

Appendix H of the 2023 Annual Criteria Monitoring Network Plan. Lakeview PM2.5 and PM10 Monitoring Site Relocation Plan

May 2023



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1. Introduction

Oregon DEQ is proposing to move the [Lakeview Center St. and M St.](#) (LCM) PM2.5 and PM10 monitoring site 0.9 kilometers to the southeast to Fremont school. The LCM site has been used by DEQ for PM10 since 1991 and PM2.5 since 1999. LCM is on private property and has recently changed ownership. The new owner has started renting out space adjacent to the site for RV living. This has resulted in loss in confidence of the data by the community leaders and suspicion that any elevated levels are from the RV residence and not the community. DEQ has not seen evidence of this, however, we cannot guarantee this will not happen in the future as we have no control over the leaser's activities. The community leaders operate the woodstove smoke reduction programs and they must have confidence in the site's data before they can convince their constituents to curb emissions. The LCM site photos below show the proximity of the RVs to our monitoring site.



Figure 1. Aerial view of Lakeview Center and M St. monitoring site with the new RVs superimposed.

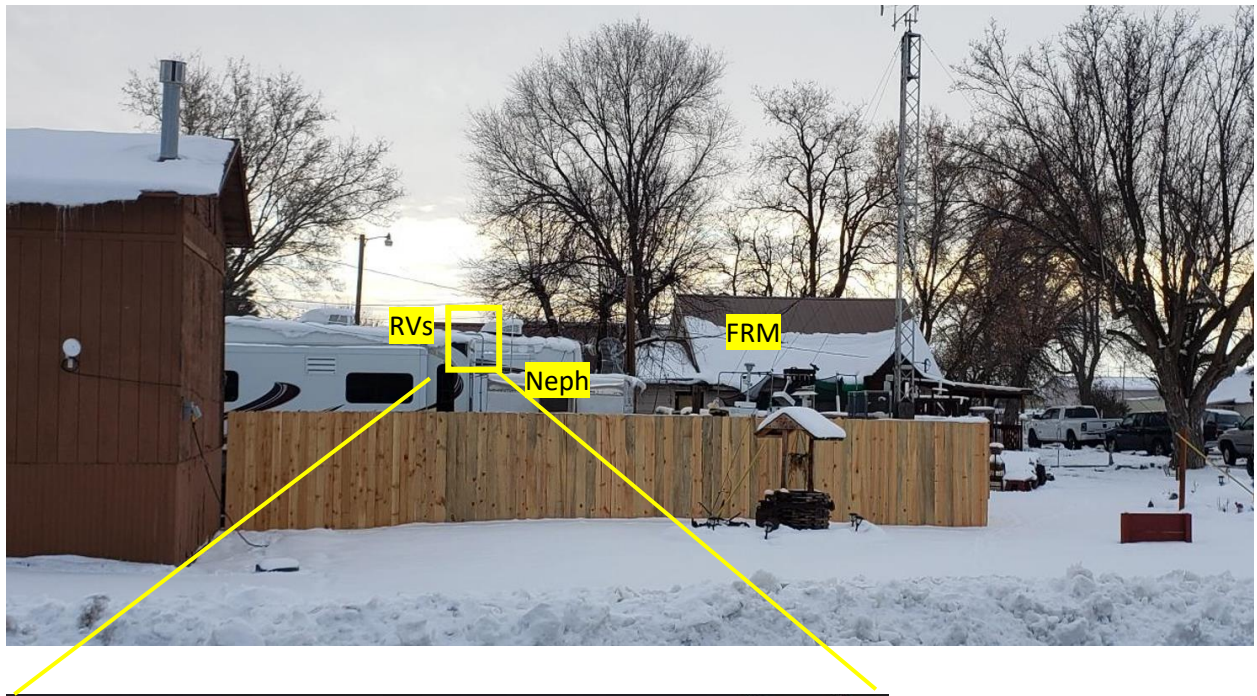


Figure 2. December 2021 view of LCM with the new fence and the RVs



Figure 3. View of LCM past the RVs in December 2021

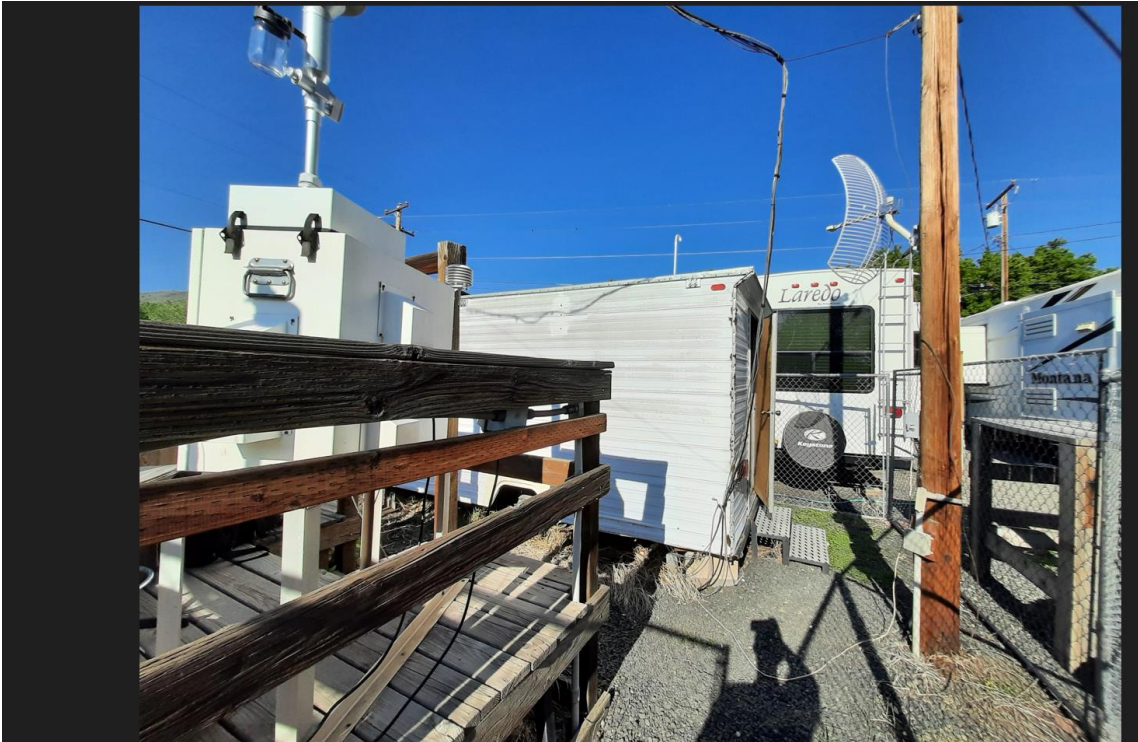


Figure 4. View of LCM across the deck toward the shelter and RVs, May 2022

DEQ agrees with the community that we need to find a more suitable location. To select a location, DEQ reviews physical considerations such as meteorology, topography, and emissions sources. DEQ also considers receptor population and environmental justice areas, and to monitor in areas with populations at risk such as the young and old. This information will be provided and the conclusions drawn from this discussed below.

2. Topography

Lakeview is next to a bluff on the east that rises around 500 meters in around three kms. Lakeview itself, is on flat ground. The LCM site is at 1449 meter elevation and the new site is at 1447 meters. That is only a two meter elevation change. The proximity to the bluff means that there is down slope cold air flow during the evening where the ground surface cools more quickly than the air above. The cool air flows down the hill into Lakeview and the surrounding valley, displacing the warmer air. This results in overnight inversions. The Lakeview topography map is shown below and can be viewed more thoroughly on Google Earth.



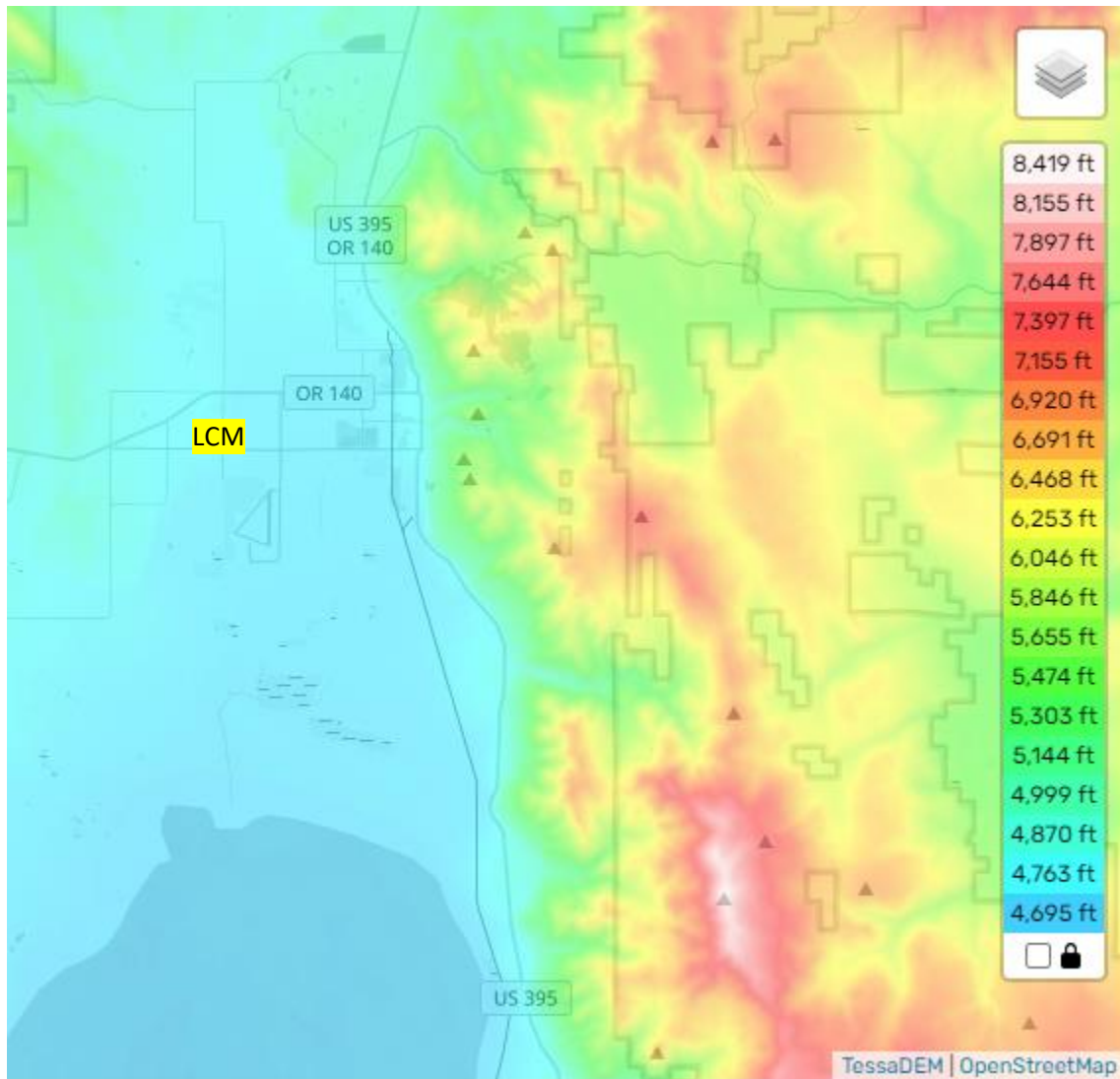


Figure 5. Aerial views of Lakeview showing the topographic changes.

3. Meteorology

Inversions

DEQ does not have inversion sensor information for Lakeview, but we do see the maximum winter PM_{2.5} values during the evening. In part, this happens because the inversion begins as the sun sets. At the same time, people may be starting up their residential wood heating sources. The graph below demonstrates the diurnal PM_{2.5} concentrations during an elevated PM_{2.5} episode in January 2019.

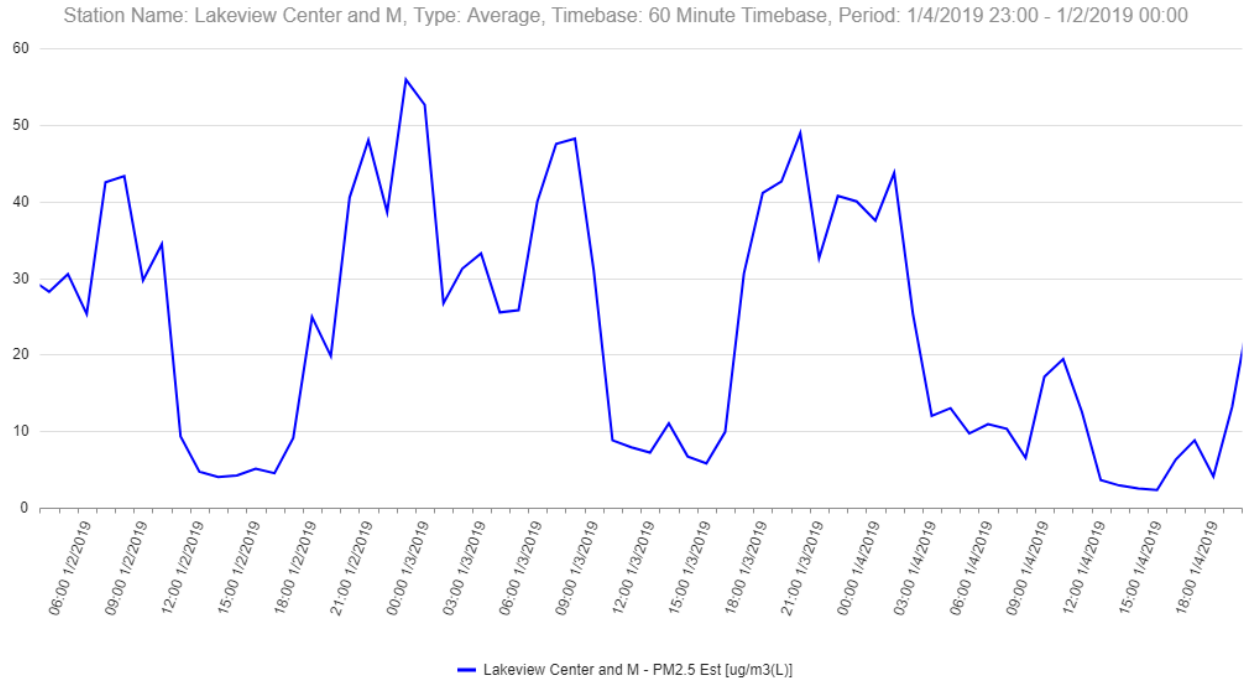


Figure 6. Lakeview PM2.5 graph demonstrating the diurnal pattern of an elevated winter episode

This graph shows the typical wintertime diurnal pattern during elevated PM2.5 events and it demonstrates how the levels start climbing around 5 pm and reach their maximum levels at midnight. The levels stay high overnight and clear out during the day as the inversion breaks when the sun heats the ground and causes instability.

Wind speeds and directions

The wind direction in Lakeview is generally from the south to east southeast as shown in the 2021 wind rose below. The 2021 wind speeds below 6 mph make up 85% of the hours.

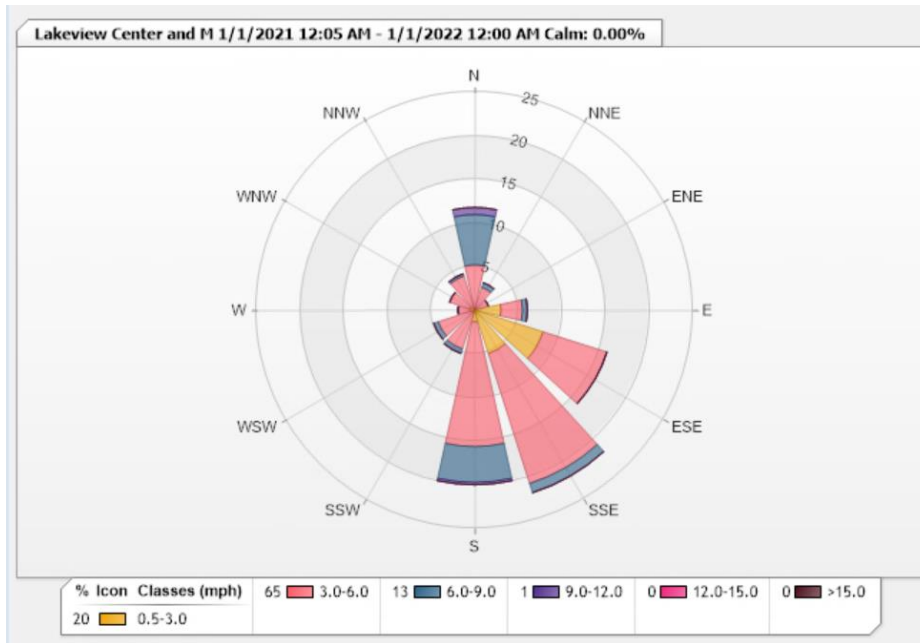


Figure 7. Lakeview annual wind rose for 2021.

The winter wind rose shows a similar direction and speed pattern as it does for the annual wind rose. Winter winds are mainly from the south to east southeast with wind speeds below 6 mph 83% of the time.

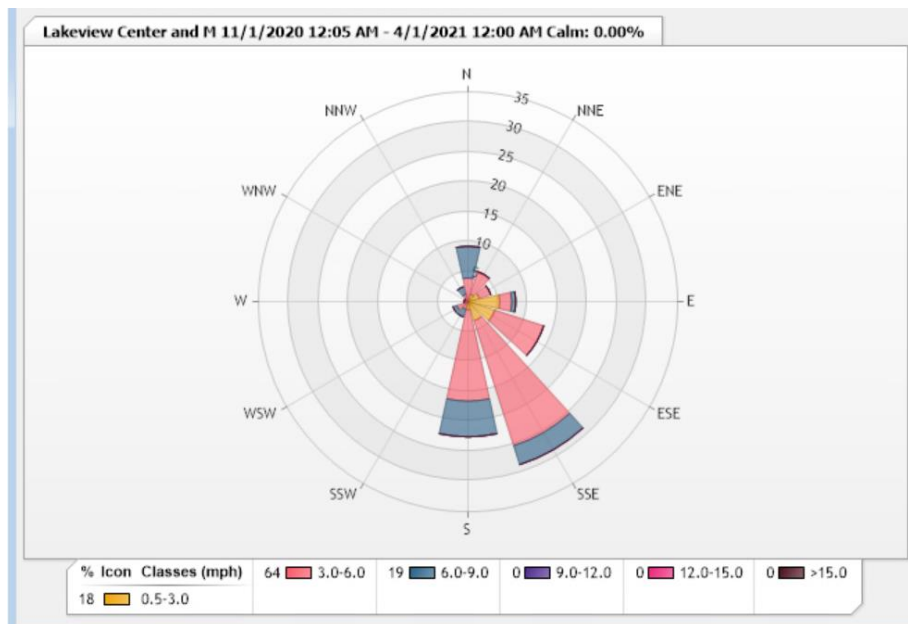


Figure 8. Lakeview wind rose for November 1, 2020 to April 1, 2021.

The wind speeds are very low during elevated winter PM_{2.5} episodes like the January 2 through 4, 2019 graph shown above. The wind rose for January 2 through 4, 2019 is shown below, and all wind speeds are below four mph. This indicates very localized emission sources and the conditions for an inversion.

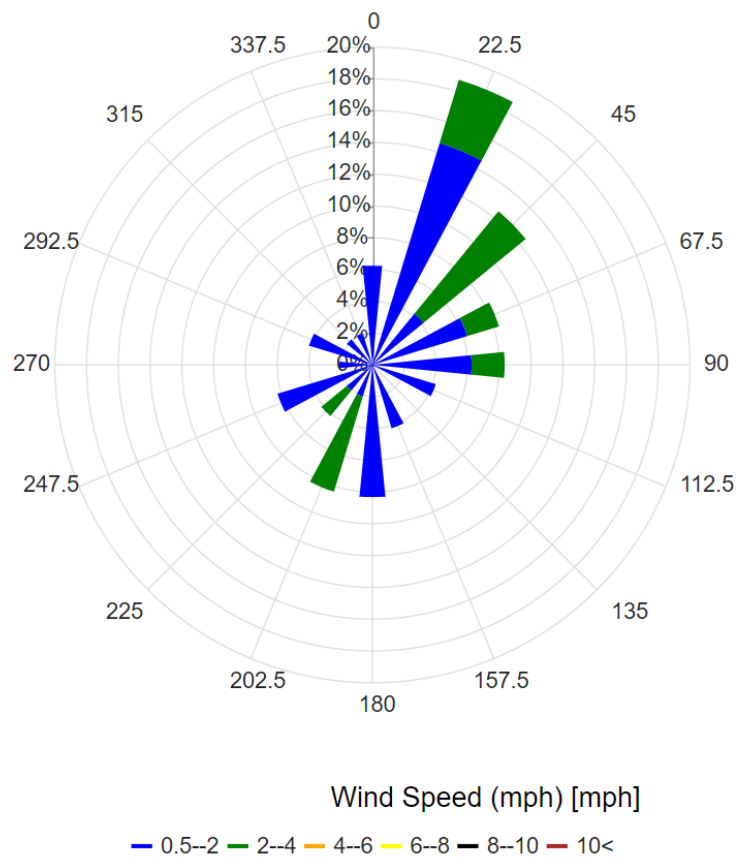


Figure 9. Lakeview wind rose for January 2 through 4, 2019.

4. Monitoring

Trends

DEQ has been monitoring for PM_{2.5} at LCM since 1999 when an FRM was set up. DEQ replaced the FRM with a nephelometer in 2003 to address budget cuts and because it was well below the existing standard of 65 $\mu\text{g}/\text{m}^3$. In 2007, DEQ reinstated the FRM for comparison to the new NAAQS of 35 $\mu\text{g}/\text{m}^3$. The PM_{2.5} trends are shown in the graph below and show concentrations above the standard but improving as actions are taken to address emission sources. PM_{2.5} estimates from the nephelometer are used for 2004-2006. The trends show an increase in wildfire smoke impacts but wildfire smoke is typically ubiquitous in small communities and site location is less important to capture concentrations.

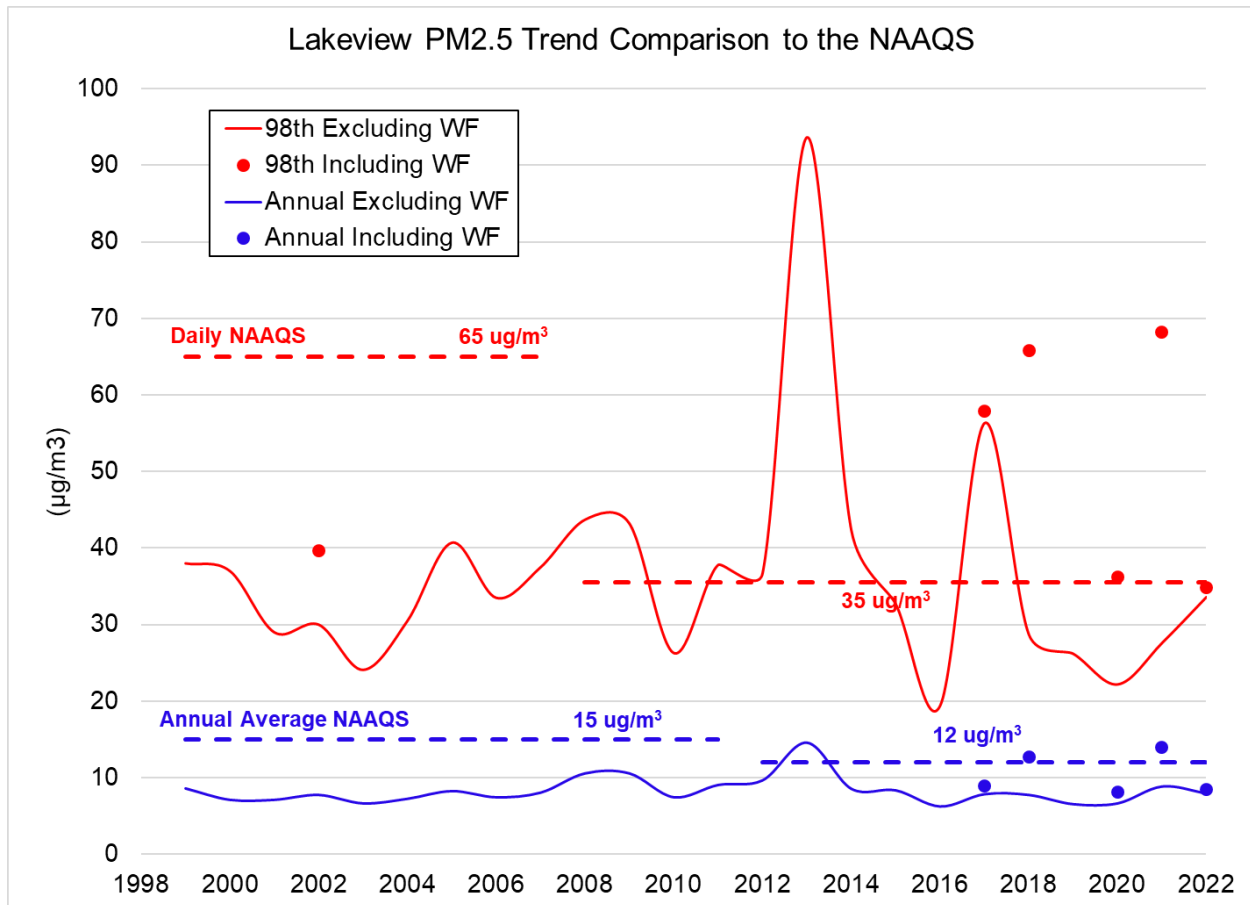


Figure 10. Lakeview PM_{2.5} trends

Seasonal Patterns

The PM2.5 monitor shows that the PM2.5 concentrations are highest in the winter months, with the exception of wildfire smoke impacts. Annual wildfires smoke impacts are becoming more common in Lakeview because of its proximity to California fires. All other times of the year have relatively low PM2.5 levels. The figure below shows 2017 to 2022 daily PM2.5 concentrations are highest during the winter and wildfires. The wildfire smoke events are highlighted in the shaded areas. The data is calculated using the FRM data every third day and the nephelometer estimated PM2.5 for the other two days.

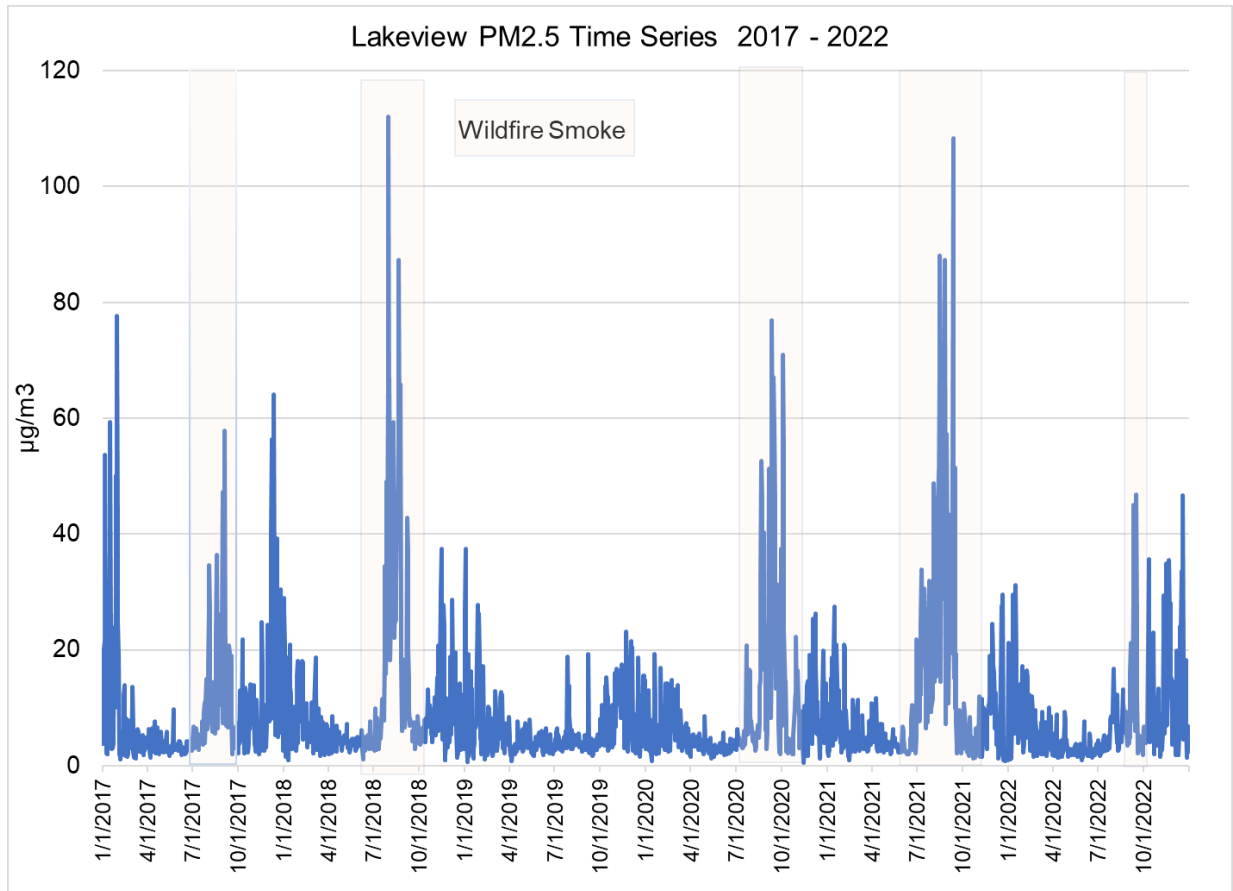


Figure 11. Lakeview PM2.5 daily concentrations from 2017 through 2021.

PM2.5 speciation

DEQ operated a PM2.5 speciation sampler in Lakeview for several years around 2010 to 2015. EPA performed Positive Matrix Factorization (PMF) (Kotchenruther, 2016) for communities across the Western US and included Lakeview in this study. A summary of the pm2.5 source factors is shown in the figure below.

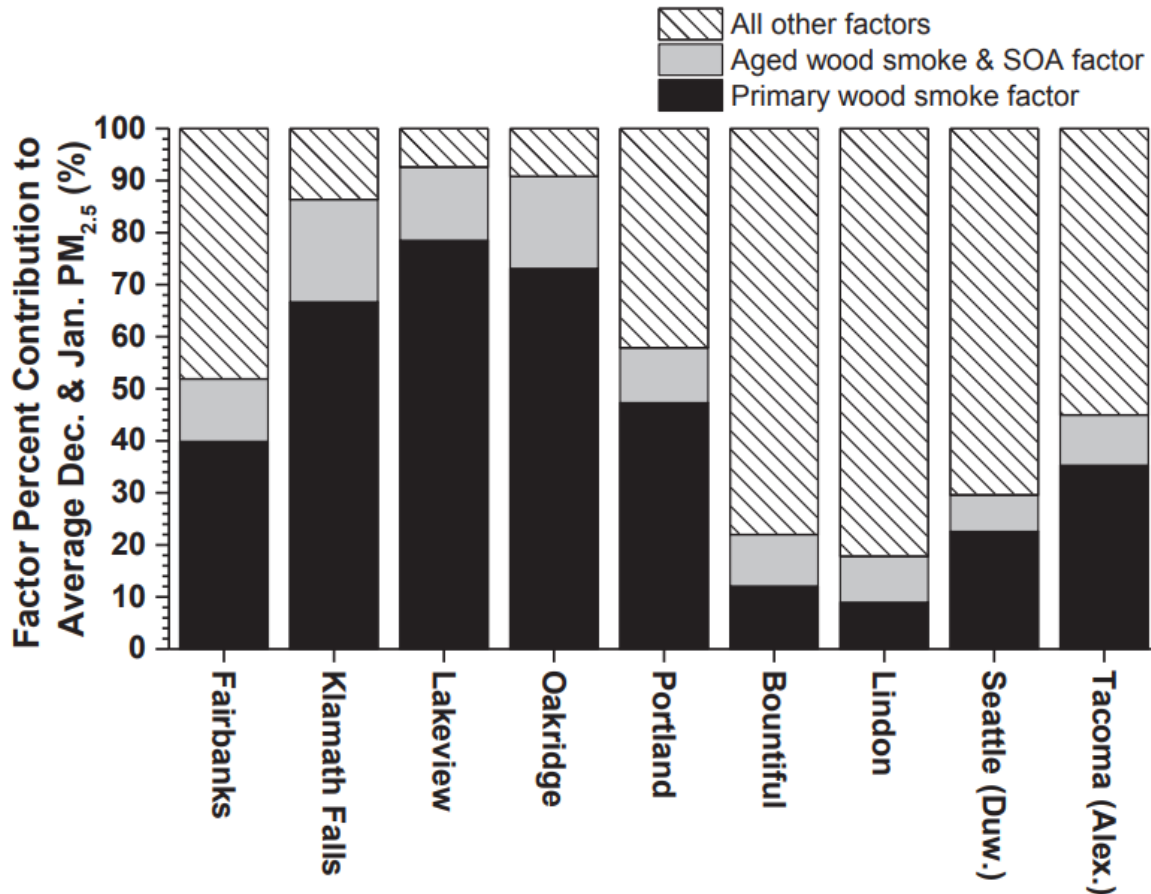


Figure 12. Percent PM2.5 December and January contributions from different speciation factors using Positive Matrix Factorization.

[Robert A. Kotchenruther, Source apportionment of PM2.5 at multiple Northwest U.S. sites: Assessing regional winter wood smoke impacts from residential wood combustion, Atmospheric Environment, Volume 142, October 2016, Pages 210-219.](#)

EPA focused the PMF on the winter months and showed that around 76% of Lakeview PM2.5 came from primary wood smoke. This indicates a strong residential wood combustion smoke contribution. EPA also showed that 16% of PM2.5 was from aged wood smoke or secondary aerosol formation. The source for this category can also be from residential wood smoke but also from other combustion sources and agriculture.

5. Emission Inventory

The latest available emission inventory (EI) for Lakeview's county (Lake) is from 2017. The Table below shows the Lake County, 2017 PM2.5 National Emission Inventory. There is not an EI for Lakeview by itself. The Lake County emission inventory has a large amount of dust estimated, however, in 2022, the DEQ emission inventory staff has questioned the validity of this estimate. Regardless, Lakeview's streets are paved so the unpaved road dust would be outside of Lakeview in the rural areas of the large county. The second highest emission source for the county is residential wood fuel combustion. Below that are the mobile and point sources.

Table 1. 2017 PM2.5 National Emission Inventory for Lake County

PM2.5 Emission Sources	tpy
Dust - Unpaved Road Dust	398
Fuel Comb - Residential - Wood	35
Dust - Paved Road Dust	20
Mobile - Non-Road Equipment - Gasoline	10
Waste Disposal	8
Industrial Processes - Mining	8
Mobile - Non-Road Equipment - Diesel	7
Mobile - On-Road Diesel Heavy Duty Vehicles	5
Mobile - On-Road non-Diesel Light Duty Vehicles	3
Commercial Cooking	3
Mobile - On-Road Diesel Light Duty Vehicles	2
Fuel Comb - Comm/Institutional - Biomass	1
Mobile - Aircraft	1

If the activities that take place outside of Lakeview are removed from the EI, the remaining emission estimate indicates that residential wood combustion, mobile sources, and dust are the major contributors. The pie chart below shows the percent of estimate emissions from each source for Lakeview using the 2017 NEI. In this estimate, residential wood combustion accounts for 41% of the PM2.5 emissions.

Lakeview 2017 Emission Inventory Estimate

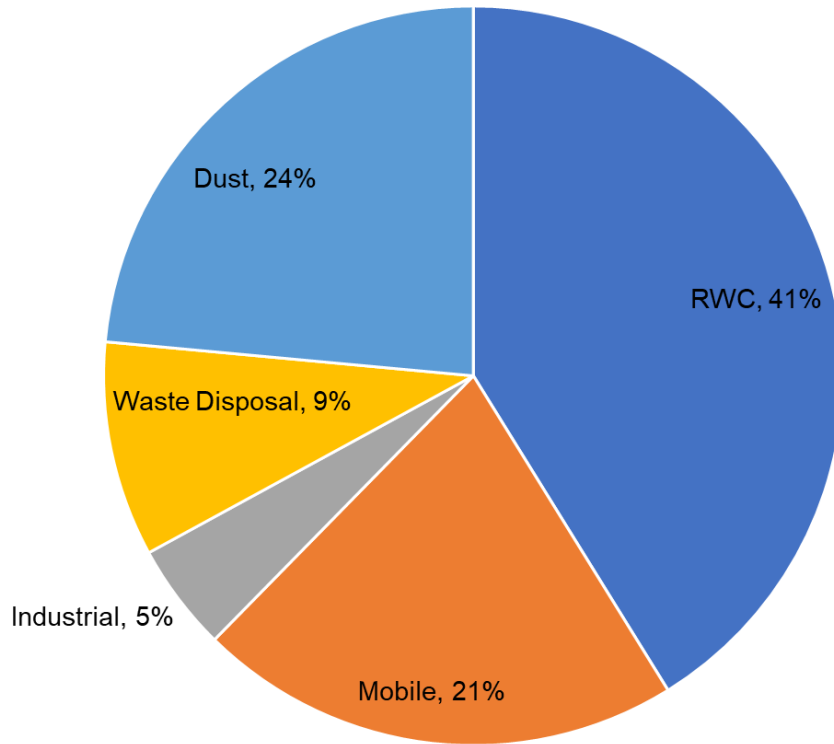


Figure 13. Lake County national emission inventory estimates for sources in Lakeview.

Note: Wildfire smoke, prescribed burning, and unpaved dust emissions were removed because the location of the monitor should not have an impact on the concentration of these emissions that come from outside the Lakeview area.

6. Demographics

DEQ is committed to including environmental justice (EJ) considerations to represent people of low income, and minority status. DEQ also strives to protect the most vulnerable people from air pollution, which is usually the old and young populations. EPA provides demographic information in EJ Screen which provides census block data on where these populations. The figures below show the EJ areas for people of color, low income, the young, the elderly, and the combined socioeconomic indicator. The figures show the existing site, LCM, and the proposed site at Fremont School. The proposed site will be discussed more in the following section.

People of color

For the people of color there is not difference between census blocks. This is not a factor in determining EJ areas.

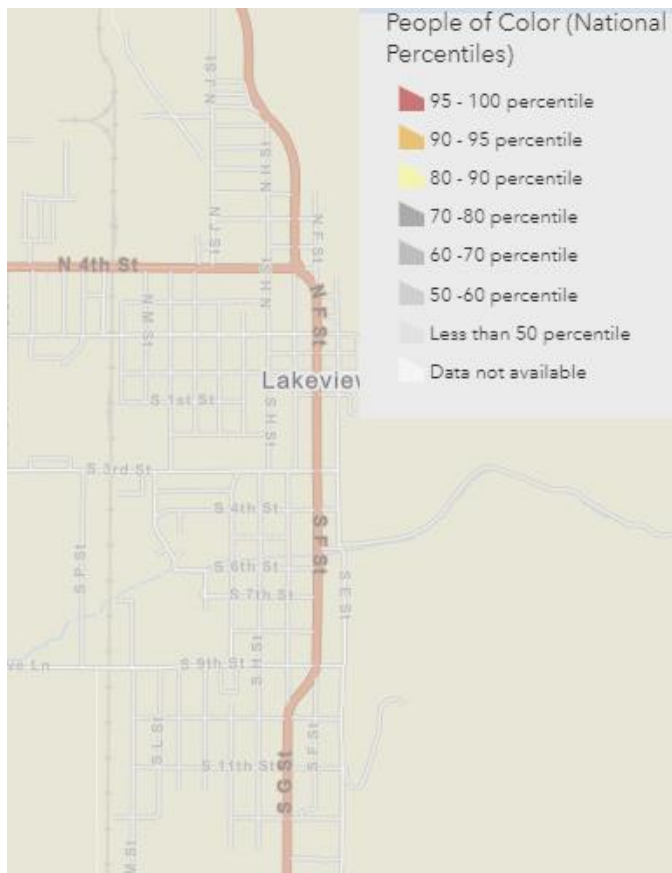


Figure 14. Lakeview people of color EJ areas

Low Income

The southern and central parts of Lakeview have a higher percentage of lower income people. The EJ area is in the census block south of Highway 140. The figures below show the current site, LCM, and the proposed new location at 1st and M Streets (LFM). For low income, they are both in the 80 to 90 percentile.

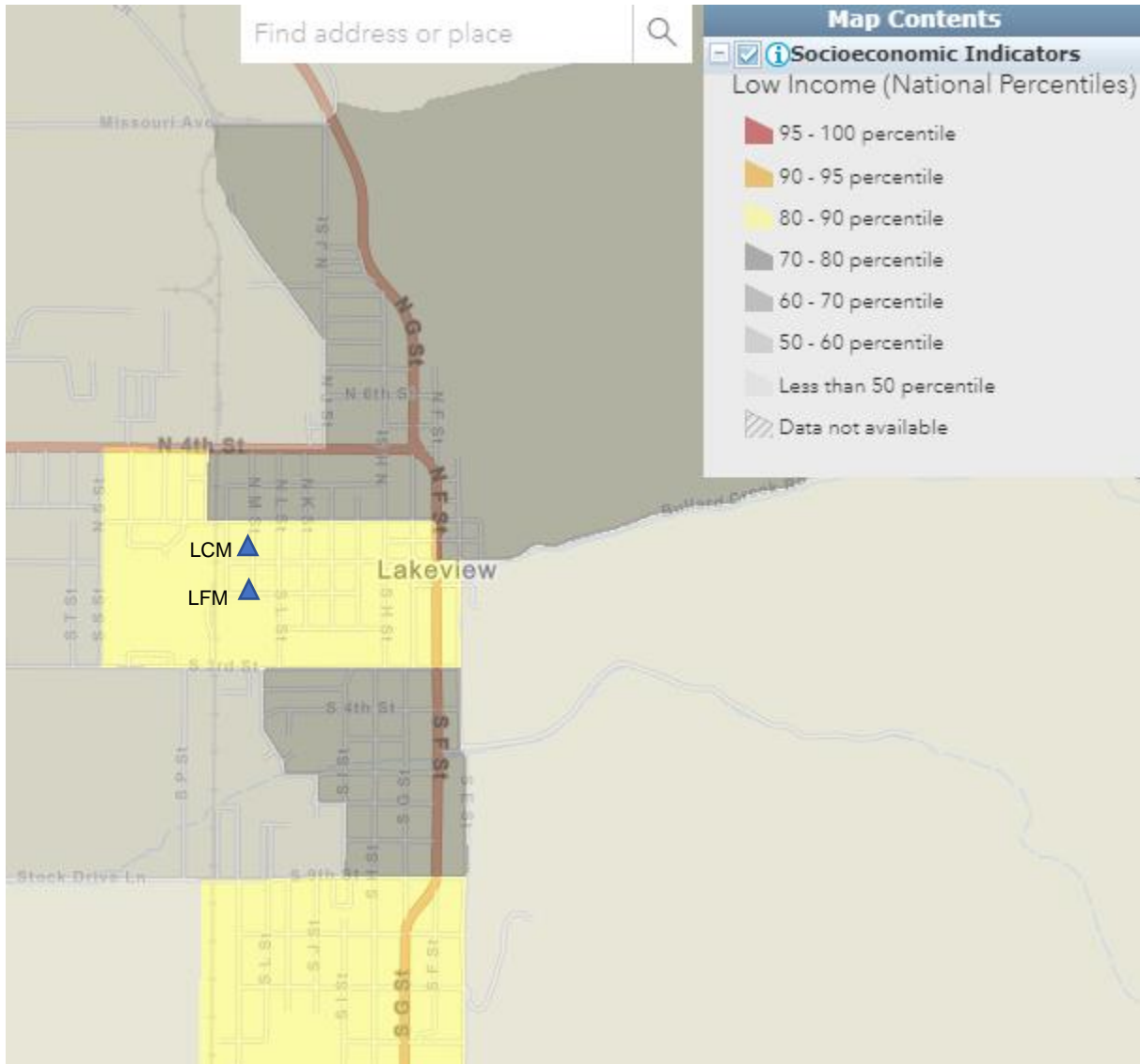


Figure 15. Lakeview lower income EJ areas.

Vulnerable populations

For the people under five years old, the area south of 3rd street had the highest population. This is consistent with the low income area and it is not surprising that young families have the lowest income. The LCM and LFM have less young people than the proposed Fremont school site but is similar to the rest of Lakeview.

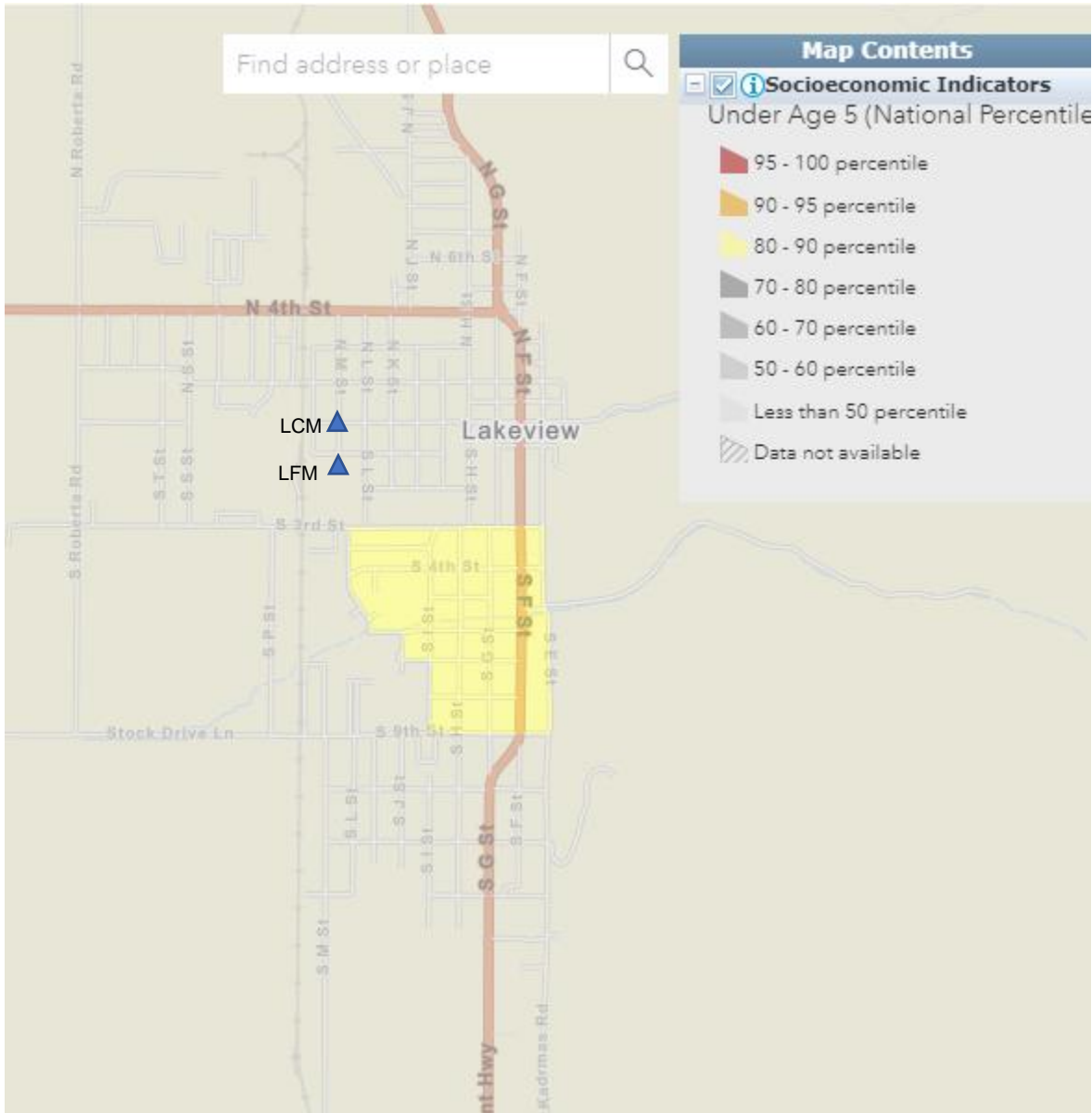


Figure 16. Lakeview population under five years old.

The people over 64, the live on the outskirts of Lakeview and in the southern part of town. For the people living in the more urban core, they live mostly in the south of town. The LCM and LFM proposed site are in the 70 to 80 percentile.

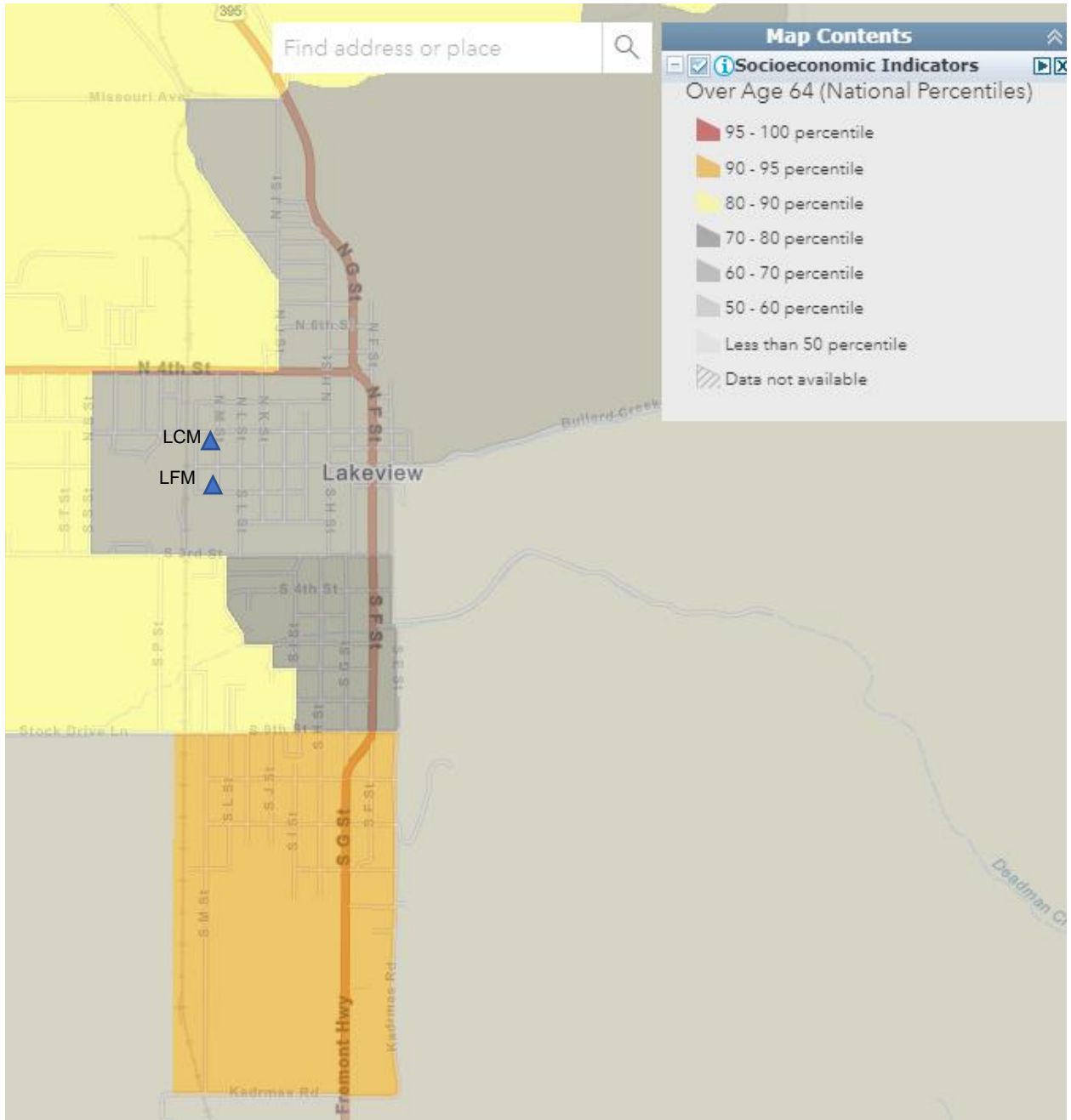


Figure 17. Lakeview population over 64 years old.

Demographic Index

The combined EJ for Lakeview provided by EJ screen is the demographic index and it shows That southern Lakeview is in the 70 to 80 percentile and the rest of Lakeview is in the 50 to 70 percentiles. The LCM and LFM proposed site are both in the 60 to 70 percentile.

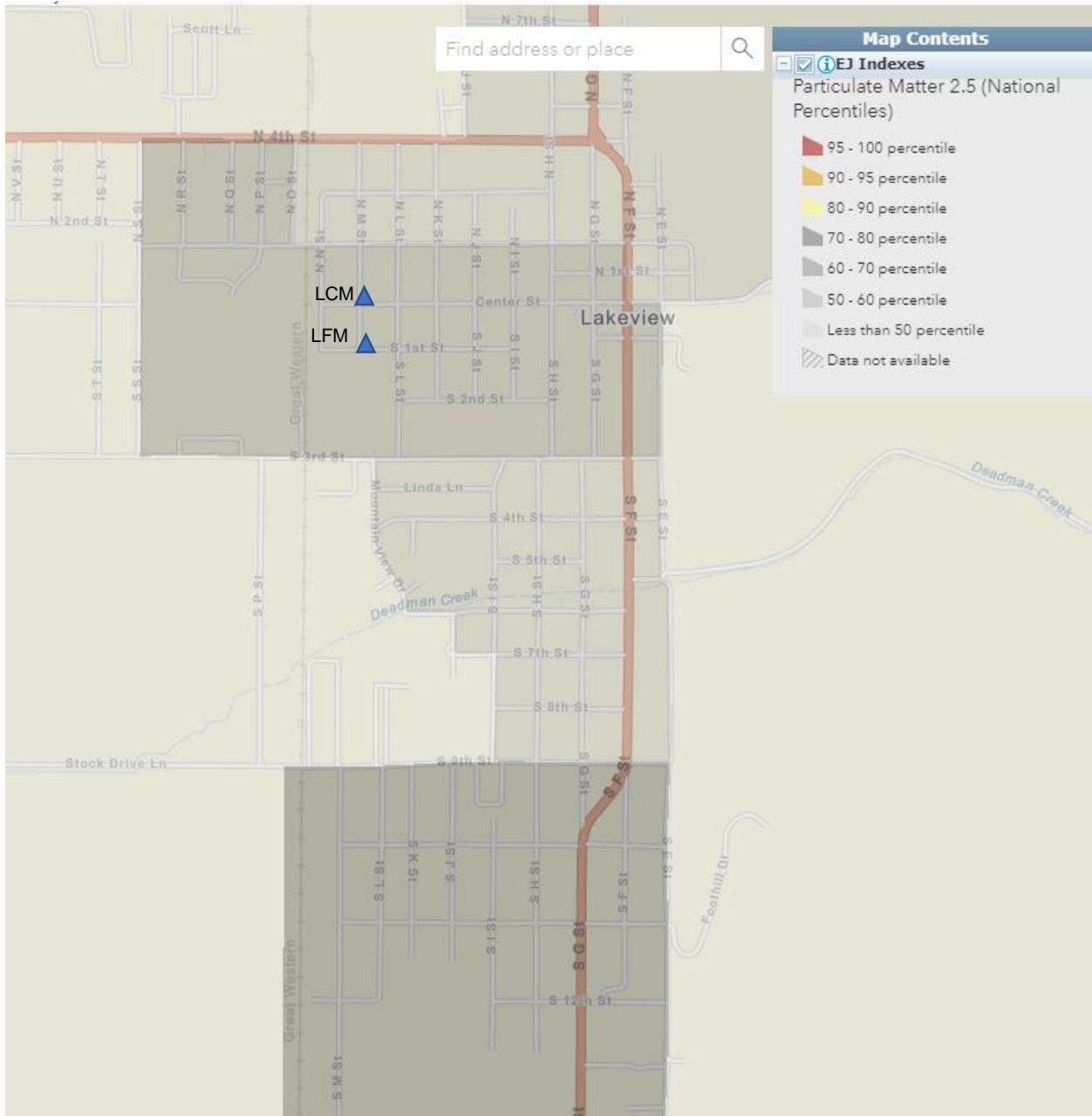


Figure 18. Lakeview demographic index

7. Proposed location

The proposed location is 0.9km to the southeast of the existing LCM site. It is at Fremont School at the intersection of South H Street and South 6th Street. The [latitude is 42.182464](#), the [longitude is 120.34890](#).

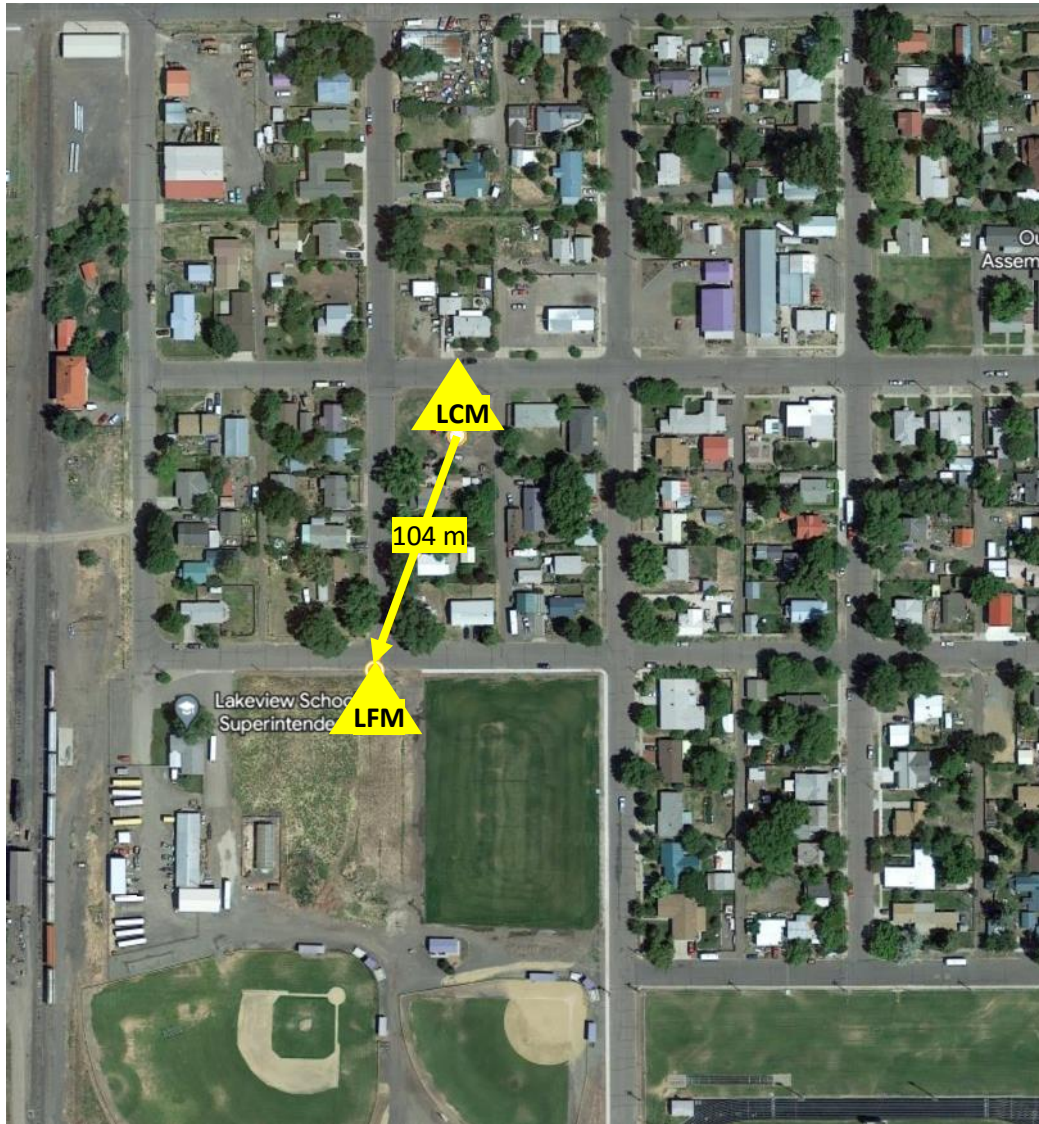


Figure 19. Direction and distance from old site to new site



Figure 20. Lakeview proposed 1st and M Str. location

The new site is in an open field, next to very low trafficked neighborhood streets, with the nearest obstruction are two deciduous trees of 10 to 13 meters tall and over 30 meters away. The probe heights will be at three meters and will not be impacted by the nearby deciduous trees, especially in the winter when PM_{2.5} is at its highest. The photos shown below show the site from four directions and show the nearest obstructions.

A zoomed Google Earth aerial photo showing the exact location of the new site on the edge of the playground.



Figure 21. Google Earth street view showing proposed site and view facing west.



Figure 22. Google Earth street view facing north from the proposed location.



Figure 23. Google Earth street view facing east from the proposed location.



Figure 24. Google Earth street view facing south from the proposed location.



Figure 25. Proposed site's distance from obstructions.



Figure 26. Height of possible obstructions to site.

8. Comparison of the PM2.5 data between sites

DEQ ran a DEQ SensOR at the proposed Lakeview 1st and M Street (LFM) site over the winter for comparison to LCM's nephelometer. After completion of monitoring at KFM, the DEQ SensOR was collocated with the nephelometer at LCM for an accuracy check. The linear regression and time series data is shown below.

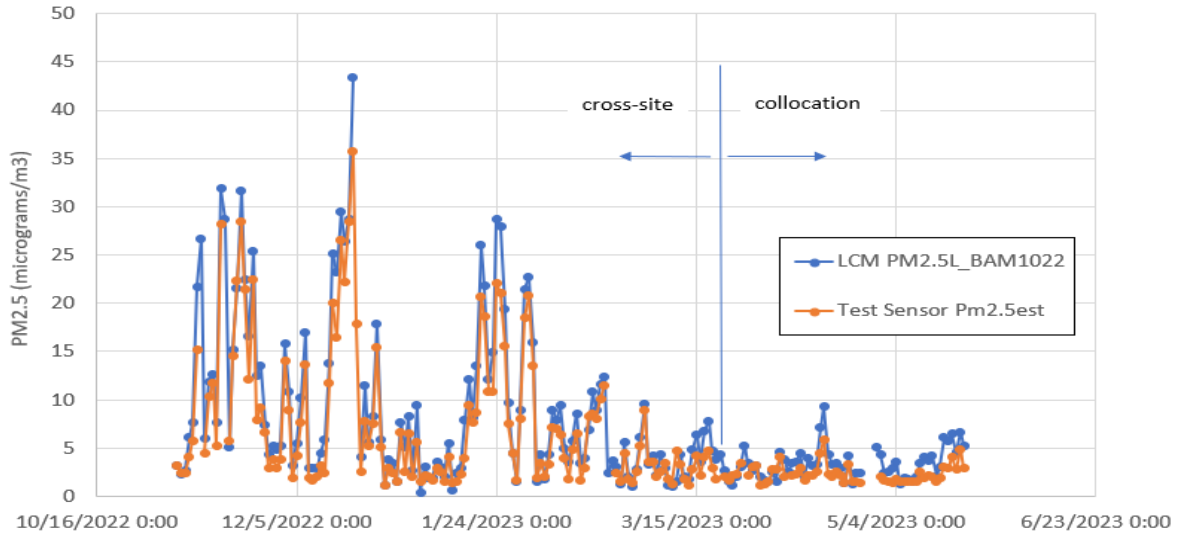


Figure 27. PM2.5 comparison at LCM and the proposed site LFM.

Note: the monitors were also collocated following the cross-site comparison to check the monitors precision with one another.

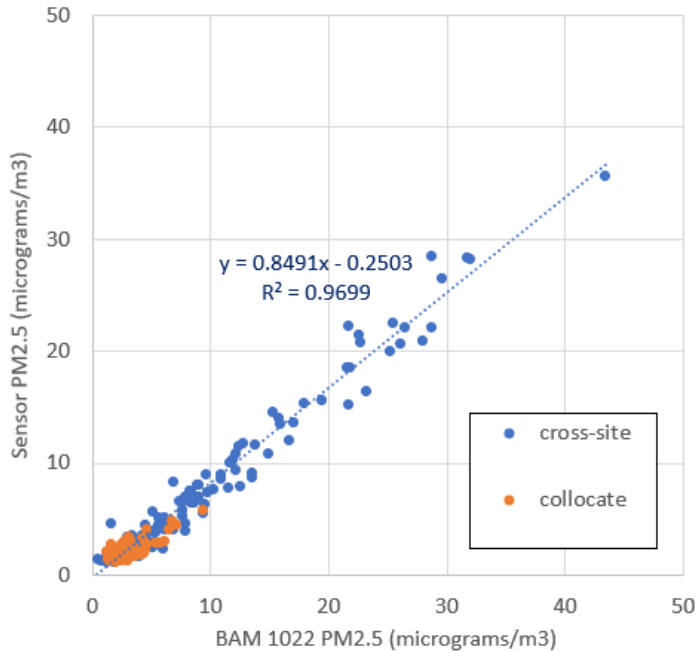


Figure 28. PM2.5 LCM and New site linear regression

The time series shows very good correlation between sites which is not too surprising since they are a block apart. This also shows that LCM was not being adversely affected by the RVs next to it. The linear regression of the two sites had an R square of 0.97 which is very good. The slope is 0.9 which is also within what we would expect when we compare the BAM1022 to the uncorrected SensOR. The slope remained roughly the same when the two instruments were collocated.

9. Monitoring methods

The new location will operate with the same PM2.5 and PM10 methods. The instruments will just be relocated to the new LFM site from LCM. The PM2.5 will be collected with a BAM1022 (method 209). The PM10 method will be the R&P Partasol 2025 with a bypass downtube for the SCC (method 127) but will eventually be estimated using PM2.5 as a surrogate. DEQ also operates wind speed, wind direction, and temperature at the LCM site. DEQ will place temperature at the new site at 2 meters. DEQ will place a windspeed and wind direction sensor on a 10 meter tower as far from the nearby trees as possible. DEQ will continue to operate a Radiance nephelometer M903 for the Air Quality Index until we determined that the BAM1022 can serve this purpose. A table with FEM site and monitoring parameters is given below.

Table 2. Proposed Monitoring site parameters

Local Site Name	Lakeview, First and M Sts (LFM)		
AQS ID	41-037-0002 (proposed)		
GPS Coordinates	42.1882, -120.3543		
Street address	1 st and M Streets., Lakeview, OR		
County	Lake		
Distance from roadways (meters)	10 meters		
Traffic count (AADT, yr)	The nearest roadway with traffic data is about 1.1 km to the north: AADT = 2800 ODOT (Hwy 20 & L St.) yr = 2019		
Groundcover (e.g. asphalt, dirt, grass)	Grass		
Representative statistical area name (CBSA,	Other		
Pollutant	PM2.5	PM10	PM2.5
Parameter code, POC	88101,1	81102,1	85202,3
MSA, CBSA, CSA or area represented	0000		
Monitor purpose	Population		
Monitoring Objective	NAAQS, AQI		
Spatial scale of Representativeness	Neighborhood		
Monitoring types	SLAMS	SLAMS	SPM
Instrument type and model	Beta Attenuation BAM 1022	Gravimetric R&P 2025	Beta Attenuation BAM 1022
Instrument parameter occurrence code	Primary	Primary	Collocate
Method number	209	127	209
FRM/FEM/FRM/other	FEM	FRM	FEM
Collecting agency	ODEQ	ODEQ	ODEQ
Analytical lab	ODEQ	ODEQ	ODEQ
Reporting agency	ODEQ	ODEQ	ODEQ
Monitoring start date	1/1/2023	1/1/2022	Summer
Current sampling frequency	Continuous	1/6	1/1
Sampling season	Annual	Annual	Annual
Probe height (meters)	2.7	3	3
Vertical distance from supporting structure (m)	1.7 meters	2 meters	0.5
Horizontal distance from supporting structure	3	3	0.5
Distance from obstructions on roof (meters)	No obstructions		
Distance from obstructions not on roof (meters)	No obstructions		
Distance from trees (meters)	35	35	35
Distance from to furnace or incinerator flue	~50	~50	~50
Unrestricted airflow (degrees)	360°	360°	360°
Probe material for reactive gases	Aluminum	Aluminum	PVC
Residence time for reactive gases (seconds)	NA	NA	
Will there be changes with the next 18 months?	Site relocation	Site relocation	Site
Is it suitable for comparison against the	Yes	Yes	No

10. Discussion

DEQ and the City of Lakeview feel it is necessary to move the LCM site because of recent land use changes on the property that casts doubt on the data. DEQ considers this an opportunity to site the monitor at a playground, in an environmental justice neighborhood where people live, work, and play. DEQ considered the topography, meteorology, monitoring data, and sources, the emission inventory, and EJ information to find the most suitable location.

Lakeview has exceeded the PM_{2.5} standard in several years since the standard was lowered. The wind direction is general from the south to east southeast and blowing across town toward the current LCM site. The proposed 1st and M Streets (LFM) site is one block south of LCM and experiences the same wind patterns. Also, during high winter concentrations there is very low wind speeds and most likely inversions from the downslope cold air flow from the hills to the east. An inversion is inferred also because the levels start to rise at sunset at around 5 pm, level off at midnight, and start to drop at sunrise when an overnight inversion would break. The inversion causes a more homogenous dispersion of PM_{2.5} across town.

The PM_{2.5} speciation PMF analysis by EPA showed the winter PM_{2.5} to be over 76% wood smoke. This is confirmed by the 2017 NEI which shows that residential wood heating is the primary in town estimated emission source. All this confirms that we should be looking for a monitoring location in a neighborhood with residential wood heating. The area around LFM is low income, residential, and will have plenty of residential wood heating.

We also want to be where people at risk are living and playing. Older people are at risk from COPD, younger people are at risk from asthma, and low income people burn more for heat, and may not have as good of filtration in the home. The proposed site at LFM is in an area that has young, old, and low income people. It is also near the Lakeview High School sports fields where people are breathing heavily and the 0.7 kilometers north of the local hospital where vulnerable people are.

Finally, the proposed location is only 0.1 km from the LCM site and in a town the size of Lakeview, this should not make a big difference as far as emission sources. The emissions are primarily from wood combustion and spread out across town. There is no large PM_{2.5} point source in Lakeview.

11. Conclusion

DEQ and the City of Lakeview request that EPA R10s give their approval for the relocation of the Lakeview Center and M St. site (41-037-0001) to the south by 0.1kms to 1st and M Street. The new location will be adjacent to a sports field in a low income area and will be more representative of where people work, live, and play. It is in an open area and won't be impacted by very near emission sources like the current site. It will still measure the main source of PM_{2.5} emissions in the area, which is residential wood burning. Finally, it will give the City of Lakeview confidence in the data so they can convince their citizens to take actions to improve air quality.