Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2017 LCCMR Work Plan

Date of Submission: October 10, 2016

Date of Next Status Update Report: December 30, 2017

Date of Work Plan Approval:

Project Completion Date: June 30, 2020

Does this submission include an amendment request? No

PROJECT TITLE: Deploying new technology to understand urban air pollution

Project Manager: Monika Vadali, PhD.

Organization: Minnesota Pollution Control Agency

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Location: Hennepin and Ramsey

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$700,000**
	Amount Spent:	**$0**
	Balance:	**$700,000**

Legal Citation: M.L. 2017, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

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:

Project Status as of June 30, 2018:

Project Status as of December 30, 2018:

Project Status as of June 30, 2019:

Project Status as of December 30, 2019:

Overall Project Outcomes and Results:

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: $ 511,500
Amount Spent: $ 0
Balance: $ 511,500

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	August 31, 2017
5. Conduct two week sensor calibration pre-test at regulatory monitor site	November 30, 2017
6. Deploy sensors to site locations	December 30, 2017

Activity 1 Status as of December 30, 2017:

Activity 1 Status as of June 30, 2018:

Activity 1 Status as of December 30, 2018:

Activity 1 Status as of June 30, 2019:

Activity 1 Status as of December 30, 2019:

Final Report Summary: August 2020

ACTIVITY 2: Conduct air monitoring for two years (December 2017 to November 2019)
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: $ 162,213
Amount Spent: $ 0
Balance: $ 162,213

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	November 30, 2019
3. Replace sensor components due to 1-year expiration date for maintaining performance	November 30, 2018
4. Conduct two week sensor calibration post-test at regulatory monitor site	December 31, 2019

Activity 2 Status as of December 30, 2017:

Activity 2 Status as of June 30, 2018:

Activity 2 Status as of December 30, 2018:

Activity 2 Status as of June 30, 2019:

Activity 2 Status as of December 30, 2019:

Final Report Summary: August 2020

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: $26,288
Amount Spent: $ 0
Balance: $ 26,288

Outcome	Completion Date
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	March 30, 2020
3. Perform data analysis and summarize project results including the creation of a project report, interactive data website, charts, and maps.	June 30, 2020
4. Host/participate in community outreach events to share results and answer citizen questions	June 30, 2020
5. Prepare at least two manuscripts for publication in peer-reviewed journals.	June 30, 2020

Activity 3 Status as of December 30, 2017:

Activity 3 Status as of June 30, 2018:

Activity 3 Status as of December 30, 2018:

Activity 3 Status as of June 30, 2019:

Activity 3 Status as of December 30, 2019:

Final Report Summary: August 2020

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:

Status as of December 30, 2018:

Status as of June 30, 2019:

Status as of December 30, 2019:

Final Report Summary: August 2020

VI. PROJECT BUDGET SUMMARY:
A. Preliminary ENRTF Budget Overview:
***This section represents an overview of the preliminary budget at the start of the project. It will be reconciled with actual expenditures at the time of the final report.**

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 69,075	Jacob Swanson, Student Advisor/Researcher (6% FTE) TBD, Data management and sharing (5% FTE) 2x Student Workers (10% FTE)
Equipment/Tools/Supplies:	$164,425	50x sensor component replacement ($2,370/each);

		50x data access agreement after 1st year ($350 for first monitor, $75 for additional); 50x cellular data ($168/each) 45x site lease and preparation including power drop, mounting, etc. ($500/site); Sampling consumables including replacement batteries, tubing, gloves, etc. ($6000); Hardware for sensor mounting during calibration test ($1,000)
Capital Expenditures over $5,000:	$462,500	50 x air pollution monitors with rechargeable battery or DC power supply ($9,250/each).
Travel Expenses in MN:	$4,000	Mileage reimbursement for student workers to deploy and maintain monitoring sites.
TOTAL ENRTF BUDGET:	**$700,000**	

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.

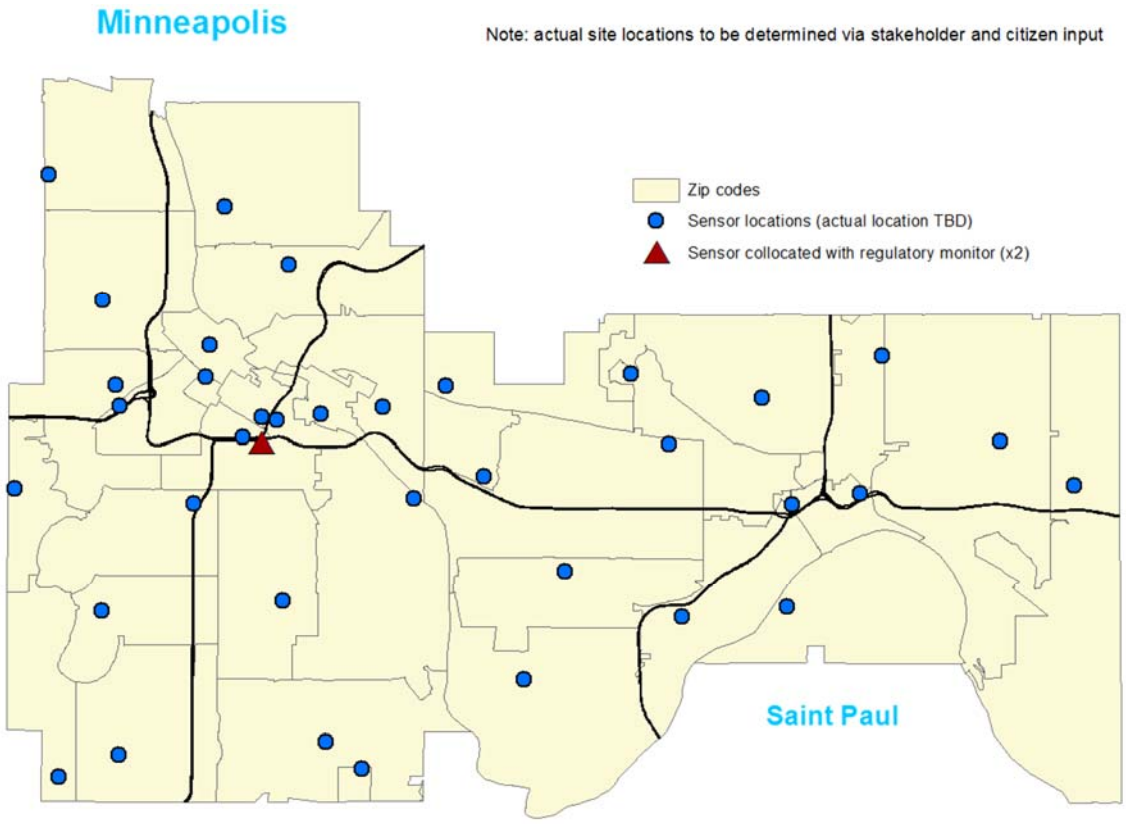
This project is also vital to developing MPCA and partner expertise on the use, interpretation and communication of results from new air sensor technology. After the project, the MPCA could move the sensors to other parts of Minnesota that would benefit from finer-scale air quality monitoring. The sensors 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:

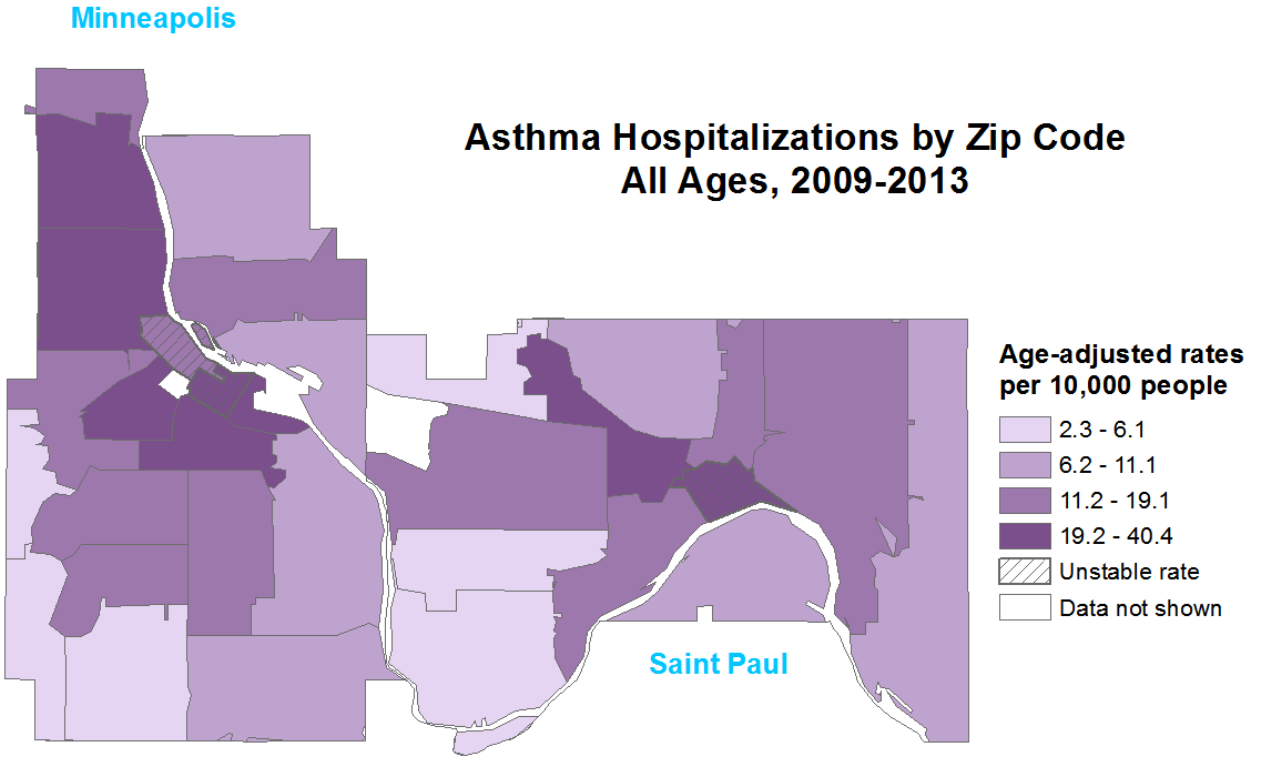
- **The project is for 3 years, will begin on 7/1/2017, and end on 6/30/2020.**
- **Periodic project status update reports will be submitted December 30 and June 30 of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2020.**

IX. VISUAL COMPONENT or MAP(S):

Air monitoring sampling design map



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.



Source Data: Minnesota Department of Health

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

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

Project Title: *Deploying new technology to understand urban air pollution*
Legal Citation: *M.L. 2017, Chp. Xx, Sec. xx, Subd. xx*
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, 2020*
Date of Report: *October 10, 2016*

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Deploy air pollution sensors at 50 sites***			***Conduct air monitoring for 2 years***			***Compile, analyze and communicate project results***				
Personnel (Wages and Benefits)	$16,500	$0	$16,500	$26,288	$0	$26,288	$26,288	$0	$26,288	$69,075	$69,075
Dr. Jacob Swanson, Student worker advisor /Project partner: $27,000; 6% FTE for 3 years											
TBD, Data management and sharing: $19,575.00, 5% FTE											
2 Student workers (advised by Dr.Swanson) $22,500.00 , 10% FTE for 3 yrs.											
Equipment/Tools/Supplies											
50x component replacement after 1-year of monitoring ($2,370 per unit)				$118,500	$0	$118,500				$118,500	$118,500
50x data access agreement after 1st year ($350 for first monitor, $75 for additional monitors)				$4,025	$0	$4,025				$4,025	$4,025
50x cellular data				$8,400	$0	$8,400				$8,400	$8,400
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	$23,000	$0	$23,000							$23,000	$23,000
Consumables (replacement lithium batteries, tubing, gloves, etc)	$3,000	$0	$3,000	$3,000	$0	$3,000				$6,000	$6,000
Hardware for sensor mounting during calibration test	$4,500	$0	$4,500							$4,500	$4,500
Capital Expenditures Over $5,000											
50x air pollution monitors with rechargeable battery or DC power supply (exact model TBD by competitive bid) (~$9250 for each monitor)	$462,500	$0	$462,500							$462,500	$462,500
Travel expenses in Minnesota											
Mileage for travel to monitoring sites	$2,000	$0	$2,000	$2,000	$0	$2,000				$4,000	$4,000
COLUMN TOTAL	**$511,500**	**$0**	**$511,500**	**$162,213**	**$0**	**$162,213**	**$26,288**	**$0**	**$26,288**	**$700,000**	**$700,000**