

M.L 2017 Project Abstract

For the Period Ending June 30, 2021

PROJECT TITLE: Assessment of Urban Air Quality

PROJECT MANAGER: Monika Vadali, PhD

AFFILIATION: Minnesota Pollution Control Agency

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: M.L. 2017, Chp. 96, Sec. 2, Subd. 07b as extended by M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 19

APPROPRIATION AMOUNT: \$ 700,000

AMOUNT SPENT: \$ 604,715

AMOUNT REMAINING: \$ 95,285

Sound bite of Project Outcomes and Results

Air pollutant concentrations cannot be assumed to be the same across all zip codes in the cities of Minneapolis and St. Paul. There are local differences observed and these can influence quality of life where one lives. Monitor placement is very important in being able to detect these differences in neighborhoods.

Overall Project Outcome and Results

Understanding small-scale differences in air pollution in urban areas is important for minimizing exposure to harmful air pollutants, particularly for vulnerable communities. This project is using new air-monitoring sensor technology to broaden our knowledge about air quality in Minneapolis and St. Paul. A total of 47 AQMESH air monitors were installed in the study area. 10 of these were co-located with existing MPCA regulatory monitors in order to more closely evaluate the use of sensor technology for accuracy. 14 monitors were located on parking lot light poles, in St. Paul public schools. 23 monitors were placed on Xcel light poles in Minneapolis in residential areas. Pollutants monitored were CO, NO, NO₂, SO₂, O₃, PM_{2.5} and PM₁₀. Data was collected from June 2019 to June 2021. In addition to the overall goal of seeing small scale differences in urban neighborhoods, this project had 3 main goals:

- Are there significant differences in pollutant concentrations between ZIP codes in the urban core?
- Are there areas with unusually high pollutant concentrations?
- Is this technology suitable for measuring small differences in air quality?

To investigate the last question, data from collocated sensors was compared to the regulatory monitoring data and it was found that there is a reasonably moderate confidence in the sensor data as they compare to the regulatory grade monitors. A strong relationship was also found between the sensor pods themselves, indicating that these would be a good tool for highlighting the differences in pollutant concentrations across the study area.

To further investigate the first 2 questions, data collected from all the sensors for all zip codes was analyzed using R (v 1.4.1717). Data was divided by region into North Minneapolis, South Minneapolis and St. Paul, based on the sensor location. Basic data statistics were computed, pollutant level charts were plotted and a generalized additive model was applied to look for trends and differences across the entire study area.

The analysis showed that although minimal, there are indeed micro level differences that can be observed. A very clear seasonal pattern can be seen for CO and O₃ concentrations across all regions. Local events like the wide spread fires in May/June 2020 and July 4th fireworks tend to slightly increase the particulate counts for a short period. Sensor placement is very important as it affects the measurements.

Residents can use this data to be more cognizant about activities that happen around them in their neighborhoods, especially on days with bad AQI, which adds more particulates into the air making it unhealthy,

and make appropriate changes for a healthier lifestyle. In St. Paul, monitoring was done in school parking lots, making these results suitable for education purposes and to understand how idling cars and buses effects short term air quality. Results specific to outdoor activities coinciding with drop off and pick up times can be useful. Extensive monitoring along roadways was not part of this project but some monitors along busy roads did show higher NOx levels. Overall, the air quality in Minneapolis and St. Paul is good but depending on where you live and any preexisting health conditions, it may affect ones quality of life. This study can inform future monitoring projects, specific areas where traffic could be examined more closely and looking at other local neighborhood sources of pollution.

Project Results Use and Dissemination

Over the past two years, various efforts were made to communicate results as and when they were analyzed. A [project website](#) was developed which is available on the MPCA's website. A tableau workbook is available with all the monitoring sites and data for all the pollutants being monitored. These can be filtered by site, pollutant and dates if desired.

6 month quarterly updates were provided to the LCCMR. In fall of 2018, project presentations were made in Minneapolis and St. Paul to solicit feedback on monitor placement. In Fall/winter 2019-2020, one year study results were presented at several meetings in Minneapolis and St. Paul to give residents an overview of what the monitors were showing in their respective zip codes. These results were also presented to the Metropolitan Council and other stakeholders.

Presentations will be made to community groups, stakeholders and interested parties. Community concerns, comments and additional analysis done, will be incorporated in the final report and published on the MPCA project webpage.



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2017 LCCMR Work Plan Final Report

Date of Submission: August 11, 2021

Final Report: August 16, 2021

Date of Work Plan Approval: 06/07/2017

Project Completion Date: June 30, 2021

PROJECT TITLE: Assessment of Urban Air Quality

Project Manager: Monika Vadali, PhD.

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Location: Hennepin and Ramsey

Total ENRTF Project Budget:	ENRTF Appropriation:	\$700,000
	Amount Spent:	\$569,578569,929
		\$583,060
		\$604,715
	Cancellation:	\$95,285
	Balance:	130,071 \$0

Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 07b as extended by M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 19

Appropriation Language:

\$700,000 the first year is from the trust fund to the commissioner of the Pollution Control Agency to set up and operate a network of 250 air pollution sensors at 50 sites to monitor fine particles, ozone, nitrogen oxides, sulfur dioxide, and carbon monoxide in each zip code for the cities of Minneapolis and St. Paul to assess variability of urban air pollution. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

Carryforward; Extension (b) The availability of the appropriation under Laws 2017, chapter 96, section 2, subdivision 7, paragraph (b), Assessment of Urban Air Quality, is extended to June 30, 2021.

I. PROJECT TITLE: Deploying new technology to understand urban air pollution

II. PROJECT STATEMENT:

This project will deploy an innovative monitoring approach using new air sensor technology to increase understanding of the variability of harmful air pollutants in urban areas. The project will achieve three objectives:

1. Improve understanding of air pollution variability within densely populated areas. This information will be used to evaluate pollution reduction opportunities, and to compare with population vulnerability and health outcome data.
2. Evaluate the use of new technologies in air pollution sensors as an innovative, cost-effective monitoring strategy.
3. Expand the availability of ambient air quality data to inform decisions, especially regarding public health improvement opportunities.

The pollutants to be monitored are fine particles, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide.

This project is needed because concern is rising about the effects of air pollution on human health, even at the levels seen in Minnesota. Of particular concern are urban areas where there are many sources of air pollution. For example, the recent Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Health (MDH) report *Life and Breath: How air pollution affects public health in the Twin Cities* showed that air pollution is associated with public health impacts such as premature death and hospitalizations.

Understanding small-scale differences in air pollution is essential to minimizing exposure to harmful air pollutants, particularly among vulnerable communities such as communities of concentrated race or poverty. Traditional air monitoring methods are cost-prohibitive to deploy at the level of coverage needed to investigate this important question. New, lower-cost sensors that measure air pollutants of concern are now available. Use of these sensors will allow MPCA to locate more monitors in a given area to answer the question about small-scale differences.

This project will purchase, deploy, and operate a network of 250 air pollution sensors at 50 sites (5 sensors per monitor, 2 sites will include duplicate monitors for quality assurance). This study design will provide one monitoring site in each zip code within the cities of Minneapolis and St. Paul. Zip codes with a larger area will have multiple monitoring sites. The cities of Minneapolis and St. Paul, MDH, and local public health advocates all have a strong interest in the approach this project describes, and the data that will be generated. Additionally, a special emphasis will be placed on sharing the data with the public. While data collection will be focused on Minneapolis and St. Paul, the project will evaluate a monitoring strategy that can be used in other parts of Minnesota.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of December 30, 2017: Exempt from submission (email sent on July 24, 2017)

Project Status as of June 30, 2018:

Since the project started, MPCA put out a bid and successfully procured the air quality sensors. AQMESH air sensors with solar powered pods were selected for use with this project. Each pod will measure particulate matter (PM₁, PM_{2.5}, PM₁₀), Ozone, Sulphur Di Oxide, Carbon Monoxide, Nitrogen oxides (NO and NO₂), temperature and relative humidity. All 250 sensors were collocated for calibration at the Blaine, Anoka MPCA reference monitoring station. All the pods have been calibrated with FRM/FEM reference station. As part of the outreach/community engagement aspect, MPCA conducted 7 open house meeting to introduce the project to residents and seek feedback on possible monitoring locations. Meetings were held in the communities to cover most of the study area in Minneapolis and St Paul.

There were problems encountered with Xcel Energy for amicable pole attachment agreements contract language. In order to get some pods into neighborhoods, five pods (50 sensors) have been deployed at MPCA monitoring stations. MPCA and Xcel Energy are working towards resolving these issues so the project can move forward as planned with sensor pod installation on light poles in the neighborhoods. Hence deployment of sensor pods in neighborhoods at the zip code level has not yet occurred.

A webpage has also been established to inform the public of the progress of the project. The webpage can be found on the MPCA website at : <https://www.pca.state.mn.us/urbanair>

“Amendment Request” (07/20/2018):

This amendment request is for 2 items to be changed:

1. Budget allocations/category
 - a. When the vendor was selected for the final purchase of the air quality sensor, the total amount quoted by the vendor was slightly higher than what was budgeted. I am requesting in this amendment to kindly approve the retroactive funds spend on the sensors. The initial budgeted amount was \$462,500. The requested change is for approval of \$520,000 allocated for sensor purchase. The team decided that this was a fair price to pay because:
 - the sensors were provided with a self-sustaining solar panel for power source, which eliminated the need for additional cost of power draws
 - the sensor unit was provided with an inbuilt GPS and cellular SIM card for direct remote data download, which eliminated the cost of buying individual modems for each unit and additional monthly mobile fees
 - the sensor company already has a website where data can be directly accessed and remote storage for the duration of the study was provided. This eliminated the additional cost of developing and supporting a web based data portal
 - b. \$3,500 Additional amount for out of state conference travel has been added. EPA has started an Air Sensor International Conference, the first of which will be in Oakland, CA in September 11 – 14, 2018. This was not available when the proposal was initially funded, a year earlier. My abstract has been accepted for a poster presentation and a minute oral presentation at the conference this year. Since this is a conference that is dedicated to air quality sensor work, it is a great platform to share and learn from people around the globe. We anticipate to attend this conference and continue to present the LCCMR grant findings here. Since it is a platform for sharing sensor work, it would be great to share experiences and results especially from Minnesota because of our unique climate, where we see extremes in cold and hot temperatures. Generally sensors are built for moderate temperatures but we have been successful in collecting meaningful data over December 2017 – July 2018, which would be of interest to a variety of sensor manufactures , who will also be at the conference. Our project already has a lot of interest due to the scale of deployment. We wish to share and present results where ever possible.

Due to the reasons mentioned above the budget spreadsheet has been modified to reflect the change in dollar amounts as follows:

- for activity 1 : capital expenditure has been increased from from \$462,500 to \$520,000
- 50x data access agreement (\$4025) and 50x Cellular data agreement (\$8400) money in Activity 2 has been removed
- Personnel (wages and benefits) for activity 1 (\$16,500) has been removed
- 50X component replacement for activity 2 has been reduced from \$118,500 to \$89,674
- 45X site leases and permits for activity 1 has been moved to activity 2, same amount of \$23,000

- Consumables amounts for activities 2 and 3 have been adjusted accordingly to reflect revised budgets of \$6,500 and \$1,000 respectively; \$3,000 has been reduced to \$500 for Activity 1.
- Hardware for Activity 1 has been reduced from \$4,500 to \$250; Increased \$0 to \$1000 for Activity 3
- additional row for \$3500 non-state travel in Activity 2 has been added; travel within state has been reduced from \$2,000 to \$0.

The total budget is still \$700,000.

2. Timelines

Due to unforeseen contracting issues with procuring access to Xcel energy street light poles for deploying the sensor units there has been a delay in deploying all the 50 units. 9 units are currently deployed at MPCA maintained monitoring sites to collocate with FER/FRM equipment. The remaining sensor units will be deployed as soon as sites are confirmed and permits are in place.

We therefore request a legislative extension of one year (e.g. until June 30, 2021) for the project. The timelines for outcomes in all activities have been changed and the final report has been pushed out to July 2021, instead of June 2020. The reason for doing so is because I want to ensure that we have the full 24 months of air quality monitoring as initially intended. This will allow us to get a complete picture of seasonal variability as well as temporal variability in exposures. Also, with all the recent construction projects around I94 and I35, a lot of traffic is being diverted into densely populated neighborhoods for detours. The extended timelines will also provide useful information not only on air quality during construction season at zip code level, but also an insight into effective planning for such events with minimal impacts.

No additional funds are being requested for the extended timeline. If any costs are incurred beyond June 2020, they will be paid for by non ENTRF funds.

[“Amendment Request #1 \(budget\) Approved by LCCMR 11/8/2018; Amendment Request #2 \(timelines\) approved by LCCMR 12/10/18.”](#)

[“Amendment request signed into law 5/31/19”](#)

Project Status as of December 30, 2018:

Since the last update in June, MPCA has successfully signed the Xcel contract for using their light poles for installation of the AQMESH monitors in Minneapolis. For St. Paul, a decision was made to install the air quality monitors in St Paul public schools. Schools were picked in each of the St Paul zipcodes and necessary permissions were obtained. Three monitors were installed in December. So far 24% of the monitors have been deployed and collection data across Minneapolis and St Paul. An updated map of the current locations of monitoring and selected locations where monitors will be installed in early spring of 2019, is attached below.

Project Status as of June 30, 2019:

All the monitors have successfully been installed in the various zip codes in the study area, both in Minneapolis and St. Paul. All required lease agreements, permit notifications and permissions were obtained and the deployment phase is now complete. There are a total of 45 monitors in the field, including some collocated with MPCA regulatory sites for comparison of data.

Monitoring data is being transmitted on a daily basis to an MPCA server. This data will be quality checked and made available to view on the MPCA urban air webpage.

A map of the final sites for all the deployed monitors is attached.

Project Status as of December 30, 2019:

A network of 45 monitoring sites has been successfully deployed and data is being actively collected on a 15 minute interval and transmitted to a MPCA maintained database every day. There are :

- 15 sites in North Minneapolis
- 13 sites in South Minneapolis
- 16 sites in St Paul,

The network covers 32 zipcodes across both cities. There are 9 sites that are collocated with MPCA monitoring sites for comparison with regulatory grade data within the study area.

A project charter and quality assurance plan have been updated with current methodologies for sensor data quality checks. All the data is also now available on the MPCA's Assessing Urban Air Quality project webpage. The data is refreshed every week and the averaging time for all data on the web is one hour.

A second round of community meetings were organized in Minneapolis and St Paul to discuss the data pages on the website and get feedback from community on how they are using the data. There were a series of media articles also published on the progress of the project.

Project status as of June 30, 2020:

All the sensors in the network are functioning well and regular maintenance is being performed as needed. One sensor situated at location, 5238 34th Ave. S. Minneapolis, was removed due to Xcel taking out wooden poles on that block to replace with shorter metal light poles. This occurred in late February. Given the circumstances after that, not able to social distance to put another sensor up and the fact that there is another sensor present in that zip code, MPCA decided to not replace that sensor. Another sensor was vandalized when we inspected it in April, so that has been replaced with a new one. Another sensor has been collocated at the Blaine site for continued comparisons with regulatory monitors.

MPCA is working with the vendor in UK to continually improve data quality and ensure sensor performance.

MPCA is also developing a QA tool for the sensor data to ensure that data on the website is a true representation on conditions and all erroneous values due to sensor malfunctions and other technical problems are handled appropriately.

One year results were presented at the Met Council Technical Advisor board meeting in January.

Project status as of December 2020:

All sensors in the network are functioning well and regular maintenance is being performed as needed. There were about 12 to 15 pods that needed particulate sensor replacements and repairs that were performed in mid summer and all the pods have been placed back into the network for data collection since then. MPCA has completed the QA tool development. After completion of one year of data collection, all the pods data was compared to the regulatory monitor and a normalization analysis was done to develop scaling factors for all the sensors, so that we can account for any drift in the sensor performance due to natural working conditions. These scaling factors will be applied and the data on the MPCA urban air webpage will be updated to reflect the adjusted data.

Due to an error on MPCA's fiscal department, the extension of funds beyond June 2020 was not updated in a timely fashion which led to the MMB cancelling all un encumbered funds. This resulted in \$77,572 being given back to the LCCMR. The project will be completed on time with the remaining funds. If additional funds are required, MPCA will pay with other agency funds as required.

Final report summary August 2021: See overall project outcomes and results below.

Overall Project Outcomes and Results:

Understanding small-scale differences in air pollution in urban areas is important for minimizing exposure to harmful air pollutants, particularly for vulnerable communities. This project is using new air-monitoring sensor technology to broaden our knowledge about air quality in Minneapolis and St. Paul. A total of 47 AQMESH air monitors were installed in the study area. 10 of these were co-located with existing MPCA regulatory monitors in order to more closely evaluate the use of sensor technology for accuracy. 14 monitors were located on

parking lot light poles, in St. Paul public schools. 23 monitors were placed on Xcel light poles in Minneapolis in residential areas. Pollutants monitored were CO, NO, NO₂, SO₂, O₃, PM_{2.5} and PM₁₀. Data was collected from June 2019 to June 2021. In addition to the overall goal of seeing small scale differences in urban neighborhoods, this project had 3 main goals:

- Are there significant differences in pollutant concentrations between ZIP codes in the urban core?
- Are there areas with unusually high pollutant concentrations?
- Is this technology suitable for measuring small differences in air quality?

To investigate the last question, data from collocated sensors was compared to the regulatory monitoring data and it was found that there is a reasonably moderate confidence in the sensor data as they compare to the regulatory grade monitors. A strong relationship was also found between the sensor pods themselves, indicating that these would be a good tool for highlighting the differences in pollutant concentrations across the study area.

To further investigate the first 2 questions, data collected from all the sensors for all zip codes was analyzed using R (v 1.4.1717). Data was divided by region into North Minneapolis, South Minneapolis and St. Paul, based on the sensor location. Basic data statistics were computed, pollutant level charts were plotted and a generalized additive model was applied to look for trends and differences across the entire study area. The analysis showed that although minimal, there are indeed micro level differences that can be observed. A very clear seasonal pattern can be seen for CO and O₃ concentrations across all regions. Local events like the wide spread fires in May/June 2020 and July 4th fireworks tend to slightly increase the particulate counts for a short period. Sensor placement is very important as it affects the measurements.

Residents can use this data to be more cognizant about activities that happen around them in their neighborhoods, especially on days with bad AQI, which adds more particulates into the air making it unhealthy, and make appropriate changes for a healthier lifestyle. In St. Paul, monitoring was done in school parking lots, making these results suitable for education purposes and to understand how idling cars and buses effects short term air quality. Results specific to outdoor activities coinciding with drop off and pick up times can be useful. Extensive monitoring along roadways was not part of this project but some monitors along busy roads did show higher NO_x levels. Overall, the air quality in Minneapolis and St. Paul is good but depending on where you live and any preexisting health conditions, it may affect ones quality of life. This study can inform future monitoring projects, specific areas where traffic could be examined more closely and looking at other local neighborhood sources of pollution.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Deploy air pollution sensors at 50 sites

Description: This activity will establish an air quality monitoring network, which includes installing one monitoring unit with five air pollution sensors in each zip code in the cities of Minneapolis and St. Paul. Some larger zip codes will have 2 monitoring sites. Establishing this network will include evaluating and selecting available air monitoring sensor systems, purchasing an air monitoring sensor system that measures the five critical air pollutants (ozone, fine particles, sulfur dioxide, nitrogen dioxide, and carbon monoxide), and includes wireless data acquisition and data storage capability. Upon receipt of the air monitoring equipment, the equipment will be tested to assess the baseline reliability, accuracy, and precision of the equipment in relationship to regulatory air monitors and from monitor to monitor. This information is critical in understanding the potential analytic uncertainty associated with the data generated by these lower cost devices. Simultaneously, this activity will identify the specific monitoring locations within the study area zip codes through a stakeholder engagement process. The stakeholder engagement process will solicit feedback on air monitoring locations through public meetings. The final site selections will be made by the project team, which includes representatives from the MPCA, MDH, City of Minneapolis, City of St. Paul, and Minnesota State University, Mankato. Upon identification of the site locations, the project team will procure all necessary permits and leases and prepare the sites to begin data collection by the end of October, 2017.

Summary Budget Information for Activity 1:

ENRTF Budget: \$ 520,750

Amount Spent: \$ 517,657

Balance: \$ 3,093

Outcome	Completion Date
1. Evaluate and select an air sensor system	July 31, 2017
2. Identify specific site locations in each zip code via stakeholder engagement	July 31, 2017
3. Procure sensor equipment and data acquisition system	November 15, 2017
4. Acquire required permits and/or lease agreements for installing monitors	December 31, 2018
5. Conduct two week sensor calibration pre-test at regulatory monitor site	November 30, 2017
6. Complete deployment of all sensors to site locations	April 30, 2019

Activity 1 Status as of December 30, 2017: Exempt from submission (email sent on July 24, 2017)

Activity 1 Status as of June 30, 2018:

In order to select the best air sensor system to fit the needs of the project and the weather conditions for MN, a nationwide solicitation for bid was created for a multi pollutant sensor system (event 7337). A panel was selected for scoring the bids that came in and the AQMESH product was chosen as the best fit. Even though it was a bit more expensive than initially budgeted, per unit, the vendor did provide a one-year supply of replacement sensors as well as additional extra hardware and an inbuilt GPS and data card for the final price. This is a savings of over \$75,000 over the life of the project. Also since these will be powered by solar panels, it eliminates the cost for replacement batteries.

For outcome 2, to identify specific locations, several open house presentations were made in different community centers around Minneapolis and St Paul for residents to understand the project as well as to seek input on sites. Based on this input, all the suggested locations were mapped in google earth and closest Xcel energy poles, were selected as tentative locations for deployment. These locations are being vetted by Xcel energy in order to ensure that they are available to use. Since we ran into issues with not being able to come to agreement on the contract terms, MPCA and Xcel are still working to finalize locations. Once this is done, we will get the required permits and install the sensors on light poles.

For outcome 5, all the sensors have been calibrated to the FRM/FEM reference station for Minnesota conditions.

For outcome 6, 5 sensor pods have been deployed at 5 locations in the study area. These are currently collocated with existing MPCA reference sites.

Outcome 1, completed by September 2017. Tentative locations for all site for outcome 2 were preliminarily identified by December 2017. Outcome 3 has been completed. Outcome 4 is still on going as and when sites are identified and where permits are required. Outcome 6 is also ongoing.

Activity 1 Status as of December 30, 2018:

Outcome 2, All locations have been verified and approved for deployment.

Outcome 4, Final stages of permits are being worked out for installation in Minneapolis.

Outcome 6, 12 monitors have been deployed so far. 5 in Minneapolis, 6 in St Paul and 1 in Blaine.

Activity 1 Status as of June 30, 2019:

Outcomes 1 through 6, have all been completed. AQMESH Sensors have been deployed in all zip codes of the study where a suitable pole was available, verified and permitted. The final list of locations for all the sensor pods is attached. This completes activity 1, establishing an air quality monitoring network in the cities of Minneapolis and St Paul.

Activity 1 Status as of December 30, 2019:

All tasks under Activity 1 have been completed. Sensor network has been established for the project study area and data is actively being collected from all sites.

Activity 1 status as of June 2020:

All tasks completed and network established and working.

Activity 1 status as of December 2020:

All tasks completed and network established and working.

Final report Summary August 2021:

All tasks completed and network established and worked successfully. All the equipment was decommissioned from sites on June 16, 2021.

ACTIVITY 2: Conduct air monitoring for two years

Description: This activity will operate and maintain the air quality monitoring network throughout the duration of the data collection period (October 2017 – November 2019). Air monitors will operate continuously, collecting data in one minute intervals for each of the five monitored pollutants (ozone, fine particles, sulfur dioxide, nitrogen dioxide, and carbon monoxide). Routine operations and maintenance activities will include monthly site checks and periodic data review. In the event of instrument malfunction, additional non-routine site visits will be necessary. Following the completion of the first year of data collection, the sensor components within the air monitors will be replaced per manufacturers recommendation. Following the completion of the two year data collection, the project team will conduct a two-week sensor reliability, accuracy, and precision post-test to assess the stability of the equipment’s performance over time.

Summary Budget Information for Activity 2:

ENRTF Budget:	\$ 150,962
Amount Spent:	\$ 60,770 53,555
	52,272 143
Balance:	\$ 90,192 97,407
	98,690 98,819

Outcome	Completion Date
1. Begin monitoring for five pollutants at each site	December , 2017
2. Conduct data quality checks and perform sensor maintenance as needed	May, 2021
3. Replace sensor components due to 1-year expiration date for maintaining performance	May, 2021
4. Conduct two week sensor calibration post-test at regulatory monitor site	May 31, 2021

Activity 2 Status as of December 30, 2017: Exempt from submission (email sent on July 24, 2017)

Activity 2 Status as of June 30, 2018:

We have installed sensors at 5 locations and are actively monitoring at these sites for all pollutants. Other sites have been identified and are being evaluated by Xcel Energy for viability of use for installation. Once the pole attachment agreements are signed, deployment to the rest of the selected locations will begin. Outcome 1 is ongoing, although monitoring has begun at 9 sites with co-located MPCA monitors in the study area. Outcome 2 will also be an ongoing event until the monitoring study is complete.

Activity 2 Status as of December 30, 2018:

Outcome 1 is ongoing. 5 pollutants are actively being monitored at 12 locations in the study area. Outcomes 2 and 3 are also ongoing. Sensors are being replaced as and when they fail and closely monitored for data transmission issues.

Activity 2 Status as of June 30, 2019:

Outcome 1 is ongoing. All the sites where sensors are deployed are being actively monitored and collected data is being reviewed for correctness.

Outcomes 2 and 3 are also ongoing and will be continued as required until May 2021. There was a firmware update required for all the sensors, which had now been completed.

Activity 2 Status as of December 30, 2019:

Outcome 1 is ongoing. Data is actively being collected from all established sites.

Outcome 2 and 3 are ongoing as well. A quality assurance plan has been established for quality checks for incoming data. Data is monitored on a daily basis. Sensors and other components are being replaced as and when failure notifications and replacement parts are available.

Activity 2 status as of June 2020:

Outcome 1 is ongoing. Data is actively being collected from all established sites.

Outcome 2 and 3 are ongoing as well. A QA tool is being developed for daily quality checks on incoming data. Every effort is being made for sensors and other components to be replaced as and when failure notifications and replacement parts are available. There has however been a slight delay in getting to all the pods since March. Some monitors with particulate matter maintenance are still ongoing but all gas sensor replacements are up to date.

Activity 2 status as of December 2020:

Outcome 1 is ongoing. Data is actively being collected from all established sites.

Outcome 2 and 3 are ongoing as well.

QA tool has been developed.

All sensors with particulate matter maintenance have been attended to and necessary repairs completed. All pods are back online.

Final report Summary August 2021:

Outcomes 1, 2, 3 and 4 have been successfully implemented and all data has been collected and stored in MPCA's database for review in the future. QA of the study data has also been completed and final as well as raw data has been stored.

ACTIVITY 3: Compile, analyze, and communicate project results

Description: This activity will compile, analyze and communicate the results of the study data. During the active monitoring period, the raw instrument data will be collected and stored on a cloud based database maintained and operated by the instrument vendor. Periodically, project team members will retrieve this data to evaluate instrument performance and to characterize preliminary results. Upon the completion of the project this data will be downloaded and stored in a state owned database. The raw study results will be quality assured, and published for public use. Project team members will also analyze and summarize the project results. These analyses will focus on assessing the use of low-cost air pollution sensors, characterizing measured variability in urban air pollution levels, and linking air pollution measurements to observed health outcomes. Anticipated products include the creation of a project report, an interactive data website, charts, and maps. In addition, the project team anticipates preparing at least two manuscripts that will be submitted for publication in peer-reviewed journals.

Summary Budget Information for Activity 3:

ENRTF Budget: \$28,288
Amount Spent: \$ 26,288 ~~11,849 0~~
Balance: \$ 2,000 ~~16,439~~
28,288

Outcome	Completion Date
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1. Develop a communications plan and forum (including a project website/webpage) to provide public access to the results of the study during the duration of the study period.	January 1, 2018
2. Quality assure, clean, and publish project data for public use	<u>July 30, 2021</u>
3. Perform data analysis and summarize project results including the creation of a project report, interactive data website, charts, and maps.	<u>July 30, 2021</u>
4. Host/participate in community outreach events to share results and answer citizen questions	<u>June 30, 2021</u>
5. Prepare at least two manuscripts for publication in peer-reviewed journals.	<u>August 30, 2021*</u>

*Note: Outcome 5 will be completed with other funds as needed

Activity 3 Status as of December 30, 2017: Exempt from submission (email sent on July 24, 2017)

Activity 3 Status as of June 30, 2018:

A webpage has been developed for project communication.

<https://www.pca.state.mn.us/urbanair>

Activity 3 Status as of December 30, 2018:

A MPCA internal database is being developed to share sensor results with the public. This will be published on the website in Spring of 2019.

Activity 3 Status as of June 30, 2019:

An internal MPCA database for storing the sensor data has been identified and all the data is now being downloaded from the AQMESH website into the MPCA database on a daily basis. Once data flow has stabilized and quality assured, will be available to view in a tableau book on the urban air webpage. Data summaries will also be available for residents in all neighborhoods to view. In early September, public meetings will be planned in different neighborhoods to show the data and continue discussions on local air quality and what the data means.

Activity 3 Status as of December 30, 2019:

For outcome 2, a quality assurance project plan has been developed and is being implemented for data quality assurance for published data.

For outcome 3, 2019 data summaries in the form of charts will be published on the website in January 2020. All current data is available to view as charts, selectable by site or parameter, on the website.

A second round of community meetings have been conducted in fall 2019 to share initial results of the study.

Activity 3 status as of June 2020:

Project results were presented to Met Council’s Transportation Advisory Board (TAB) and Technical Advisory Committee (TAC) as well as the Community Environmental Advisory Commission (CEAC) in Minneapolis in January/February. No other in person meetings have been conducted since.

Activity 3 status as of December 2020:

Data is being updated on the MPCA web page on a weekly basis. No in person meetings/presentations have been conducted this year.

Final report Summary August 2021:

Outcomes 1,2,3 have been completed. For outcome 4, a communications plan is being developed, to establish the best way to reach the most community groups in a mixed/hybrid, virtual/in-person mode. Results will also be shared with stakeholders and presented at conferences. Journal papers will be published looking at more specific details. This will be an ongoing tasks and MPCA funds will be used if necessary.

V. DISSEMINATION:

Description: The project team will take advantage of all opportunities to share the data and results generated by this project with other agencies, interested stakeholders, the research community, and the general public. At a minimum, the project team will: 1) hold several public meetings, 2) maintain a project website, 3) publish a final project report, and 4) submit at least two articles for publication in peer reviewed journals. Final project data will be publically available.

Status as of December 30, 2017:

Status as of June 30, 2018:

- A webpage has been created (<https://www.pca.state.mn.us/urbanair>)
- Project manager has given an interview on the project to MPR, August 2017
- Article has been published on the project on the vendor's monthly publication magazine , March 2018 (<https://www.aqmesh.com/news/mpca-aqmesh-small-sensor-aq-network-takes-shape-in-minneapolis/>)
- Project abstract accepted for poster presentation at the Air sensors international conference in Oakland, CA, September 2018
- Project abstract accepted for podium presentation at the 10th International Aerosol Conference in St.Louis, Missouri, September 2018

Status as of December 30, 2018:

Status as of June 30, 2019:

Webpage will be updated with:

- Final monitoring sites in each zip code in the study area
- Address for each site
- Tableau book for viewing the data

Status as of December 30, 2019:

Project website updated with data for all site on a weekly basis.

Project results have been shared as presentations with community group in North Minneapolis, South Minneapolis, St.Paul, MDH, Met council, clean air Minnesota group and other interested citizens and stakeholder groups.

Status as of June 2020:

No additional outreach that already mentioned previously.

Status as of December 2020:

No additional outreach than already mentioned previously

Final report Summary August 2021:

Over the past two years, various efforts were made to communicate results as and when they were analyzed. A [project website](#) was developed which is available on the MPCA's website. A tableau workbook is available with all the monitoring sites and data for all the pollutants being monitored. These can be filtered by site, pollutant and dates if desired.

6 month quarterly updates were provided to the LCCMR. In fall of 2018, project presentations were made in Minneapolis and St. Paul to solicit feedback on monitor placement. In Fall/winter 2019-2020, one year study results were presented at several meetings in Minneapolis and St. Paul to give residents an overview of what the

monitors were showing in their respective zip codes. These results were also presented to the Metropolitan Council and other stakeholders. Presentations will be made to community groups, stakeholders and interested parties. Community concerns, comments and additional analysis done, will be incorporated in the final report and published on the MPCA project webpage.

VI. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview:

See attached budget spreadsheet

Explanation of Use of Classified Staff: Classified staff is not directly funded from this project.

Explanation of Capital Expenditures Greater Than \$5,000: The cost of each air monitoring unit used to establish the budget for this project is roughly \$9,250. Each unit will include 5 air pollution sensors and a wireless data acquisition system.

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 0

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 16% FTE. (This is to cover time for Dr. Swanson and the summer work for the student workers, school covers funding for students during the academic year)

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
Non-state			
n/a	\$	\$	
State			
45% FTE for 2 full time MPCA staff persons	\$165,050	\$0	
TOTAL OTHER FUNDS:	\$165,050	\$0	

VII. PROJECT STRATEGY:

A. Project Partners:

Partners receiving ENRTF funding

- Student workers (Advised by Jacob Swanson), Minnesota State University, Mankato, \$ 22,500
- Jacob Swanson, Minnesota State University, Mankato, \$27,000

Partners NOT receiving ENRTF funding

- City of Minneapolis provide assistance for identifying monitoring locations; assist with required permits
- City of St. Paul, provide assistance for identifying monitoring locations; assist with required permits
- Minnesota Department of Health, assist with developing risk-communication material for the public.

B. Project Impact and Long-term Strategy:

MPCA will work with the cities and other partners to follow up on any small-scale differences in air quality detected by the sensors, to identify and address potential sources through pollution prevention efforts. Project results will also further inform our understanding of the relationship between public health and air pollution. This knowledge will help us refine existing air quality program strategies to protect and enhance public health.

This project is also vital to developing MPCA and partner expertise on the use, interpretation and communication of results from new air sensor technology. After the project, the MPCA could move the sensors

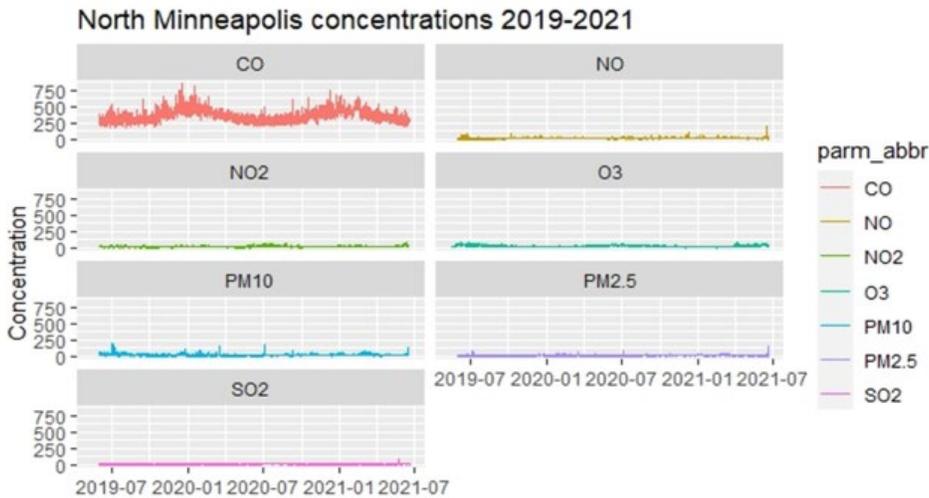
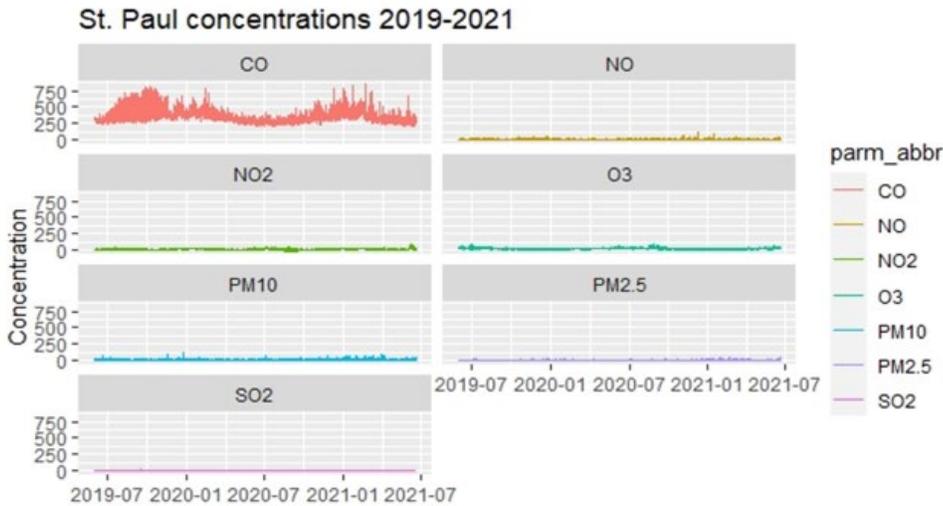
to other parts of Minnesota that would benefit from finer-scale air quality monitoring. The sensors could also support citizen-science efforts. Building upon the strong expertise of the MPCA and our partners, the project will improve access to air quality information and result in better protection of public health into the future.

VIII. REPORTING REQUIREMENTS:

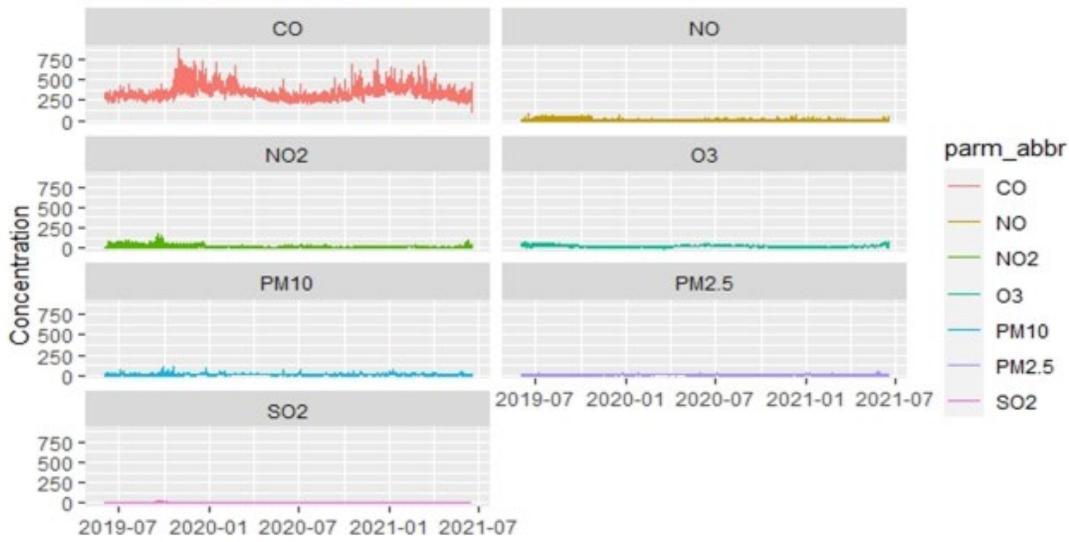
- The project is for 4 years, will begin on 7/1/2017, and end on 6/30/2021.
- Periodic project status update reports will be submitted December 30 and June 30 of each year.
- A final report and associated products will be submitted between June 30 and August 31, 2021,

IX. VISUAL COMPONENT or MAP(S):

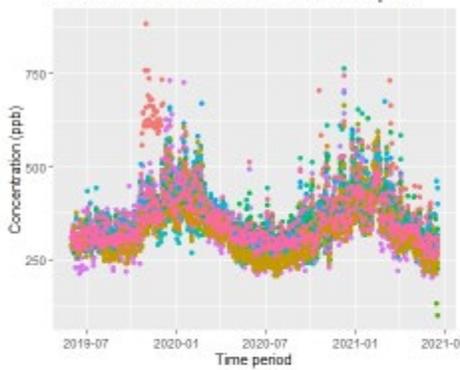
Below are some charts and maps that have been developed based on the final data analysis for the entire monitoring period. *These are subject to change based on further refinement or input from community/stakeholders, for clarity purposes.*



South Minneapolis concentrations 2019-2021

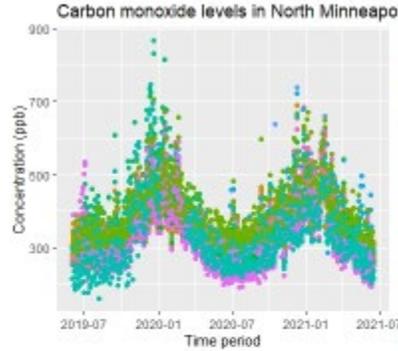


Carbon Monoxide levels in South Minneapolis



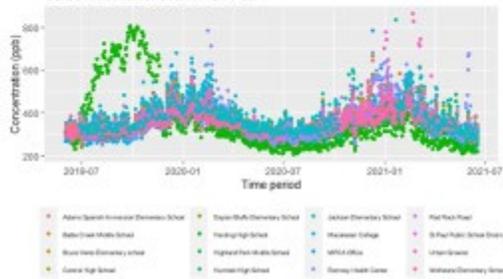
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- Andersen School
 - Anishinabe Academy
 - Cedar-Isles-Dean
 - Diamond Lake
 - Fulton
 - Howe
 - Jordan
 - Kaewaydin
 - Kenny
 - Kingsfield
 - Lyndale
 - Near Road I-35N-94
 - Northrop
 - Powderhorn Park

Carbon monoxide levels in North Minneapolis

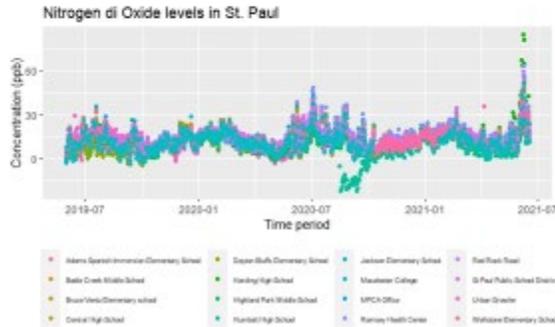
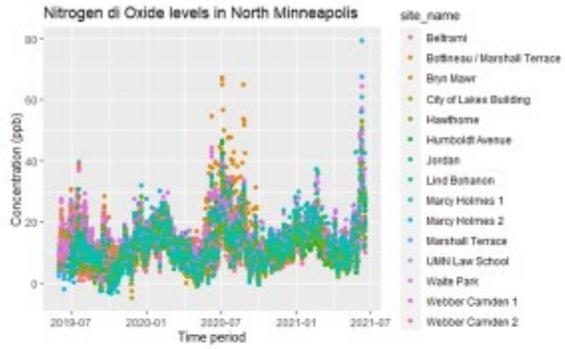
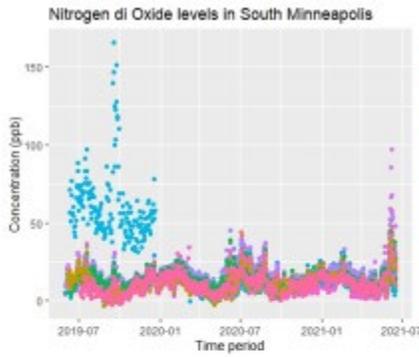
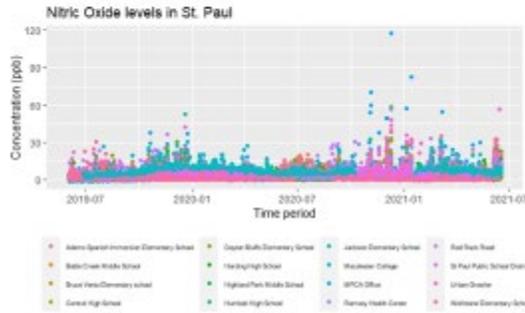
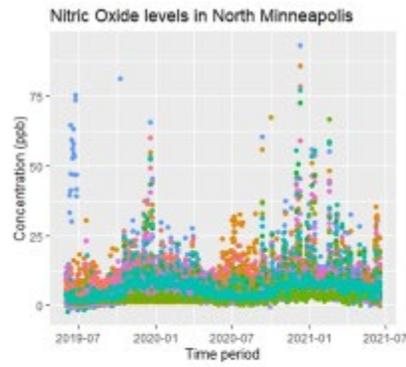
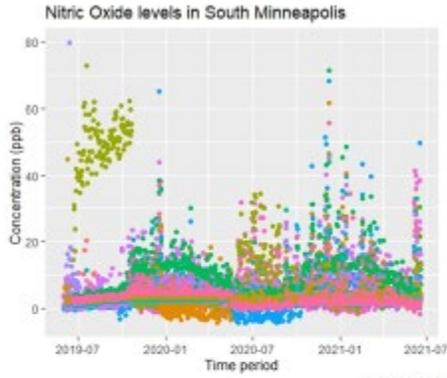


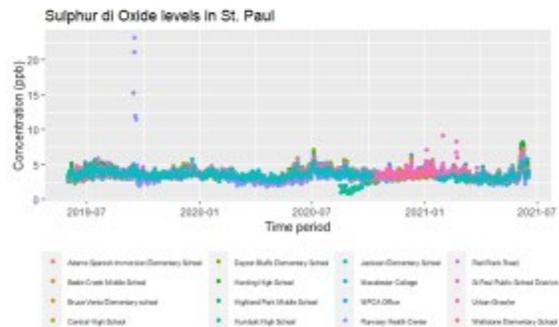
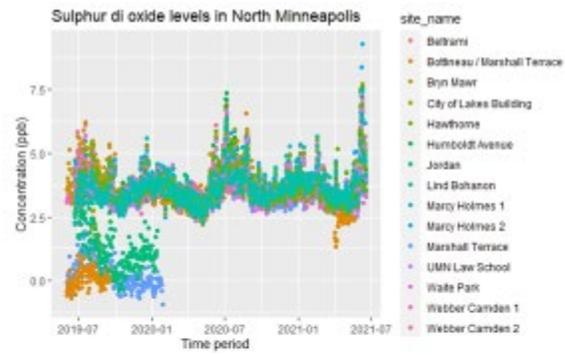
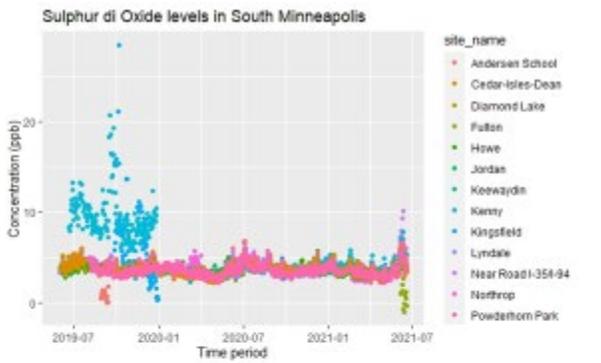
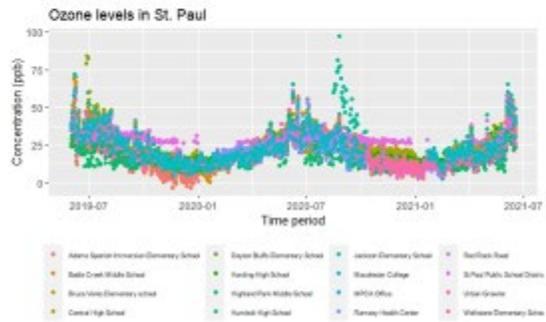
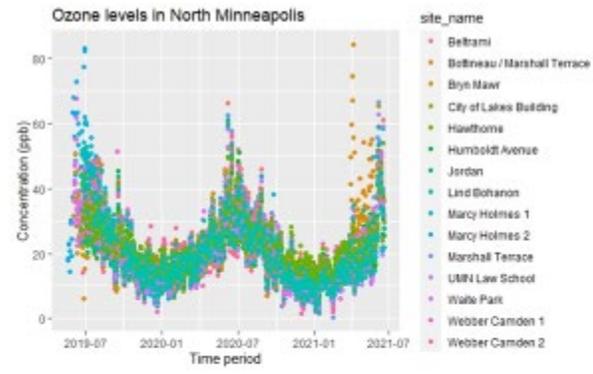
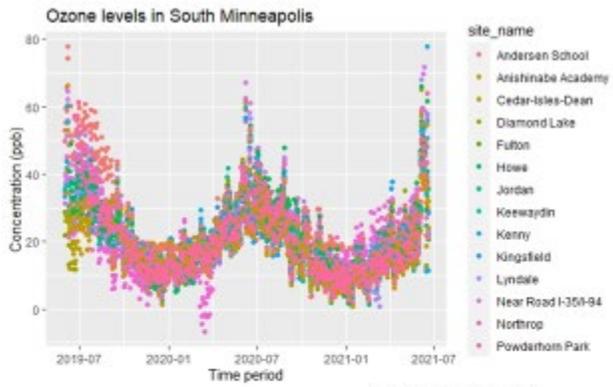
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- Beltrami
 - Bottineau / Marshall Terrace
 - Bryn Mawr
 - City of Lakes Building
 - Hawthorne
 - Humboldt Avenue
 - Jordan
 - Lind Bohanon
 - Marcy Holmes 1
 - Marcy Holmes 2
 - Marshall Terrace
 - UMN Law School
 - Walts Park
 - Webber Camden 1
 - Webber Camden 2

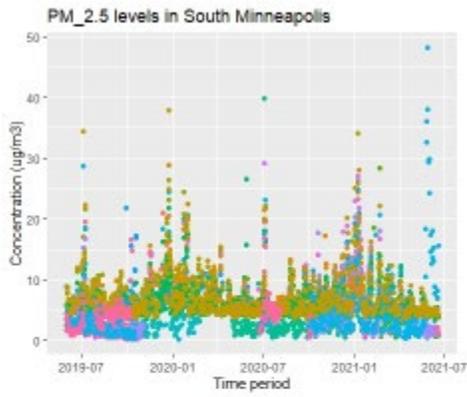
Carbon monoxide levels in St. Paul



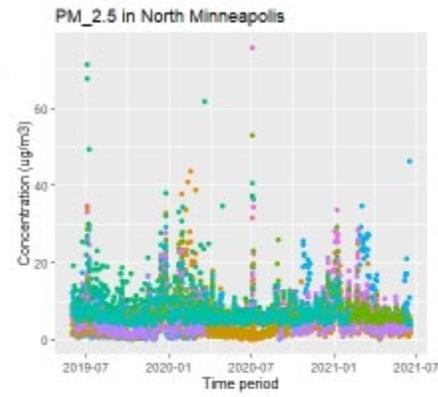
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- Baker Street Middle School
- Blandford Elementary School
- Central High School
- Dayton Street Elementary School
- Franklin High School
- Highland Park Middle School
- Pioneer High School
- Jackson Elementary School
- Macalester College
- UMN Office
- Ramsey Middle School
- Park Rock Road
- St. Paul Public School District
- Upper Grand
- Washburn Elementary School



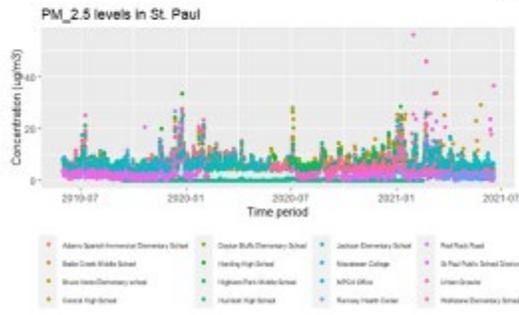




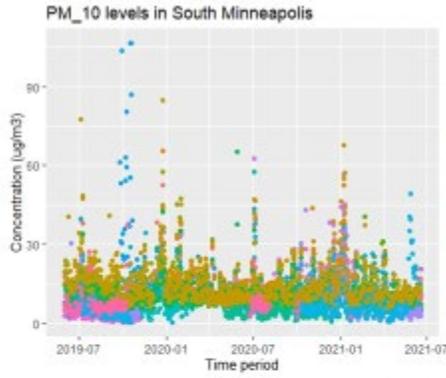
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 - Anishinabe Academy
 - Cedar-Isles-Dean
 - Diamond Lake
 - Fulton
 - Howe
 - Jordan
 - Kaewaydin
 - Kenny
 - Kingsfield
 - Lyndale
 - Near Road I-35W-04
 - Northrop
 - Powderhorn Park



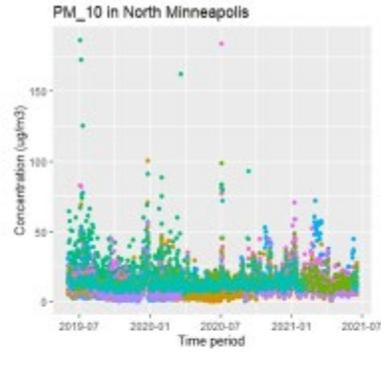
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 - City of Lakes Building
 - Hawthorne
 - Humboldt Avenue
 - Jordan
 - Lind Bohanon
 - Marcy Holmes 1
 - Marcy Holmes 2
 - Marshall Terrace
 - UMN Law School
 - Walt Park
 - Webber Camden 1
 - Webber Camden 2



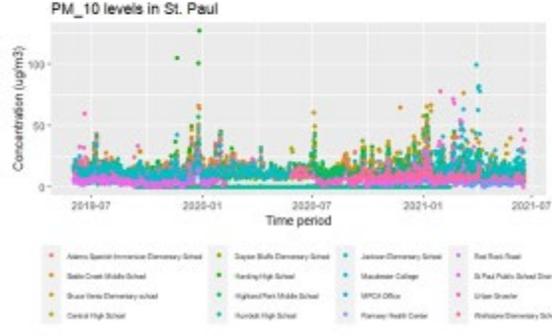
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- Baker Creek Middle School
- Brace Street Elementary School
- Central High School
- Clayton Middle School
- Headley High School
- Highland Park Middle School
- Humboldt High School
- Jackson Elementary School
- Madison College
- MPCA Office
- Palmer Health Center
- Paul Park Road
- St. Paul Public School District
- Union Square
- Webster Elementary School



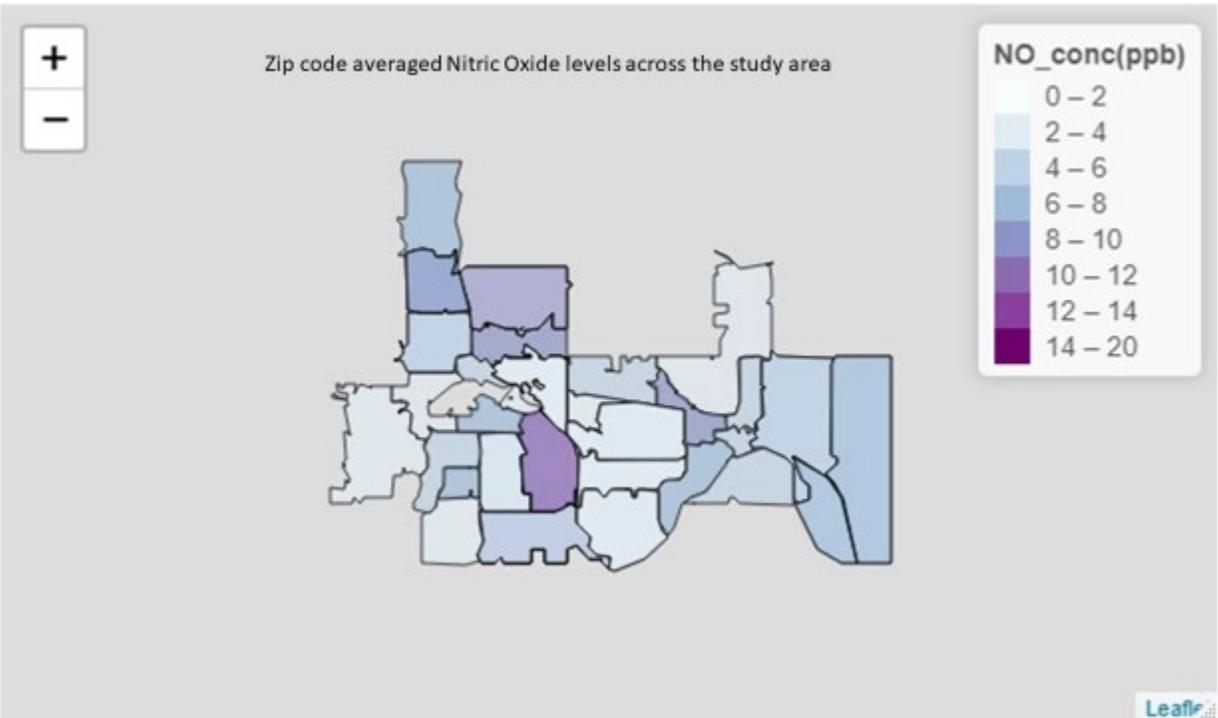
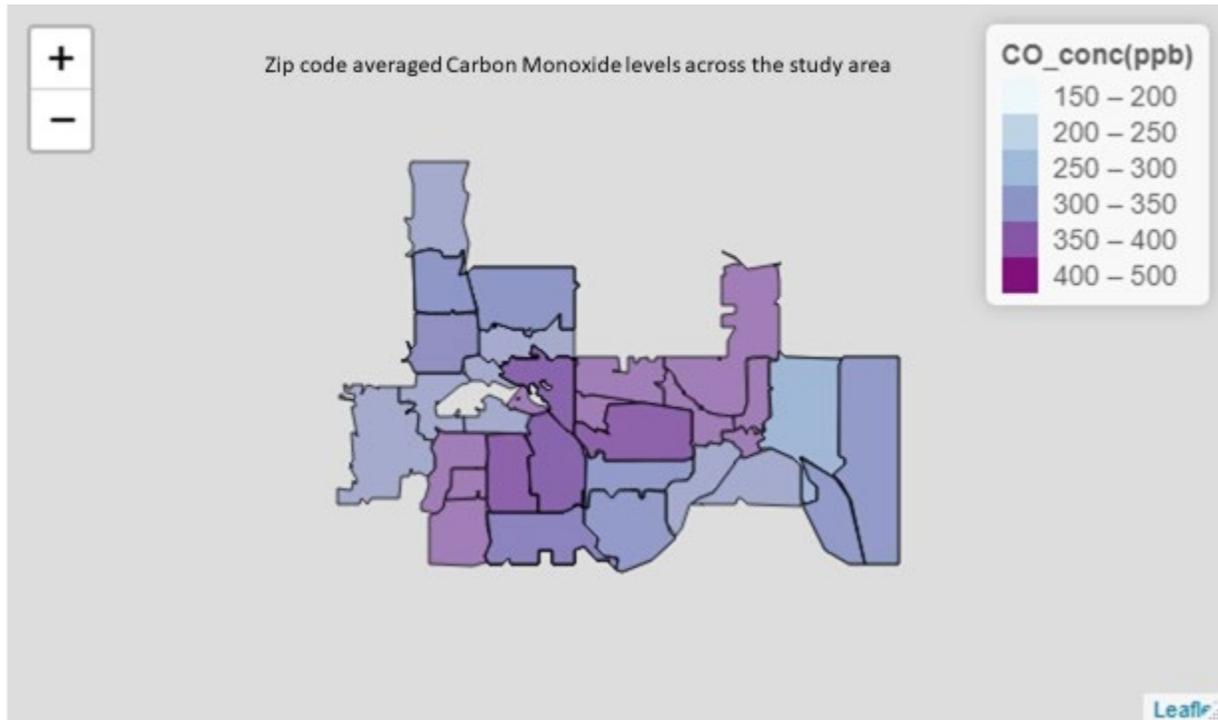
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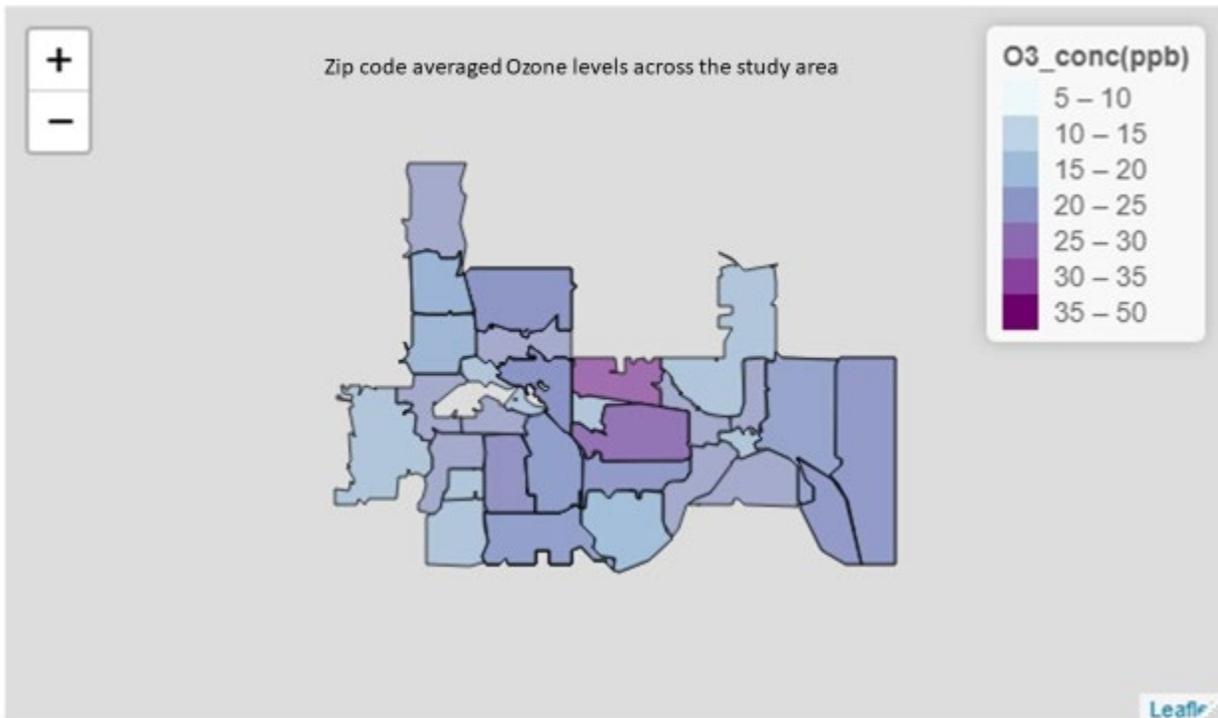
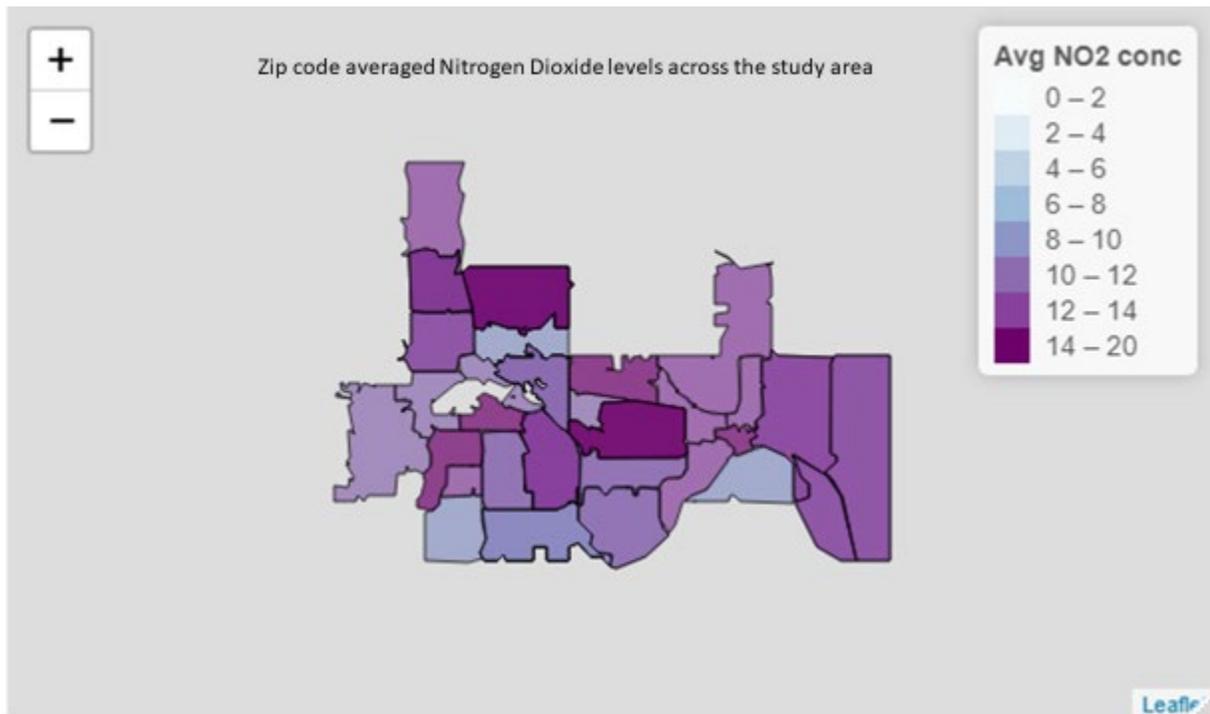


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 - Bottineau / Marshall Terrace
 - Bryn Mawr
 - City of Lakes Building
 - Hawthorne
 - Humboldt Avenue
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 - Webber Camden 2

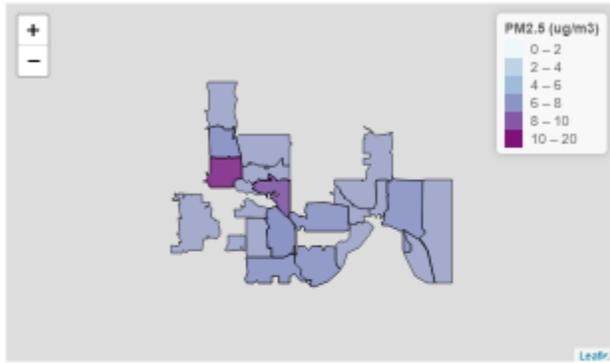


- Albany Special Instruction Elementary School
- Baker Creek Middle School
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- Headley High School
- Highland Park Middle School
- Humboldt High School
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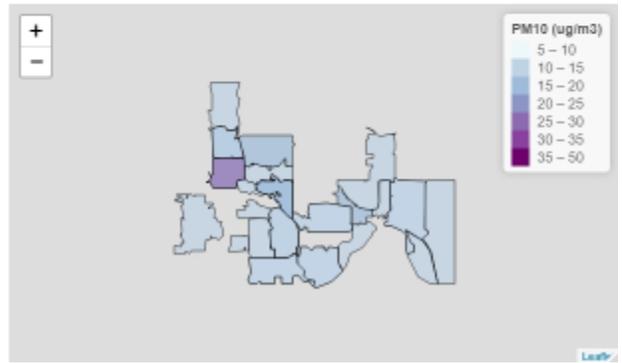




Zip code averaged PM_{2.5} levels across the study area



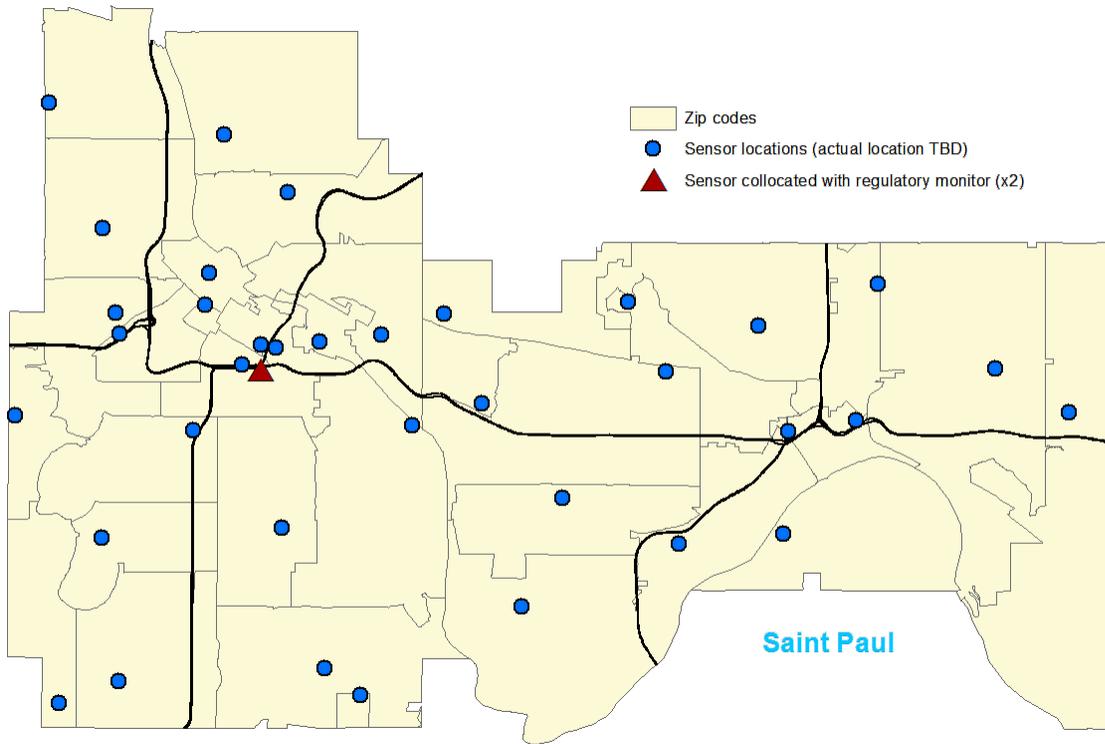
Zip code averaged PM₁₀ levels across the study area



Air monitoring sampling design map

Minneapolis

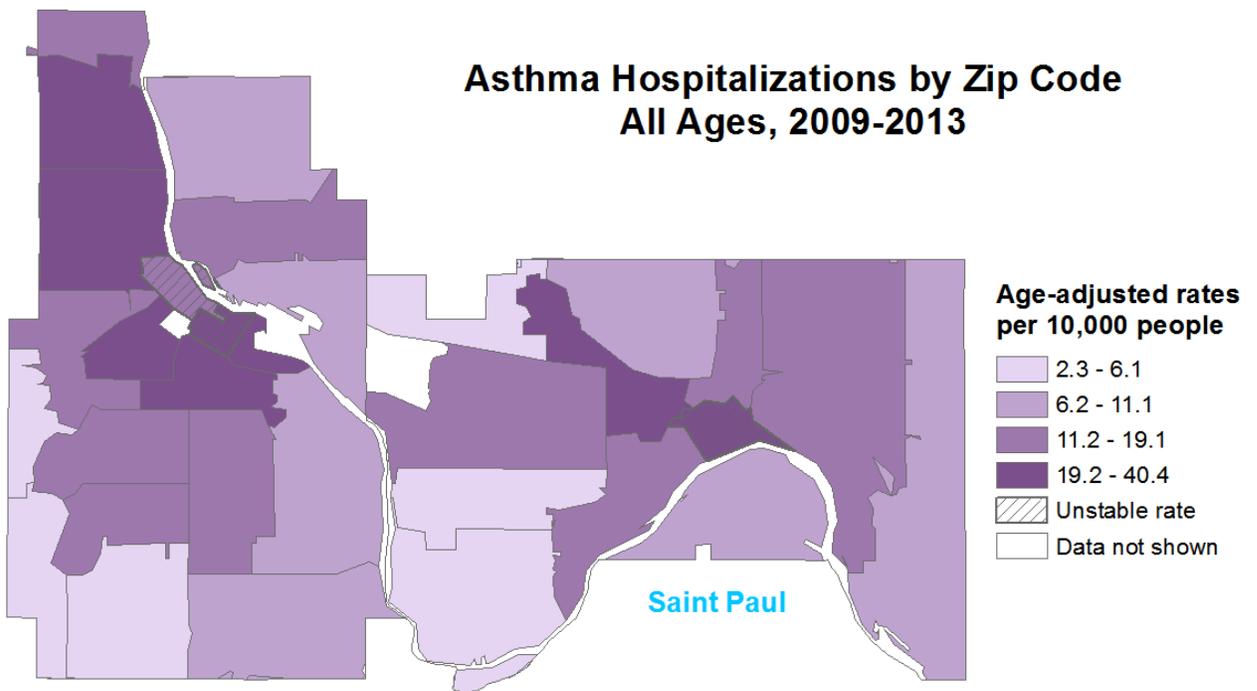
Note: actual site locations to be determined via stakeholder and citizen input



Note: 2 additional sensors will be collocated at the regulatory monitoring site in Blaine. The Blaine monitoring site measures the full suite of pollutants that are also measured by the sensors.

Minneapolis

Asthma Hospitalizations by Zip Code All Ages, 2009-2013

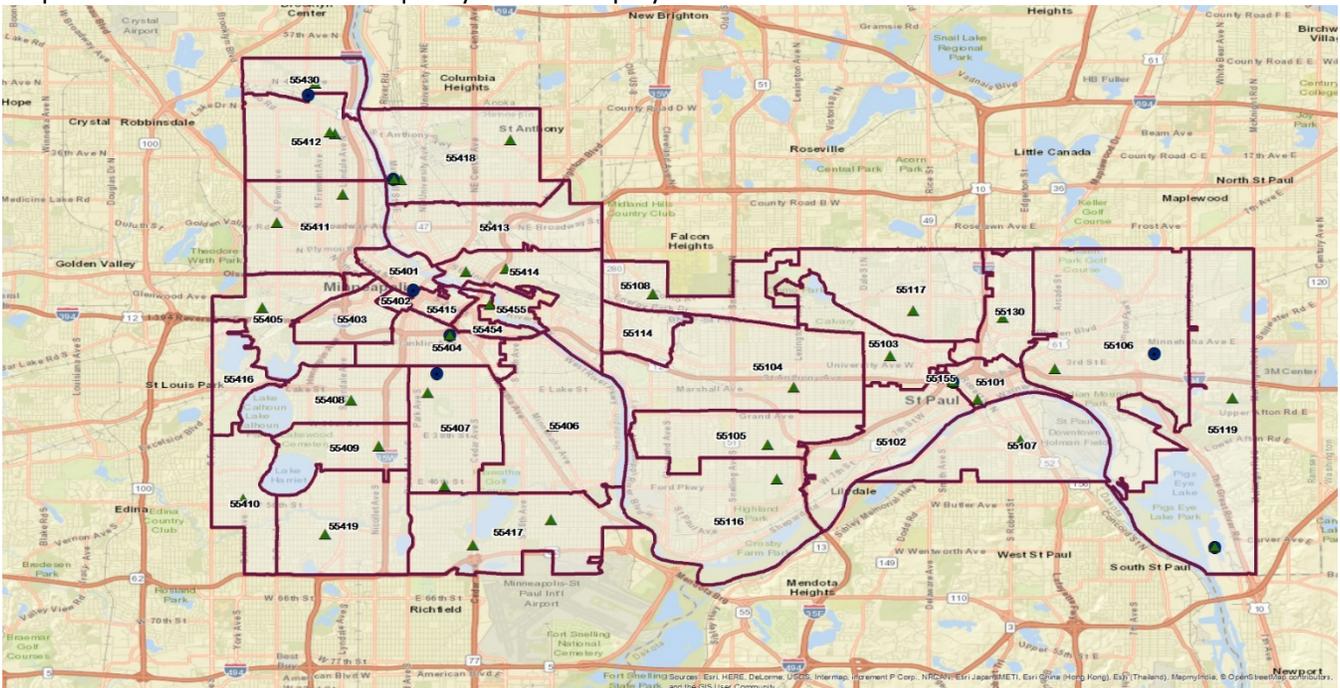


Source Data: Minnesota Department of Health

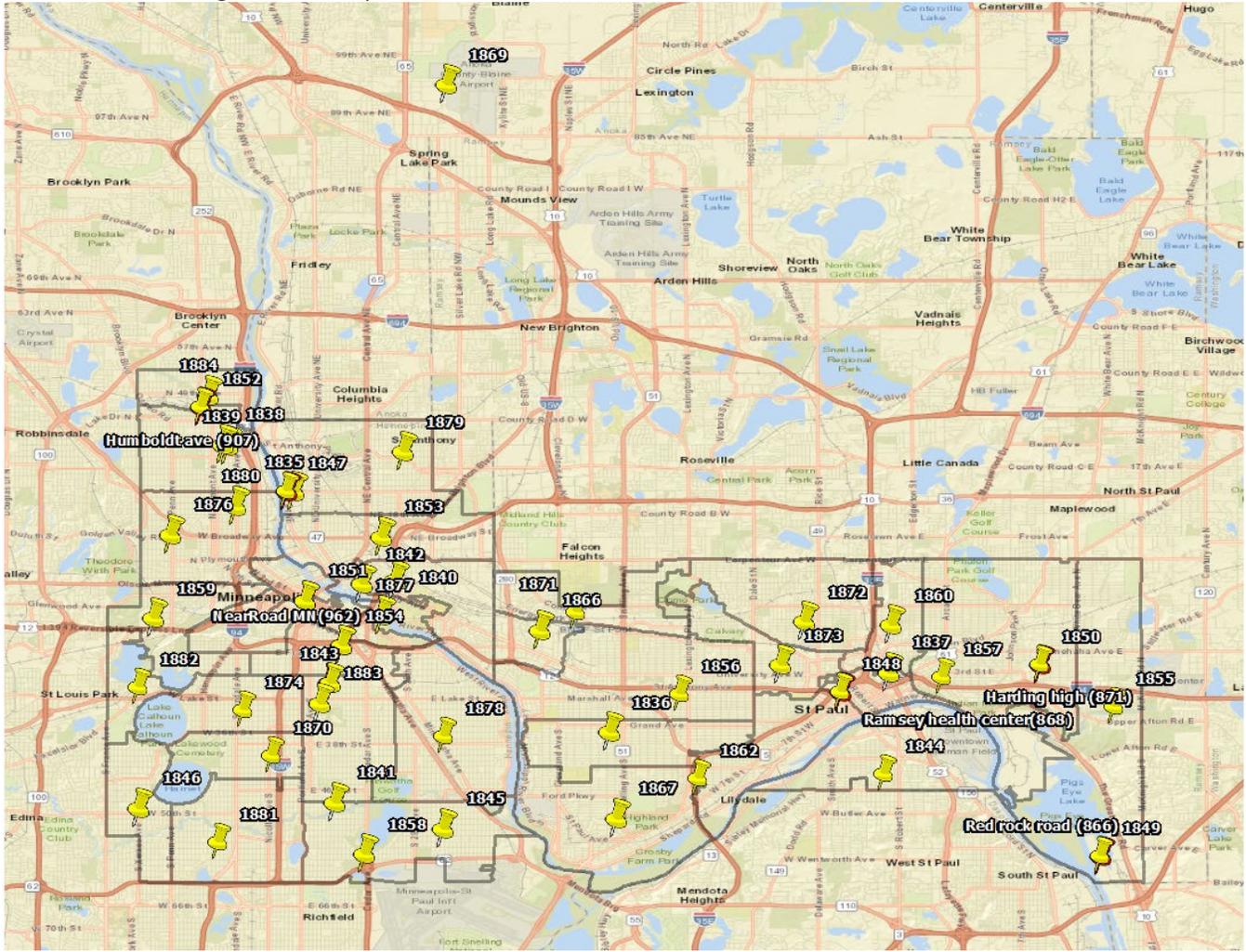
Comparison of regulatory and sensor based (AQ-MESH) monitors



Map of selected locations for air quality monitor deployment



Final site monitoring location map



Final site location details (June 2019)

AQMESH Serial number	Location latitude	Location longitude	City	County	Site name	Address	Zip code	Final
1835150	45.01343	-93.26999	Minneapolis	Hennepin	Marshall Terrace	2511 Grand st NE	55418	5/
1836150	44.93806	-93.17108	St Paul	Ramsey	Macalester college	1600 Grand Ave	55105	5/
1837150	44.95671	-93.08347	St Paul	Ramsey	MPCA Office	520 Lafayette Road N	55155	1/
1838150	45.02810	-93.29200	Minneapolis	Hennepin	Webber Camden 1	4011 Colfax Ave N	55412	5/
1839150	45.02761	-93.29044	Minneapolis	Hennepin	Webber Camden 2	40th St W & Bryant Ave N	55412	5/
1840150	44.98543	-93.23802	Minneapolis	Hennepin	Marcy Holmes 1	1015 SE 7 th St.	55414	5/
1841150	44.91603	-93.25717	Minneapolis	Hennepin	Northrop	4700 S. 13th Ave	55407	5/
1842150	44.98443	-93.24839	Minneapolis	Hennepin	Marcy Holmes 2	419 University Ave SE	55414	5/
1843150	44.95350	-93.25830	Minneapolis	Hennepin	Andersen School	2727 10th Ave S	55407	10
1844150	44.92501	-93.08490	St Paul	ramsey	Humbolt High school	30 Baker St E	55107	1/

1845150	44.90787	-93.22296	Minneapolis	Hennepin	Keewaydin	5238 34th Ave S	55417	5/
1846150	44.91421	-93.31837	Minneapolis	Hennepin	Fulton	Xerxes Ave S & W 49th St	55410	5/
1847150	45.01361	-93.27205	Minneapolis	Hennepin	Bottineau/Marshall terrace	2522 Marshall St NE	55418	5/
1848150	44.95070	-93.09850	St Paul	Ramsey	Ramsey health center	555 Cedar St	55101	9/
1849150	44.89940	-93.01710	St.Paul	Ramsey	Red Rock road	1450 Red rock Rd	55119	4/
1850150	44.95930	-93.03590	St Paul	Ramsey	Harding high school	1540 East 6th St	55106	10/
1851150	44.97930	-93.26110	Minneapolis	Hennepin	City of Lakes building	309 2nd Ave S	55401	9/
1852150	45.03970	-93.29870	Minneapolis	Hennepin	Humboldt Avenue	4646 N Humboldt Ave	55412	10/
1853150	44.99930	-93.24236	Minneapolis	Hennepin	Beltrami	1117 Filmore Ave N	55413	5/
1854150	44.96520	-93.25480	Minneapolis	Hennepin	Near Road I-35/I-94	1444 18th St E	55404	5/
1855150	44.94580	-93.01273	St Paul	Ramsey	Battle creek middle school	2121 N Park Drive	55119	12/
1856150	44.94987	-93.14899	St Paul	Ramsey	Central Sr High school	275 Lexington Pkwy N	55104	12/
1857150	44.95539	-93.06690	St Paul	Ramsey	Dayton Bluffs Elem school	262 Bates Ave	55106	12/
1858150	44.89981	-93.24765	Minneapolis	Hennepin	Diamond Lake	5638 Cedar Ave S	55417	5/
1859150	44.97285	-93.3122	Minneapolis	Hennepin	Bryn Mawr	416 Sheridan Ave S	55405	5/
1860150	44.97162	-93.08269	St Paul	Ramsey	Bruce Vento Elem school	409 Case Ave E	55130	1/
1862150	44.92343	-93.14305	St Paul	Ramsey	Adams Spanish Immersion Elem school	615 S Chatsworth St	55102	1/
1866150	44.97004	-93.19285	St Paul	Ramsey	Urban Growler	2325 Endicott St	55114	6/
1867150	44.91110	-93.16889	St Paul	Ramsey	Highland Park middle school	975 Snelling Ave S	55116	1/
1869150	45.14070	-93.22200	Blaine	Anoka	Ncore	2289 Co Rd J	55449	12/
1870150	44.93058	-93.27678	Minneapolis	Hennepin	Kingsfield	E 40th St & 1st Ave S	55409	6/
1871150	44.97577	-93.18130	St Paul	Ramsey	St Paul Public school districts	1930 Como Ave	55108	1/
1872150	44.97262	-93.10994	St Paul	Ramsey	Wellstone elementary	1041 Marion St	55117	1/
1873150	44.95907	-93.11736	St Paul	Ramsey	Jackson Elementary school	437 edmund Ave W	55103	1/
1874150	44.94481	-93.28548	Minneapolis	Hennepin	Lyndale	W 32nd St. & Harriet Ave	55408	6/
1876150	44.99998	-93.30832	Minneapolis	Hennepin	Jordan	2015 Penn Ave N	55411	6/
1877150	44.97462	-93.24247	Minneapolis	Hennepin	UMN Law school	21st Ave S & 22nd Ave S	55455	6/
1878150	44.93683	-93.22285	Minneapolis	Hennepin	Howe	3629 34th Ave S	55406	6/

1879150	45.02584	-93.23574	Minneapolis	Hennepin	Waite Park	Ulysses st NE & 32nd Ave NE	55418	57
1880150	45.00886	-93.28809	Minneapolis	Hennepin	Hawthorne	2807 Lyndale Ave N	55411	6
1881150	44.90334	-93.29350	Minneapolis	Hennepin	Kenny	Dupont Ave S & W 55th St	55419	6
1882150	44.95205	-93.31854	Minneapolis	Hennepin	Cedar-Isles-Dean	W 28th St & S Xerxes Ave	55416	6
1883150	44.94717	-93.26162	Minneapolis	Hennepin	Powderhorn Park	3040 Elliot Ave S	55407	57
1884150	45.04342	-93.29670	Minneapolis	Hennepin	Lind Bohanon	4835 Fremont Ave N	55430	57

MPCA Asset number	AQMESH Serial number	Location lat	Location long	City	County	Site name	Address	Zip code	Final Install date
1751612	1835150	45.01343	93.26999	Minneapolis	Hennepin	Marshall Terrace	2511 Grand st NE	55418	5/30/2019
1751627	1836150	44.93806	93.17108	St Paul	Ramsey	Macalester college	1600 Grand Ave	55105	5/30/2019
1751626	1837150	44.95671	93.08347	St Paul	Ramsey	MPCA Office	520 Lafayette Road N	55155	1/14/2019
1751616	1838150	45.02810	93.29200	Minneapolis	Hennepin	Webber Camden 1	4011 Colfax Ave N	55412	5/29/2019
1751622	1839150	45.02761	93.29044	Minneapolis	Hennepin	Webber Camden 2	40th St W & Bryant Ave N	55412	5/29/2019
1751624	1840150	44.98543	93.23802	Minneapolis	Hennepin	Marcy Holmes 1	1015 SE 7 th St.	55414	5/15/2019
1751609	1841150	44.91603	93.25717	Minneapolis	Hennepin	Northrop	4700 S. 13th Ave	55407	5/14/2019
1751623	1842150	44.98443	93.24839	Minneapolis	Hennepin	Marcy Holmes 2	419 University Ave SE	55414	5/15/2019
1751628	1843150	44.95350	93.25830	Minneapolis	Hennepin	Andersen School	2727 10th Ave S	55407	10/3/2018
1751629	1844150	44.92501	93.08490	St Paul	Ramsey	Humbolt High school	30 Baker St E	55107	1/15/2019
1751607	1845150	44.90787	93.22296	Minneapolis	Hennepin	Keewaydin	5238 34th Ave S	55417	5/14/2019
1751640	1846150	44.91421	93.31837	Minneapolis	Hennepin	Fulton	Xerxes Ave S & W 49th St	55410	5/16/2019
1751625	1847150	45.01361	93.27205	Minneapolis	Hennepin	Bottineau/Marshall terrace	2522 Marshall St NE	55418	5/31/2018
1751604	1848150	44.93058	93.27678	Minneapolis	Hennepin	Kingsfield	E 40th St & 1st Ave S	55409	9/28/2019
1751613	1849150	44.89940	93.01710	St.Paul	Ramsey	Red Rock road	1450 Red rock Rd	55119	4/12/2018
1751633	1850150	44.95930	93.03590	St Paul	Ramsey	Harding high school	1540 East 6th St	55106	10/25/2018
1751631	1851150	44.97930	93.26110	Minneapolis	Hennepin	City of Lakes building	309 2nd Ave S	55401	9/27/2018
1751632	1853150	44.99930	93.24236	Minneapolis	Hennepin	Beltrami	1117 Filmore Ave N	55413	5/30/2019
1751630	1854150	44.96520	93.25480	Minneapolis	Hennepin	Near Road I-35/I-94	1444 18th St E	55404	5/15/2018
1751620	1855150	44.94580	93.01273	St Paul	Ramsey	Battle creek middle school	2121 N Park Drive	55119	12/20/2018

1751615	1856150	44.94987	93.14899	St Paul	Ramsey	Central Sr High school	275 Lexington Pkwy N	55104	12/20/2018
1751614	1857150	44.95539	93.06690	St Paul	Ramsey	Dayton Bluffs Elem school	262 Bates Ave	55106	12/20/2018
1751634	1858150	44.89981	93.24765	Minneapolis	Hennepin	Diamond Lake	5638 Cedar Ave S	55417	5/14/2019
1751608	1859150	44.972847	93.3122	Minneapolis	Hennepin	Bryn Mawr	416 Sheridan Ave S	55405	5/16/2019
1751591	1860150	44.97162	93.08269	St Paul	Ramsey	Bruce Vento Elem school	409 Case Ave E	55130	1/14/2019
1751596	1862150	44.92343	93.14305	St Paul	Ramsey	Adams Spanish Immersion Elem school	615 S Chatsworth St	55102	1/15/2019
1751619	1863150	45.03970	93.29870	Minneapolis	Hennepin	Humboldt Avenue	4646 N Humboldt Ave	55412	9/16/2018
1751635	1865150	44.95214	93.22486	Minneapolis	Hennepin	Anishinabe Academy	3100 E 28th St	55406	12/16/2019
1751636	1866150	44.97004	93.19285	St Paul	Ramsey	Urban Growler	2325 Endicott St	55114	6/6/2019
1751610	1867150	44.91110	93.16889	St Paul	Ramsey	Highland Park middle school	975 Snelling Ave S	55116	1/14/2019
1751638	1868150	44.95070	93.09850	St Paul	Ramsey	Ramsey health center	555 Cedar St	55101	9/4/2019
1751637	1869150	45.14070	93.22200	Blaine	Anoka	Ncore	2289 Co Rd J	55449	12/1/2017
1751600	1871150	44.97577	93.18130	St Paul	Ramsey	St Paul Public school districts	1930 Como Ave	55108	1/15/2019
1751618	1872150	44.97262	93.10994	St Paul	Ramsey	Wellstone elementary	1041 Marion St	55117	1/14/2019
1751621	1873150	44.95907	93.11736	St Paul	Ramsey	Jackson Elementary school	437 edmund Ave W	55103	1/14/2019
1751597	1874150	44.94481	93.28548	Minneapolis	Hennepin	Lyndale	W 32nd St. & Harriet Ave	55408	6/5/2019
1751601	1876150	44.99998	93.30832	Minneapolis	Hennepin	Jordan	2015 Penn Ave N	55411	6/4/2019
1751611	1877150	44.97462	93.24247	Minneapolis	Hennepin	UMN Law school	21st Ave S & 22nd Ave S	55455	6/4/2019
1751605	1878150	44.93683	93.22285	Minneapolis	Hennepin	Howe	3629 34th Ave S	55406	6/5/2019
1751594	1879150	45.02584	93.23574	Minneapolis	Hennepin	Waite Park	Ulyssess st NE & 32nd Ave NE	55418	5/30/2019

1751592	1880150	45.00886	93.28809	Minneapolis	Hennepin	Hawthorne	2807 Lyndale Ave N	55411	6/4/2019
1751617	1881150	44.90334	93.29350	Minneapolis	Hennepin	Kenny	Dupont Ave S & W 55th St	55419	6/5/2019
1751595	1882150	44.95205	93.31854	Minneapolis	Hennepin	Cedar-Isles-Dean	W 28th St & S Xerxes Ave	55416	6/5/2019
1751602	1883150	44.94717	93.26162	Minneapolis	Hennepin	Powderhorn Park	3040 Elliot Ave S	55407	5/15/2019
1751599	1884150	45.04342	93.29670	Minneapolis	Hennepin	Lind Bohanon	4835 Fremont Ave N	55430	5/29/2019

Updated site list. There were 2 pods that were moved and 1 additional site that was added. (December 2019)

**Environment and Natural Resources Trust Fund
M.L. 2017 Final Project Budget**



Project Title: Assessment of Urban Air Quality

Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 07b as extended by M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 19

Project Manager: Monika Vadali, Ph.D.

Organization: Minnesota Pollution Control Agency

M.L. 2017 ENRTF Appropriation: \$ 700,000

Project Length and Completion Date: # Years: 3, June 30, 2021

Date of Report: August 16, 2021

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 budget 12/30/2020	Amount Spent	Activity 1 Balance	Activity 2 budget 12/30/2020	Amount Spent	Activity 2 Balance	Activity 3 budget 12/30/2020	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	<i>Deploy air pollution sensors at 50 sites</i>			<i>Conduct air monitoring for 2 years</i>			<i>Compile, analyze and communicate project results</i>				
Personnel (Wages and Benefits)	\$0	\$0	\$0	\$26,288	\$4,556	\$21,732	\$26,288	\$26,288	\$0	\$52,576	\$21,732
<i>Dr. Jacob Swanson, Student worker advisor /Project partner: \$27,000; 6% FTE for 3 years</i>											
<i>TBD, Data management and sharing: \$19,575.00, 5% FTE</i>											
<i>2 Student workers (advised by Dr.Swanson) \$22,500.00 , 10% FTE for 3 yrs.</i>											
Equipment/Tools/Supplies											
<i>50x component replacement after 1-year of monitoring (\$2,370 per unit)</i>				\$89,674	\$46,025	\$43,649				\$89,674	\$43,649
<i>50x data access agreement after 1st year (\$350 for first monitor, \$75 for additional monitors)</i>				\$0	\$0	\$0				\$0	\$0
<i>50x cellular data</i>				\$0	\$0	\$0				\$0	\$0
<i>45x site leases/permits (\$50/pole) and preparation (power drop, mounting, etc). Note: 4 samplers will be located at MPCA owned sites. Estimate based on \$500/per site</i>	\$0	\$0	\$0	\$23,000	\$8,175	\$14,825				\$23,000	\$14,825
<i>Consumables (replacement lithium batteries, tubing, gloves, etc)</i>	\$500	\$349	\$151	\$6,500	\$606	\$5,894	\$1,000	\$0	\$1,000	\$8,000	\$7,045
<i>Hardware for sensor mounting during calibration test</i>	\$250	\$182	\$68				\$1,000	\$0	\$1,000	\$1,250	\$1,068
Capital Expenditures Over \$5,000											
<i>50x air pollution monitors with rechargeable battery or DC power supply (exact model TBD by competitive bid) (~\$9250 for each monitor)</i>	\$520,000	\$517,125	\$2,875							\$520,000	\$2,875
Travel expenses in Minnesota											
<i>Mileage for travel to monitoring sites and local conference</i>	\$0	\$0	\$0	\$2,000	\$0	\$2,000				\$2,000	\$2,000
<i>Conference travel expenses out state(07/20/2018. This will mostly be for 1 out state air sensor specific conferences)</i>				\$3,500	\$1,409	\$2,091				\$3,500	\$2,091
COLUMN TOTAL	\$520,750	\$517,657	\$3,093	\$150,962	\$60,770	\$90,192	\$28,288	\$26,288	\$2,000	\$700,000	\$95,286