Air Monitoring Data

for **Pasadena**

November 2021 – October 2022

Air Pollutants

Nitrogen Oxides (NOx)	Volatile Organic Compounds (VOC)	Ozone (O3)	Particulate Matter (PM2.5)
Oxides of nitrogen - primarily emitted by vehicles and industrial facilities. Contributes to breathing problems, smog, acid rain, ozone	Highly reactive carbon compounds – emitted by vehicles, industries, gasoline equipment, paints, chemicals, solvents etc. Toxic at high concentrations, contributes to ozone	Ground level ozone – forms due to reactions between NOx and VOCs in sunlight and heat. Contributes to breathing difficulties, respiratory issues	Inhalable particles - dust, dirt, soot, and even smaller – emitted by industries, vehicles, construction sites, fires, unpaved roads Contributes to heart & lung complications, asthma

Sources of Pollution

Toxic Release Inventory (TRI)

Industrial and federal facilities that report toxic chemical releases.

Typically, larger facilities involved in manufacturing, metal mining/recycling, electric power generation, petrochemical, refining, and chemical manufacturing and hazardous waste treatment.

Concrete Batch Plants (CBP)

Facilities that combine sand, cement, and other aggregates to make concrete

Typically, neighborhood-level facilities, that are significant sources of particulate matter (dust), diesel truck smoke, noise and light pollution among other nuisances.

Roads / Freeways / Trains (yards)

Vehicular exhaust significantly emits a noxious brew of multiple types of pollution:

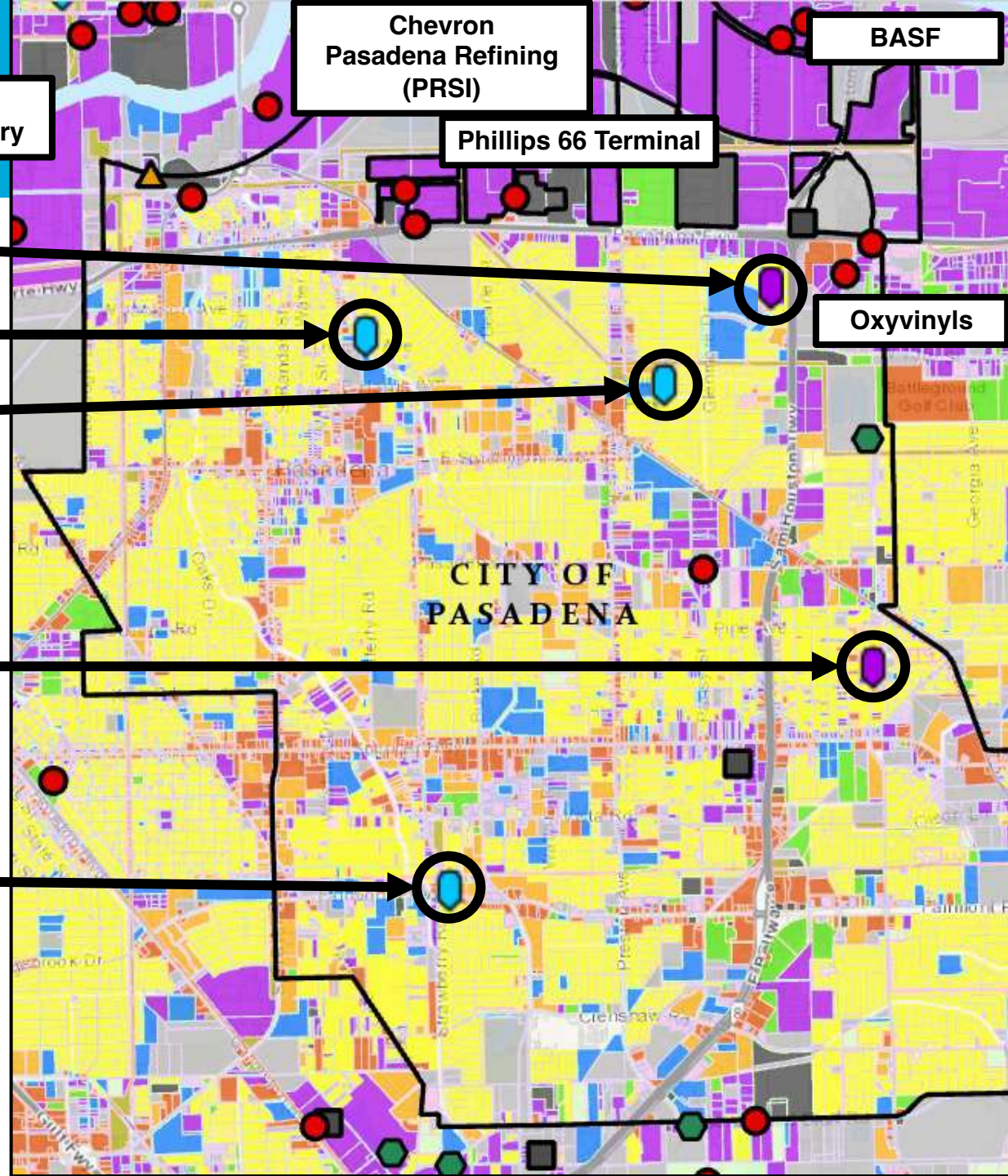
NOx, VOCs, PM2.5, GHGs and the precursors for ozone and smog

Superfund sites

Polluted waste locations in the United States contaminated with extremely hazardous substances. Usually abandoned.

Uncleaned sites are continued sources of ground, air, and water pollution into the neighboring areas.

Pasadena: Land Use Map



- Single-Family Residential
- Multi-Family Residential
- Commercial
- Office
- Public & Institutional
- Industrial
- Park & Open Spaces
- Transportation & Utility
- Undeveloped
- Agriculture Production
- Unknown

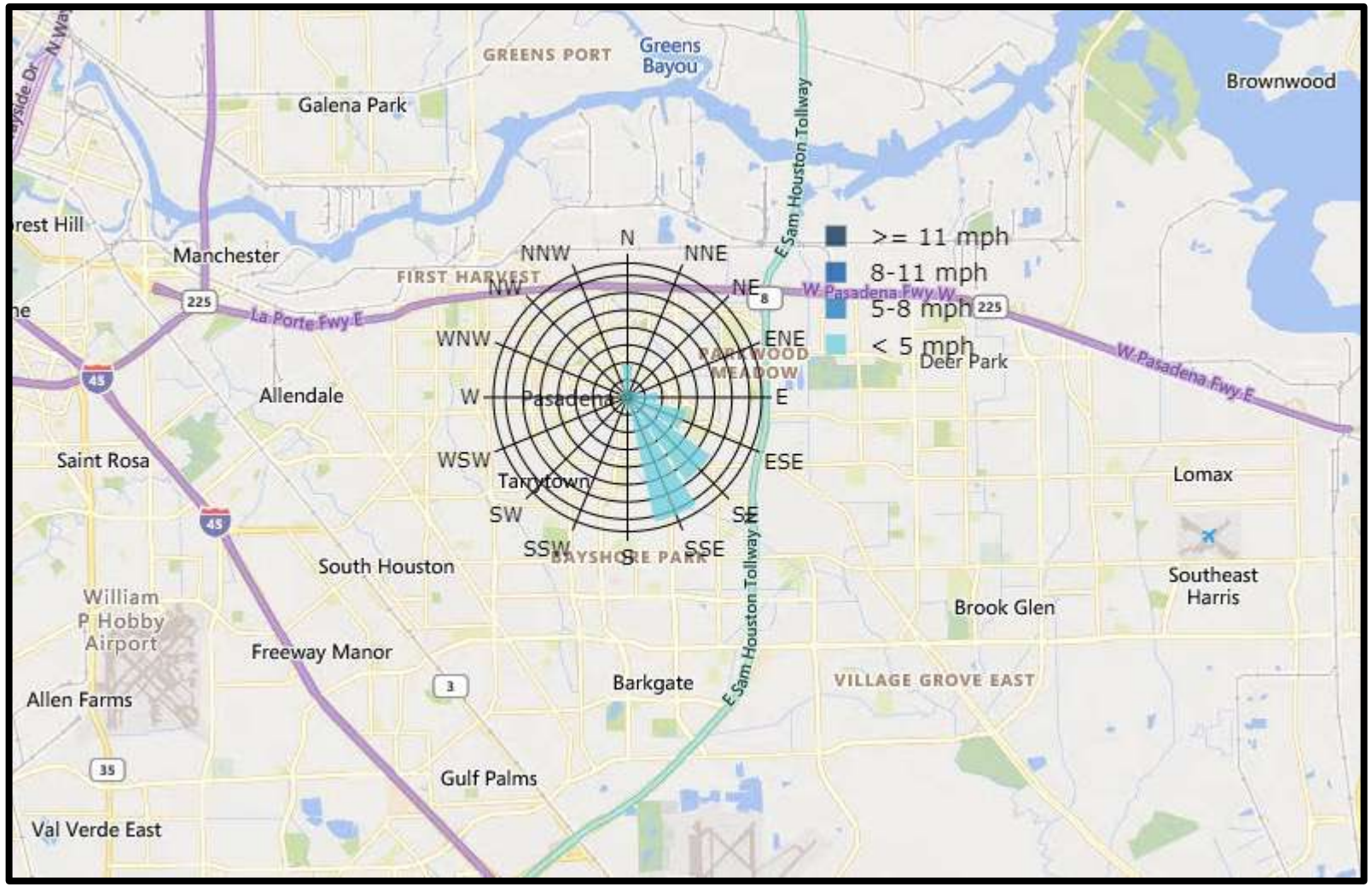
- Superfund Sites 2022
- Texas TRI Facilities, 2020
- Concrete Batch Plants 2021
- Active Municipal Solid Waste sites

- APIS
- Purple Air

Wind Direction and Speed

Averaged over:
Nov ‘21 – Oct ‘22

Sources of pollution upwind of the monitors make significant contributions to readings and measurements



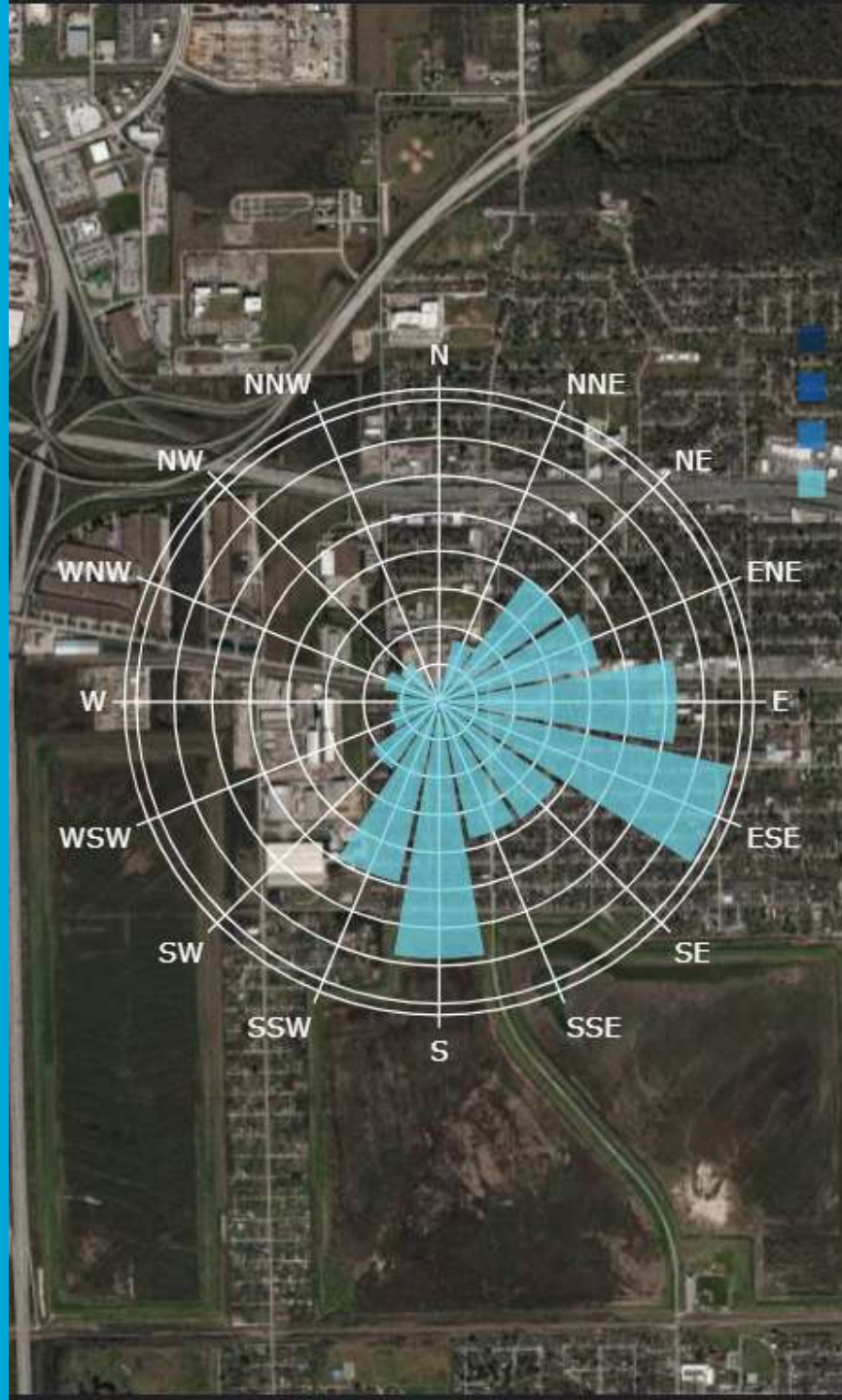
Predominant winds: SOUTHEAST

In line with regional prevailing winds from the Gulf of Mexico

Air Monitor Measurements

Nov 2021 – Oct 2022

1. Nitrogen Oxides (NOx)
2. Ozone (O3)
3. Volatile Organic Compounds (VOCs)
4. Particulate Matter (PM)

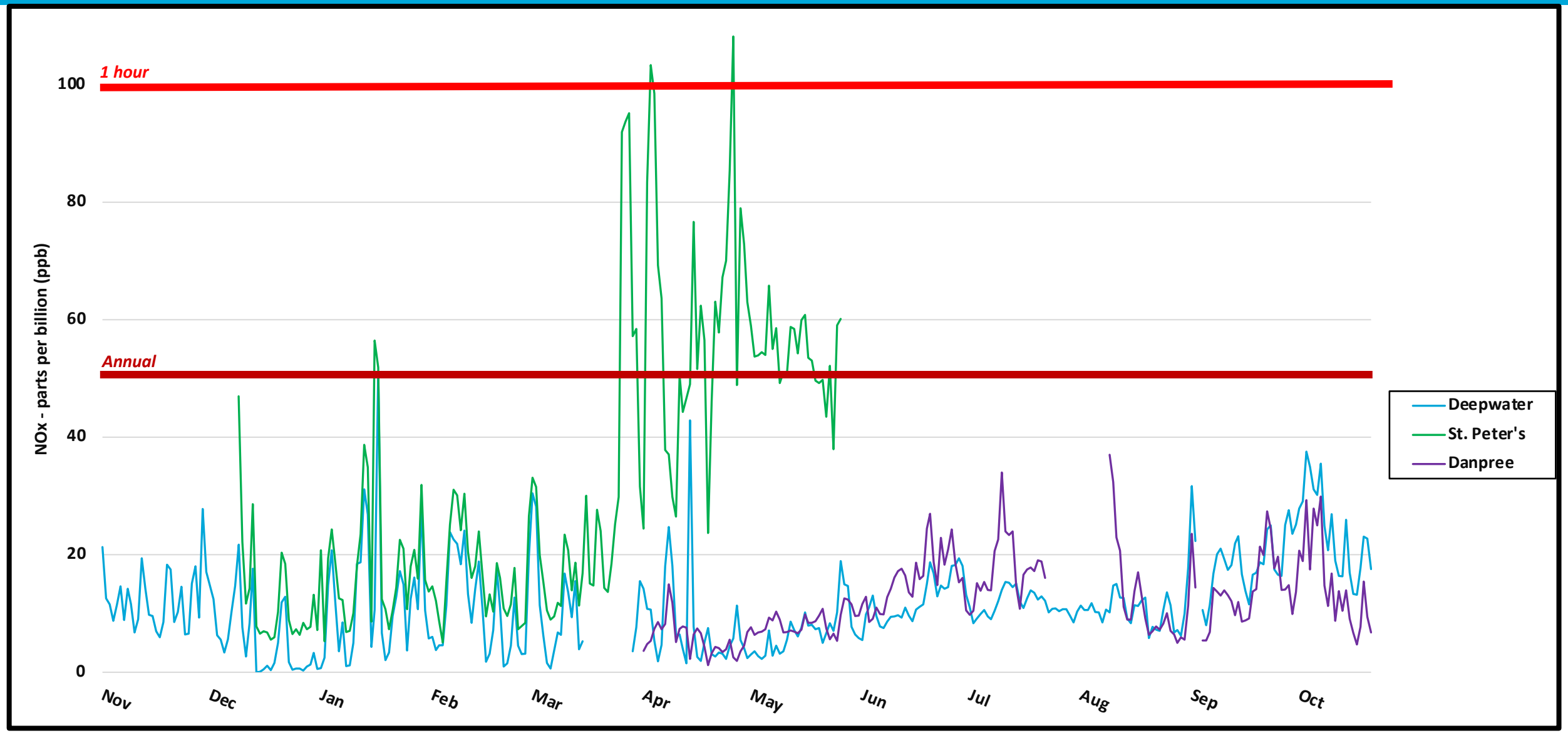


Nitrogen Oxides (NOx)

Includes Nitrogen Oxide (NO) and Nitrogen Dioxide (NO2)

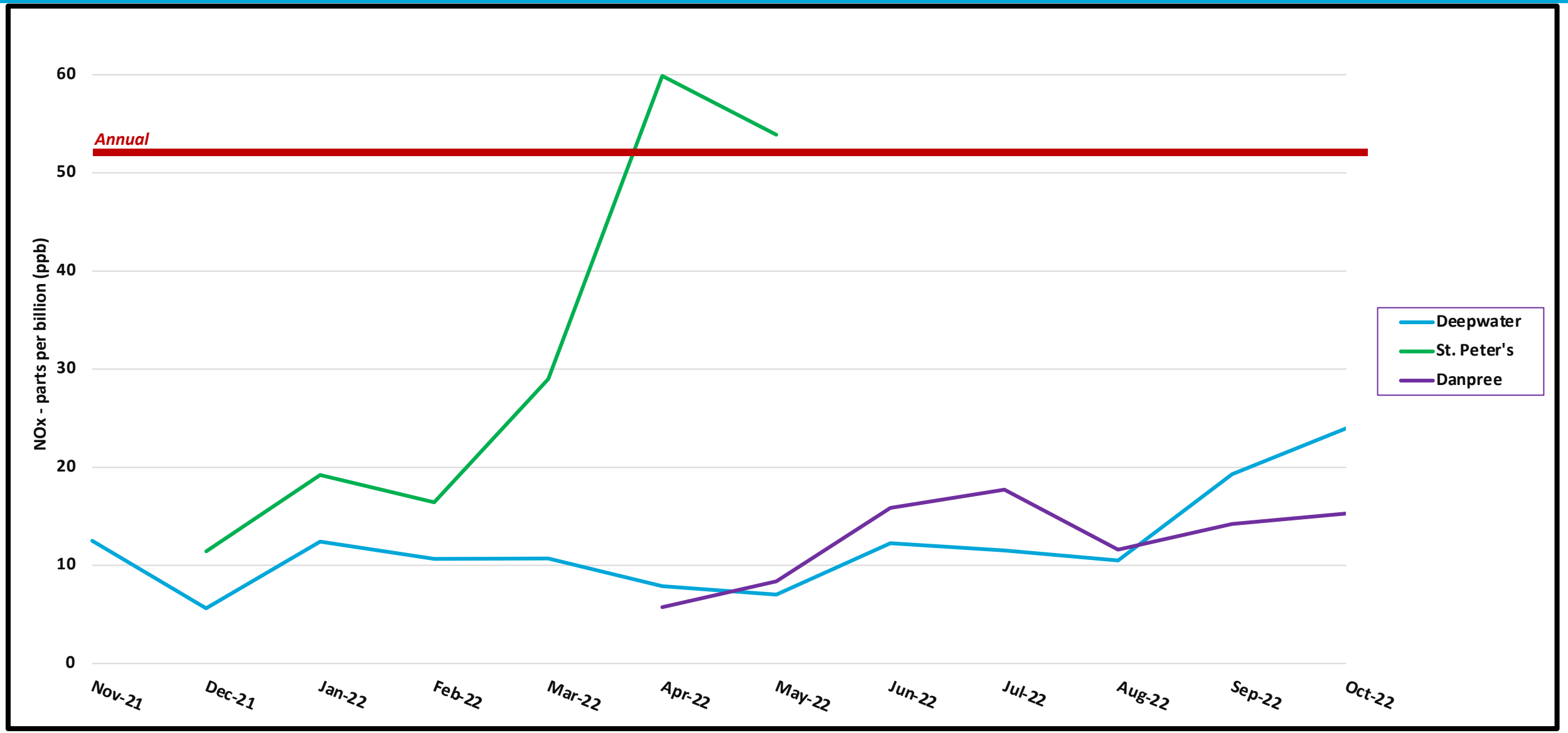
NOx: Day-to-Day

EPA NOx standard	1 hour	Annual
	100 ppb	53 ppb



NOx: Monthly Averages

EPA NOx standard	Annual
	53 ppb



NOx: Monthly Averages

EPA NOx standard	Annual
	53 ppb

	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Overall
Deepwater	12.5	5.6	12.4	10.6	10.7	7.9	7.0	12.2	11.5	10.5	19.3	24.0	12.0
St Peter		11.4	19.2	16.4	29.0	59.9	53.9						31.6
Danpree						5.7	8.4	15.9	17.7	11.6	14.2	15.3	12.7

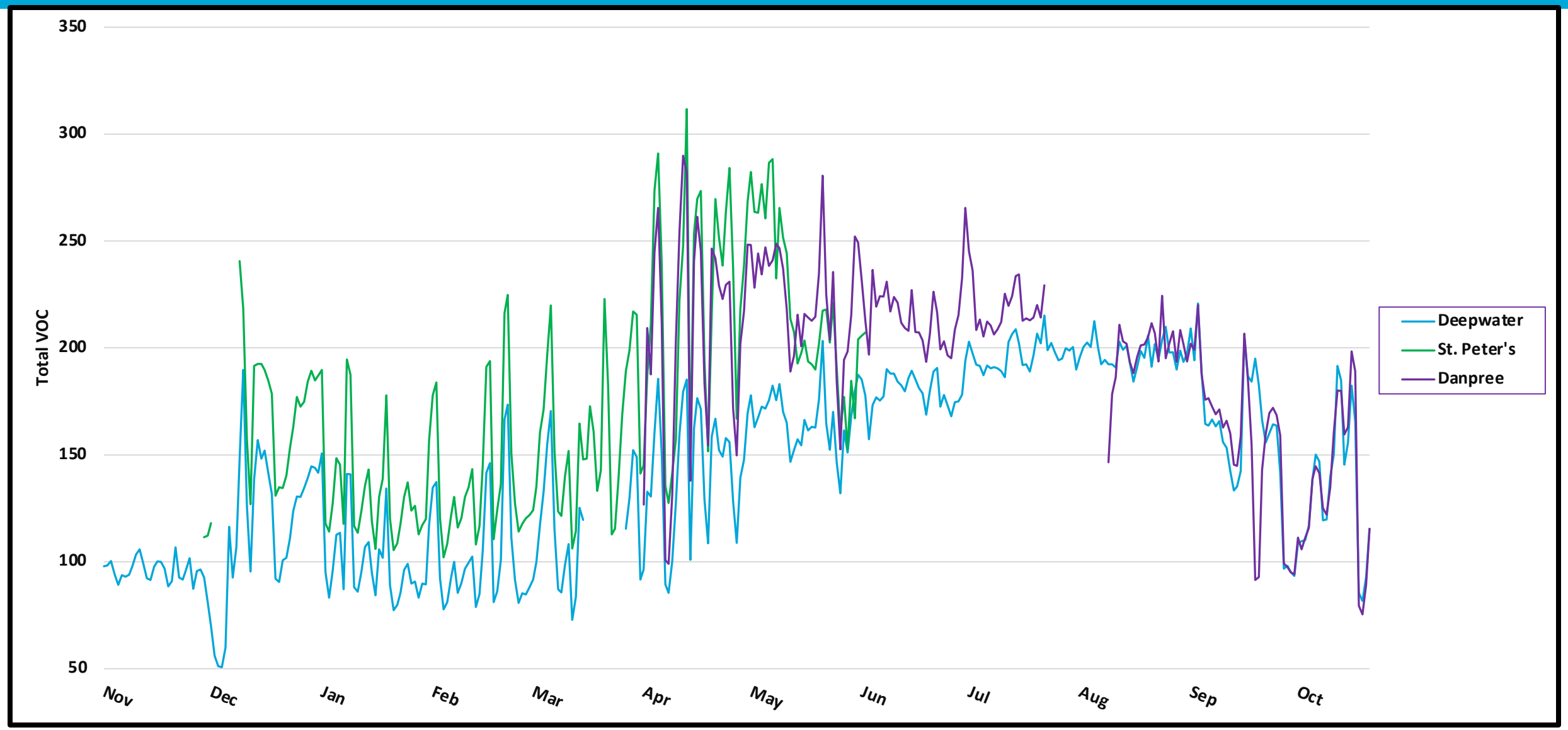
Major takeaways

- Daily values peak on average in the morning and evenings: 8 am and 6 pm
- Trending towards generally higher concentrations with time
    - Especially at St. Peters
- St. Peters monitor exposed to higher concentrations
    - Likely pollution from Ship Channel and freeway traffic
    - More heavily industrialized areas nearby
- Concerning peaks recorded at St Peters: Exceeding EPA standards
    - Highest frequency in March – June
    - Peaks at Danpree and Deepwater in Sept - Oct

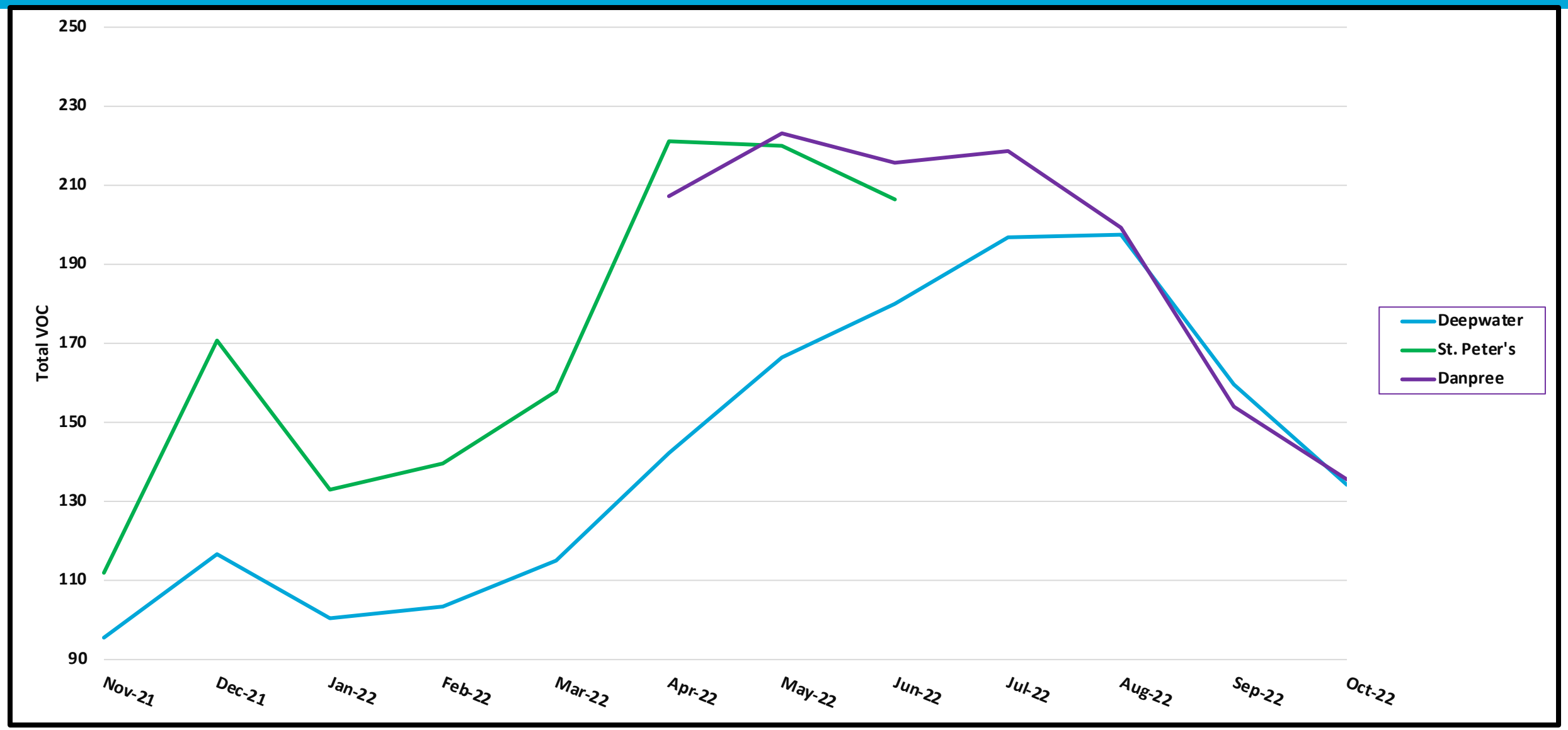
Volatile Organic Compounds (VOCs)

Includes benzene, ethylene, formaldehyde, butadiene, propane, and ethane among many others

Total VOC: Day-to-Day



Total VOC: Monthly Averages



Total VOC: Monthly Averages

	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Overall
Deepwater	95.5	116.7	100.5	103.4	115.0	142.3	166.5	180.0	196.9	197.5	159.6	134.2	142.3
St Peter	112.0	170.7	133.0	139.6	157.8	221.1	220.0	206.4					170.1
Danpree						207.3	223.2	215.7	218.7	199.3	154.0	135.6	193.4

Major takeaways

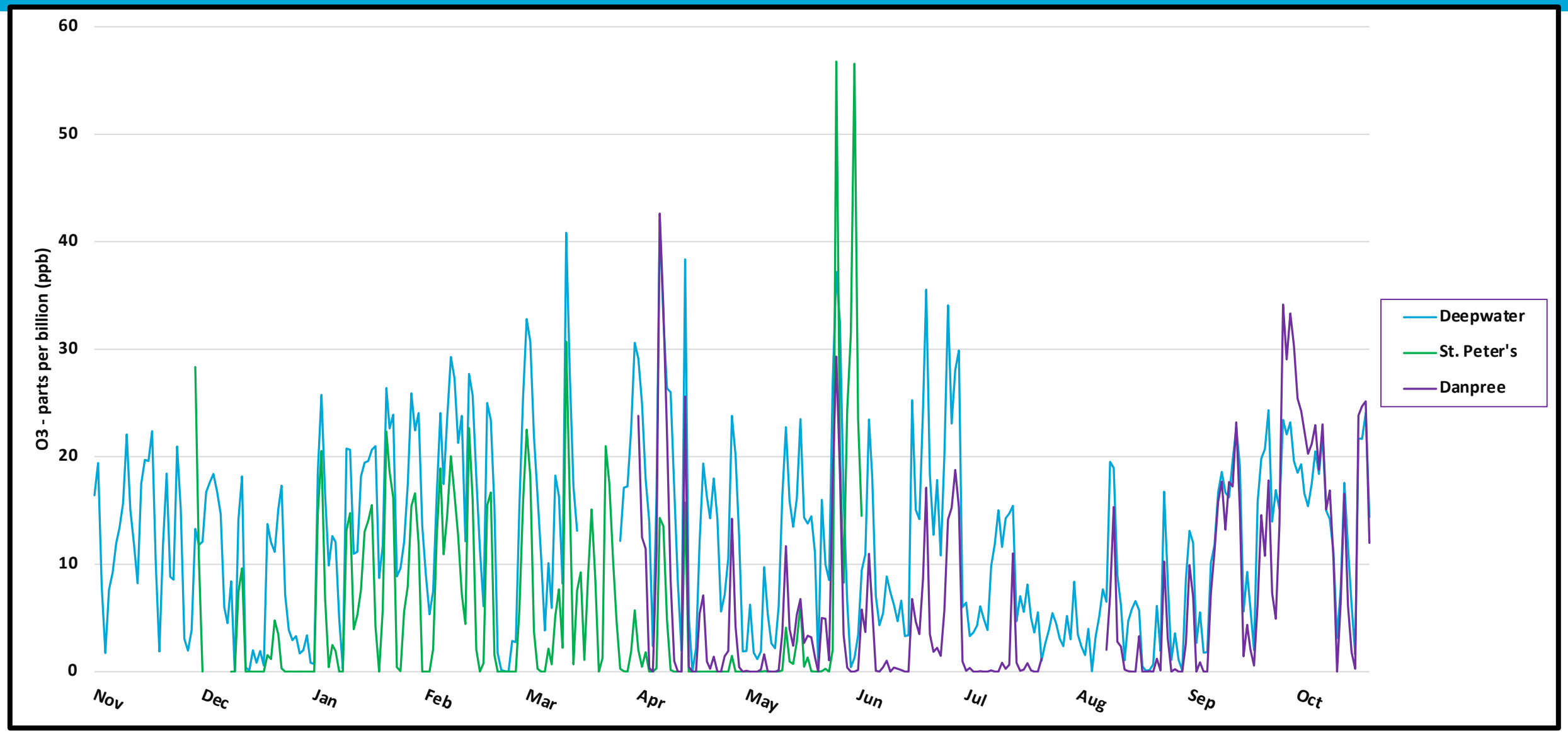
- Daily values peak on average in the mornings: 5-10 am
  - Lowest in the afternoons/evenings. Picks back up at 12-4 am
  - Could be an industrial source
- Trending upward until the summer (July). Going back down since
  - Dec – May more volatile. June – Oct more stable
- St. Peters and Danpree recording highest recordings
  - Potential sources of concern may be closer
- Few peaks outside of regular cycles – likely emission events
  - Primarily at Danpree

Ozone (O3)

***Ground level ozone* (not stratospheric) that contributes to smog formation**

Ozone (O3): Day-to-Day

EPA O3 standard	8 hour
	70 ppb



Ozone: Monthly Averages

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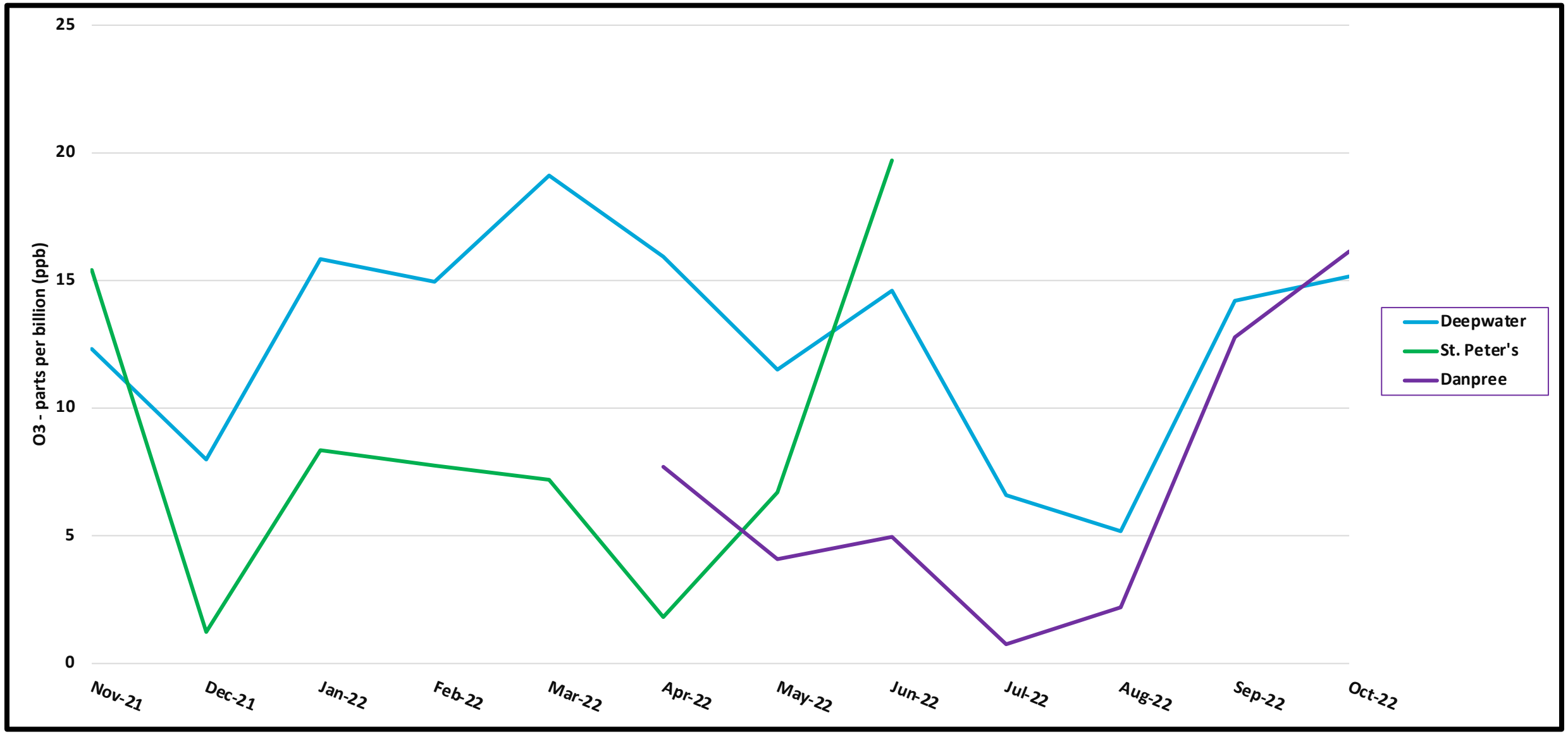


Ozone: Monthly Averages

EPA O3 standard	8 hour
	70 ppb

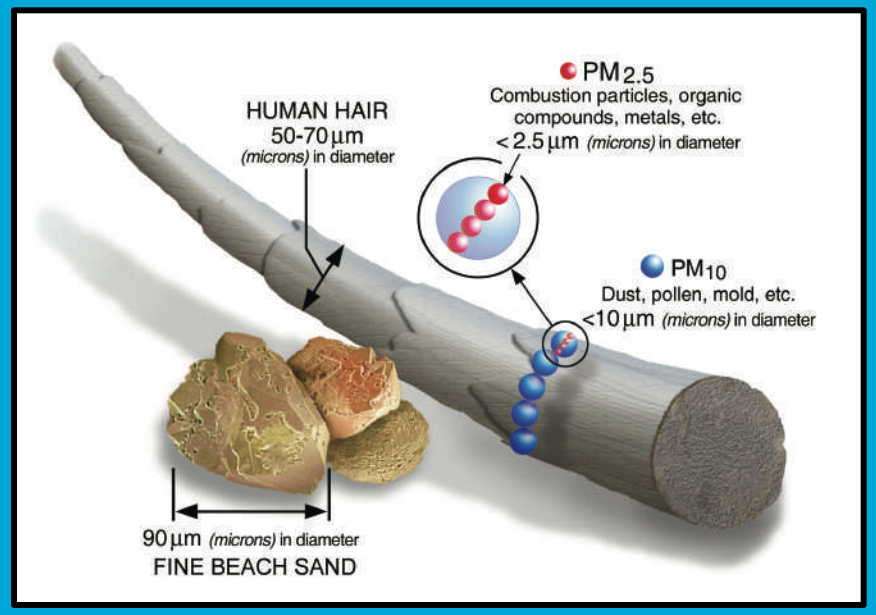
	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Overall
Deepwater	12.3	8.0	15.8	15.0	19.1	15.9	11.5	14.6	6.6	5.2	14.2	15.2	12.8
St Peter	15.4	1.2	8.4	7.7	7.2	1.8	6.7	19.7					8.5
Danpree						7.7	4.1	5.0	0.8	2.2	12.8	16.1	6.9

Major takeaways

- Daily values peak regularly twice: Mornings and evenings
  - Likely reflecting traffic patterns
  - Zero concentrations regularly at night: 1-8 am
- Peaked in the spring – declined in the summer – going back up in Sept
  - Possibly following conflicting NOx and VOC patterns
- Deepwater exposed to highest levels
  - Peaks highest in the summer
- Peaks are highest and most prolonged in the summer
  - Lasting into the late evenings and nights

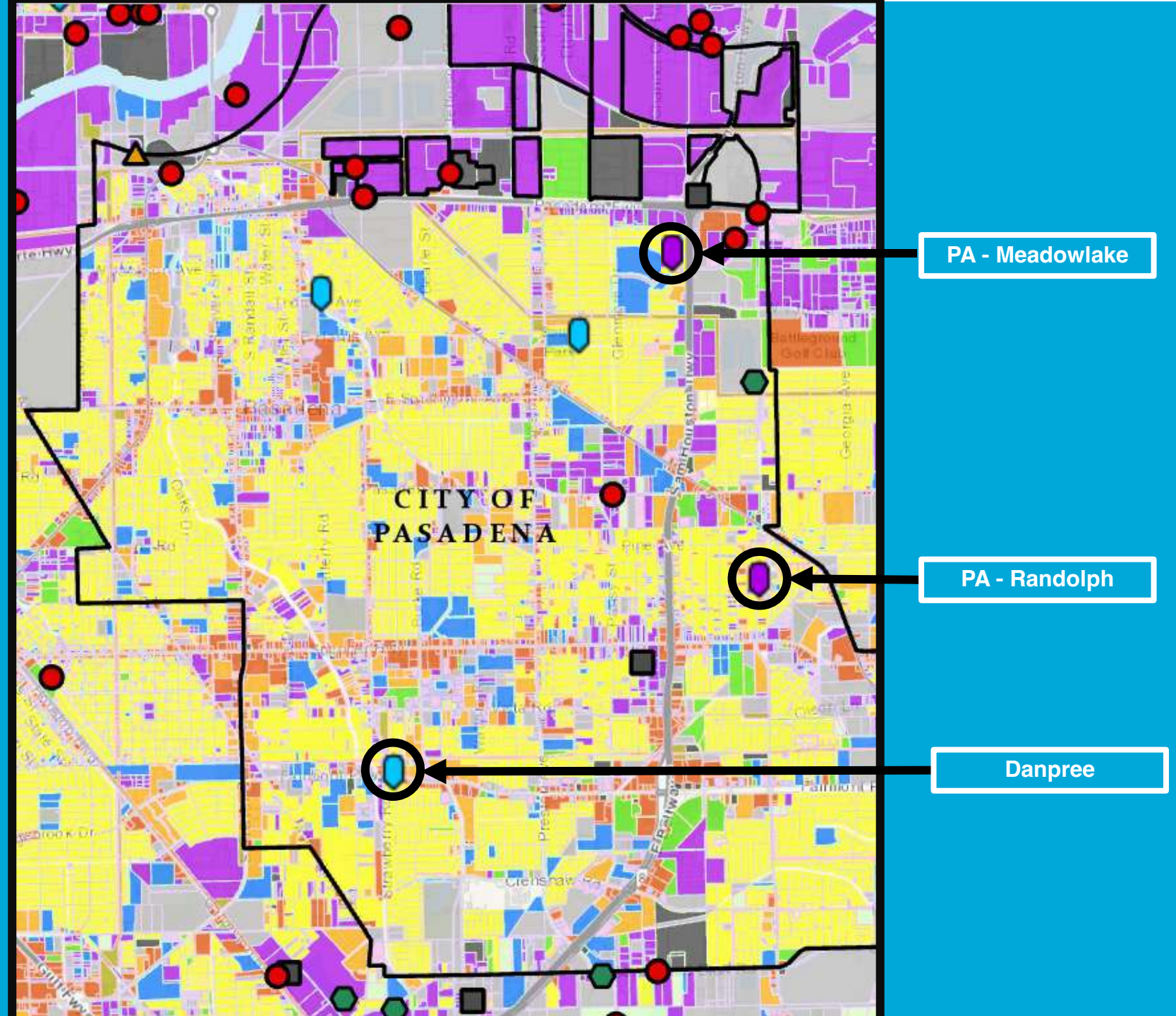
Particulate Matter 2.5 (PM2.5)

Fine inhalable particles that can penetrate deep into the lungs



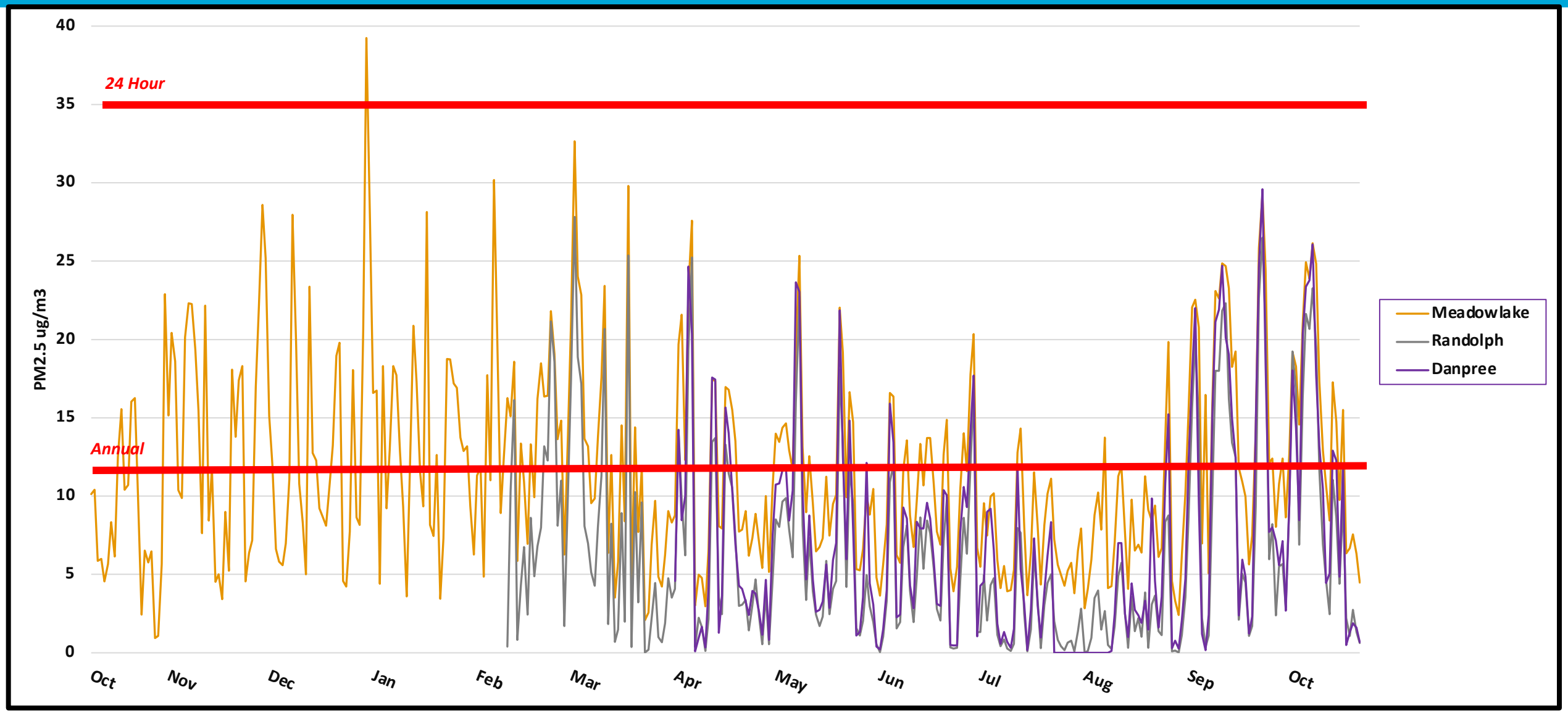
Purple Air Monitors

map.purpleair.com



PM 2.5: Day-to-Day

EPA PM 2.5 standard	24 hour	Annual
	35 ug/m3	12 ug/m3



PM 2.5: Monthly Averages

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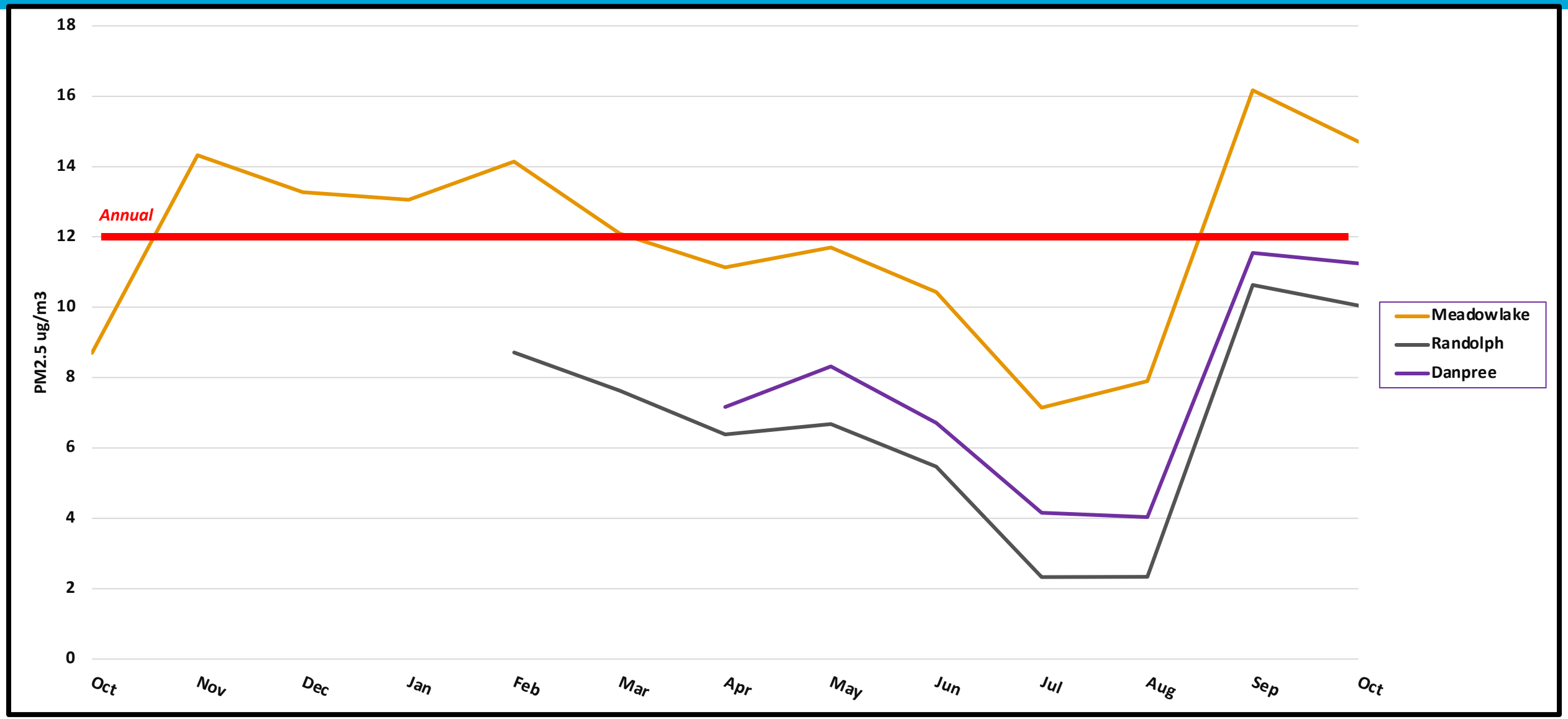


PM: Monthly Averages

EPA PM 2.5 standard	Annual
	12 ug/m3

	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Overall
Meadowlake	14.3	13.3	13.1	14.1	12.1	11.1	11.7	10.4	7.1	7.9	16.2	14.7	11.9
Randolph				8.7	7.6	6.4	6.7	5.5	2.3	2.3	10.6	10.1	6.7
Danpree						7.2	8.3	6.7	4.2	4.0	11.5	11.2	7.6

Major takeaways

- Daily values do not peak as regularly
    - Reflecting some unpredictable influence: Likely industrial
- Peaked in the winter – declined in the spring/summer – going back up
    - Possibly a larger regional pattern (observed in Northside as well)
- Meadowlake exposed to highest levels
    - Above EPA standard: Nov ‘21 – March ‘22 and Sept – Oct ‘22
- Peaks highest in the winter
    - Recent peaks at around similar levels across monitors

REVIEW

Methodology

- Calculated pure averages (mean) for each month and overall
  - Easy comparison with EPA standards
  - No further statistical manipulation
- Plotted progression of monthly averages on a line graph
  - To track seasonal pollution trends
- Screenshots of raw day-to-day measurements
  - To visualize short term spikes and exceedances of standards
- Observed times of highest daily pollution levels
- Tested hypotheses with real-world maps, data, information
  - Drawing informed conclusions about measurement/trend causes

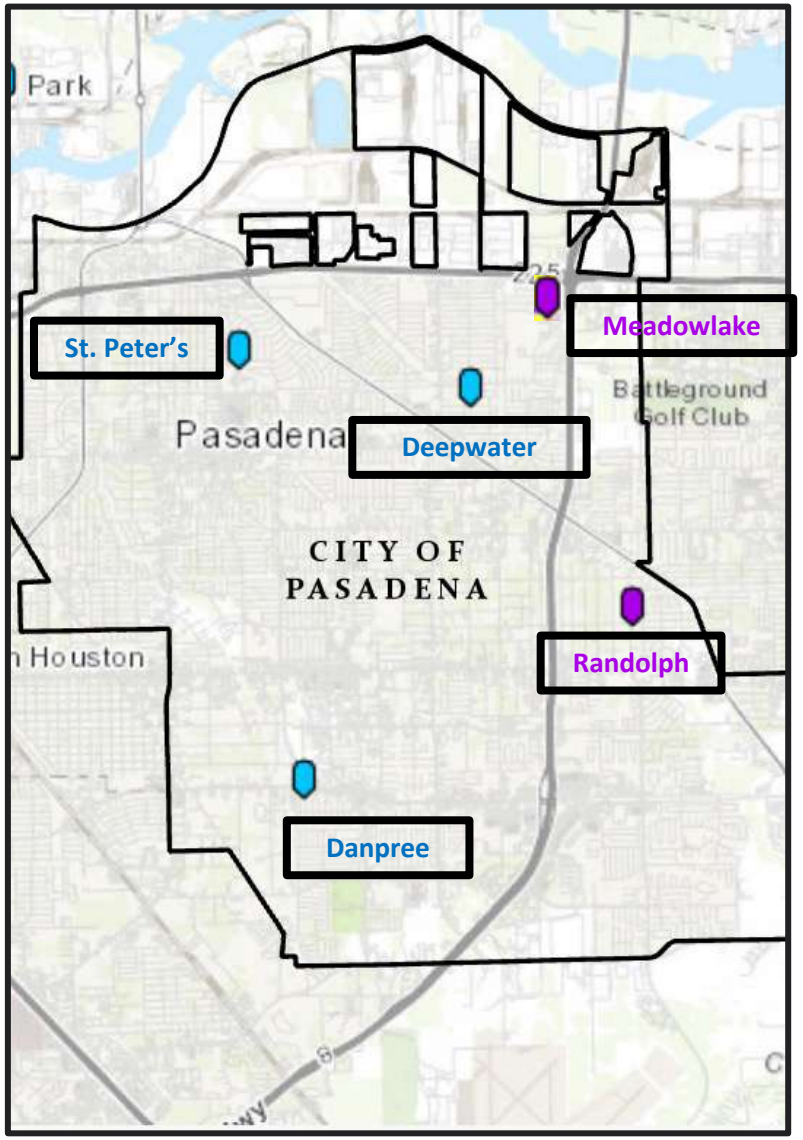
Caveats / Limitations

- **EPA Standards:**
  - Guidelines for public health protection. Regularly updated / revised
  - Just because averages aren't at/near limit, doesn't mean there aren't effects
  - Short-term spikes can still have significant effects

- **Monitors:**
  - Limited by wind direction, technology (pollutants measured)
  - Area of location: Results may be affected by seemingly smaller events
    - E.g.: Idling cars, household events, fireworks, outages, etc.
  - Sensitivity: A high measurement point to multiple possible sources. Cannot pinpoint 100%
  - There may be pollution levels and types that are not being caught
  - Limited number of monitors across neighborhood: Not everywhere

Conclusions: Nov 2021 – Oct 2022

NOX	VOC	O3	PM2.5
Highest at St. Peters	Highest at St. Peters (Danpree, Deepwater)	Highest at Deepwater (then St. Peters)	Highest at Meadowlake
Higher peaks at St. Peters (exceeding EPA standards)	Higher peaks and more activity at St. Peters and Danpree	Higher peaks at St. Peters and Deepwater	Significant peaks at all monitors (exceeding EPA standards)
Morning & evening dual daily peak	Late night – early morning daily peak	Morning & evening dual daily peak	Irregular peaks
Trending generally upwards with time	Trending downward since peak in summer	Peak in March-Apr. Trending generally downward until Sept 2022	Peak in Dec-Jan. Trending downward until Sept 2022



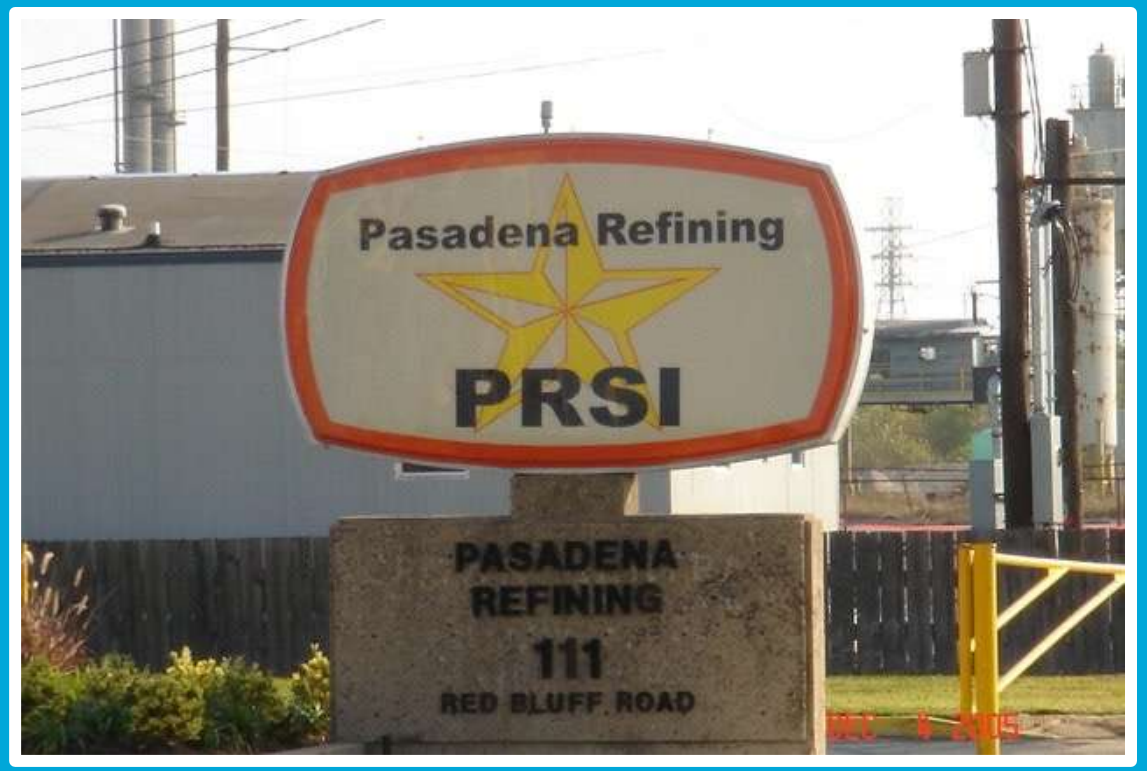
Next Steps

- Will continue collecting and analyzing data
- Averages may change as monitors capture more emissions
  - Greater amounts of data coming in will improve accuracy
- Will develop action plans
- Identifying new locations for additional monitors:
  - To expand network

RESEARCH REPORT

July 2022

Houston Refinery (LyondellBasell)



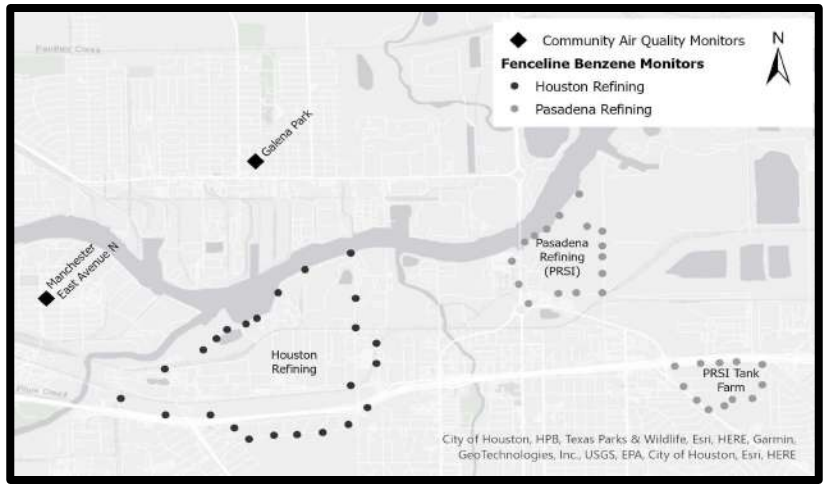
Pasadena Refining (PRSI) (Chevron, 2019)

Research Report: LyondellBasell & Chevron

- Completed by: The Center for Applied Environmental Science (CAES)

- Modeled self-reported emission estimates and compared it with values recorded at fenceline air monitors
  - Are the refineries' self-reported emissions reliable?
  - Do these match up with pollution levels measured in the community?

- Used emission numbers and data from 2019



Major Takeaways

- Inconsistency between self-reported emissions and monitor recordings
  - Benzene: 10 - 100 times higher than reported
    - Exceeding maximum exposure guidelines / standards at many locations
  - PM: Severe underreporting in flaring emissions

- Potential limitations due to recent developments:
  - Lyondell: Decommissioning oil refinery. Transitioning to “chemical recycling”
  - PRSI: Acquired by Chevron 2019. Making changes to processes

- Opportunity to use data and recommendations from report in future permit oppositions:
  - Steps for refineries to take to reduce air pollution impacts

QUESTIONS