Air Quality Measurements in Louisville:

Green for Good

Green Heart Louisville

Louisville Superfund Research Program

Pradeep Prathibha

Jay Turner Lab

Department of Energy, Environmental and Chemical Engineering

Washington University in St. Louis

Southern Transportation and Air Quality Summit
August 20, 2019

Washington University in St. Louis
James McKelvey School of Engineering

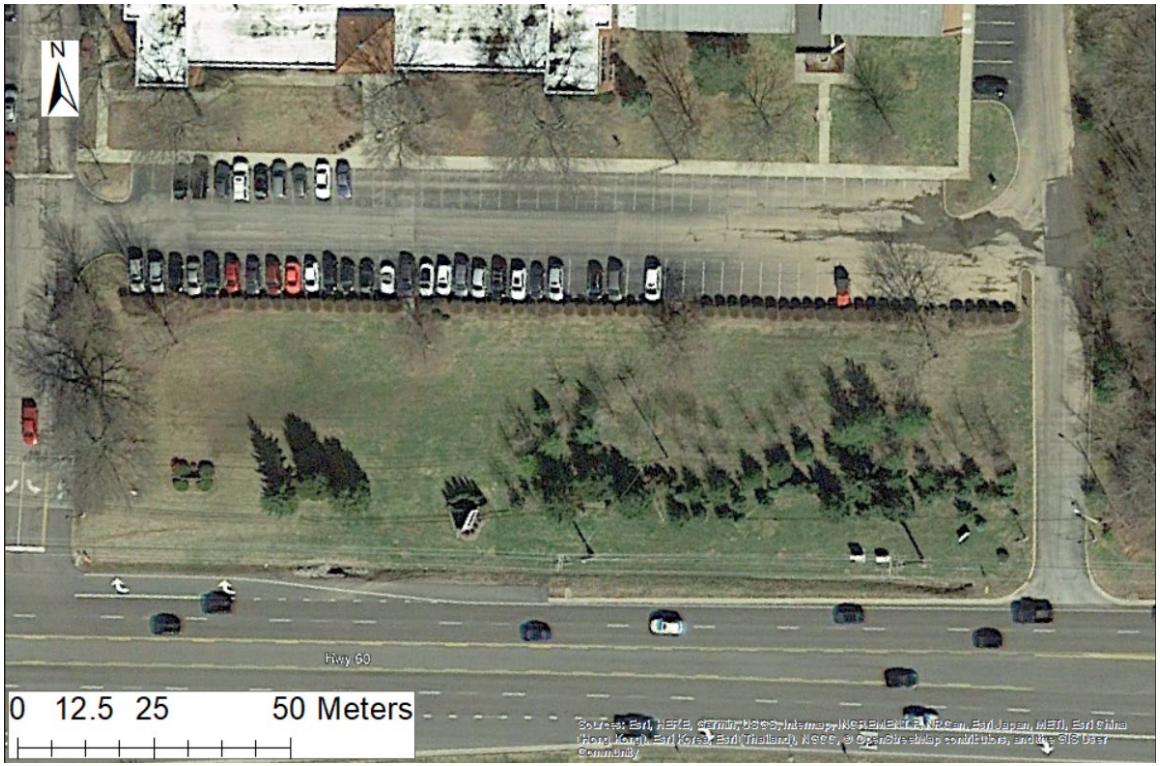
Three Projects

1. **Green for Good / St. Margaret Mary (SMM) School (PI: Turner)**
   Quantify pollutant removal by a near-road engineered vegetative buffer (continuation of FHWA/DOT)

2. **Green Heart Louisville (PI: Aruni Bhatnagar)**
   Assess impact of increasing neighborhood greenspaces on cardiovascular health

3. **Louisville Superfund Research Program (PI: Sanjay Srivastava)**
   Project 4: Characterizing Urban- and Finer-Scale Spatial Variability for Select VOC Superfund Compounds (PI: Turner)

Engineered vegetative buffer - Installed Fall 2016



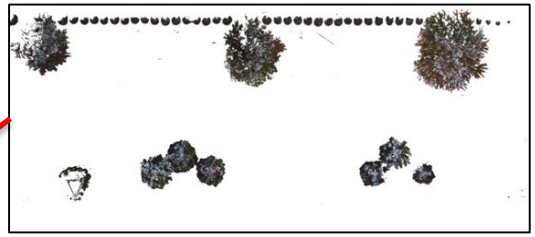
Quantify pollutant removal by a near-road engineered vegetative buffer

Engineered vegetative buffer

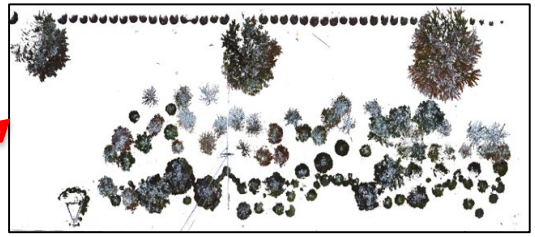
Aerial (Google Earth)

3D Terrestrial LIDAR

Oct. 2016



Feb. 2018



Engineered vegetative buffer

3D Terrestrial LIDAR

Side view

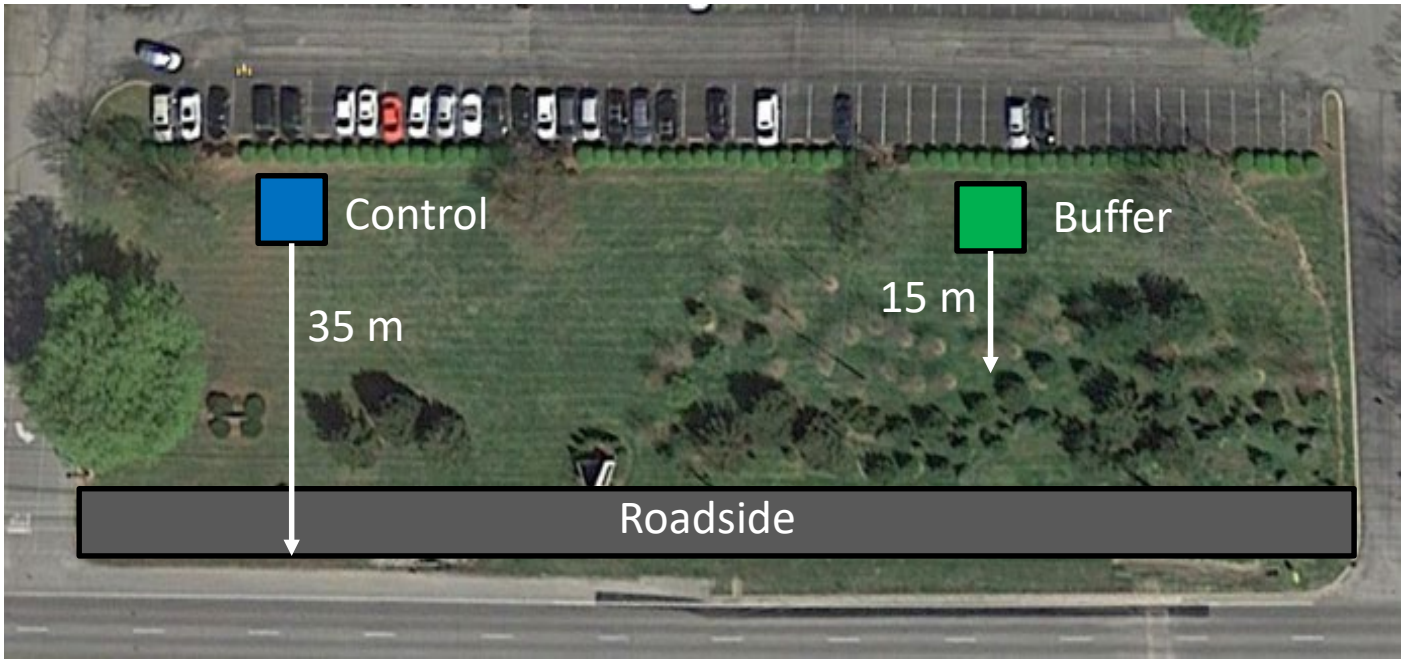
Passive sampling: Oxides of Nitrogen (NO_x)

- Pilot Study (through Summer 2017)

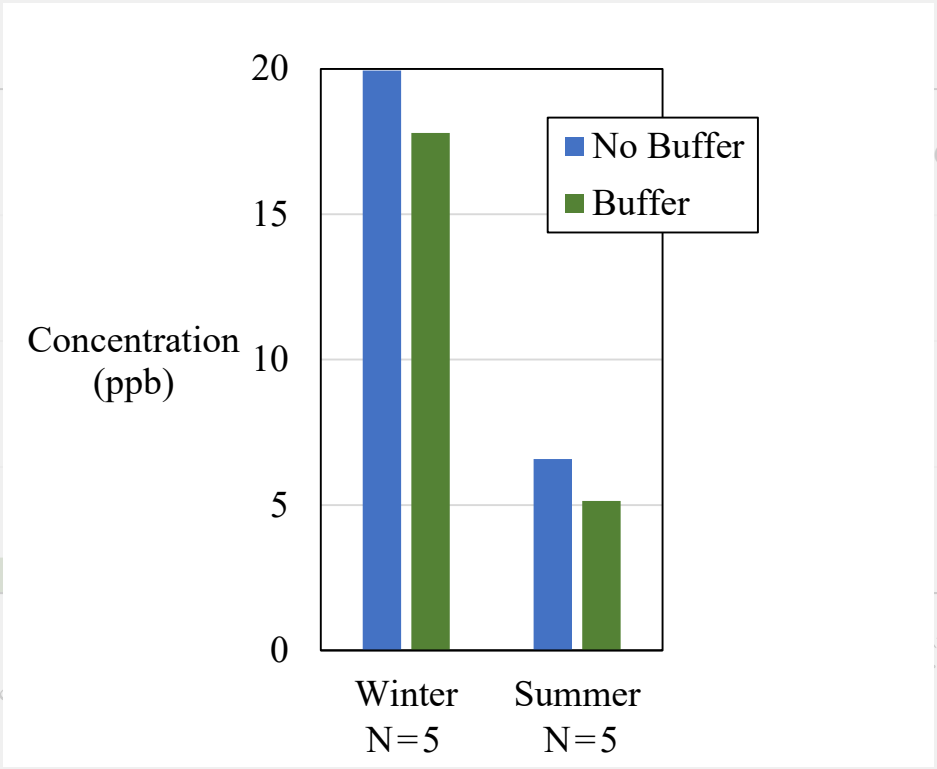
  Periodic, nominally one-week integrated samples

- Oct. 2017 – Aug. 2018

  Two-week integrated samples collected once a month



Passive sampling: Near-road Oxides of Nitrogen (NO_x)



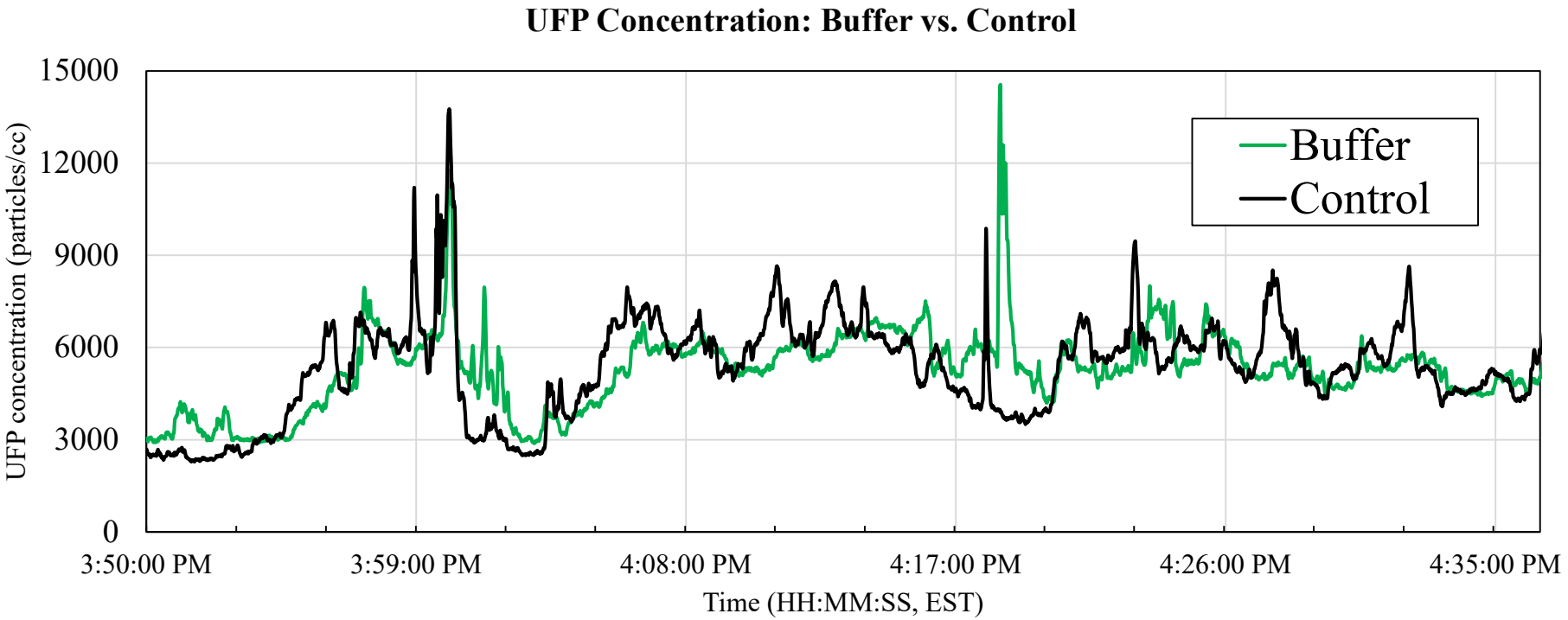
Win.: -11% (2.1 ppb)
Sum.: -22% (1.5 ppb)

High Time Resolution Sampling

- Ultrafine particles (UFP) < 100 nm in size
- Sound
- Camera
- Solar radiation
- Wind speed, direction

- Suspended Particles: number concentration, size distribution
- Gases: NO, NO_2, CO, CO_2, total oxidants (O_3 + NO_2)

Ultrafine Particles (1-sec)



Traffic pattern matters!

Green Heart Louisville

GREEN HEART LOUISVILLE

University of Louisville

The Nature Conservancy

City of Louisville (various agencies)

Cornell University

Hyphae Design Lab

US Forest Service

Washington University in St. Louis

(and others)

Green Heart Louisville

Objective: Examine linkages between vegetation exposure and cardiovascular (CVD) health

Mediators include air quality and psychosocial factors

HYPOTHESIS

Exposure to neighborhood greenery diminishes CVD risk by decreasing levels of local air pollution

Health and wellness – Beyond CVD

PRE-INTERVENTION (~1 year)	Baseline measurements
INTERVENTION (~2 years)	Large-scale installation of trees, grasses, and shrubs in the study area
POST-INTERVENTION (~1.5 years)	Repeat pre-intervention measurements biennially

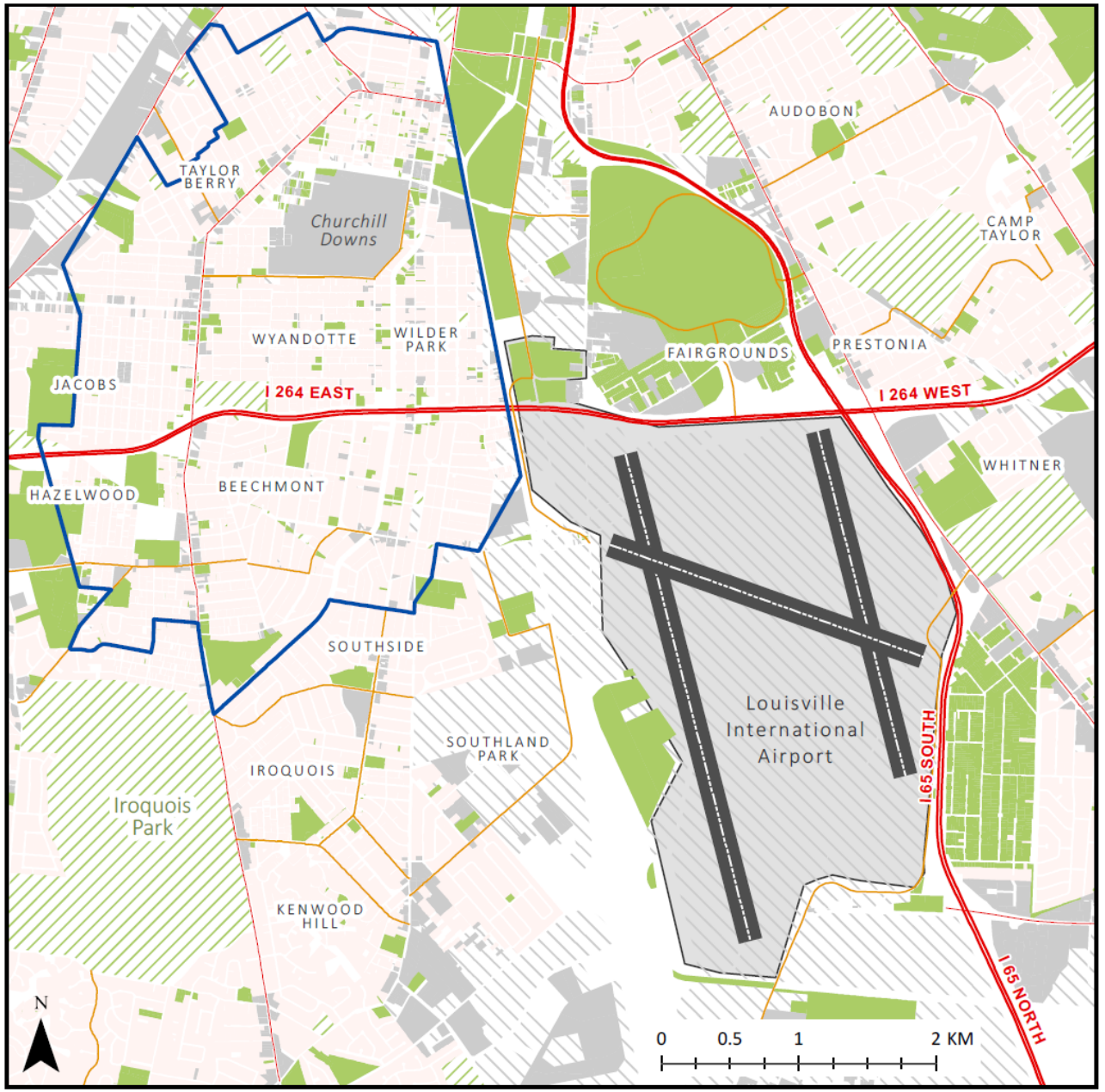
Air Pollutant Measurement Objectives

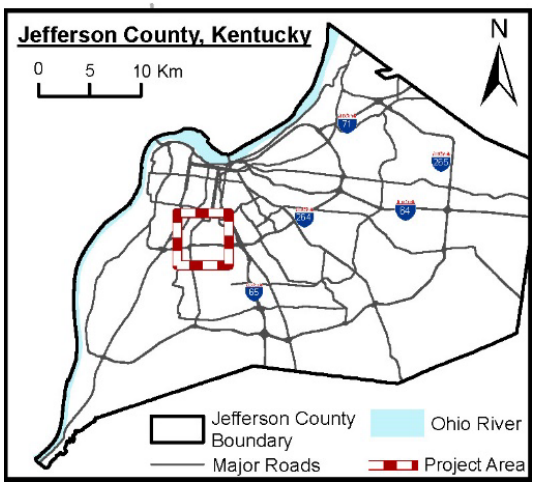
1. Assess efficacy of vegetation to reduce air pollution
- Near-road
- Neighborhood-scale

2. Exposure estimates to support the health effects studies
- Measurements to drive and validate land use regression modeling (LUR) for residential-level pollutant estimates

GREEN HEART LOUISVILLE

louisville.edu/greenheart





Louisville Superfund Research Center

Objective: Characterize exposure to select VOC Superfund Chemicals

HYPOTHESIS

VOC Superfund Chemicals exhibit high spatial variability in urban, and possibly neighborhood, scales because of differential patterns in emission sources and their zones of influence

UofL SCHOOL OF MEDICINE

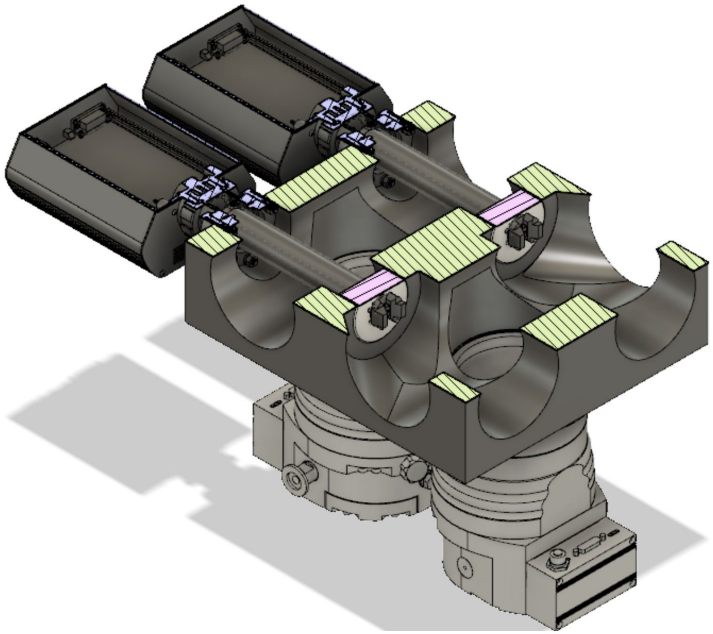
NIH National Institute of Environmental Health Sciences *Superfund Research Program*

Aims

Instrument Development– Brent Williams Group (WashU)

Design, construct, and validate a portable field gas chromatograph (GC) **suitable for mobile monitoring** (5-min resolution)

- Speciated Monitoring of VOCs
  - GC separation
  - Selective MS detection
- 4-channel parallel sample collection and analysis
- High spatiotemporal resolution



Pollutant Spatiotemporal Variability

Fixed-site monitoring

1. Passive sampling: NO_x, O_3
2. High time resolution air quality and noise monitoring
3. Residential (indoor) monitoring (~40 homes)

Mobile-platform monitoring

NO_x, O_3

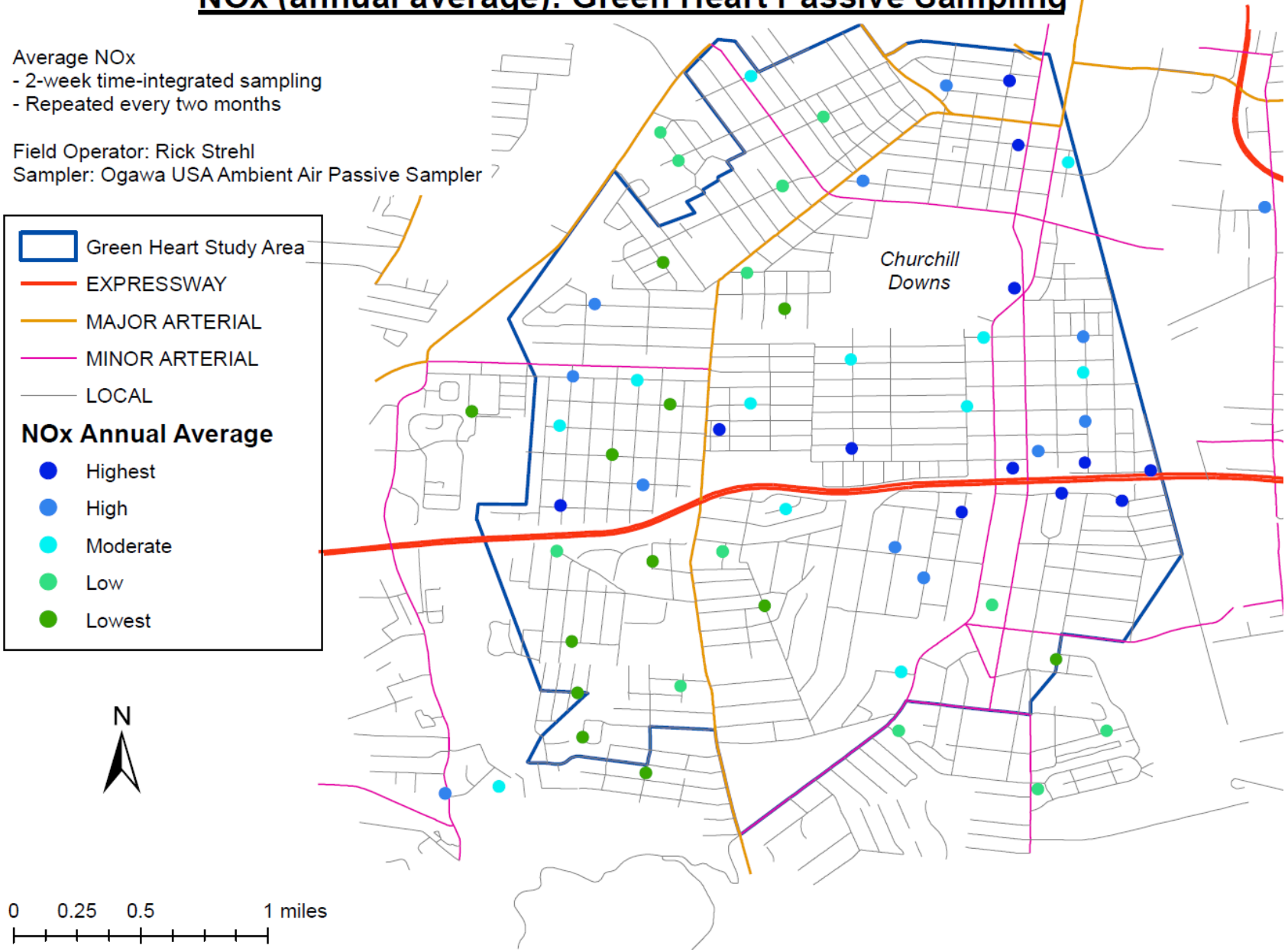
(N = 60)

Noise

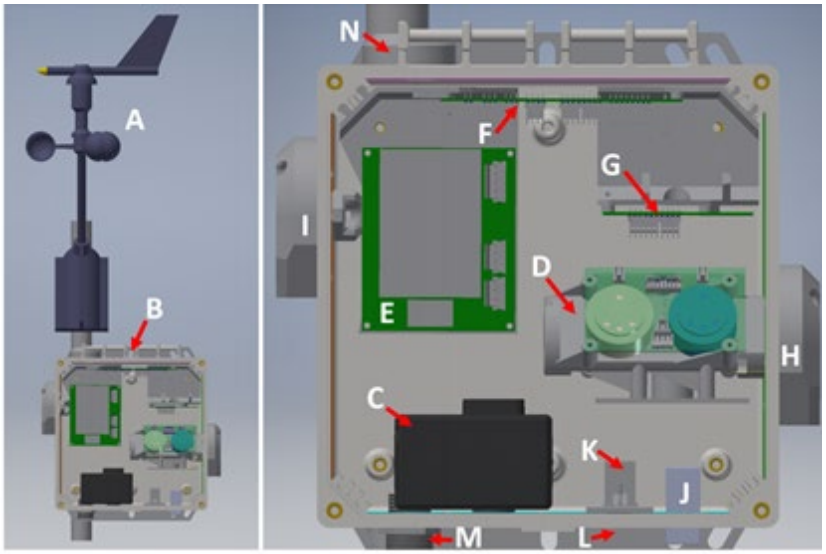
NOx (annual average): Green Heart Passive Sampling

Average NOx
- 2-week time-integrated sampling
- Repeated every two months

Field Operator: Rick Strehl
Sampler: Ogawa USA Ambient Air Passive Sampler



High time resolution monitoring: ARISense nodes



GAS-phase

NO, NO_2, CO_2, CO

Total oxidants: $O_3 + NO_2$

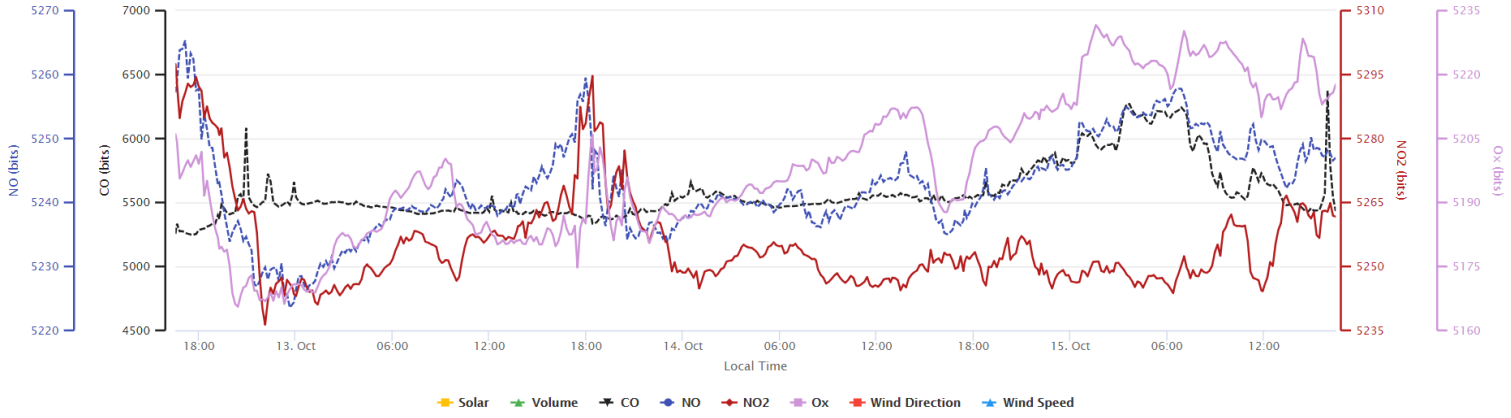
PARTICLE-phase

Optical Particle Counter

1. Number concentration
2. Size distribution

0.4 – 17 µm (16 bins)

Environmental	Relative humidity	Solar intensity
	Temperature	Audible noise detection



High time resolution monitoring (1-second)

Ultrafine particles (UFP)

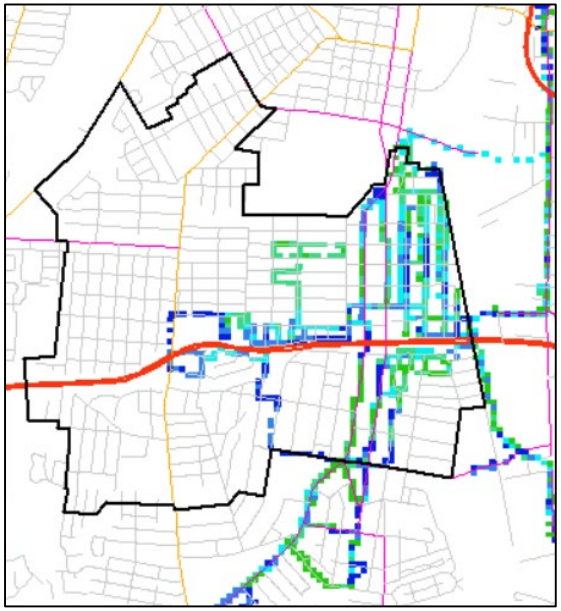
7 – 2000 nm
50% detection at 8 nm

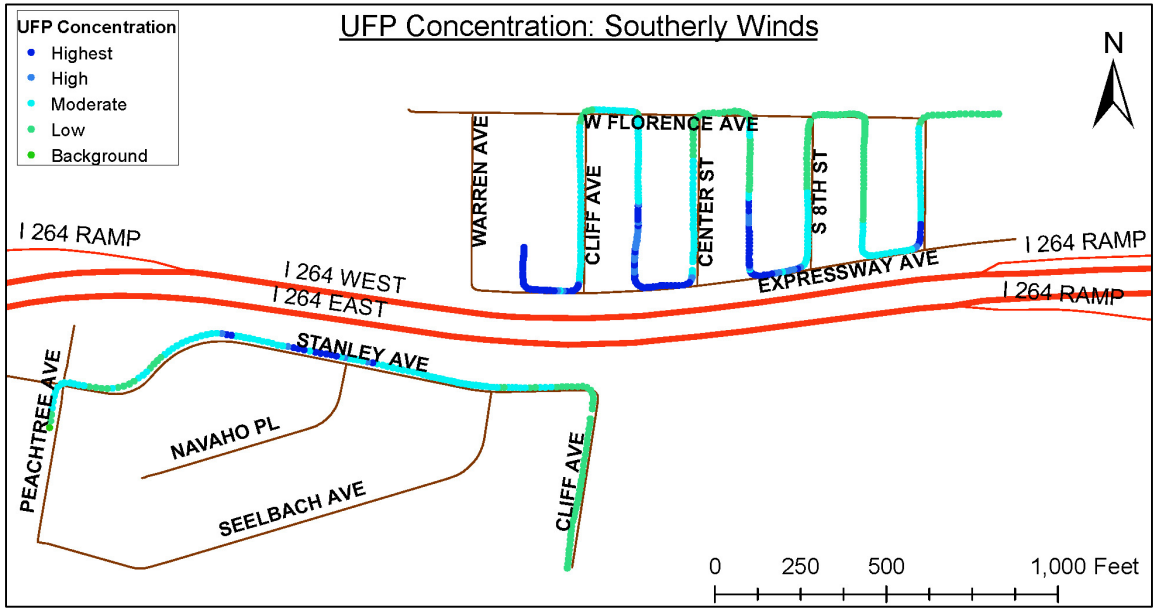
Black carbon (BC)
Tricolor Absorption

Particulate Matter
(PM_1, $PM_{2.5}$, PM_{10})

Ultrasonic Anemometer
Wind speed and direction, Temperature

Mobile-platform Monitoring



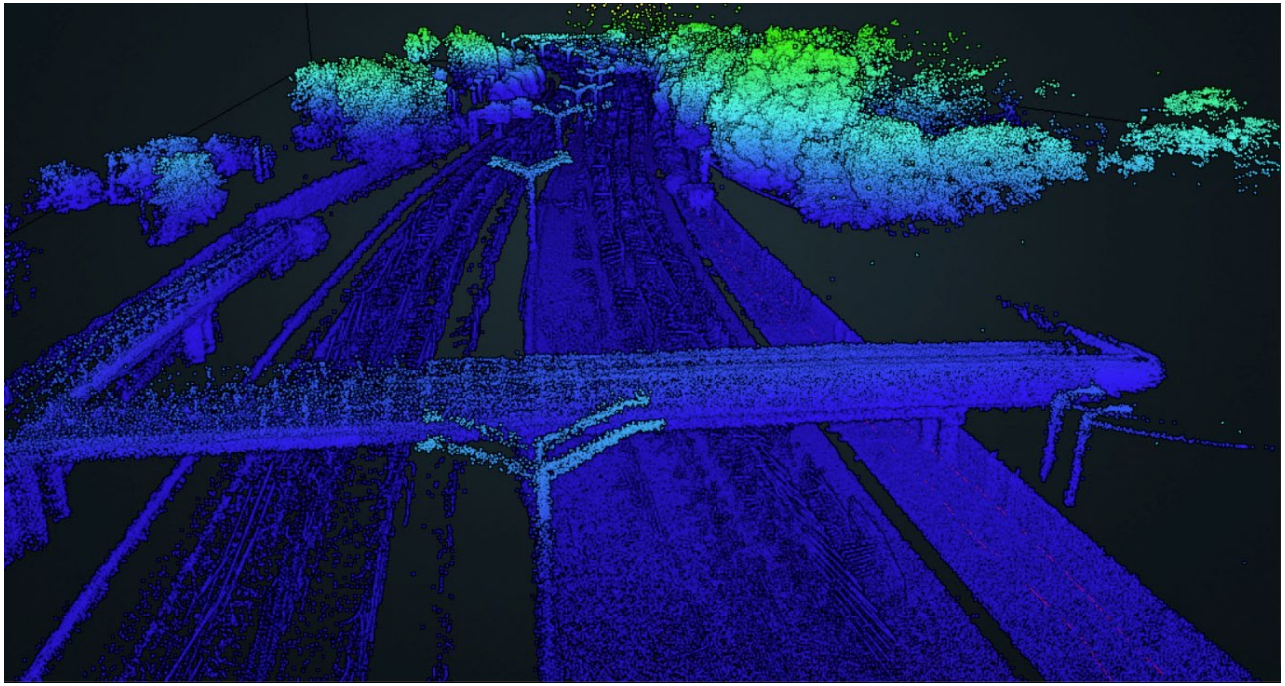


Land-use Regression (LUR) modeling using GIS

Community-level exposure estimates

Looking forward

- Characterize vegetation for TRAP mitigation



- HEAL: association between exposure and CVD risk