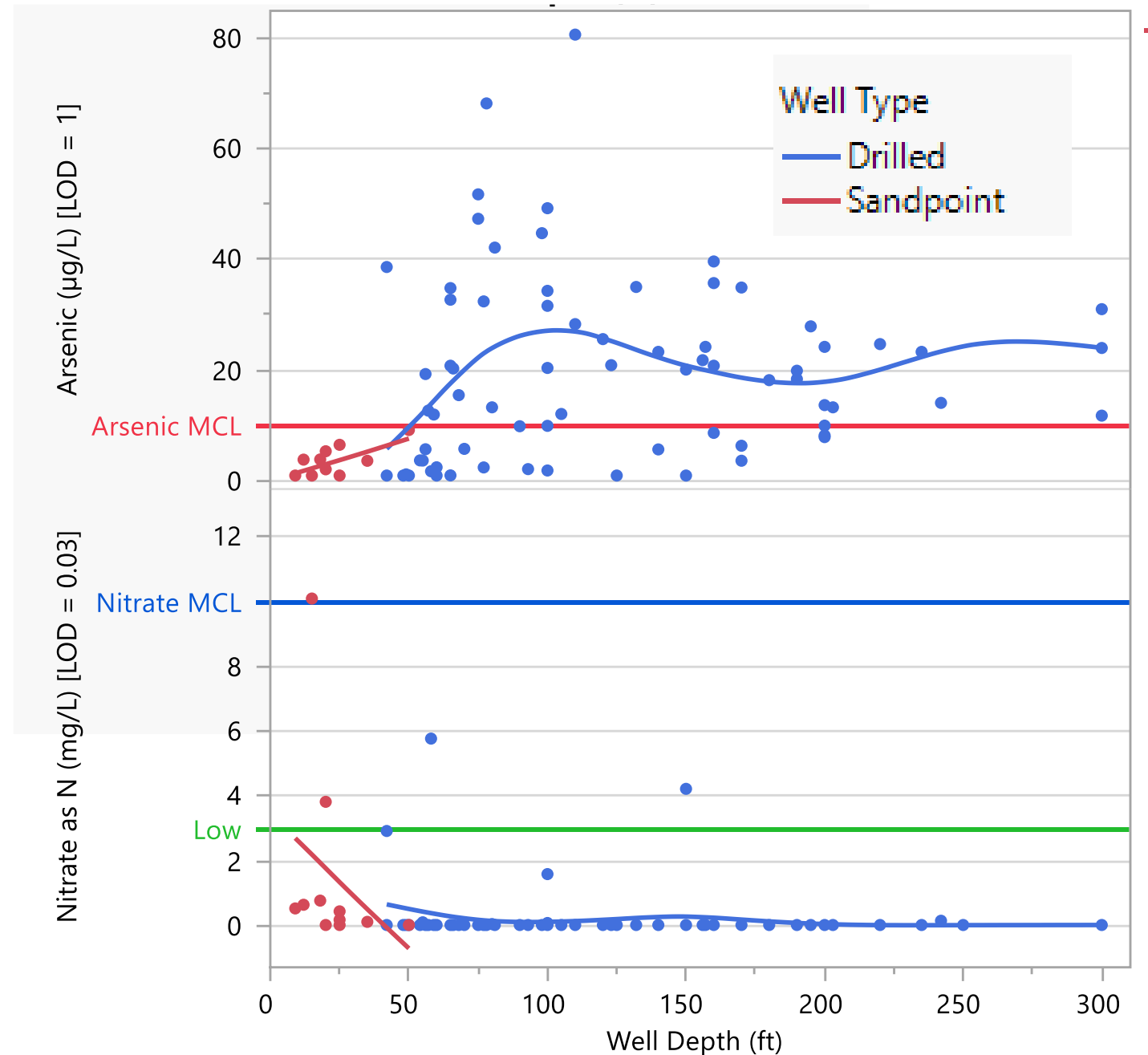


Senn's Beach (Above) is not likely a random blip. Note that of the 7 samples, 3 are positive, vs Haugen's Pt 7 samples with zero positive. Both have median = 0.03 (LOD)



Well Depth vs Nitrate

- It seems that while shallow sandpoint wells have lower arsenic levels, the trade off is potential for increased nitrate from surface water contamination.



Where(28 rows excluded)

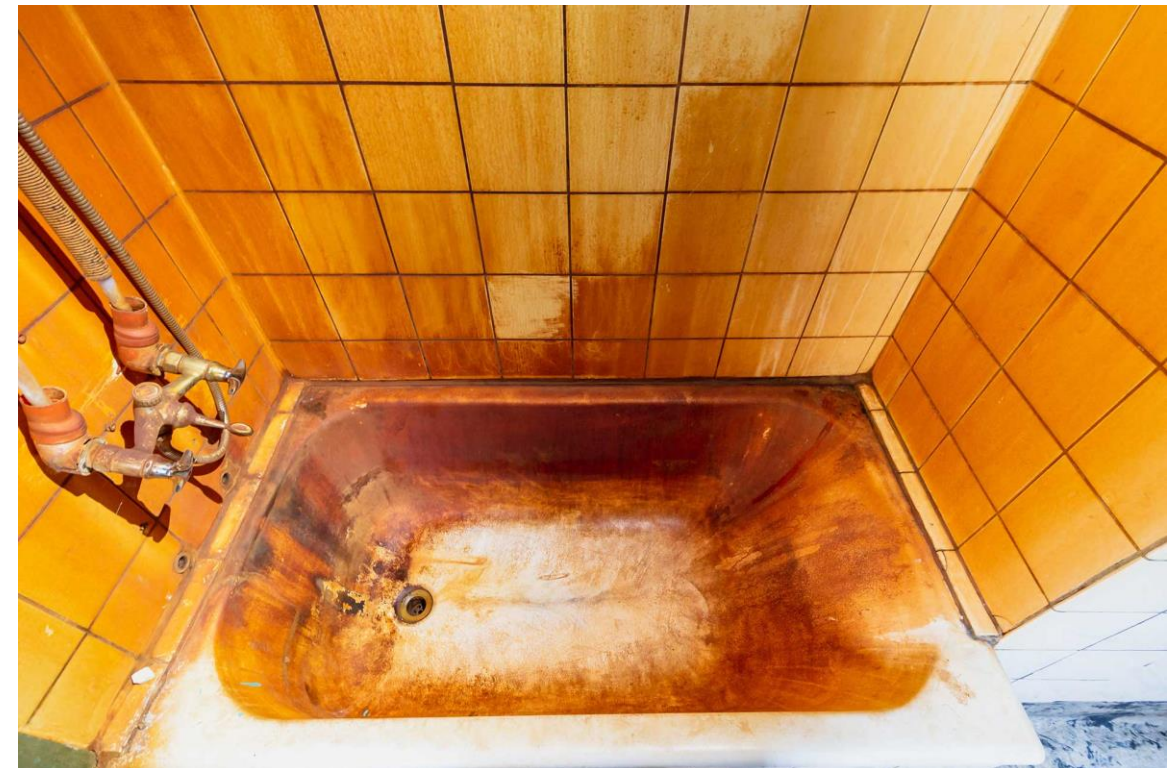
Iron in drinking water

- Iron in drinking water does not pose a health risk.
- It can cause issues with taste and smell of water and discoloration of household fixtures.
- It can be effectively removed by softening or oxygen induction iron oxidation followed by precipitate particle filtering.
- Reverse osmosis works well o softened water to remove bulk of iron.

Periodic Table of the Elements

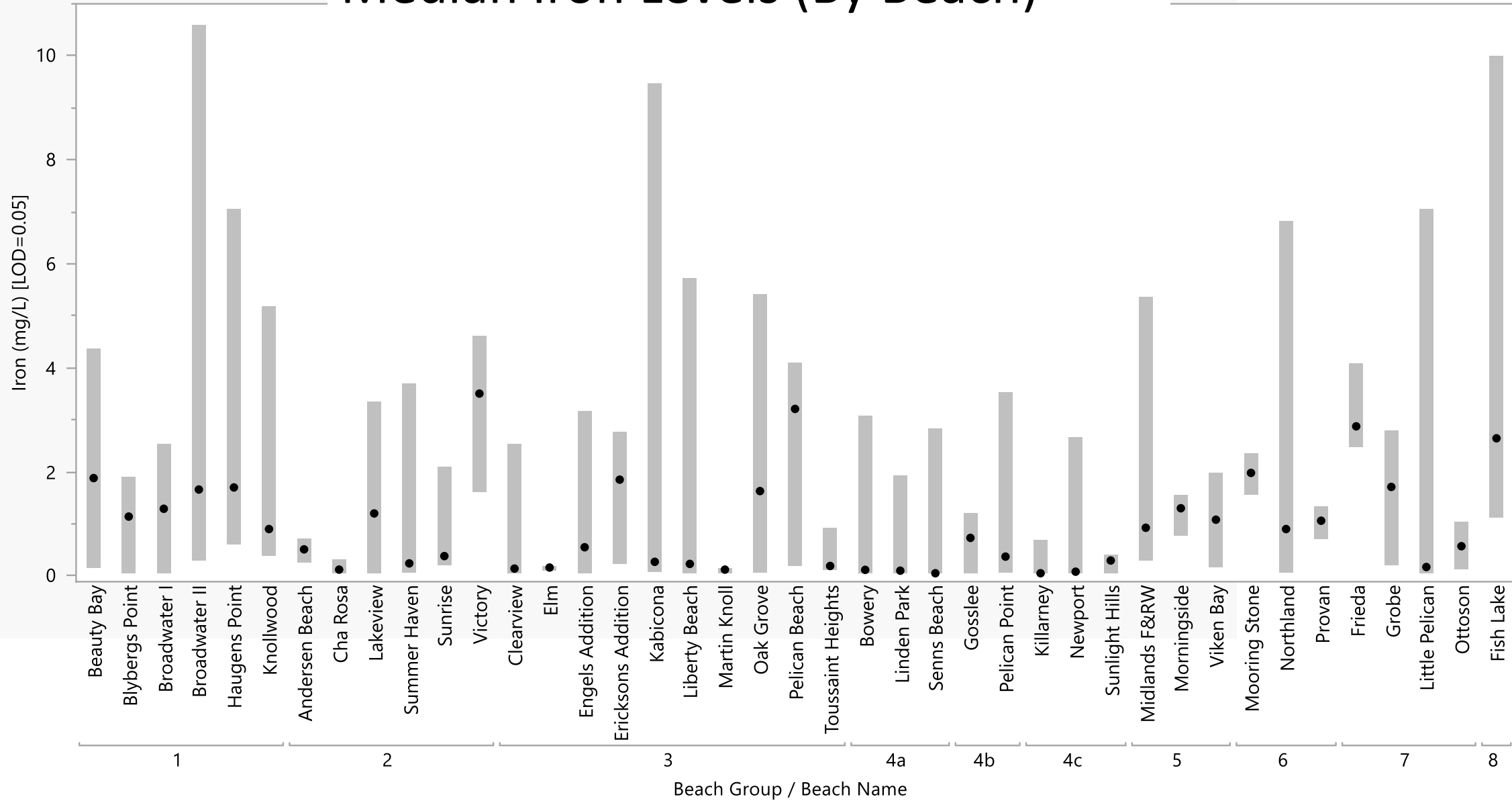
The image shows a standard periodic table of elements. The element Iron (Fe) is highlighted with a red circle. The table includes element symbols, atomic numbers, and names. A legend at the top left explains the color coding for the state of matter (gas, liquid, solid, unknown) and the subcategory in the metal-metalloid-nonmetal trend (alkali metals, alkaline earth metals, transition metals, lanthanides, actinides, post-transition metals, metalloids, reactive nonmetals, noble gases, and unknown chemical properties).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
IA	IIA	IIIB	IVB	VB	VIB	VII	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.63	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.084	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium 209	85 At Astatine 210	86 Rn Radon 222
87 Fr Francium 223	88 Ra Radium 226	89-103 Actinides	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 266	107 Bh Bohrium 264	108 Hs Hassium 277	109 Mt Meitnerium 268	110 Ds Darmstadtium 271	111 Rg Roentgenium 272	112 Cn Copernicium 285	113 Nh Nihonium 284	114 Fl Flerovium 289	115 Mc Moscovium 288	116 Lv Livermorium 293	117 Ts Tennessine 294	118 Og Oganesson 294
89 La Lanthanum 138.905	90 Ce Cerium 140.12	91 Pr Praseodymium 140.908	92 Nd Neodymium 144.24	93 Pm Promethium 145	94 Sm Samarium 150.36	95 Eu Europium 151.964	96 Gd Gadolinium 157.25	97 Tb Terbium 158.925	98 Dy Dysprosium 162.50	99 Ho Holmium 164.930	100 Er Erbium 167.259	101 Tm Thulium 168.930	102 Yb Ytterbium 173.054	103 Lu Lutetium 174.967			
105 Ac Actinium 227	106 Th Thorium 232.038	107 Pa Protactinium 231.036	108 U Uranium 238.029	109 Np Neptunium 237.048	110 Pu Plutonium 244	111 Am Americium 243	112 Cm Curium 247	113 Bk Berkelium 247	114 Cf Californium 251	115 Es Einsteinium 252	116 Fm Fermium 257	117 Md Mendelevium 258	118 No Nobelium 259	119 Lr Lawrencium 262			



Median Iron Levels (By Beach)

● Median



Where(28 rows excluded)
Error band is constructed using the minimum and maximum of the data.

Manganese in drinking water

- Manganese is an essential trace mineral for human health. Humans should get about 2mg / day. Bone, brain, immune function critical.
- Excess manganese will cause real health effects.
- It can cause issues with taste and smell of water and discoloration of household fixtures (Usually black).
- It can be effectively removed by softening or reverse osmosis.

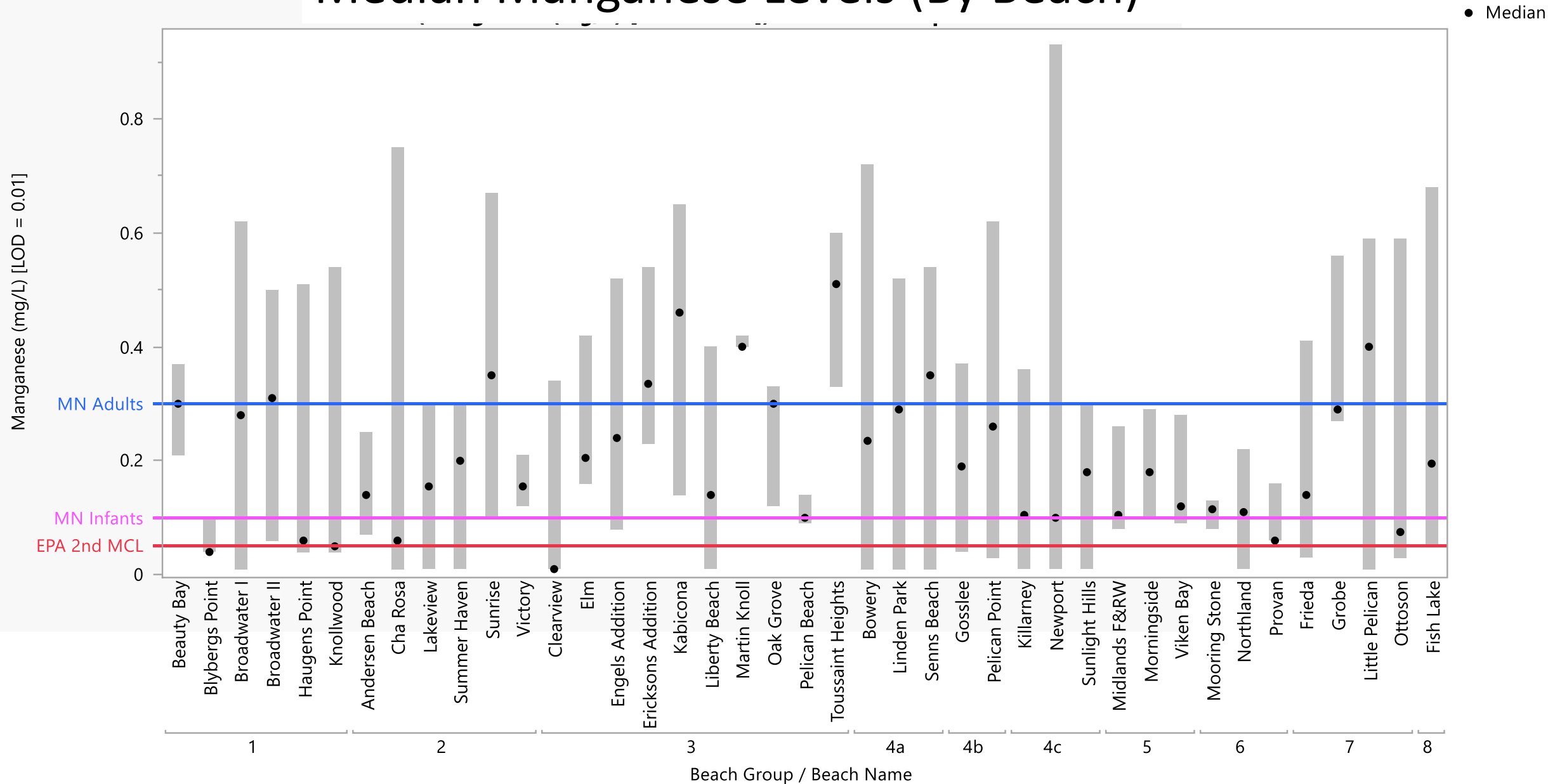
Periodic Table of the Elements

The image shows a standard periodic table of elements. The element Manganese (Mn) is highlighted with a red circle. It is located in the 7th period, 8th group, and is part of the d-block. The table includes element symbols, atomic numbers, and names. A legend at the top left explains the color coding for the states of matter and subcategories in the metal-metalloid-nonmetal trend.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
IA	IIA	IIIB	IVB	VB	VIB	VII	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 18.998	10 Ne Neon 20.18
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.69	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.63	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium 209	85 At Astatine 210	86 Rn Radon 222
87 Fr Francium 223	88 Ra Radium 226	89-103 Actinides	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 266	107 Bh Bohrium 264	108 Hs Hassium 277	109 Mt Meitnerium 268	110 Ds Darmstadtium 271	111 Rg Roentgenium 272	112 Cn Copernicium 285	113 Nh Nihonium 284	114 Fl Flerovium 289	115 Mc Moscovium 288	116 Lv Livermorium 293	117 Ts Tennessine 289	118 Og Oganesson 294
57 La Lanthanum 138.905	58 Ce Cerium 140.12	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 145	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.930	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.967			
89 Ac Actinium 227	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.083	99 Es Einsteinium 252.083	100 Fm Fermium 257.105	101 Md Mendelevium 258.105	102 No Nobelium 259.108	103 Lr Lawrencium 260.107			

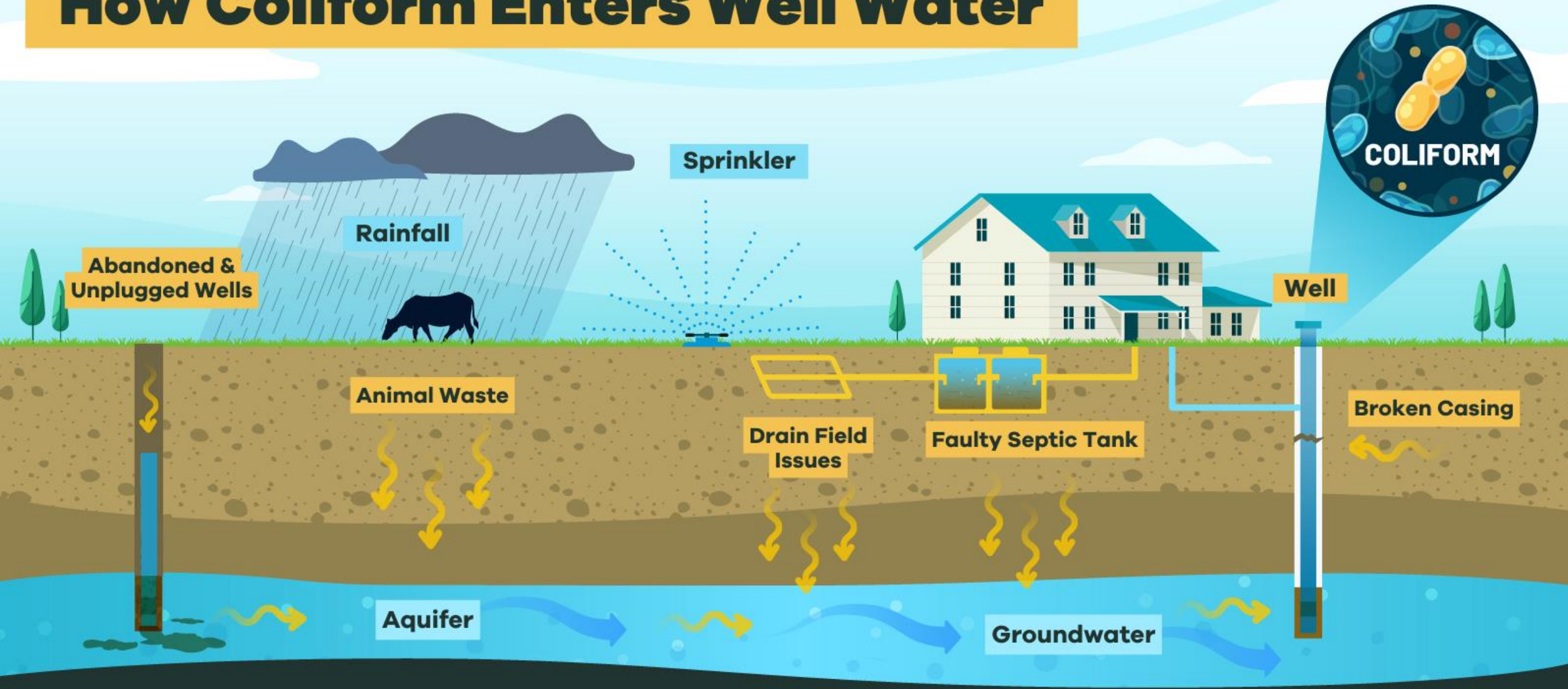


Median Manganese Levels (By Beach)



Where(28 rows excluded)
Error band is constructed using the minimum and maximum of the data.

How Coliform Enters Well Water



There are many ways coliform can enter the groundwater that supplies your well. Be alert and test annually.

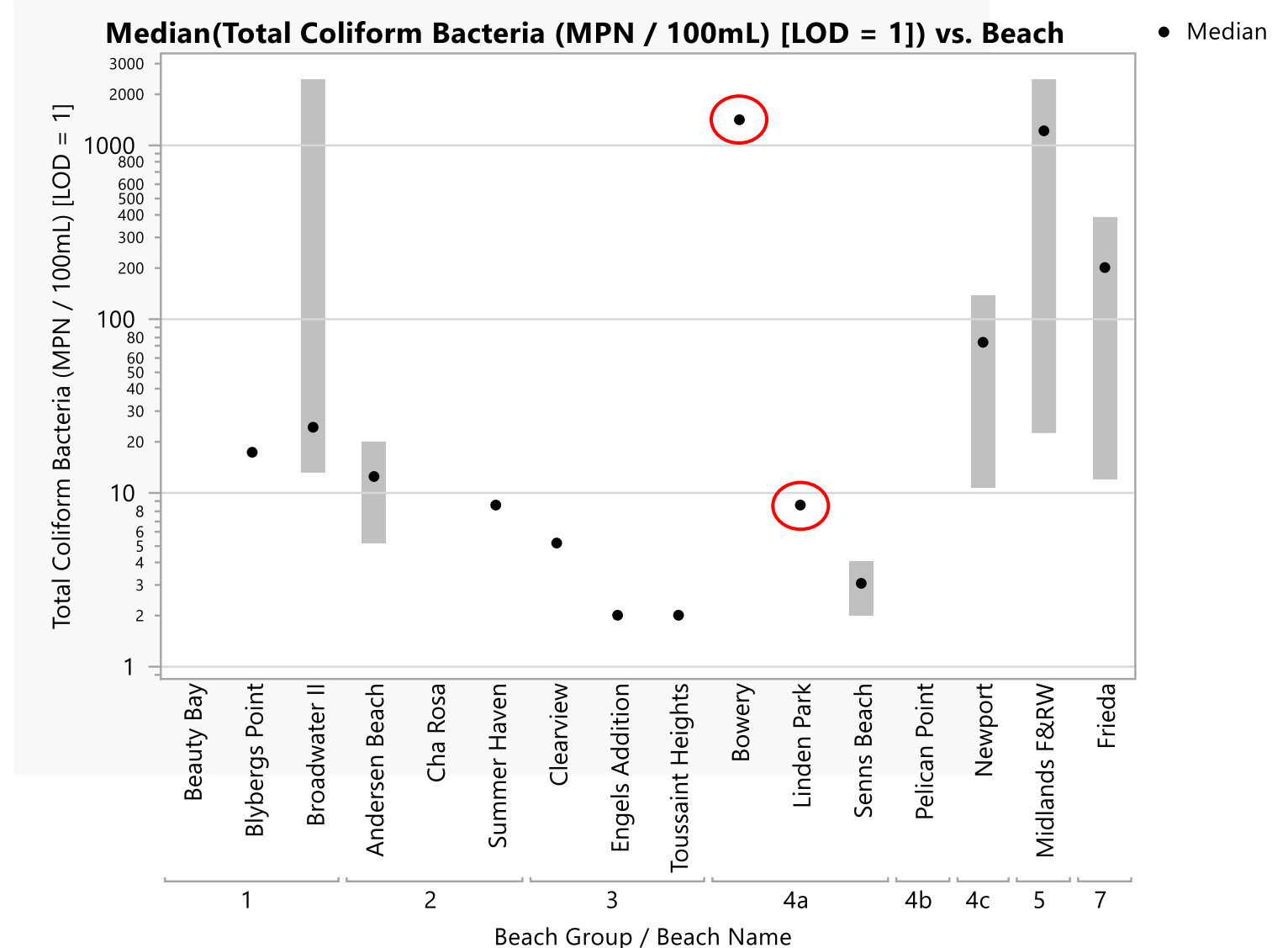
Original: Michigan Department of Health and Human Services

 **tap score**

mytapscore.com

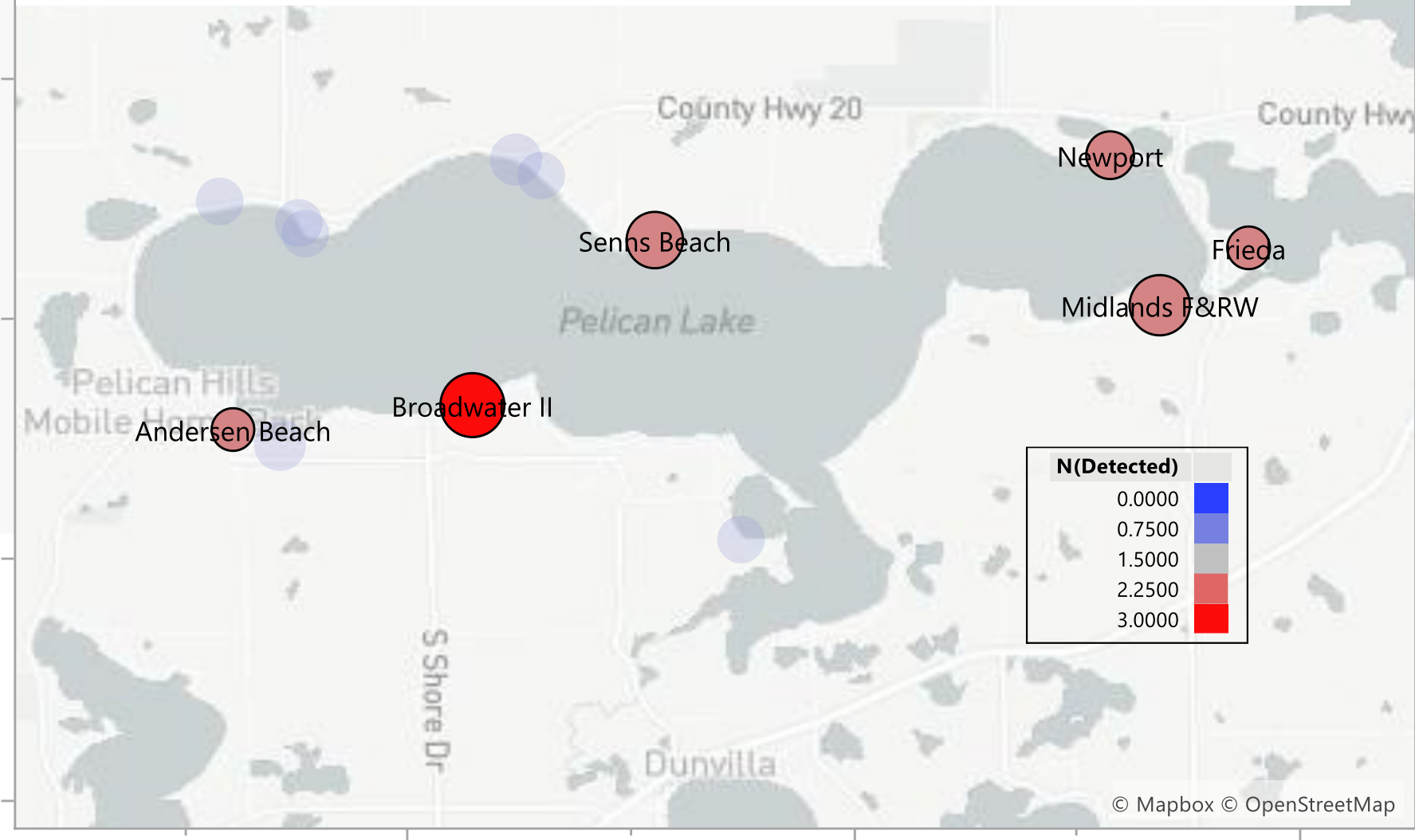
Coliform Bacteria in Drinking Water

- The study found coliform bacteria present in 23 (11%) of the 219 raw well water samples.
- 2 of the 28 post-softened samples also tested positive for coliforms.
- Despite sanitization of faucet on site, it is very possible that the bacteria were introduced during sampling.
- That said, it seems unlikely that multiple sampling errors will occur within a beach.
- Two of the samples (red circles) tested positive for *E. coli* as part of the coliform population.
- Wells with coliform contamination should be remediated by a professional.



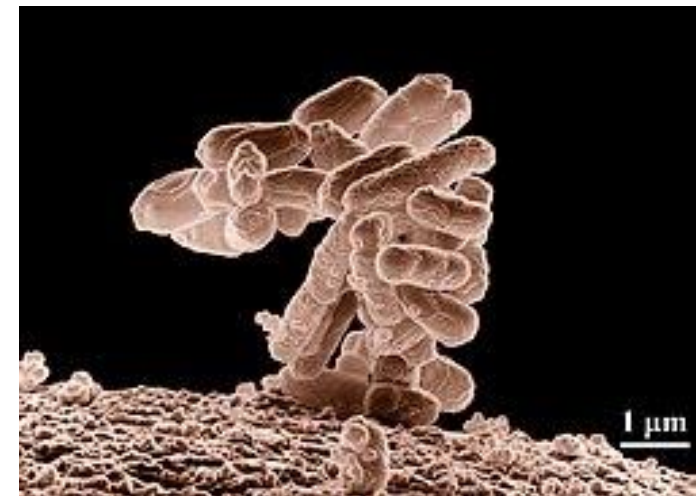
Beaches with multiple coliform detections in raw well water samples

Beach Group	Beach Name	Well Samples	Coliform Bacteria Detected [LOD = 1]	% Reported Sandpoint
1	Broadwater II	9	3	0%
2	Andersen Beach	4	2	0%
4a	Senns Beach	7	2	43%
4c	Newport	5	2	60%
5	Midlands F&RW	8	2	0%
7	Frieda	4	2	50%
1	Blybergs Point	5	1	0%
2	Summer Haven	6	1	50%
3	Clearview	5	1	60%
3	Engels Addition	5	1	0%
3	Toussaint Heights	5	1	0%
4a	Bowery	6	1	25%
4a	Linden Park	5	1	40%
1	Beauty Bay	5	0	20%
1	Broadwater I	7	0	43%
1	Haugens Point	7	0	0%
1	Knollwood	5	0	0%
2	Cha Rosa	5	0	33%
2	Lakeview	6	0	75%
2	Sunrise	5	0	50%
2	Victory	4	0	33%
3	Elm	4	0	0%
3	Ericksons Addition	4	0	50%
3	Kabicona	5	0	50%
3	Liberty Beach	5	0	33%
3	Martin Knoll	3	0	0%
3	Oak Grove	5	0	0%
3	Pelican Beach	5	0	0%
4b	Gosslee	5	0	20%
4b	Pelican Point	7	0	20%
4c	Killarney	4	0	
4c	Sunlight Hills	4	0	0%
5	Morningside	3	0	33%
5	Viken Bay	7	0	0%
6	Mooring Stone	4	0	0%
6	Northland	7	0	17%
6	Provan	5	0	0%
7	Grobe	5	0	75%
7	Little Pelican	7	0	17%
7	Ottoson	4	0	0%
8	Fish Lake	8	0	0%



Coliform Bacteria do not belong in your water supply.

- Symptoms of a coliform bacteria infection can include diarrhea, stomach cramps, nausea, and headaches.
- *Citrobacter*, *Enterbacter*, *Klebsiella*, *Escherichia* are some of the genera in the coliform group.
- Wells, piping, heaters, softeners can all harbor coliforms.
- Chemical treatment (bleaching) is typically used to clean system.
- If new coliforms come in after treatment, the water source may be contaminated.



Accidental sampling of softened well water gives some interesting results.

	Raw well water (n=219)		
Measurement	Mean	Median	EPA Limit
Arsenic ($\mu\text{g/L}$) [LOD = 1]	14.71	6.89	10
Iron (mg/L) [LOD=0.05]	1.46	0.87	n/a
Manganese (mg/L) [LOD = 0.01]	0.22	0.18	0.05
Nitrate as N (mg/L) [LOD = 0.03]	0.49	0.03	10
Total Coliform Bacteria (MPN / 100mL) [LOD = 1]	33.0	1.0	<1
Total Hardness (mg/mL) [LOD = 6.62]	322.7	325.0	n/a

Samples from softened well water sources show drastically reduced median hardness (-98%), iron (-94%), and manganese (-94%) levels, but softening had much smaller effect on arsenic level reduction (-55%) and no influence (or positive?) on mean Nitrate.

Next Steps

- Property owners that at on beaches with elevated risks should probably have their water tested. (So should everyone else)
- If you have elevated Arsenic, Manganese, or coliforms were detected, you should probably look into addressing this.
 - Well maintained softeners do a good job with total hardness, iron, and manganese. Not so well for arsenic and nitrate.
 - Reverse osmosis systems can remove a lot of these contaminants but can be costly to maintain and just fix the drinking / cooking water tap.
 - Bacterial contamination should be confirmed by a retest and then remediated (and retested).
- The LID and its members can use these results to weigh the benefit of engineering solutions (like municipal water treatment and delivery) if desired.

ANY
QUESTIONS?



My water treatment system



Menards in DL - \$250 R/O system

