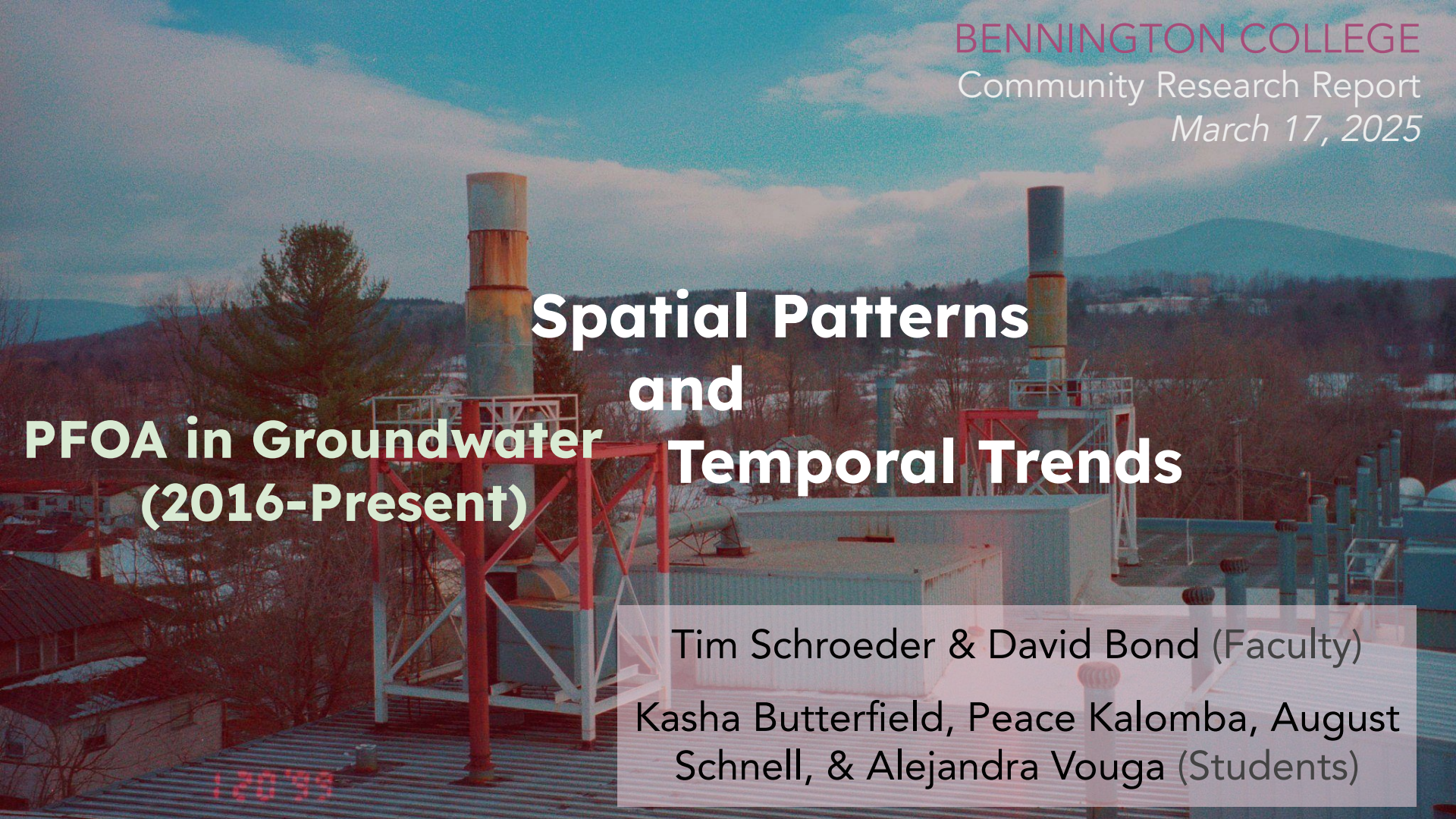

BENNINGTON COLLEGE
Community Research Report
March 17, 2025

PFOA in Groundwater (2016-Present)

Spatial Patterns and Temporal Trends

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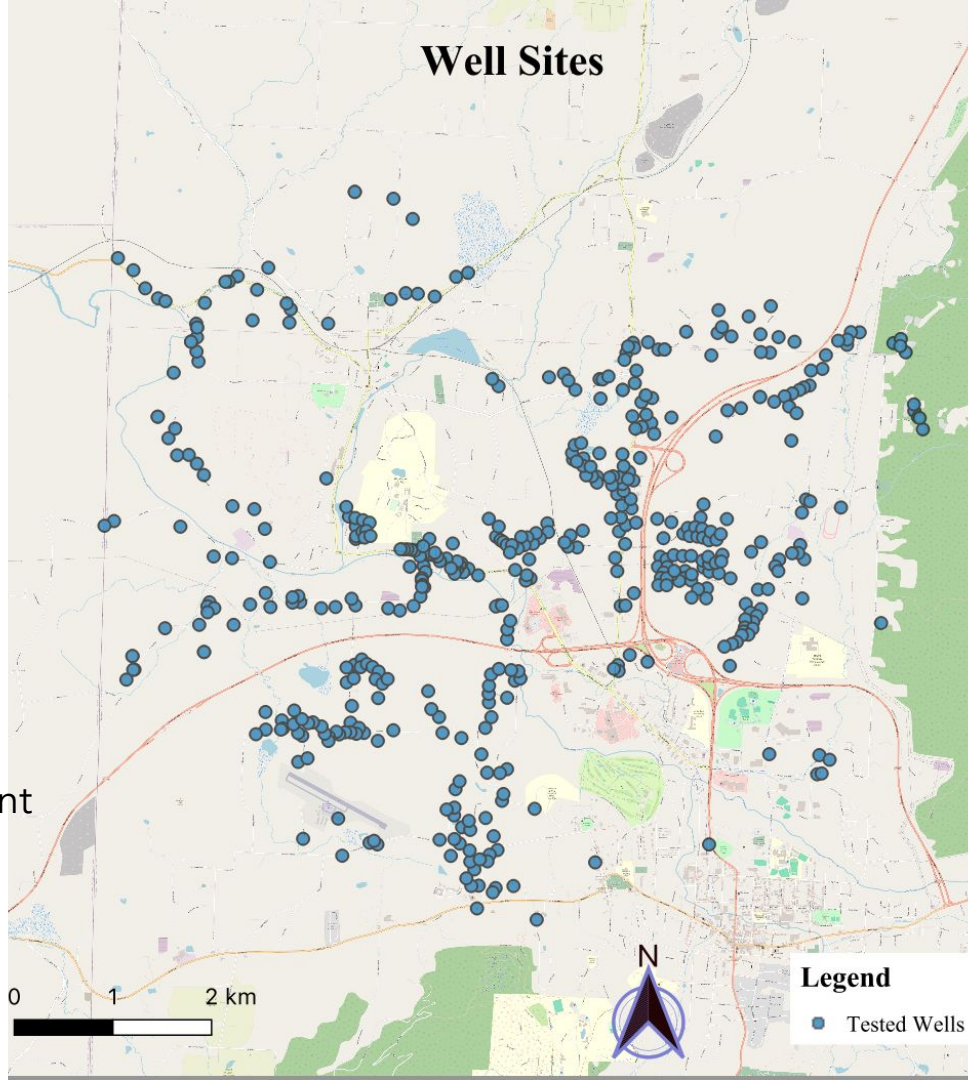
PFOA Dataset Overview

(data from VT DEC)

- PFOA data from ongoing monitoring of private wells around Bennington (2016 to present).
- Over 6,000 samples from Bennington Region in dataset.

Bennington College analysis:

- We cleaned up full dataset.
- We only considered samples from raw water or POET Influent (unfiltered groundwater).
- We did not include samples from POET Midpoint and POET Effluent (drinking water post-GAC filter).
- We analyzed 4,797 samples from 698 unique wells in Bennington Region.



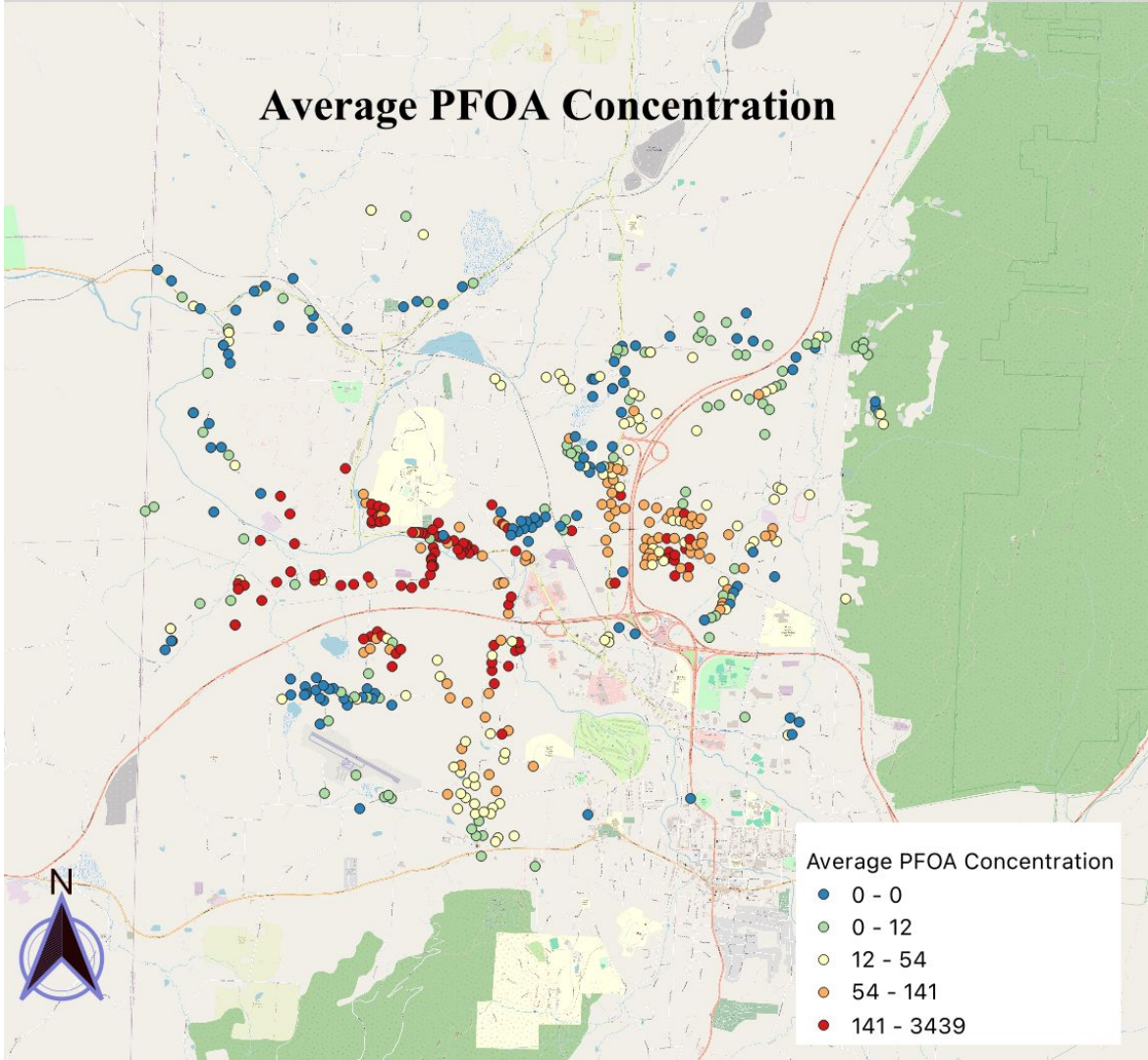
DATASET: Compiled all data on PFOA levels in wells (and calculated average PFOA level in each well) and GPS coordinates for each well.

ANALYZED our dataset for:

1. Spatial Patterns
2. Temporal Trends

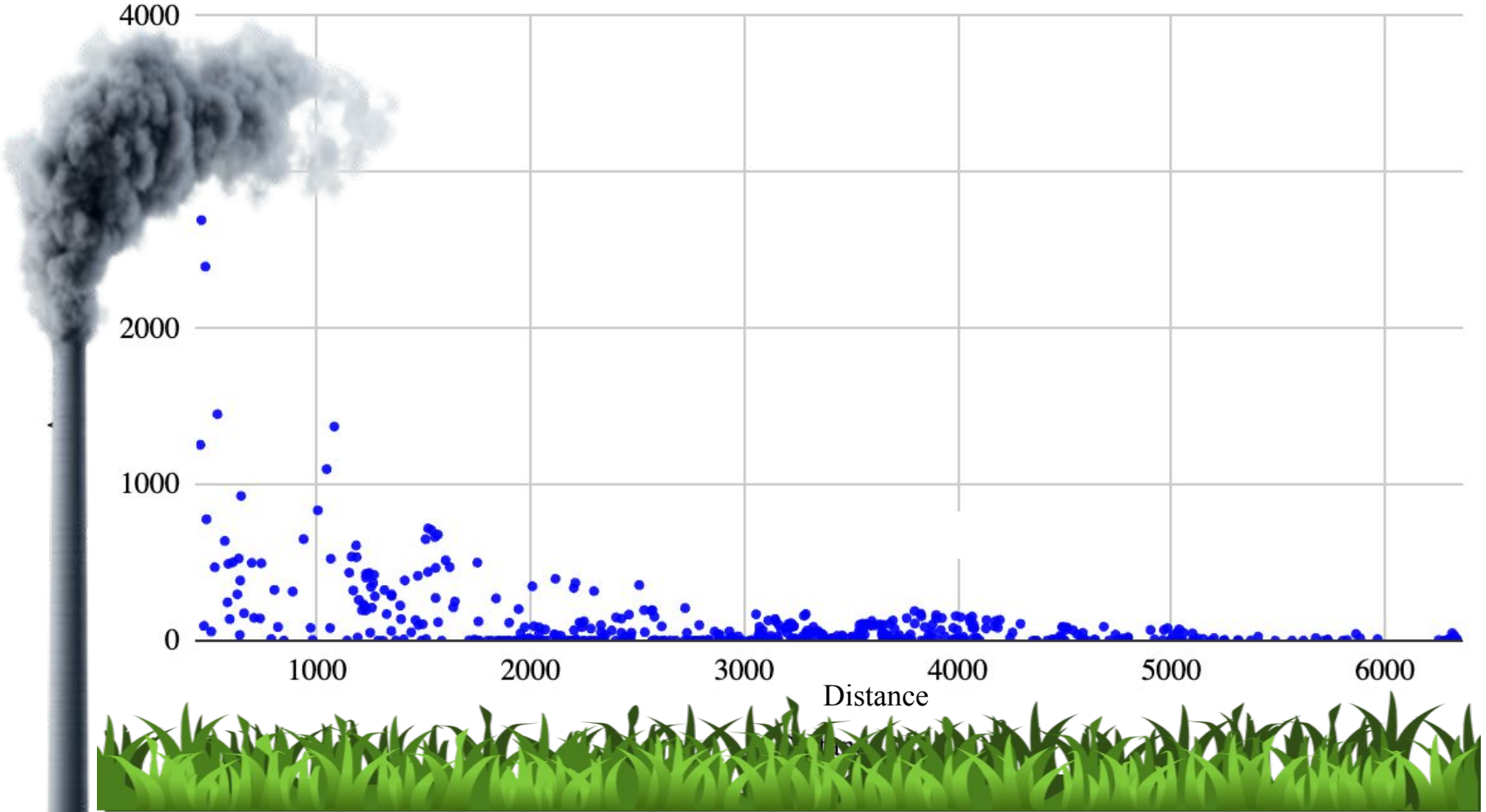
VERMONT
Drinking Water Standard (PFOA):
20 ppt

FEDERAL (EPA)
Drinking Water Standard (PFOA):
4 ppt

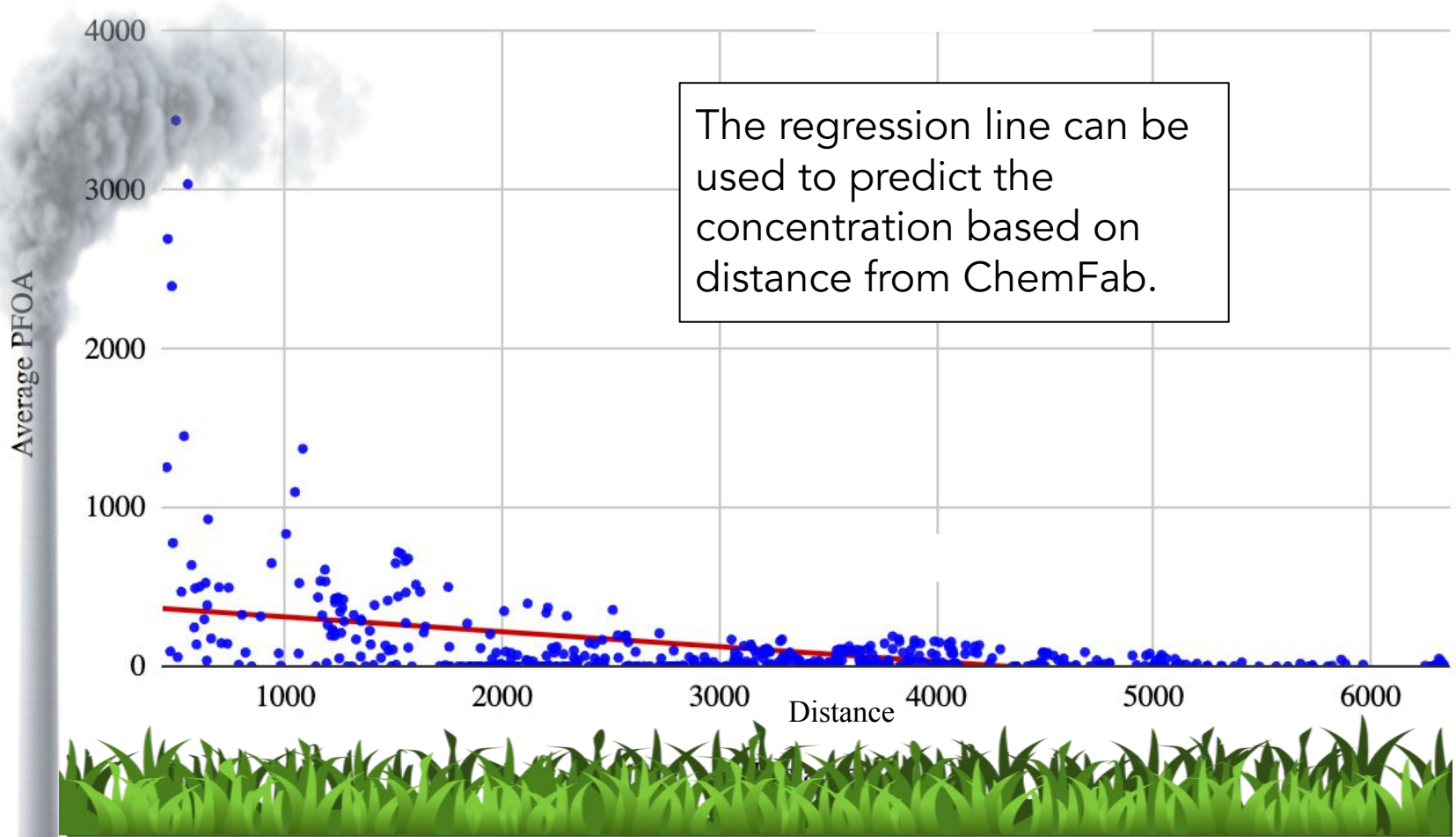


1. Spatial Patterns

Average PFOA vs. Distance from ChemFab



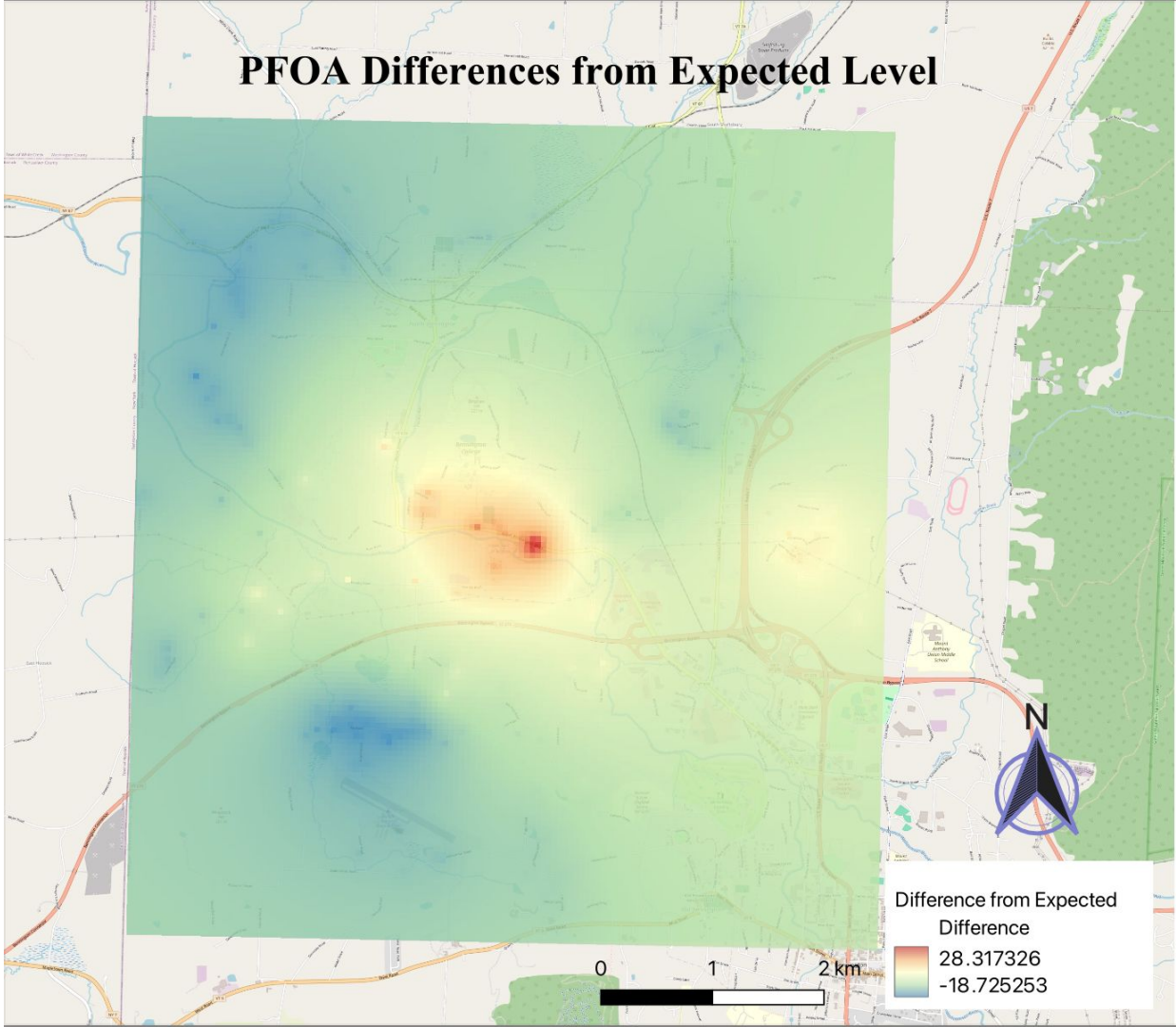
Average PFOA vs. Distance from ChemFab



The regression line can be used to predict the concentration based on distance from ChemFab.

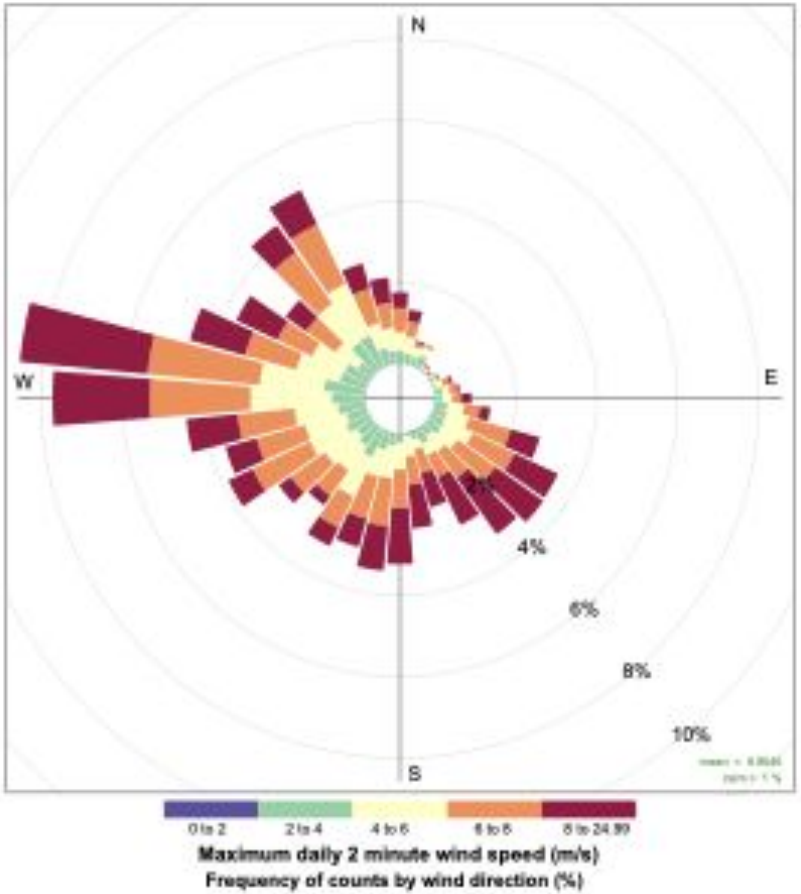
Interpolation/averaging map of contamination divergence from predicted value

Red & Orange: Higher concentration than expected
Green & Blue: Lower concentration than expected
Yellow: Roughly consistent with the expected pattern.



Predominant Wind Directions Recorded Bennington Airport over a 10 year Period

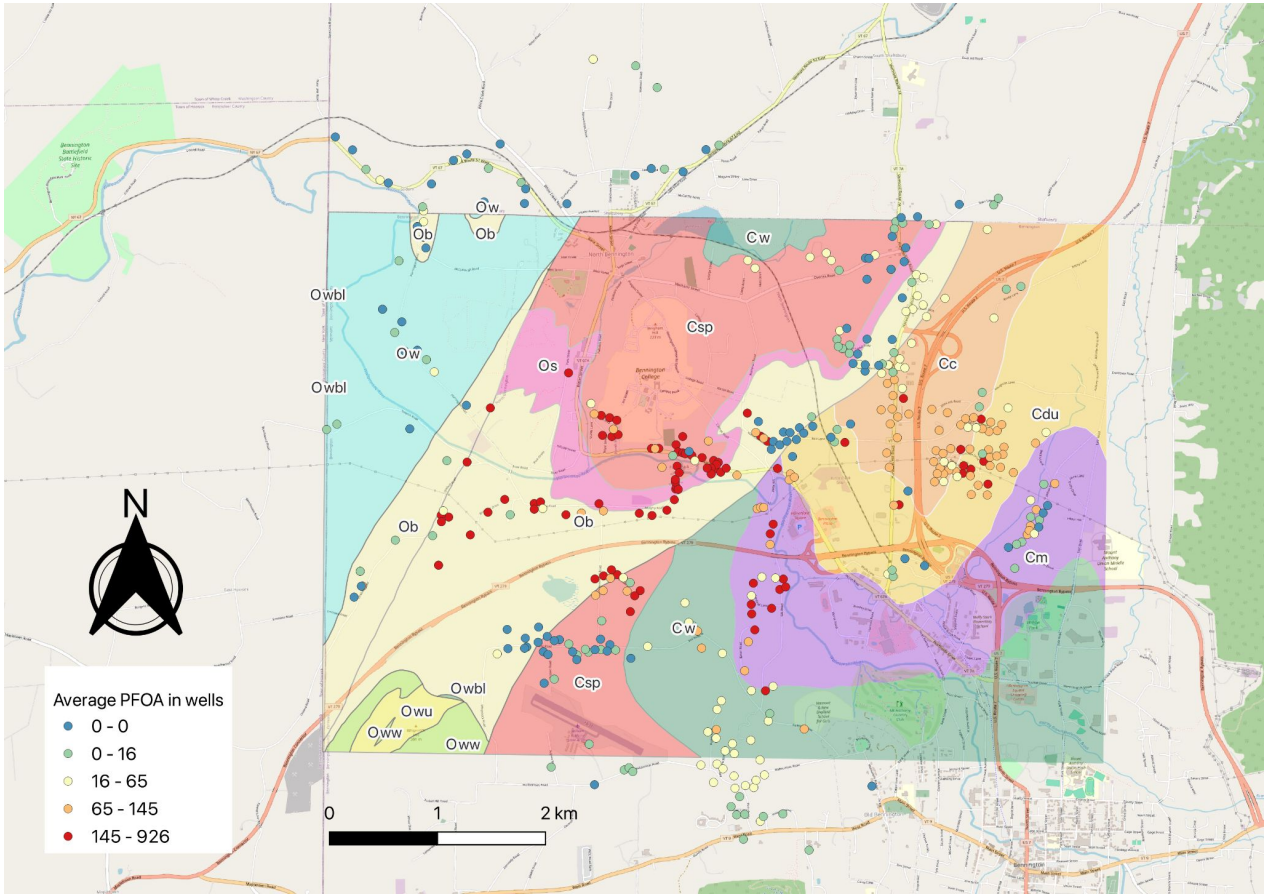
Winds blowing from the Northwest to the Southeast



Are some bedrock formations more contaminated than others?

- To analyze the patterns of the PFOA levels with the bedrock formations we did an overlay analysis of the wells with the bedrock geologic map layer in QGIS software
- Intersected the wells and the bedrock formations
- Statistical analysis: ANOVA and Tukey Pairwise Test

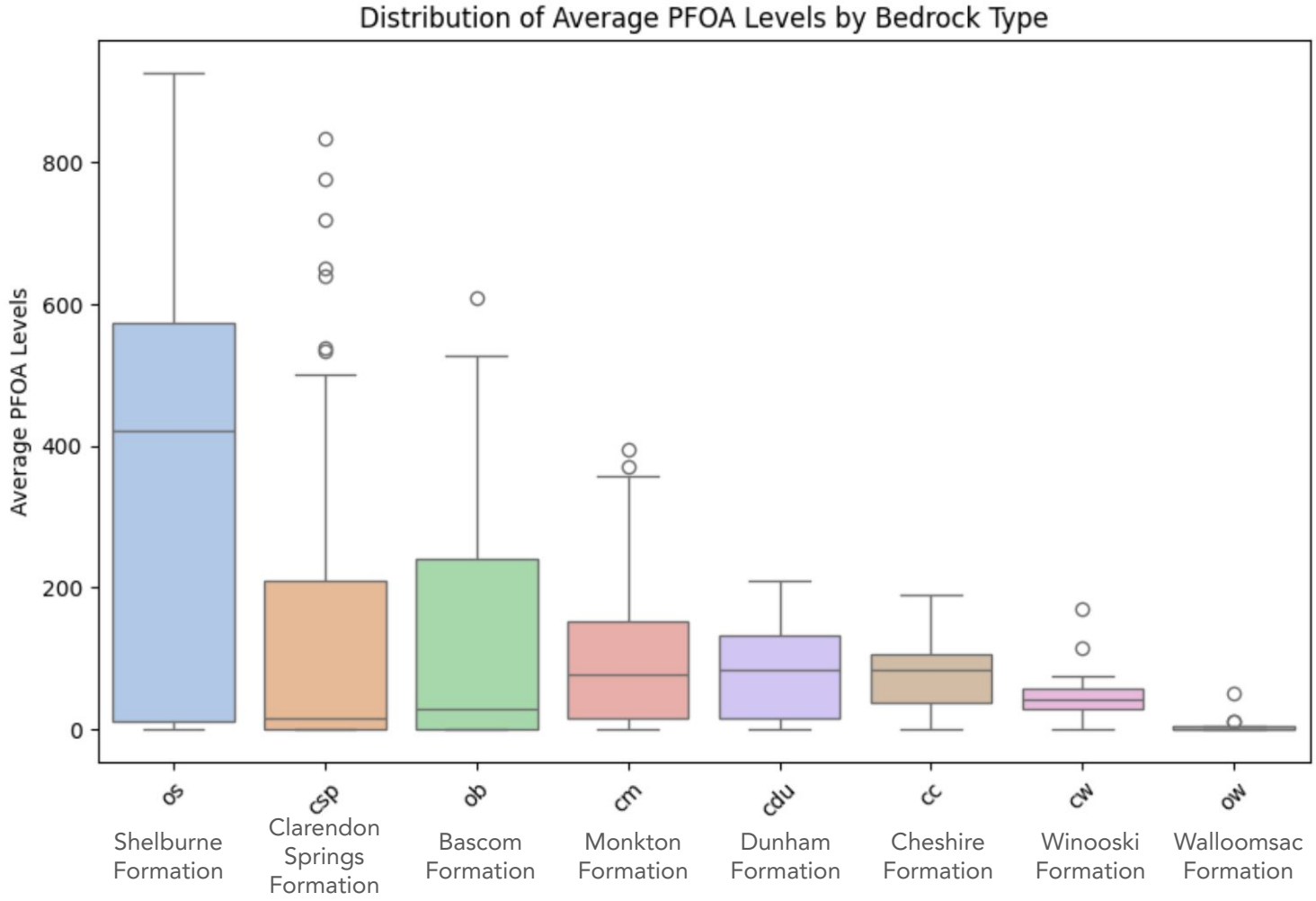
Bennington Bedrock Map



Lithcodes:

- Oww - Whipstock Breccia Member
- Owu - Quartzose and Siltstone Phyllite, Chert horizons in the Whipstock Breccia
- Owbl - Black Slate and Gray to Blue Chert Member
- Ow - Walloomsac Formation
- Os - Shelburne Formation
- Ob - Bascom Formation
- Cw - Winooski Formation
- Csp - Clarendon Springs Formation
- Cm - Monkton Formation
- Cdu - Dunham Formation
- Cc - Cheshire Formation

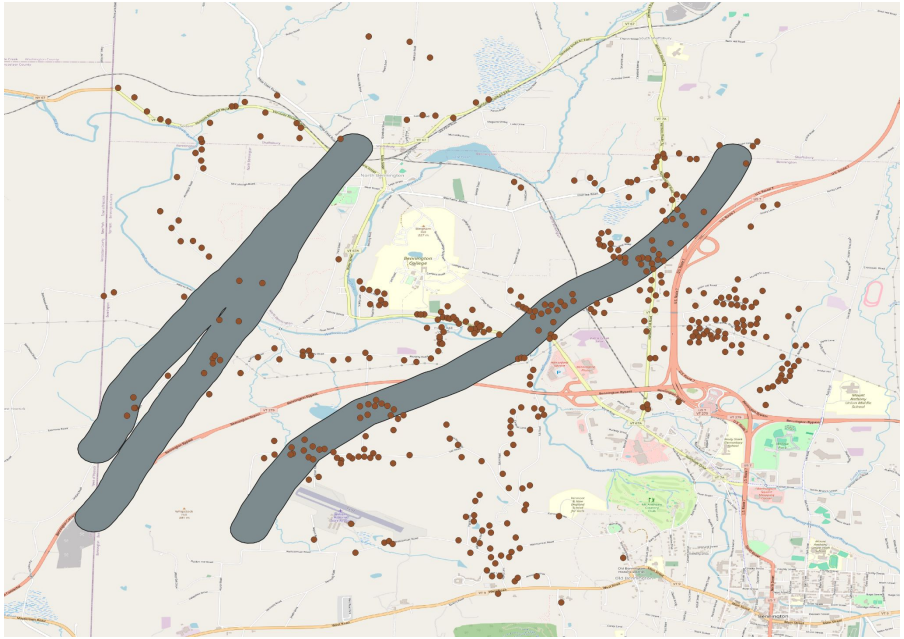
Bedrock Geology: Kim et al., 2017 VT Geologic Survey

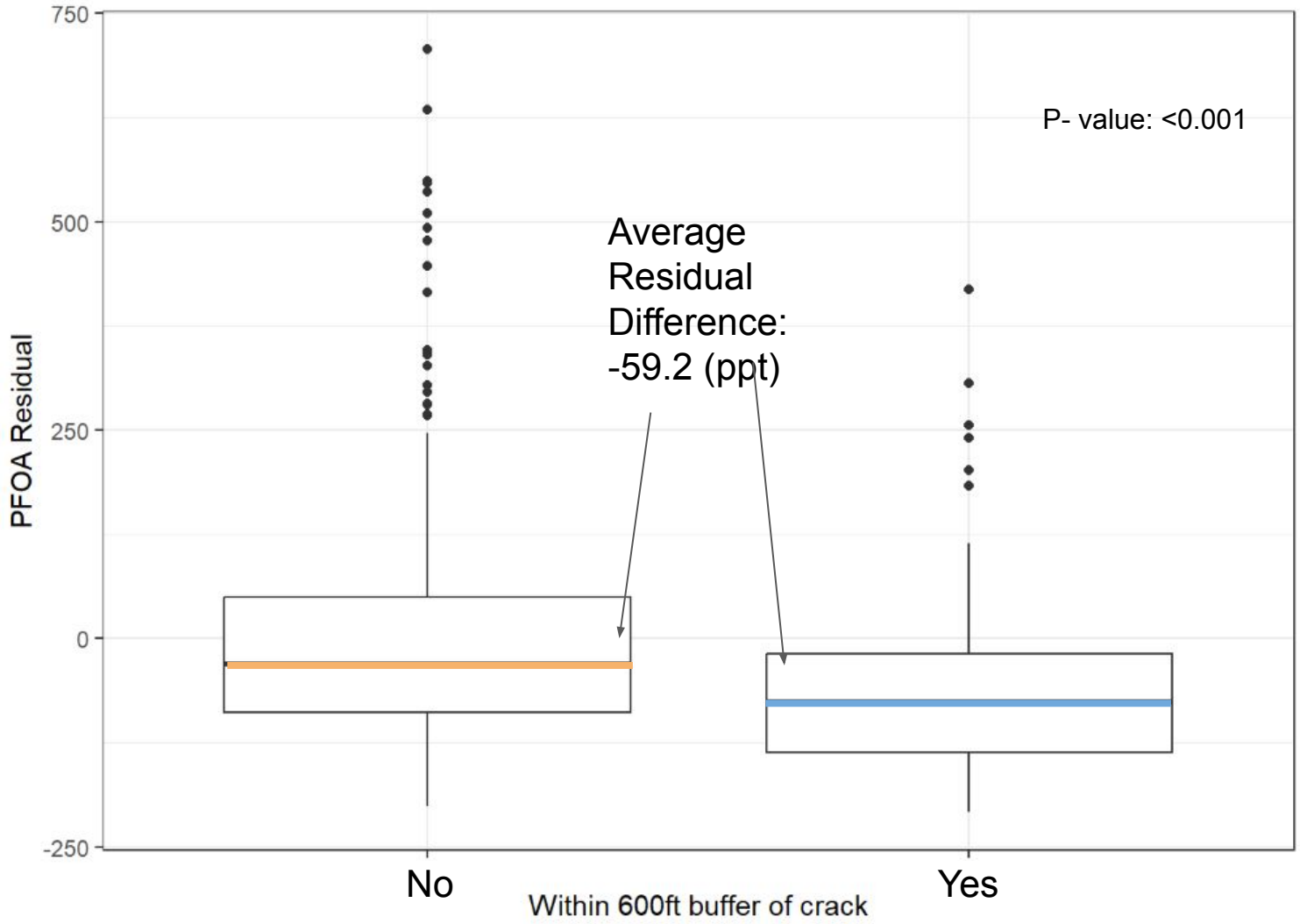

Distribution of Average PFOA Levels by Bedrock Type
Average PFOA Levels
0
200
400
600
800
os
Shelburne Formation
csp
Clarendon Springs Formation
ob
Bascom Formation
cm
Monkton Formation
cdu
Dunham Formation
cc
Cheshire Formation
cw
Winooski Formation
ow
Walloomsac Formation

Are major bedrock faults a conduit for PFOA?

Qs: Do wells that fall in the bedrock fault areas have a statistically significant difference in PFOA levels.

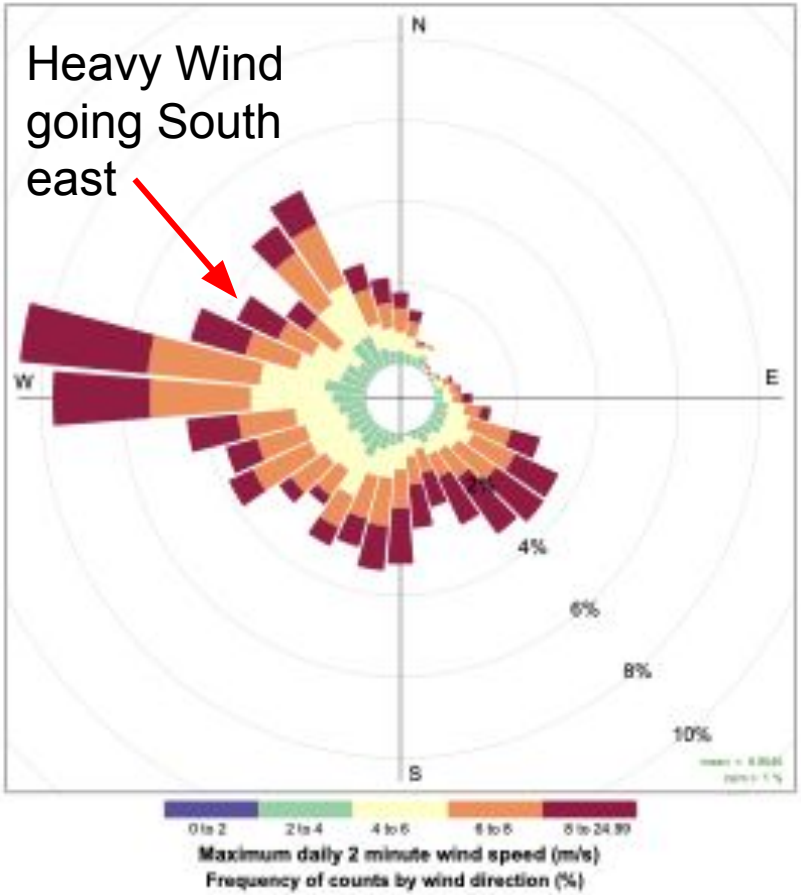
Ans: Yes, there is a statistically significant difference, with wells not on the bedrock faults having higher than expected PFOA levels.




750
500
250
0
-250
PFOA Residual
P- value: <0.001
Average
Residual
Difference:
-59.2 (ppt)
No
Yes
Within 600ft buffer of crack

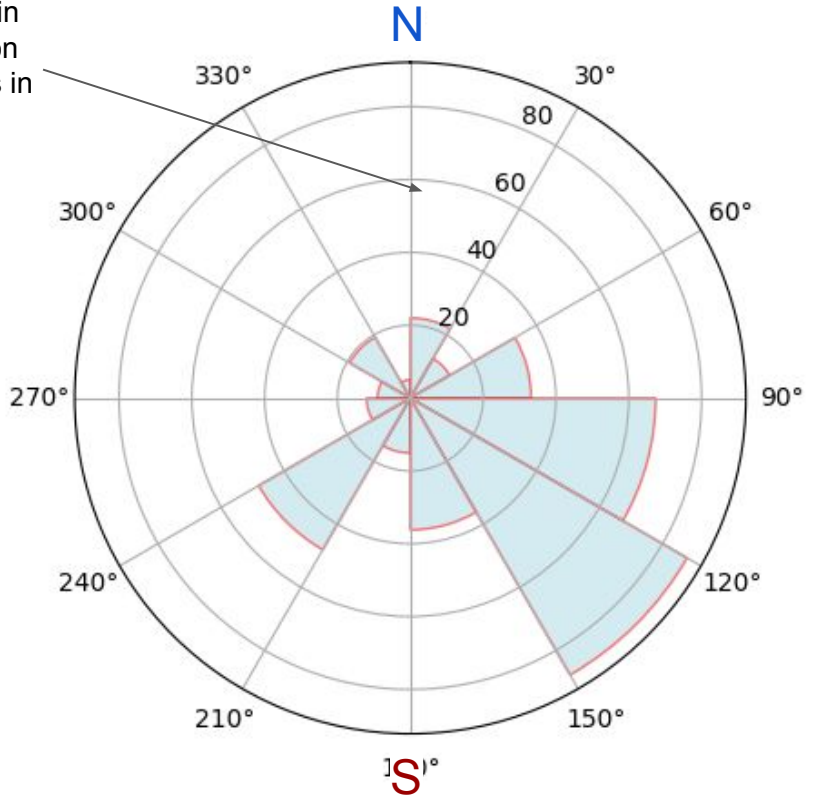
Wind Direction and PFOA levels

- Found compass direction from ChemFab to each well
- Sorted them into 30 degree bins and calculated average PFOA levels.
- Made two polar histograms:
  - One with all PFOA wells
  - One with wells exceeding 200 ppt removed



200 ppt cut off

PFOA lvls in
ts per trillion
t) for wells in
t direction

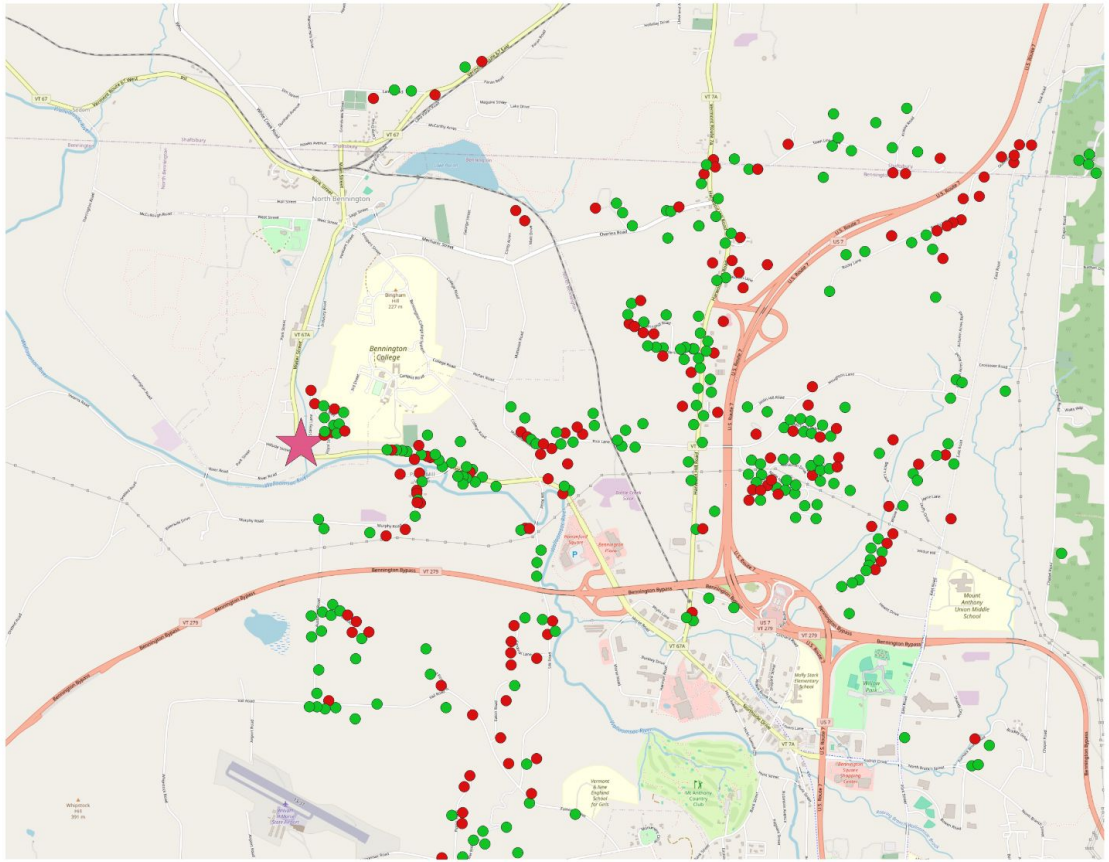


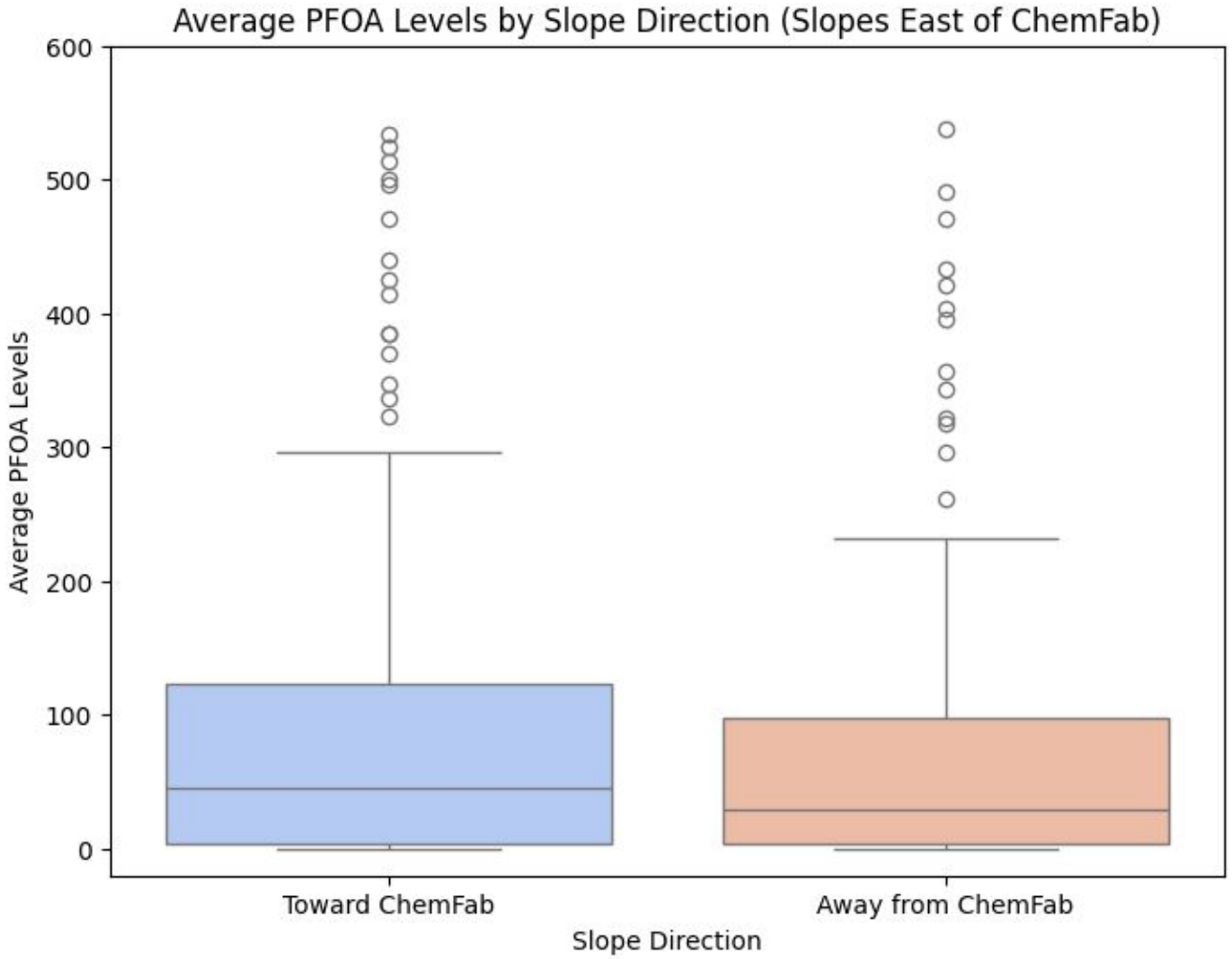
PFOA levels in relation to land slope direction

Slope-Aspect analysis in GIS

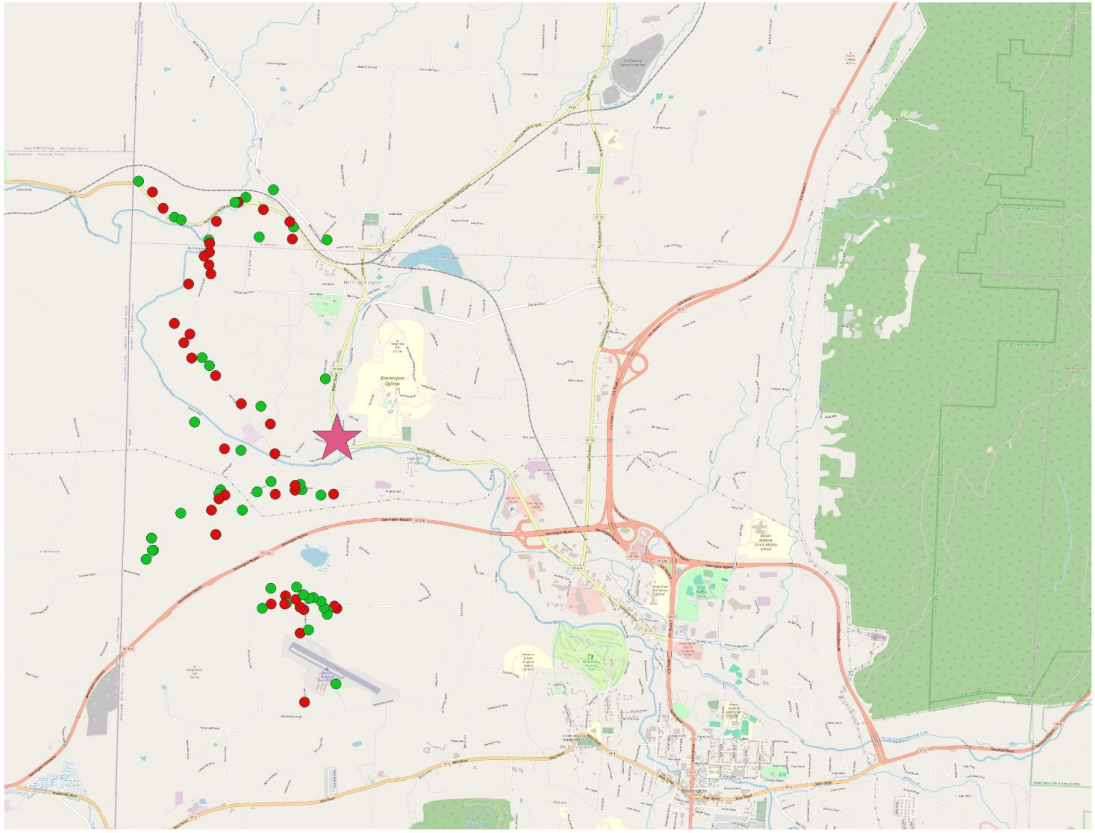
- Wells divided up east and west of ChemFab
- On the east; slopes with an aspect of 0-180 face toward ChemFab, 180-360 face away from ChemFab
- On the west; slopes with an aspect of 0-180 face away from ChemFab, 180-360 faces toward ChemFab
- No statistically significant results for both analyses

Map Showing Slope Direction (East of ChemFab)



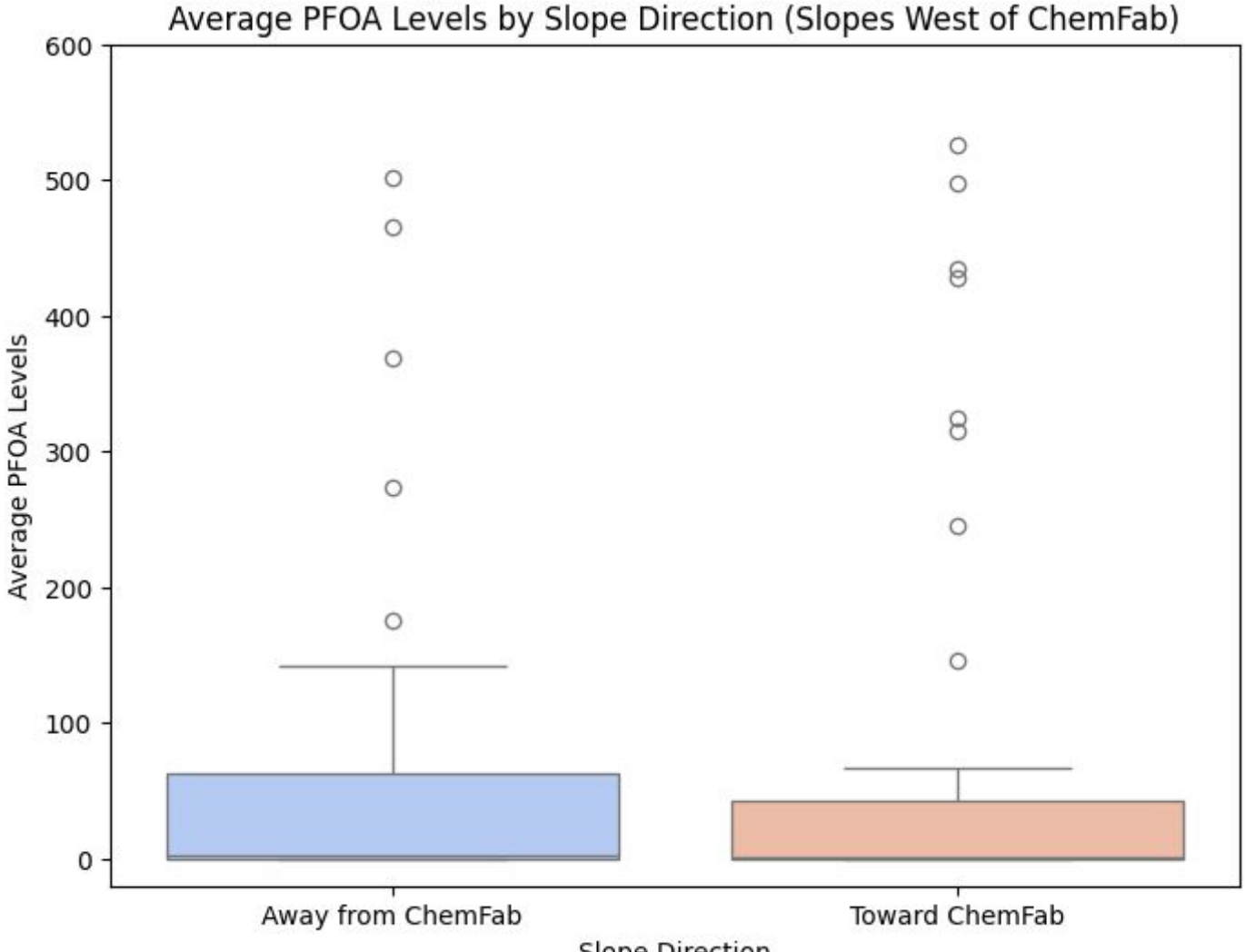

Average PFOA Levels by Slope Direction (Slopes East of ChemFab)
Average PFOA Levels
600
500
400
300
200
100
0
Toward ChemFab
Away from ChemFab
Slope Direction

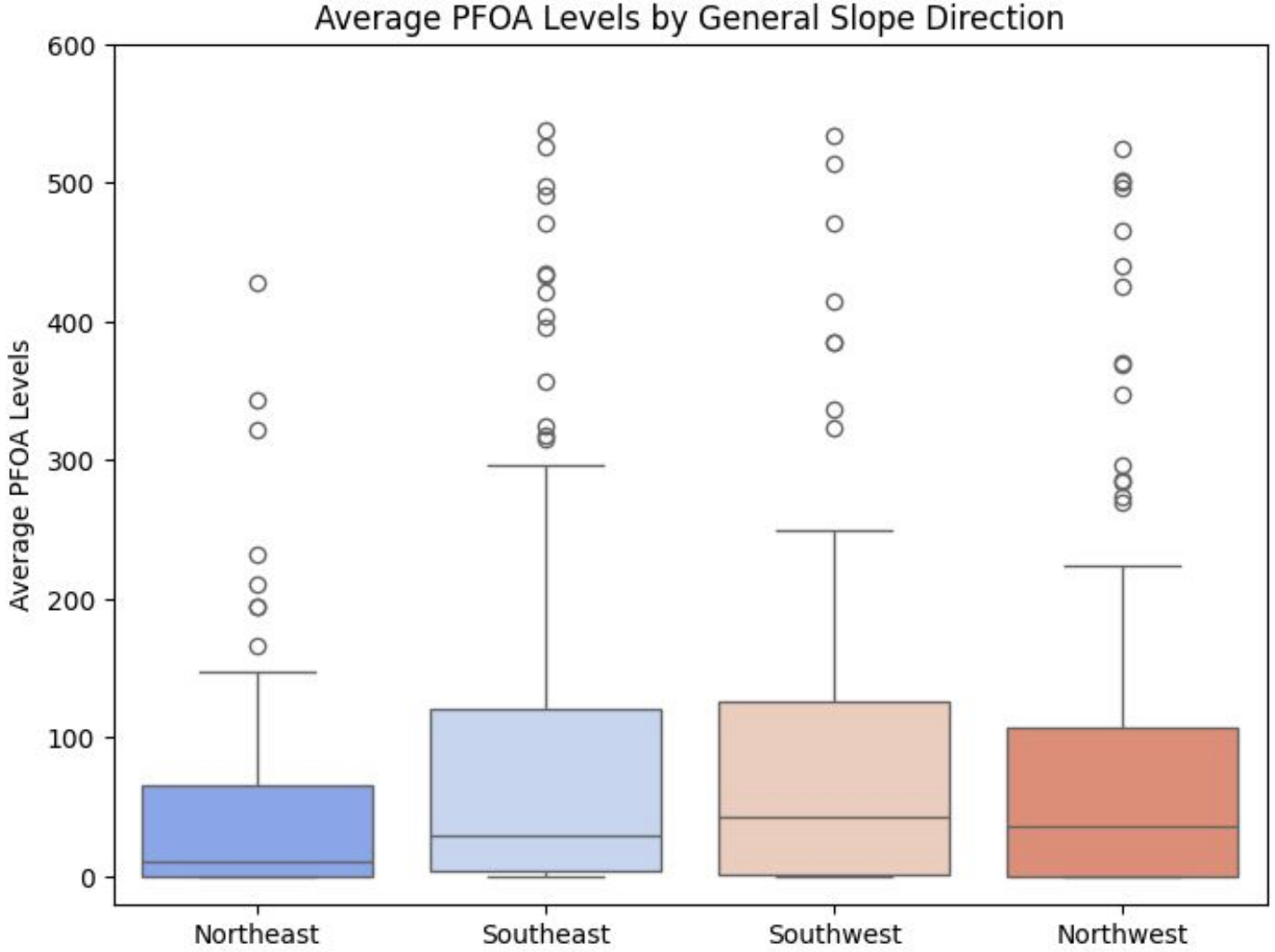
Map Showing Slope Direction (West of ChemFab)



Slopes
- Facing Towards ChemFab
- Facing Away from ChemFab
- ChemFab

0 1,000 2,000 m


Average PFOA Levels by Slope Direction (Slopes West of ChemFab)
Average PFOA Levels
600
500
400
300
200
100
0
Away from ChemFab
Toward ChemFab
Slope Direction

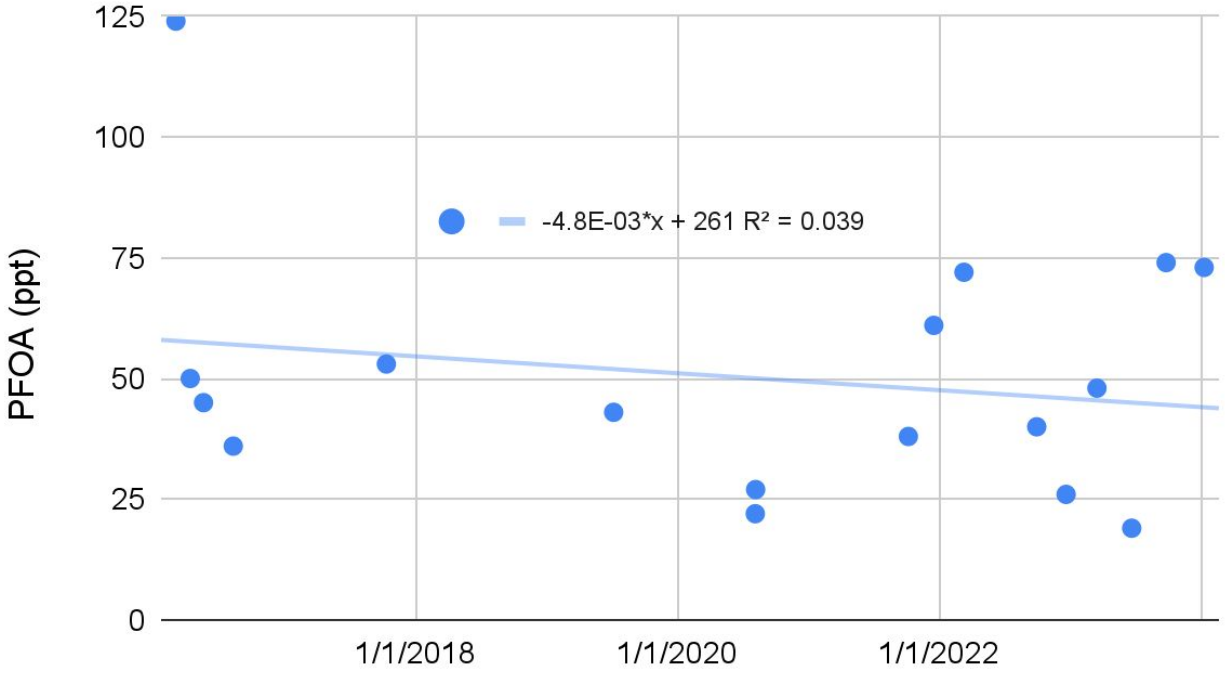

Average PFOA Levels by General Slope Direction
Average PFOA Levels
600
500
400
300
200
100
0
Northeast
Southeast
Southwest
Northwest

2. Temporal Trends

Temporal Analysis

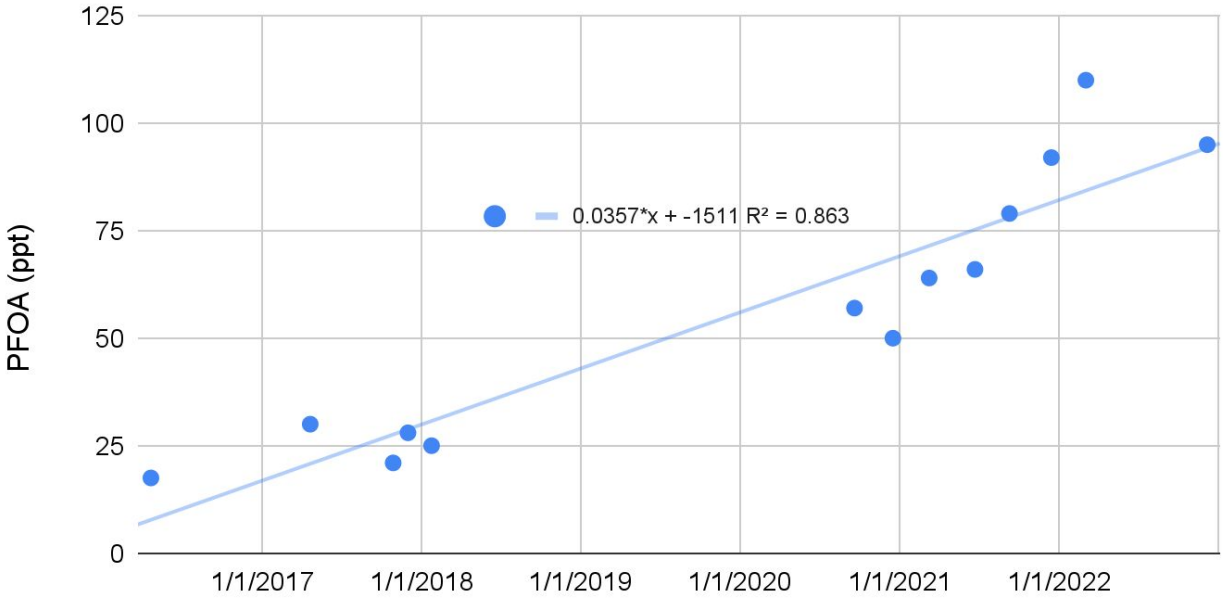
- Goal: Determine if there is trend of increasing or decreasing PFOA concentration
- Null Hypothesis (& what I expected): There will be no temporal trend visible in the data
- Performed a time-series linear regression on analyses from individual wells
- Only considered wells with >500 days time gap between initial and final sampling, AND the average PFOA concentration for all samples is > 2 ppt
- This comprises 323 wells/sites

Results:



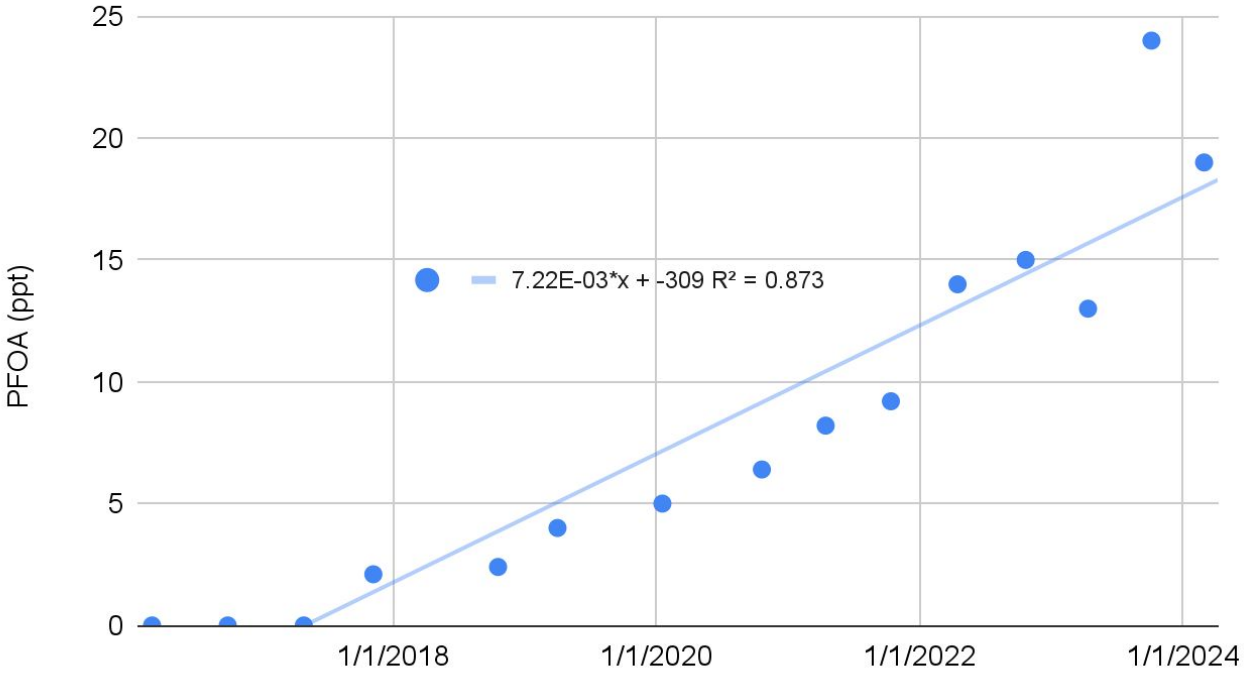
Example of a site with an decreasing concentration trend

Results:



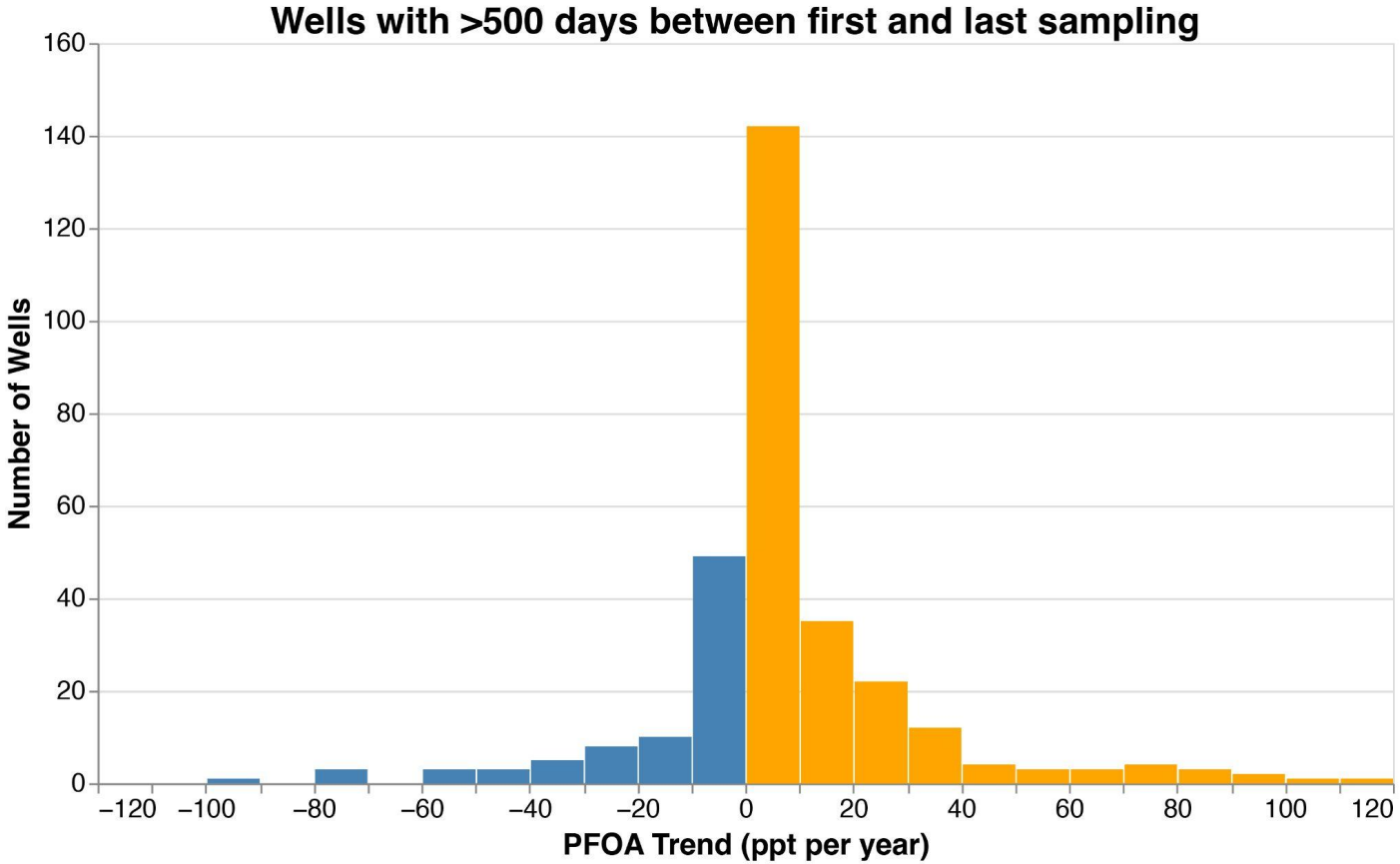
Example of a site with an increasing concentration trend

Results:



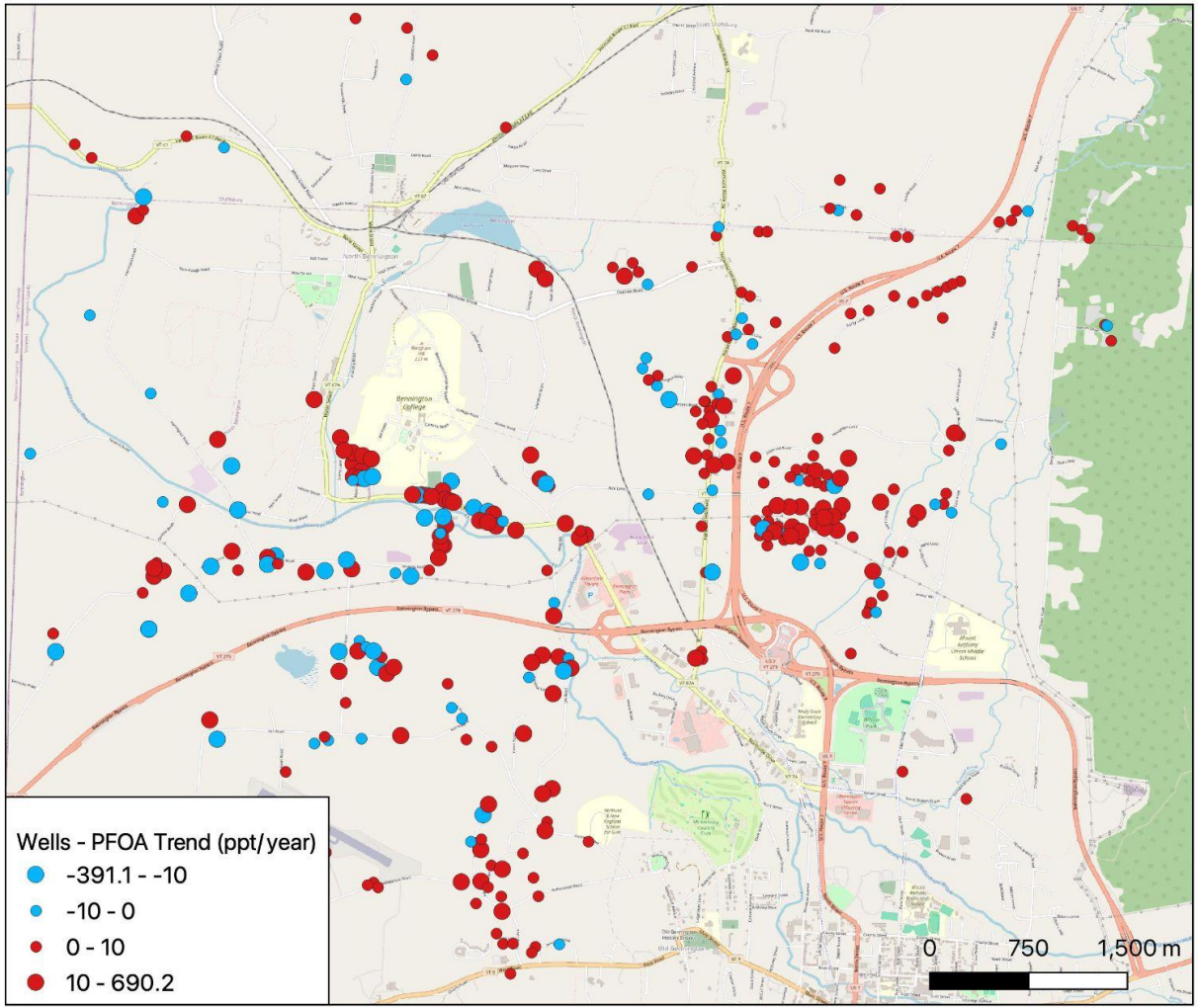
Example of a site with an increasing concentration trend, and from which this initial samples was ND

Putting it all together:

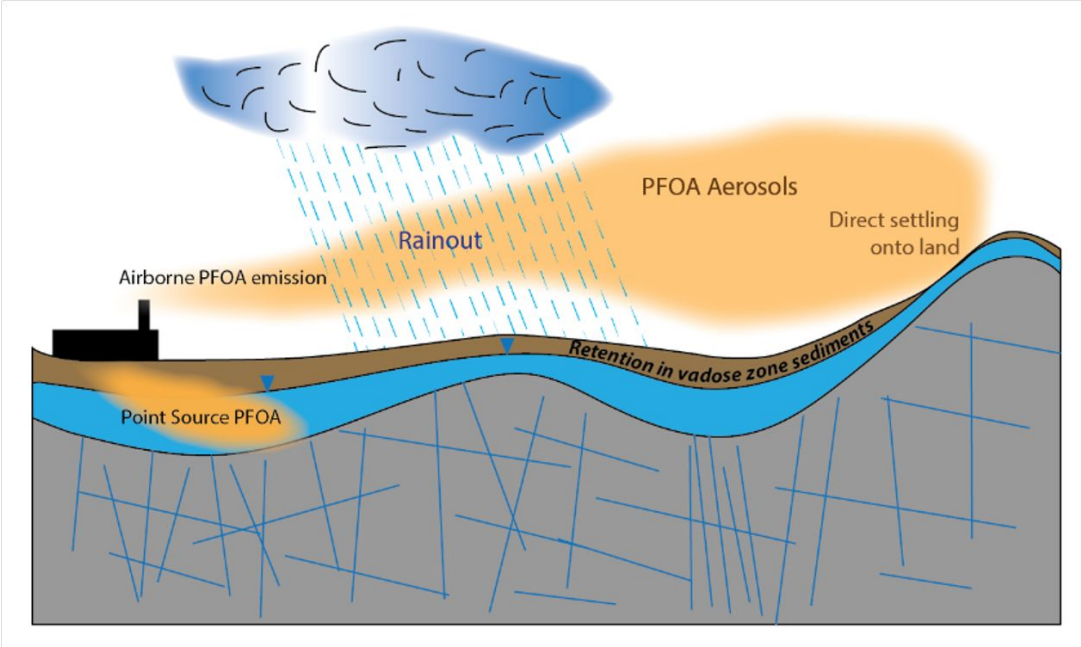


Histogram is clearly skewed toward positive slope (i.e. increasing PFOA trend)

239 increasing
84 decreasing



Is there a spatial pattern in the temporal trend?

Conclusions

- Results are consistent with earlier work indicating that PFOA was dominantly spread by air emission
- Secondary controls based on local topography and variability in bedrock aquifer flow patterns
- Temporal analysis indicates that PFOA levels continue to rise across the region
- Monitoring should continue across the region