PARTNERS IN COMMUNITY FORESTRY

2024 CONFERENCE

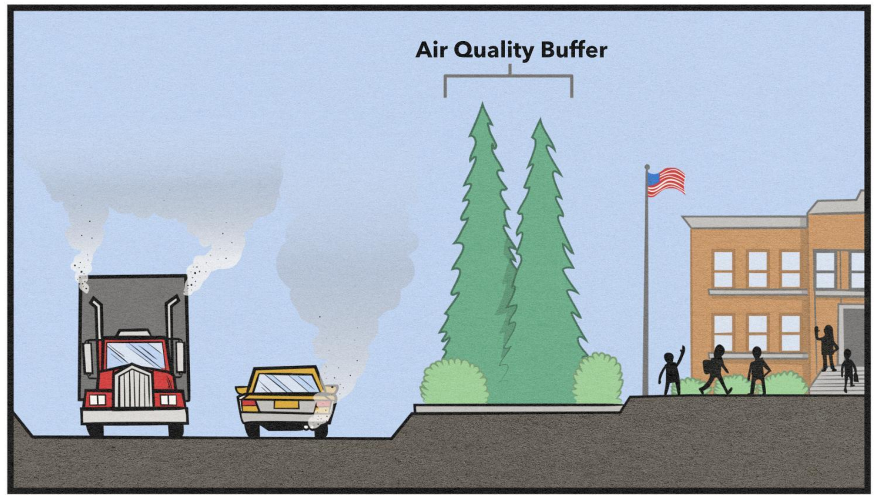
Arbor Day Foundation™

Improving Schoolyard Air Quality with Vegetative Buffers

The Morton Arboretum | THE CHAMPION of TREES

The Center for Tree Science

Creating the scientific knowledge and technical expertise necessary to sustain trees.



PRESENTED BY:

Michelle Catania

Green Industry Outreach Coordinator
The Morton Arboretum
mcatania@mortonarb.org

TEAM

Environmental Law & Policy Center
- Susan Mudd, Senior Policy Advocate (*Principal Contact for Logistics*)

The Morton Arboretum
- Michelle Catania, Green Industry Outreach Coordinator

U.S. Forest Service
- Michael Rizo, Program Specialist
- Drew Hart, Chicago Region Natural Resources Specialist

In Coordination with IL DOT & Chicago DOT
- Melissa Del Rosario, Landscape Maintenance
- Fabiola Quiroz, Landscape Maintenance
- Jeff Brink, Senior City Forester
- Allison Preble, City Forester

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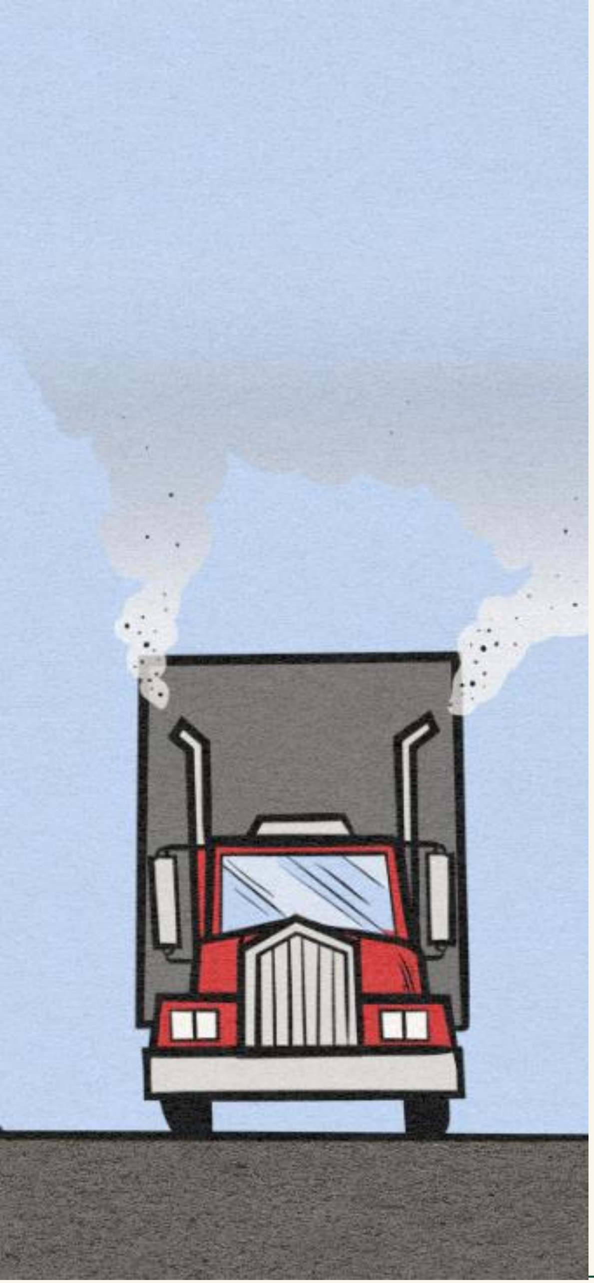
- Sheila Batka, Air Quality Specialist
- Kara Belle, Healthy Schools Coordinator
- Megan Gavin, Environmental Education Coordinator
- Kathy Kowal, Healthy Communities Team/NEPA
- Jen Blonn Tyler, Healthy Communities Team/NEPA (*Principal Contact for Logistics*)

U.S. EPA ORD/OTAQ
- Dr. Richard Baldauf, Research Physical Scientist/Engineer, U.S. EPA ORD/OTAQ
- Ken Davidson, EPA Region 9/OTAQ

University of Illinois, Urbana Champaign & Depave Chicago
- Mary Pat McGuire, PLA, Chair, Master of Landscape Architecture Program & Students (**Nital, Anne & Amy**)



Outline

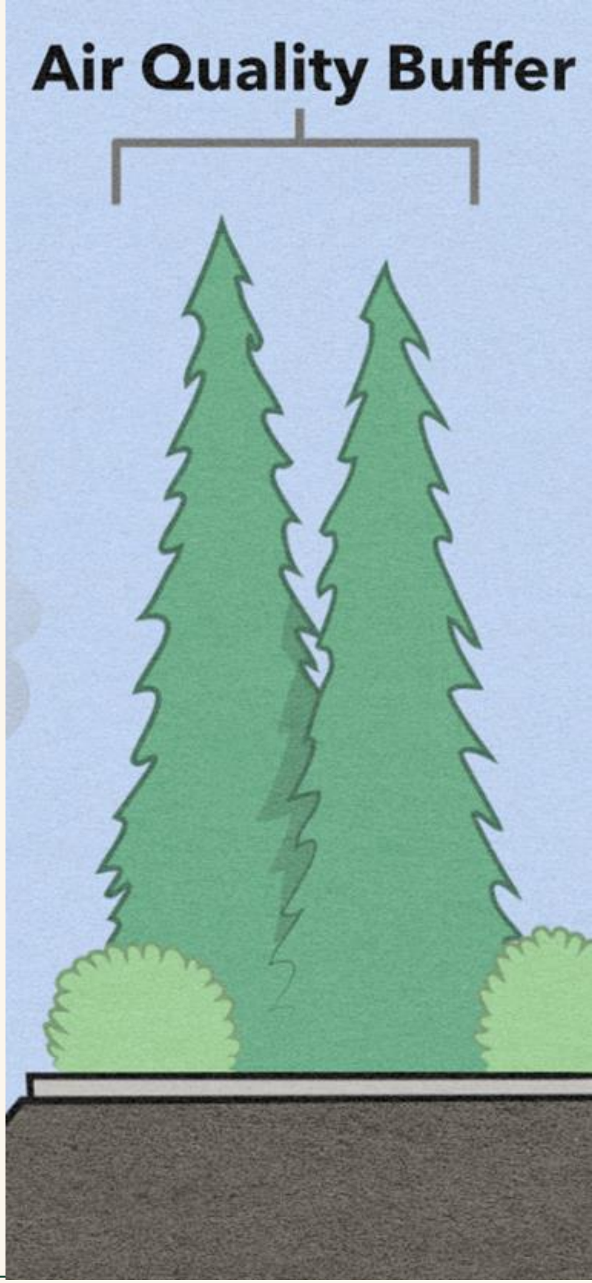
Poor Air Quality

Vegetation Barriers

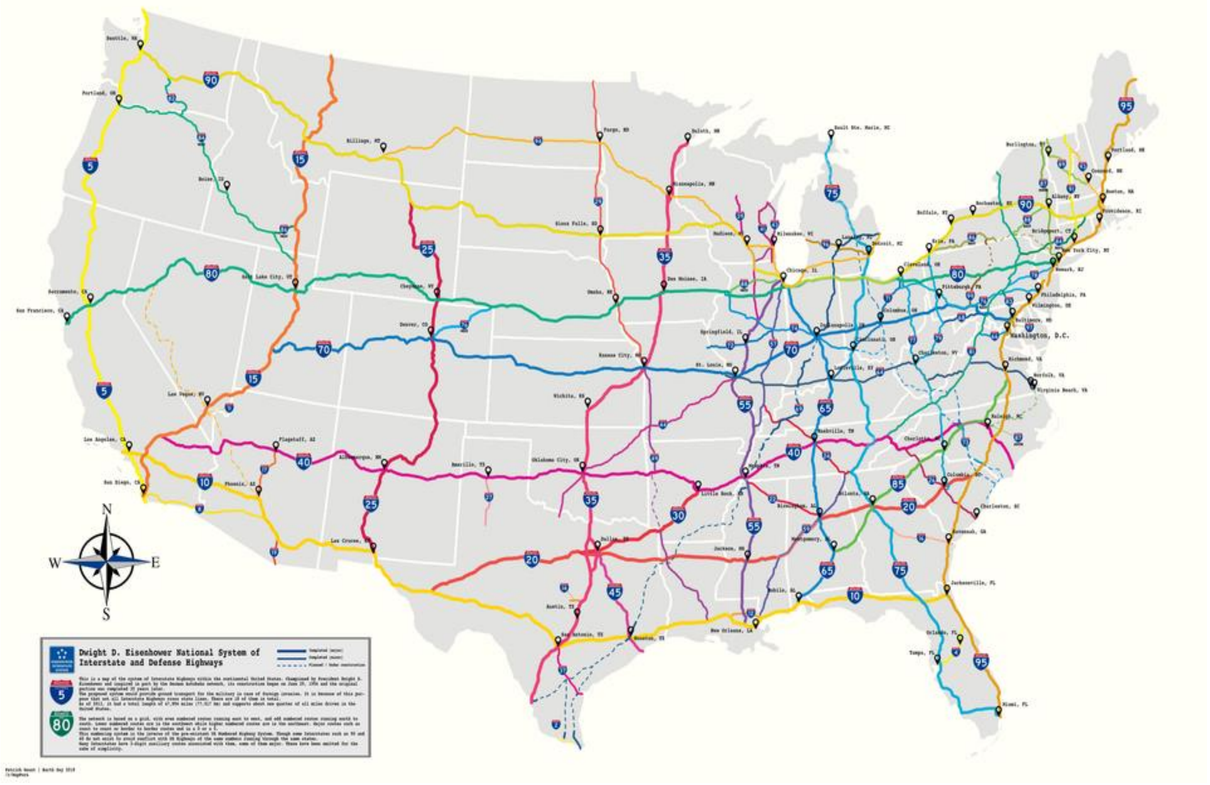
Vegetation Barrier Toolkit
for Schools & Communities

Pilot Sites for Vegetative Barriers

Air Quality Monitoring & Next Steps



POOR AIR QUALITY



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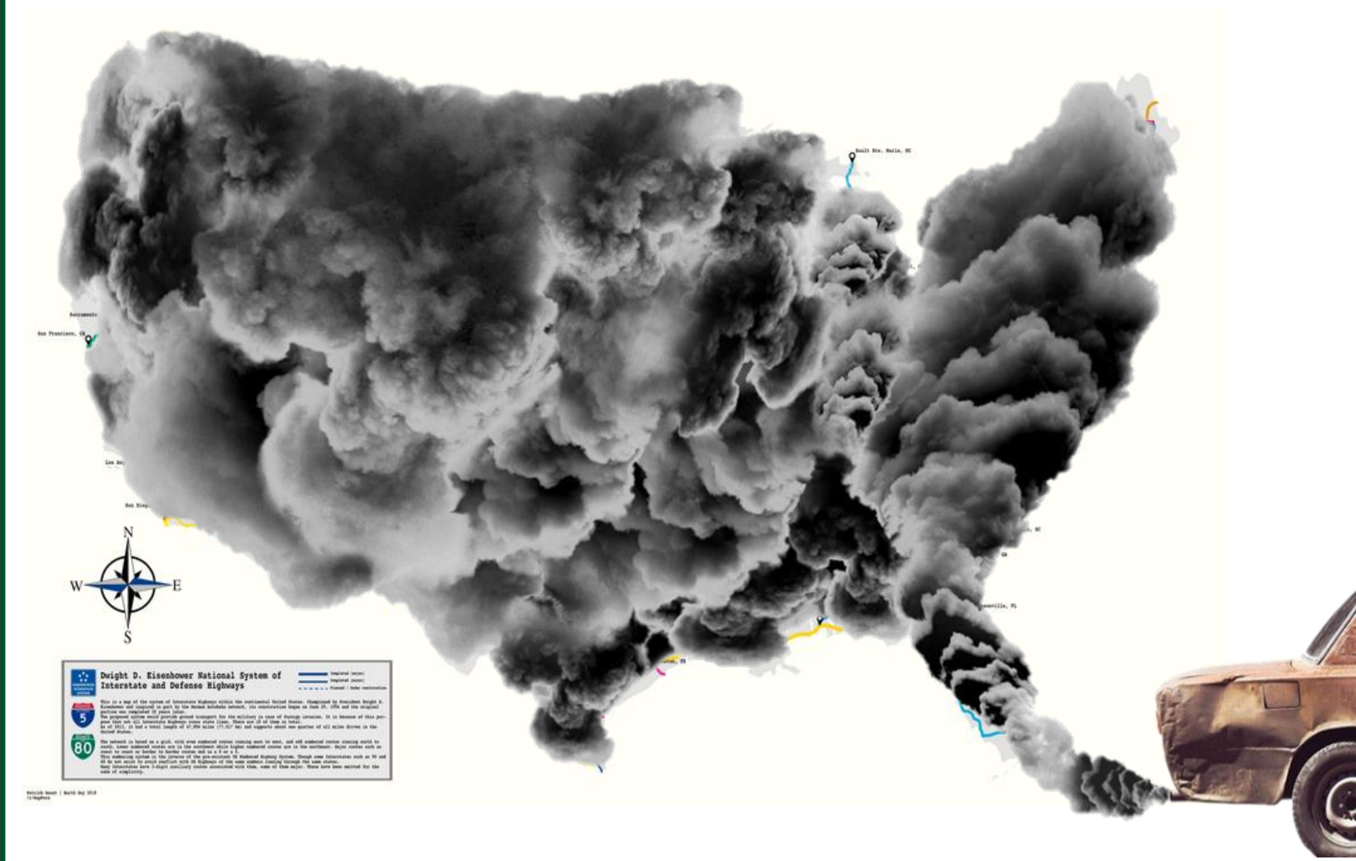
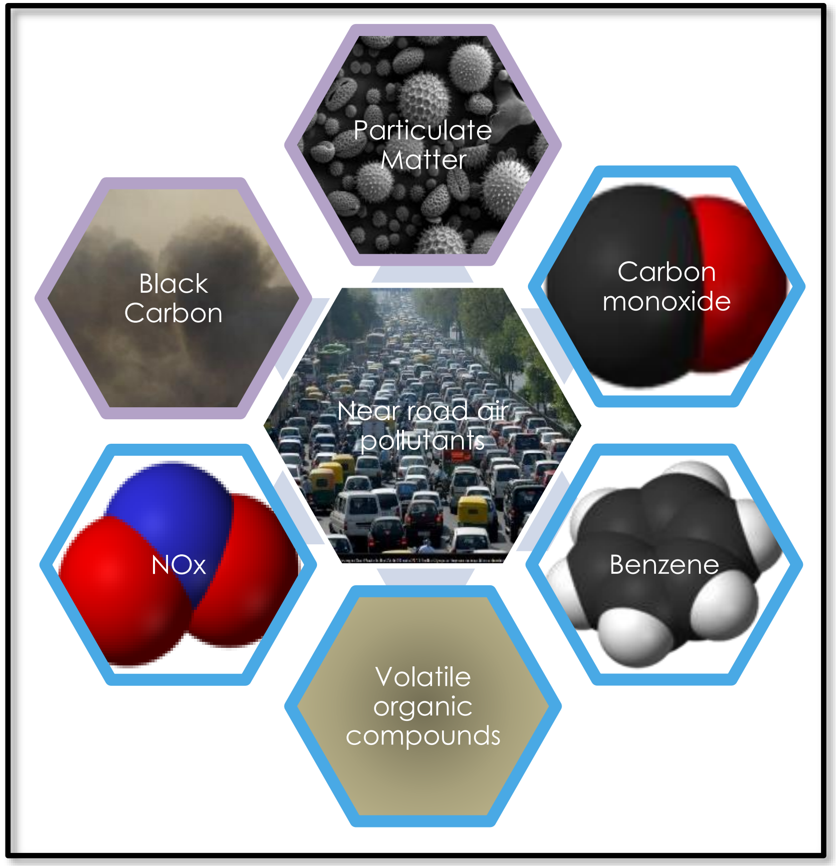


PARTNERS IN COMMUNITY FORESTRY CONFERENCE
CHICAGO, IL
NOVEMBER 20-21, 2024

Poor Air Quality

- Combination of **gases** and particulate matter



Criteria Air Pollutants

EPA calls these pollutants "criteria" air pollutants because it sets NAAQS for them based on the criteria, which are characterizations of the latest scientific information regarding their effect on health or welfare.

Sulfur Dioxide

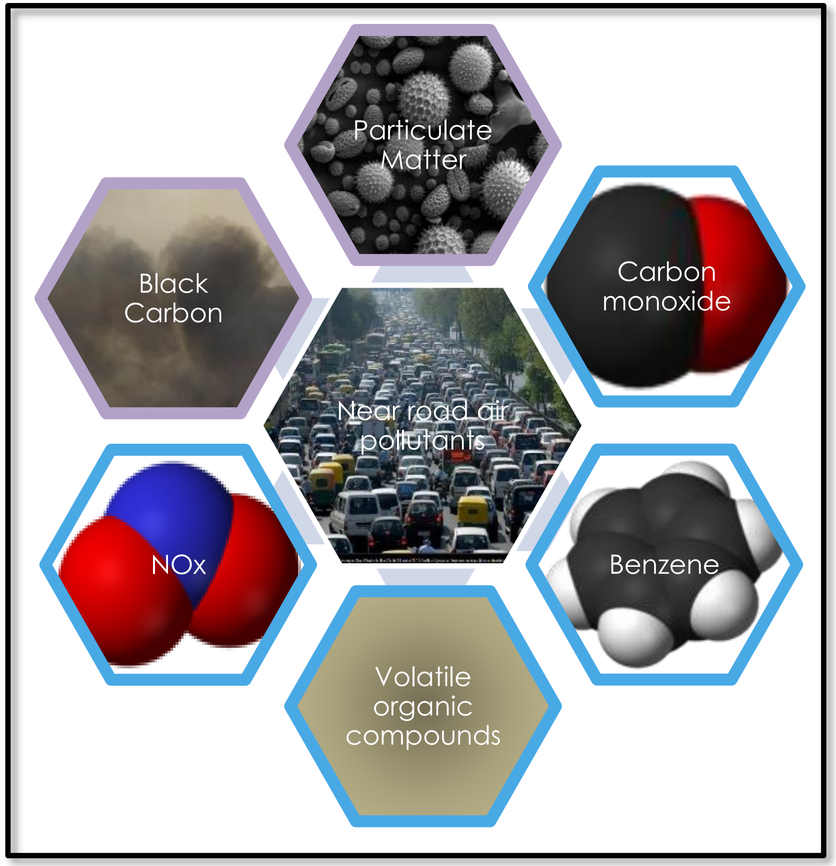
Ground-level Ozone

Nitrogen Dioxide

Carbon Monoxide

Poor Air Quality

- Combination of gases and **particulate matter**



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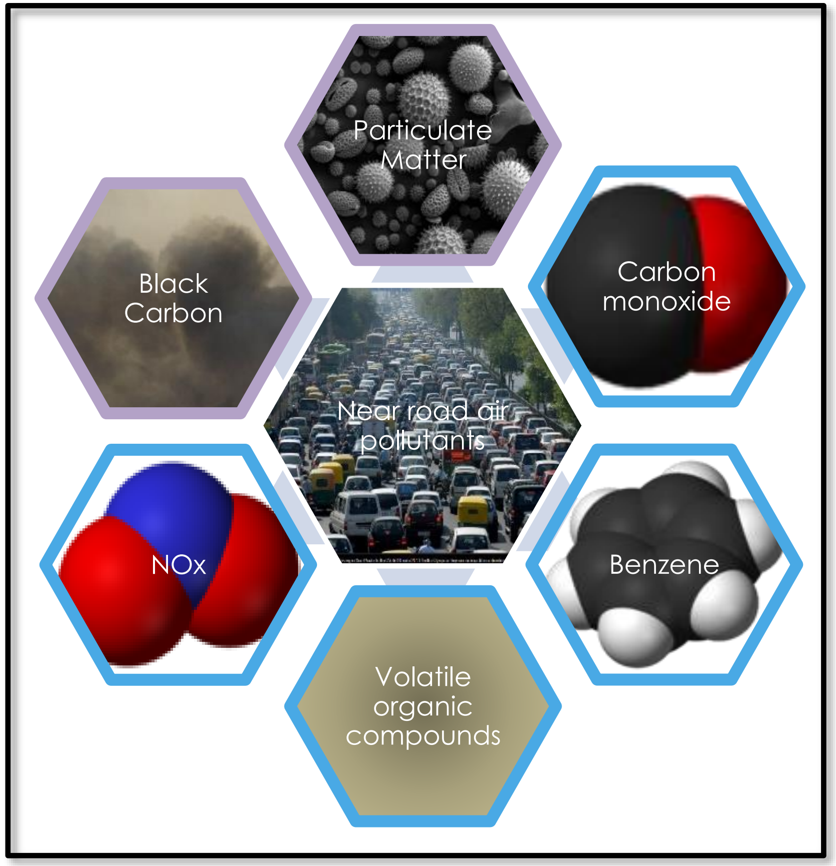

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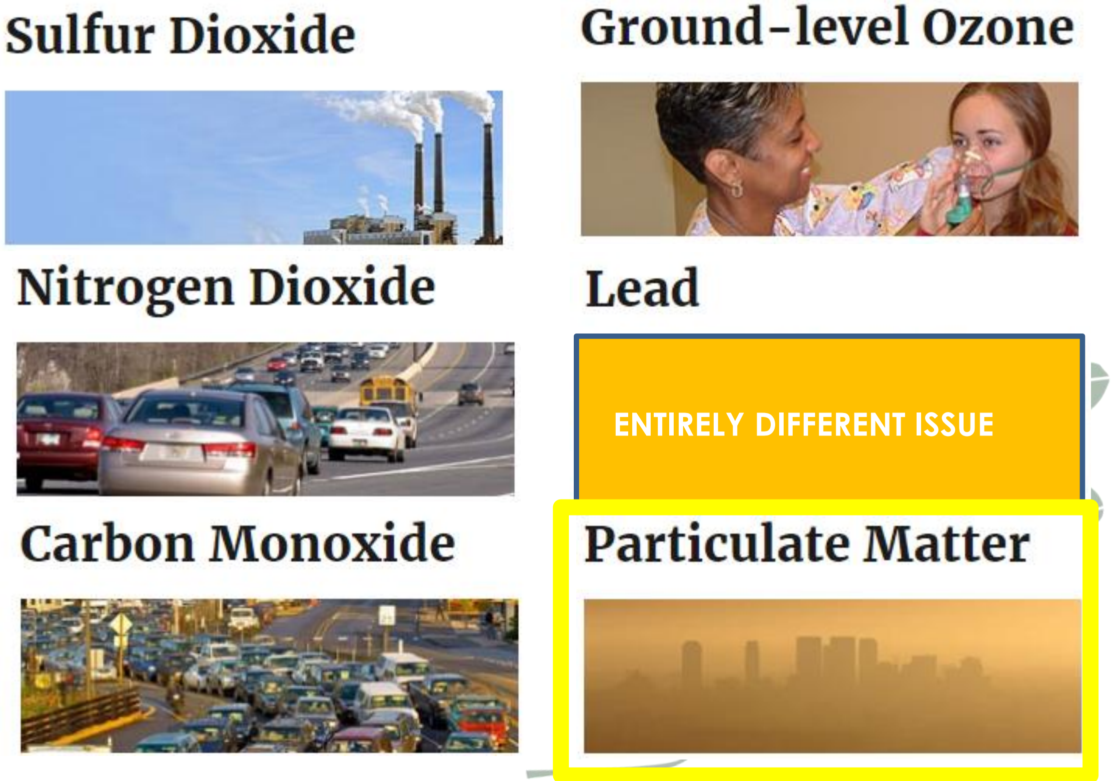

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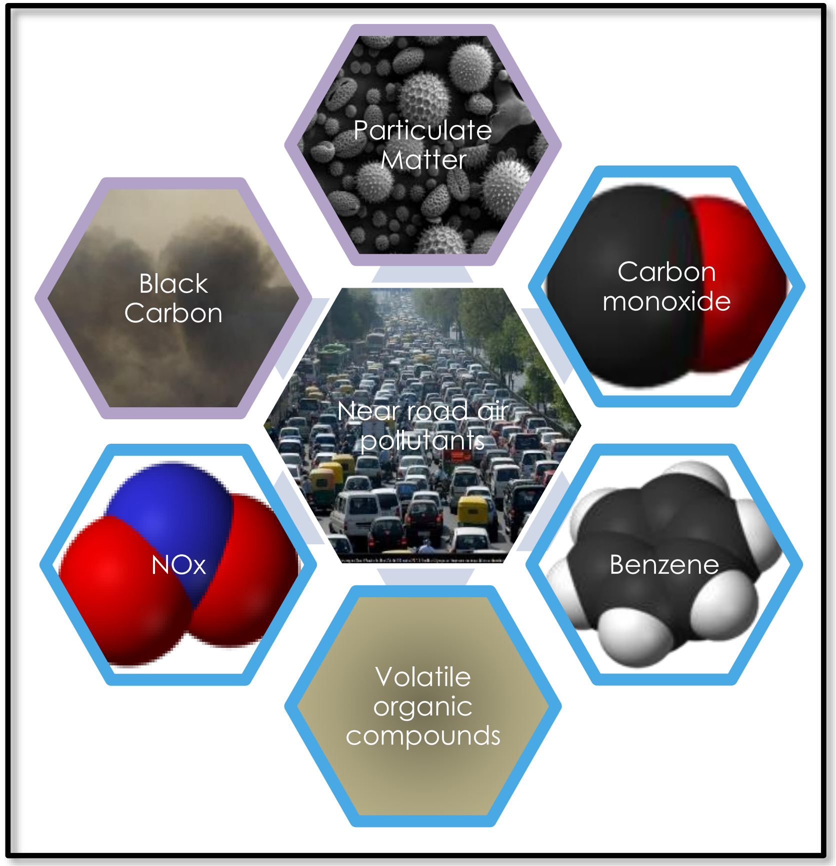
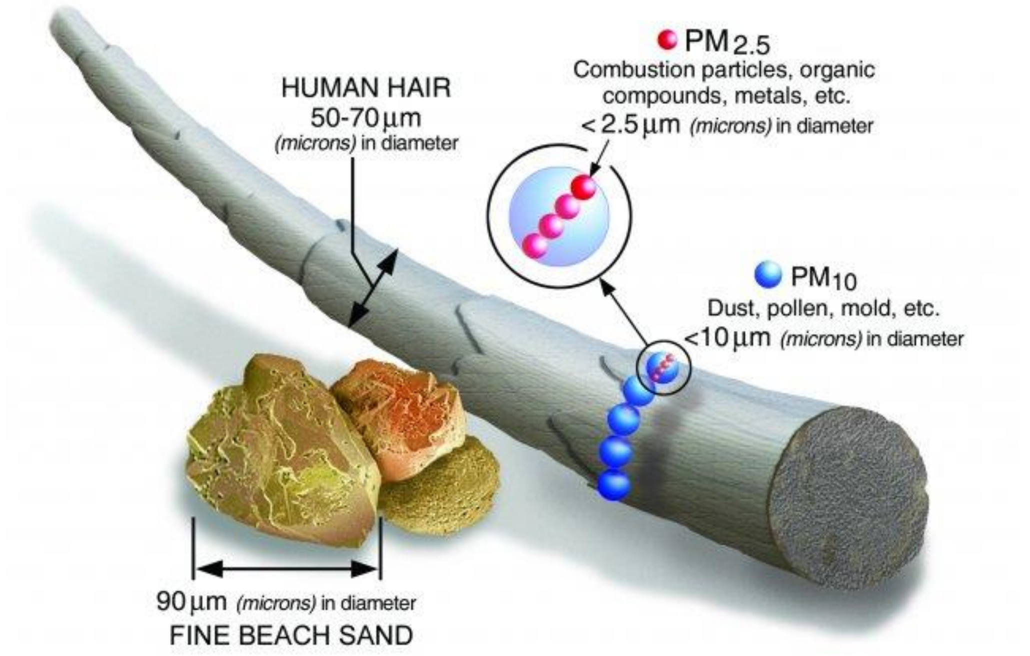
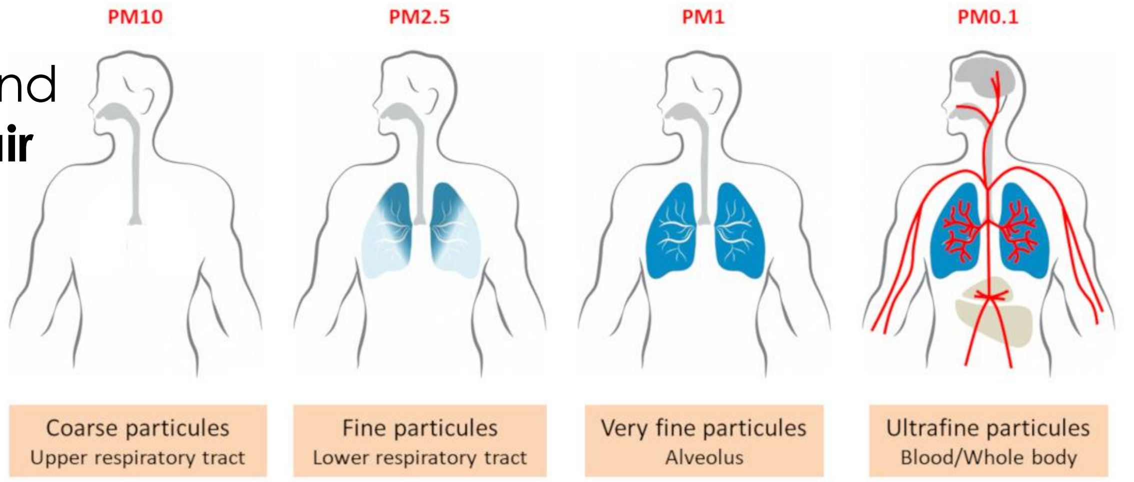


- **PM** is the mixture of **solid** particles and **liquid** droplets in **suspension**
- Dust, dirt, soot or smoke
- Commonly found **suspended in air**





Source: Encyclopedia of the Environment

Poor Air Quality






Sources

- Anthropogenic sources
  - Stationary emissions
    - Factories, powerplants, smelters, etc.
    - Road dust
  - Mobile emissions – on road & nonroad
    - Vehicles, planes, trains emissions
    - Brake and tire wear

Poor Air Quality

Sources

- Anthropogenic
  - <u>Stationary emissions</u>
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    - Road dust
  - <u>Mobile emissions</u> – on road & nonroad
    - Vehicles, planes, trains emissions
    - Brake and tire wear
- Natural
  - Volcanic
  - Wind-blown dust (eolian sands)

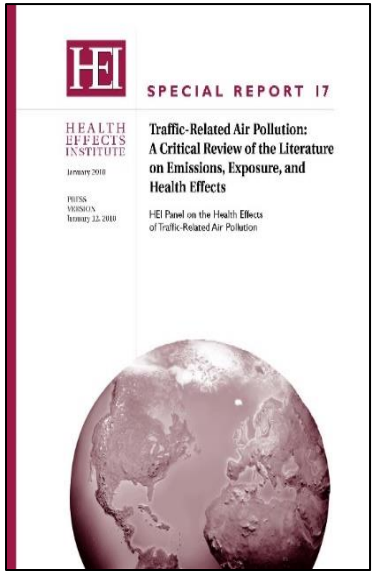
Composition of Near-Road Air Pollution

- Elevated concentrations near road due to:
  - Increasing **traffic**
  - Congestion with "**stop & go**"
  - Certain meteorological or **terrain**
    - calm winds during rush hour
    - street canyons
  - **Old**, **poorly maintained vehicles**

- Populations in close proximity to source:
  - **In USA** –
    - Over **50 million people** estimated to live **within 300 ft (100 m)** of a source
    - Almost **17,000 schools** are estimated to be **within (820 ft) 250 m** of a source
  - Massive health impacts

Poor Air Quality

Asthma & Cardiovascular Health Concerns


HEI
SPECIAL REPORT 17
HEALTH EFFECTS INSTITUTE
Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects
HEI Panel on the Health Effects of Traffic-Related Air Pollution

Increased health risks from air pollution near roadways:

- Kids, older adults, those with cardiopulmonary disease
- Greater impacts in lower socioeconomic populations

Studies have linked:

- Respiratory and cardiovascular health
- Cancer including childhood leukemia
- **Cognitive development**
- Birth and developmental effects

- **Onset** of childhood asthma
- Other respiratory problems
- Impaired lung function
- Total mortality
- Cardiovascular mortality
- Cardiovascular morbidity

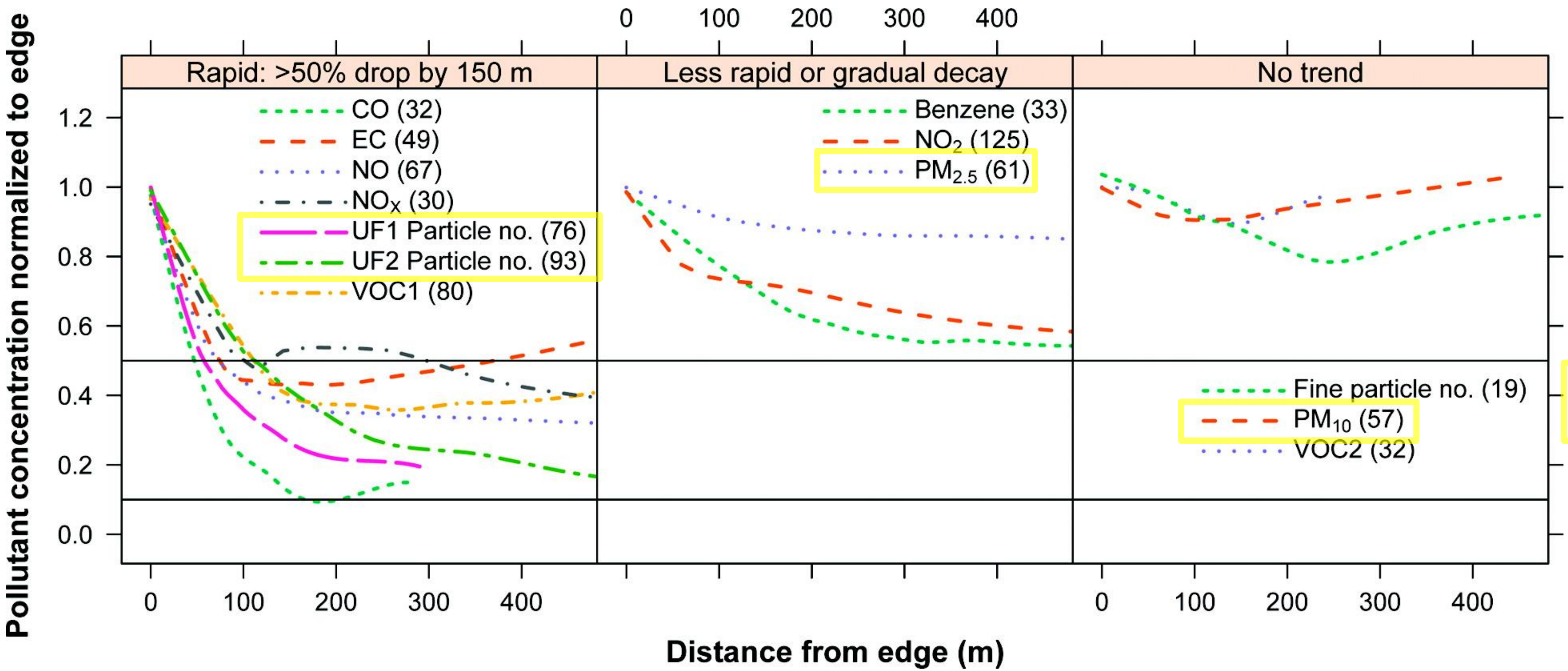
Modified EPA Slide

References: Health Effects Institute, 2010; Perez et al., Environ. Health Persp., 2012; Gauderman et al., LANCET, 2007; https://chicagohealthatlas.org/indicators/HCSATHP?topic=adult-asthma-rate

Slide acknowledgement: U.S. EPA *Best Practices for Reducing Near Road Pollution at Schools* Oct 2020 Webinar ; Photo: The Guardian.com

Poor Air Quality

- Combination of gases and **particulate matter**
- Often elevated near large transportation corridors
  - Highest concentrations 500 – 1,000 ft (150-300 m) from source



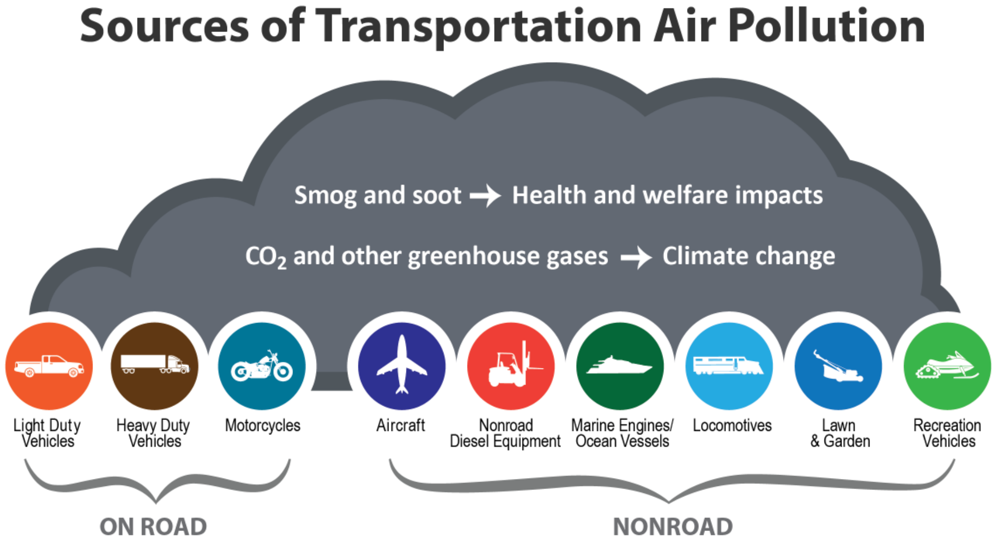
CO – carbon monoxide
EC- elemental carbon
NO- nitric oxide
NOx – nitrogen oxides
UF1 - >3 nm – 352 nm *
UF2 – 15 nm – 1000 nm *
VOC1 – varies w distance
Benzene – petroleum bioproduct
NO2 – Nitrogen dioxide
Fine Particle - 300-20,000nm
PM10 – less than 10 nm
VOC2 – does not vary w distance

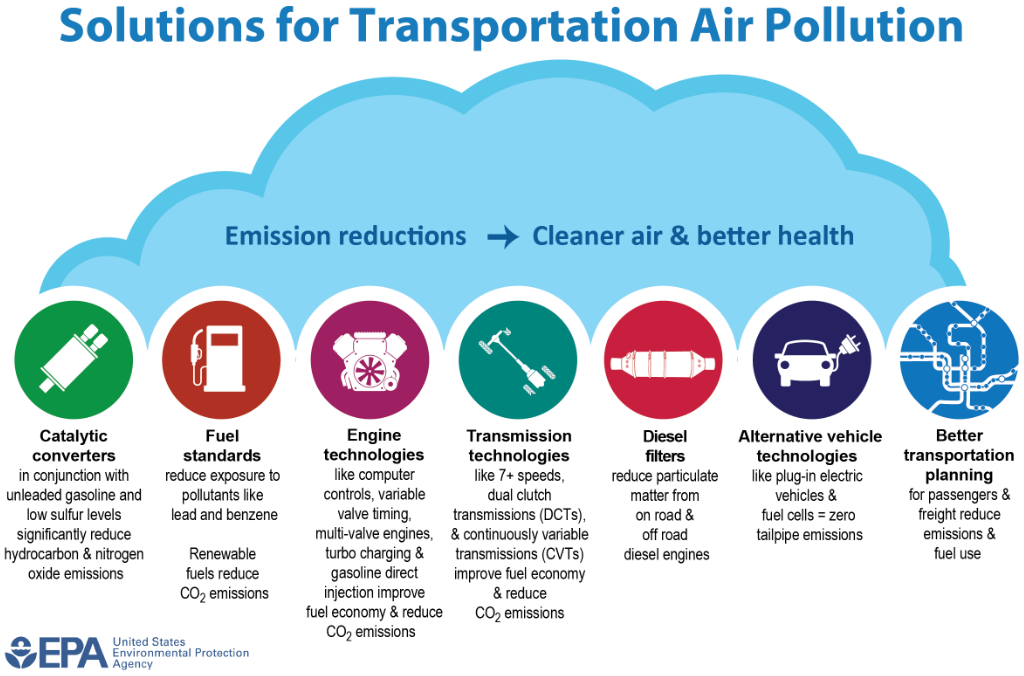
* Size range in literature

Near-roadway air quality: synthesizing the findings from real-world data.

A. Karner, D. Eisinger, D. Niemeier • Published 18 June 2010 • Environmental Science • Environmental science & technology

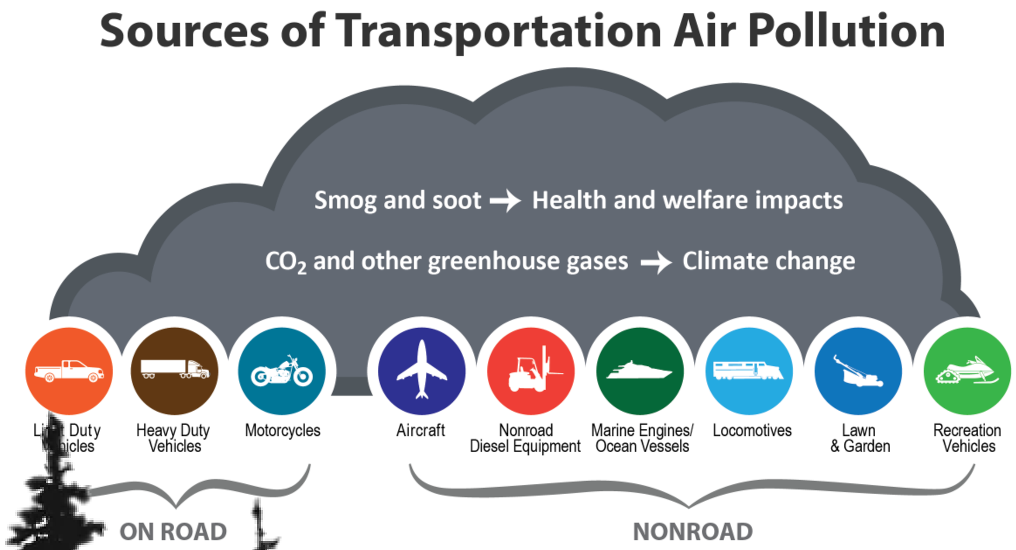
Poor Air Quality

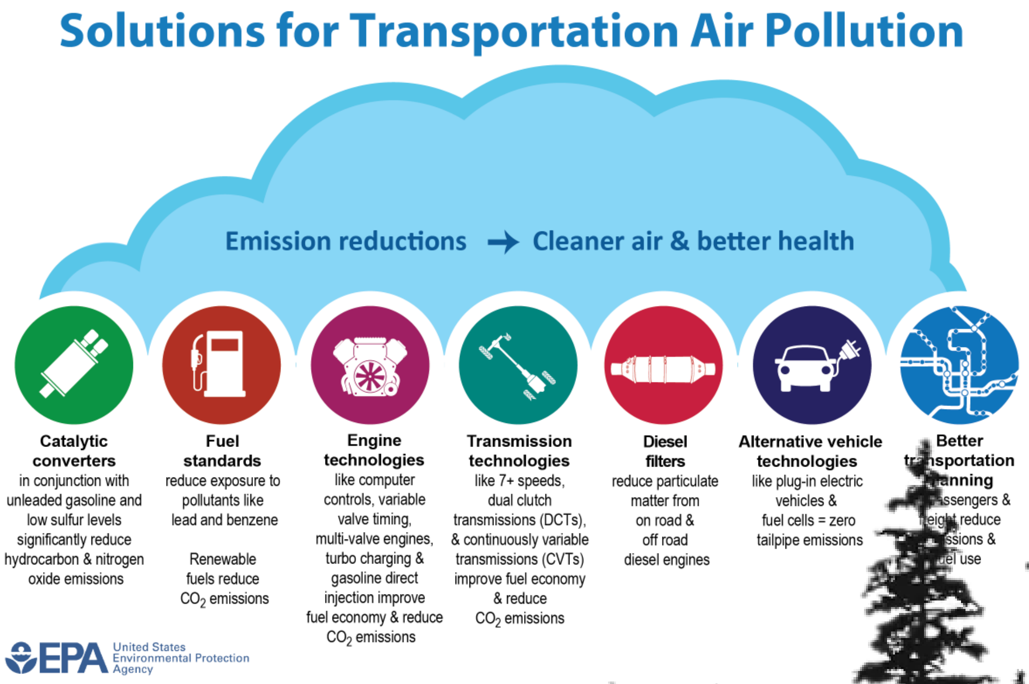




Source: modified from EPA

Poor Air Quality





Let's add **Vegetation Barriers** to Solutions

Poor Air Quality

- Vegetative barriers have other positive attributes
  - Reduce noise
  - Reduce stormwater runoff/flooding
  - Improve water quality
  - Increase carbon sequestration
  - Reduce heat island effects
  - Improve aesthetics/property values
  - Enhance community livability
  - Generally, improve public health

PNAS

Green spaces and cognitive development in primary schoolchildren

Payam Dadvand[a,b,c,1], Mark J. Nieuwenhuijsen[a,b,c], Mikel Esnaola[a,b,c], Joan Forns[a,b,c,d], Xavier Basagaña[a,b,c], Mar Alvarez-Pedrerol[a,b,c], Ioar Rivas[a,b,c,e], Mónica López-Vicente[a,b,c], Montserrat De Castro Pascual[a,b,c], Jason Su[f], Michael Jerrett[g], Xavier Querol[e], and Jordi Sunyer[a,b,c,h]

[a]Centre for Research in Environmental Epidemiology (CREAL), 08003 Barcelona, Spain; [b]Experimental and Health Sciences, Pompeu Fabra University, 08003 Barcelona, Catalonia, Spain; [c]Ciber on Epidemiology and Public Health (CIBERESP), 28029 Madrid, Spain; [d]Department of Genes and Environment, Division of Epidemiology, Norwegian Institute of Public Health, 0473, Oslo, Norway; [e]Department of Geosciences, Institute of Environmental Assessment and Water Research, Spanish National Research Council (CSIC-IDEA), 08034 Barcelona, Catalonia, Spain; [f]Environmental Health Sciences, School of Public Health, University of California, Berkeley, CA 94720-7360; [g]Department of Environmental Health Sciences, Fielding School of Public Health, University of California, Los Angeles, CA 90095; and [h]Hospital del Mar Medical Research Institute (IMIM), 08003 Barcelona, Catalonia, Spain

Edited by Susan Hanson, Clark University, Worcester, MA, and approved May 15, 2015 (received for review February 18, 2015)

Exposure to green space has been associated with better physical and mental health. Although this exposure could also influence cognitive development in children, available epidemiological evidence on such an impact is scarce. This study aimed to assess the association between exposure to green space and measures of cognitive development in primary schoolchildren. This study was based on 2,593 schoolchildren in the second to fourth grades (7–10 y) of 36 primary schools in Barcelona, Spain (2012–2013). Cognitive development was assessed as 12-mo change in developmental trajectory of working memory, superior working memory, and inattentiveness by using four repeated (every 3 mo) computerized cognitive tests for each outcome. We assessed exposure to green space by characterizing outdoor surrounding greenness at home and school and during commuting by using high-resolution (5 m × 5 m) satellite data on greenness (normalized difference vegetation index). Multilevel modeling was used to estimate the associations between green spaces and cognitive development. We observed an enhanced 12-mo progress in working memory and superior working memory and a greater 12-mo reduction in inattentiveness associated with greenness within and surrounding school boundaries and with total surrounding greenness index (including greenness surrounding home, commuting route, and school). Adding a traffic-related air pollutant (elemental carbon) to models explained 20–65% of our estimated associations between school greenness and 12-mo cognitive development. Our study showed a beneficial association between exposure to green space and cognitive development among schoolchildren that was partly mediated by reduction in exposure to air pollution.

neurodevelopment | greenness | cognition | built environment | school

Contact with nature is thought to play a crucial and irreplaceable role in brain development (1, 2). Natural environments including green spaces provide children with unique opportunities such as inciting engagement, risk taking, discovery, creativity, mastery and control, strengthening sense of self, inspiring basic emotional states including sense of wonder, and enhancing psychological restoration, which are suggested to influence positively different aspects of cognitive development (1–3). Beneficial effects of green spaces on cognitive development might accrue from direct influences such as those above, with green space itself exerting the positive influence or through indirect, mediated pathways. The ability of green spaces to mitigate traffic-related air pollution (TRAP) (4) could lead to a beneficial impact of green spaces on cognitive development, because exposure to TRAP has been negatively associated with cognitive development in children (5). Further to TRAP, green spaces can also reduce noise (6), which itself too has been negatively associated with cognitive development (7). Moreover, proximity to green spaces, particularly parks, has been suggested to increase physical activity (8), and higher levels of physical activity are related to improved cognitive development (9). Outdoor surrounding greenness has also been reported to enrich microbial input from the environment (10), which may positively influence cognitive development (10). Through these pathways, exposure to green space, including outdoor surrounding greenness and proximity to green spaces, could influence cognitive development in children, yet the available population-based evidence on the association between such exposure and cognitive development in children remains scarce.

The brain develops steadily during prenatal and early postnatal periods, which are considered as the most vulnerable windows for effects of environmental exposures (11). However, some cognitive functions closely related with learning and school achievement—such as working memory and attention—develop across childhood and adolescence as an essential part of cognitive maturation (12–14). We therefore hypothesized a priori that exposure to green space in primary schoolchildren could enhance cognitive development. Accordingly, our study aimed to assess the association between indicators of exposure to green space and measures of cognitive development, including working memory (the system that holds multiple pieces of transitory information in the mind where they can be manipulated), superior working memory (working memory that involves continuous updating of the working memory buffer), and inattentiveness in primary schoolchildren. As a secondary aim, we also evaluated the mediating role of a reduction in air pollution as one of the potential mechanisms underlying this association.

Significance

Green spaces have a range of health benefits, but little is known in relation to cognitive development in children. This study, based on comprehensive characterization of outdoor surrounding greenness (at home, school, and during commuting) and repeated computerized cognitive tests in schoolchildren, found an improvement in cognitive development associated with surrounding greenness, particularly with greenness at schools. This association was partly mediated by reductions in air pollution. Our findings provide policymakers with evidence for feasible and achievable targeted interventions such as improving green spaces at schools to attain improvements in mental capital at population level.

Author contributions: P.D., M.J.N., X.Q., and J. Sunyer designed research; M.J.N., J.F., M.A.-P., I.R., M.L.-V., M.D.C.P., X.Q., and J. Sunyer performed research; M.E., X.B., J. Su, and M.J. contributed new reagents/analytic tools; P.D., M.E., and X.B. analyzed data; and P.D. and J. Sunyer wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

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This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1503402112/-/DCSupplemental.

ENVIRONMENTAL SCIENCES

www.pnas.org/cgi/doi/10.1073/pnas.1503402112

PNAS | June 30, 2015 | vol. 112 | no. 26 | 7937–7942

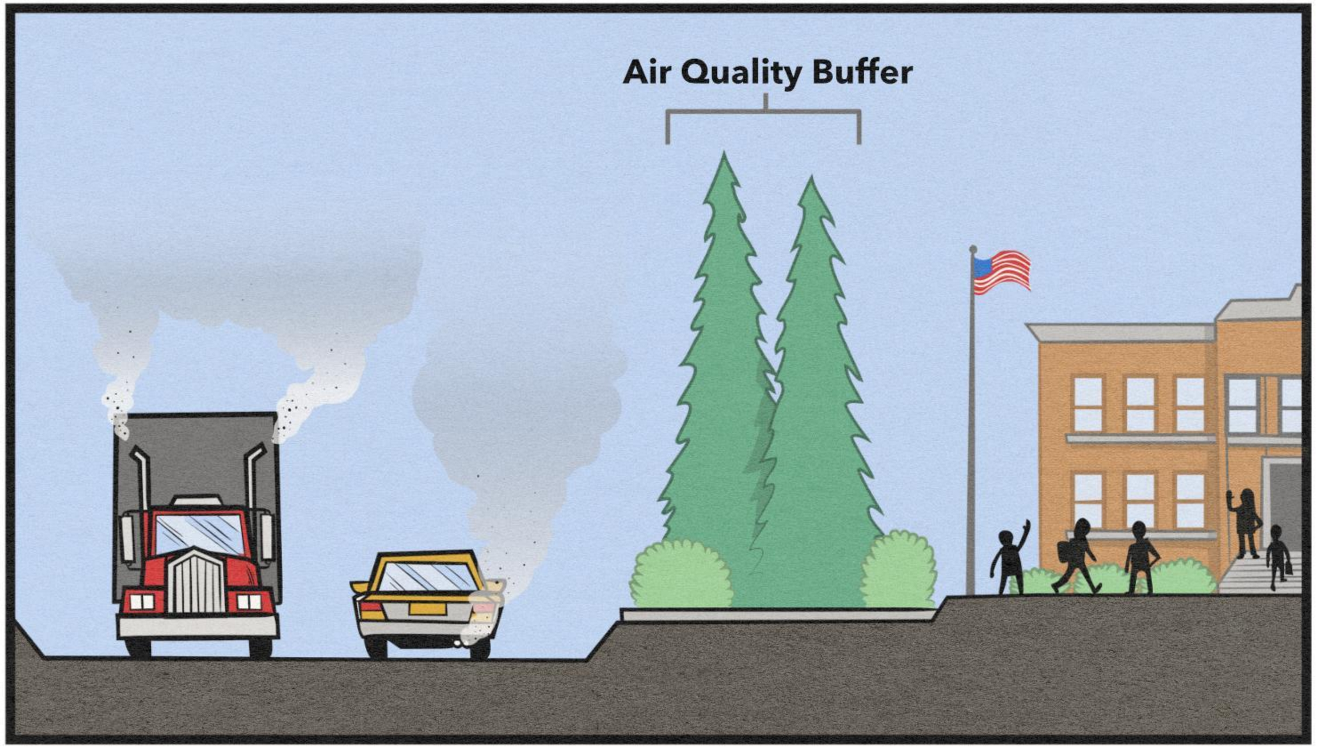
"Exposure to green space has been associated with better physical and mental health"

Slide: U.S. EPA

VEGETATIVE BARRIERS

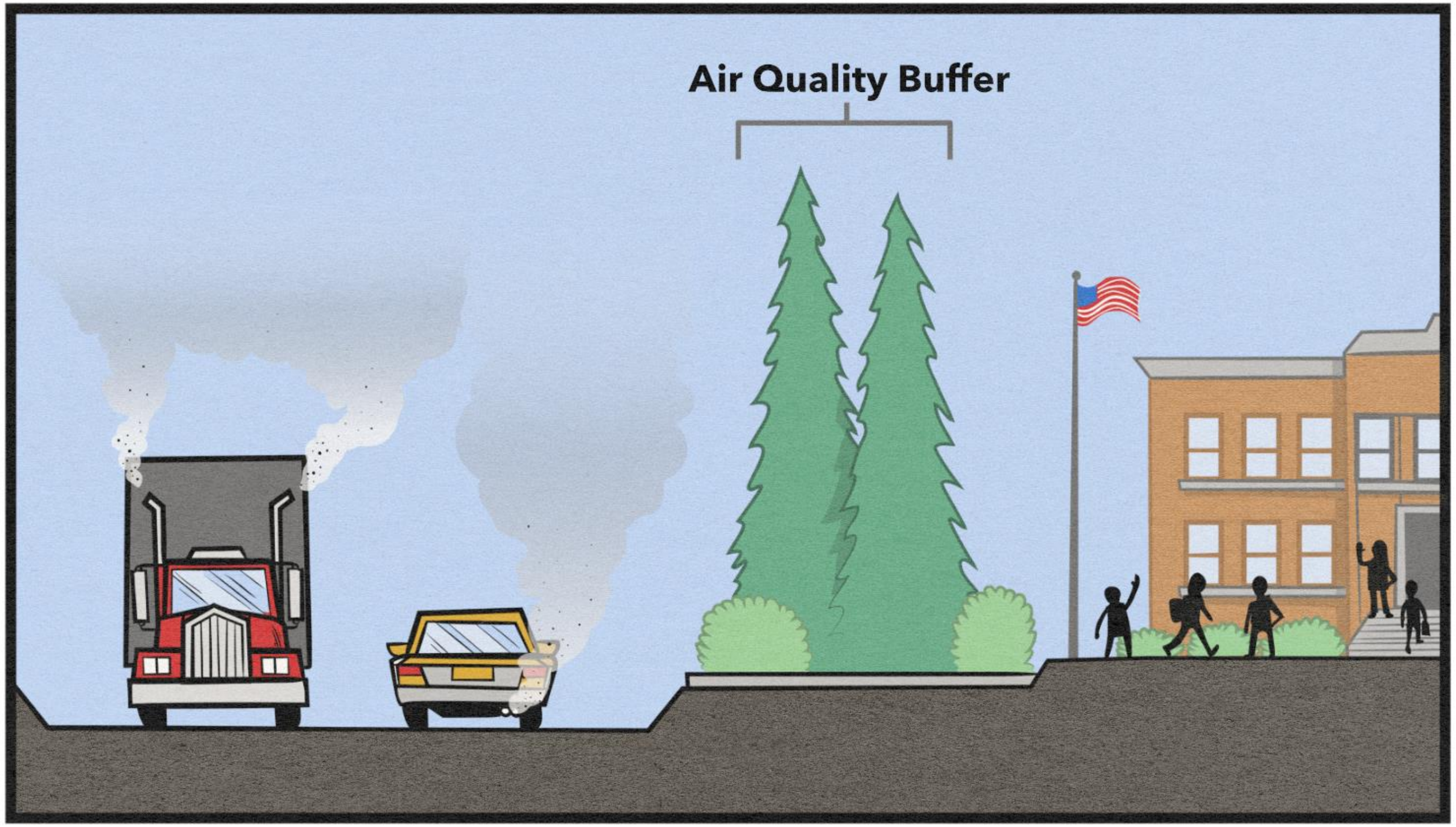
or

BUFFERS



What is a Vegetative Barrier?

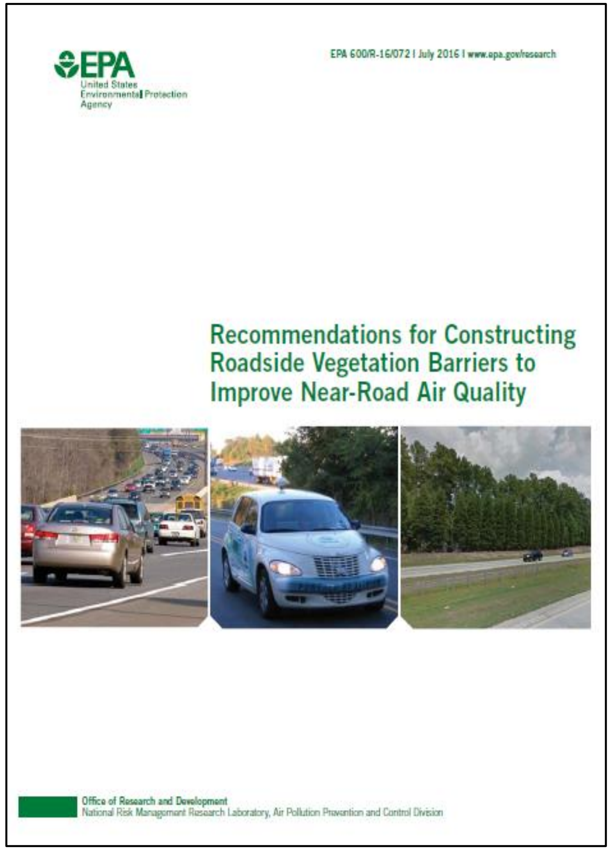
"Vegetation barriers are a collection of trees and shrubs that separate a source of pollutions such as a highway from places where people live, learn, work, and play."



TMA Toolkit

EPA Urban Vegetation Recommendations

- Design & implement planting projects in US & Europe
- vegetation alone OR combined with solid barriers
- Higher the barrier = higher the pollution reduction
  - **> 13 ft (4 m) tall, ideally 9.8 ft (3m) thick**
- Pollutants CAN meander around edges – **go long**!
  - Sensitive areas should be **> 164 ft (50 m) from edge**
- Pollutants do not disappear!
  - "upwind" sources may need to be considered
  - Expect deposition at barrier
    - accumulate in soil
- The closer to the source the better!


EPA
United States Environmental Protection Agency
EPA 600/R-16/072 | July 2016 | www.epa.gov/research

Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality

Office of Research and Development
National Risk Management Research Laboratory, Air Pollution Prevention and Control Division

Slide adopted from Dr. Richard Baldauf, EPA

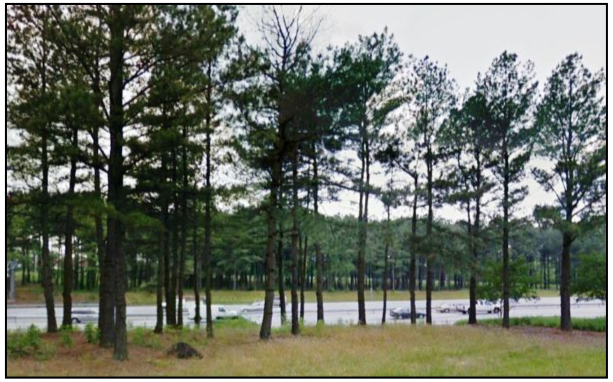
Adequate

- No gaps in vegetation
- Complete coverage from ground to top of canopy
- Thickness adequate to reduce porosity & avoid gaps
- Conifers and thick shrubs are ideal
  - Minimal seasonal effects/complex, rough, waxy surfaces

Inadequate

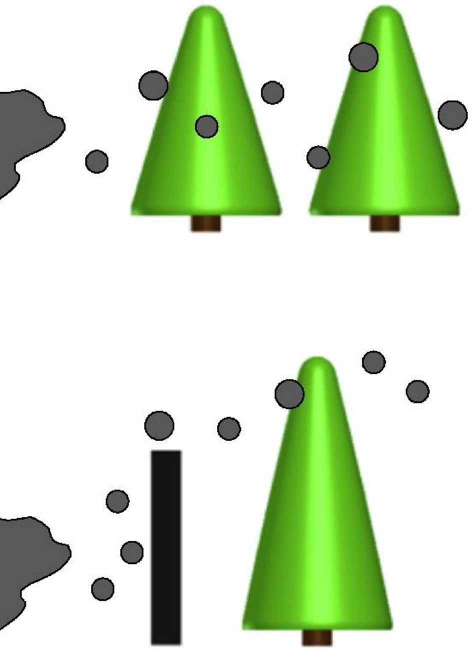
- Gaps in vegetation
- Incomplete coverage from ground to top of canopy
- Not thick enough
- Deciduous trees used where conifers would have thrived

Filtering Component

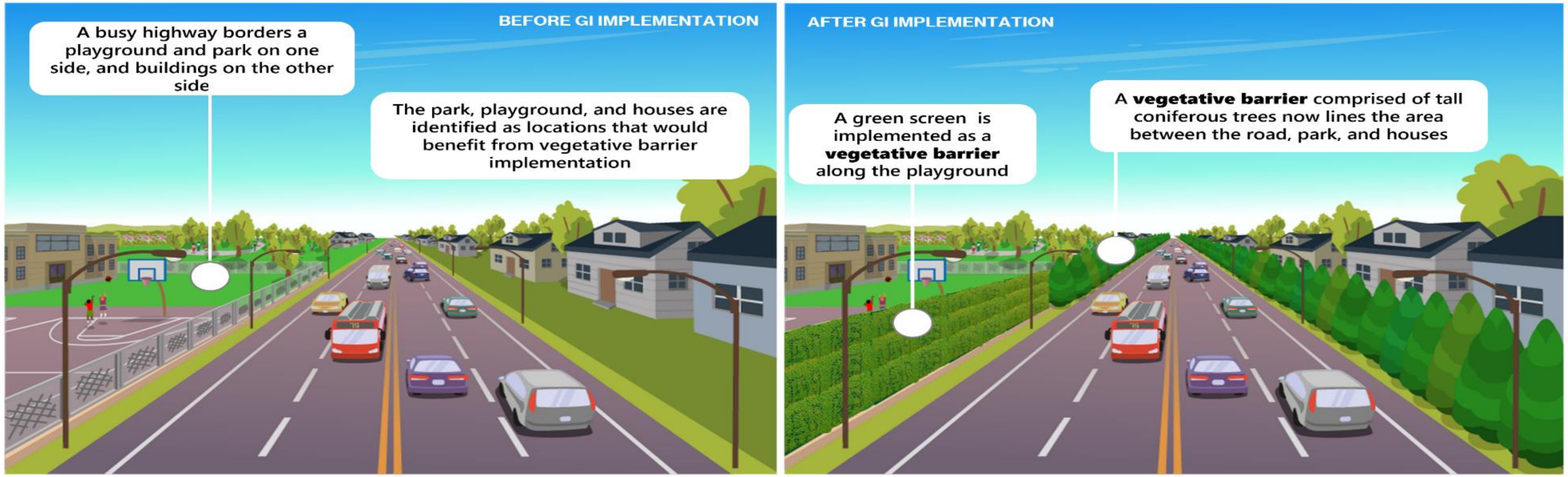


Slide modified: Baldauf, EPA

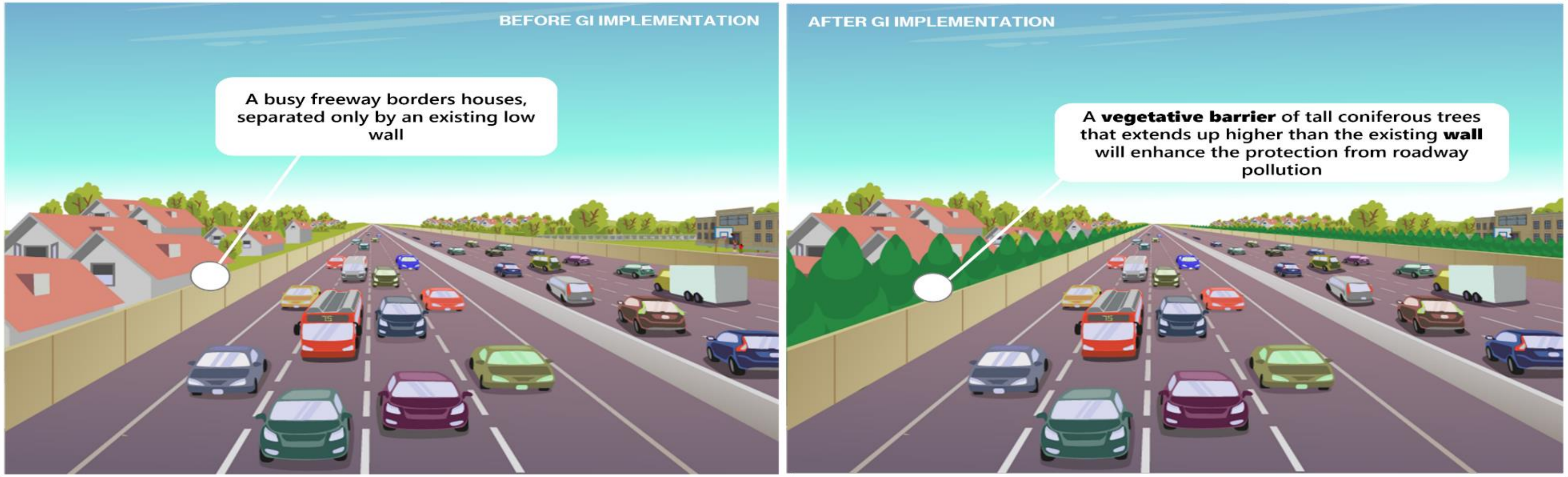
Examples of Trees & Trees+Wall



Open Road: Single or low multi-story buildings along a busy road

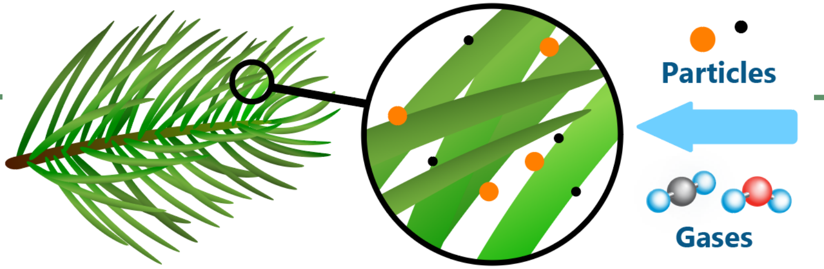


Open Road: A busy freeway alongside houses



Slide modified: Baldauf, EPA

Plants Trap & Filter PM



The result is lower roadway pollutant concentrations in the area protected by the vegetative barrier

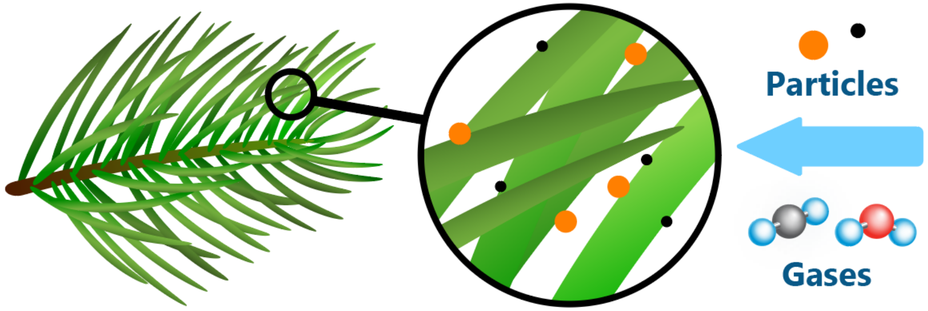
Pollutants are dispersed into the air by roadside trees

Some pollutants are filtered and others are absorbed directly by foliage

Air pollution produced by vehicles on heavily trafficked roadway

Slide: Baldauf, EPA and Region 5 Air Quality Team

What happens to the PM? Let's take a closer look!



SEM Images

- Produces detailed, magnified images by scanning its surface using focused beam of electrons
- Provide information on:
  - Topography – distribution of features
  - Composition – what the material is made of
  - Morphology – the form, shape, or structure

Costs:
$80,000-2,000,000 USD

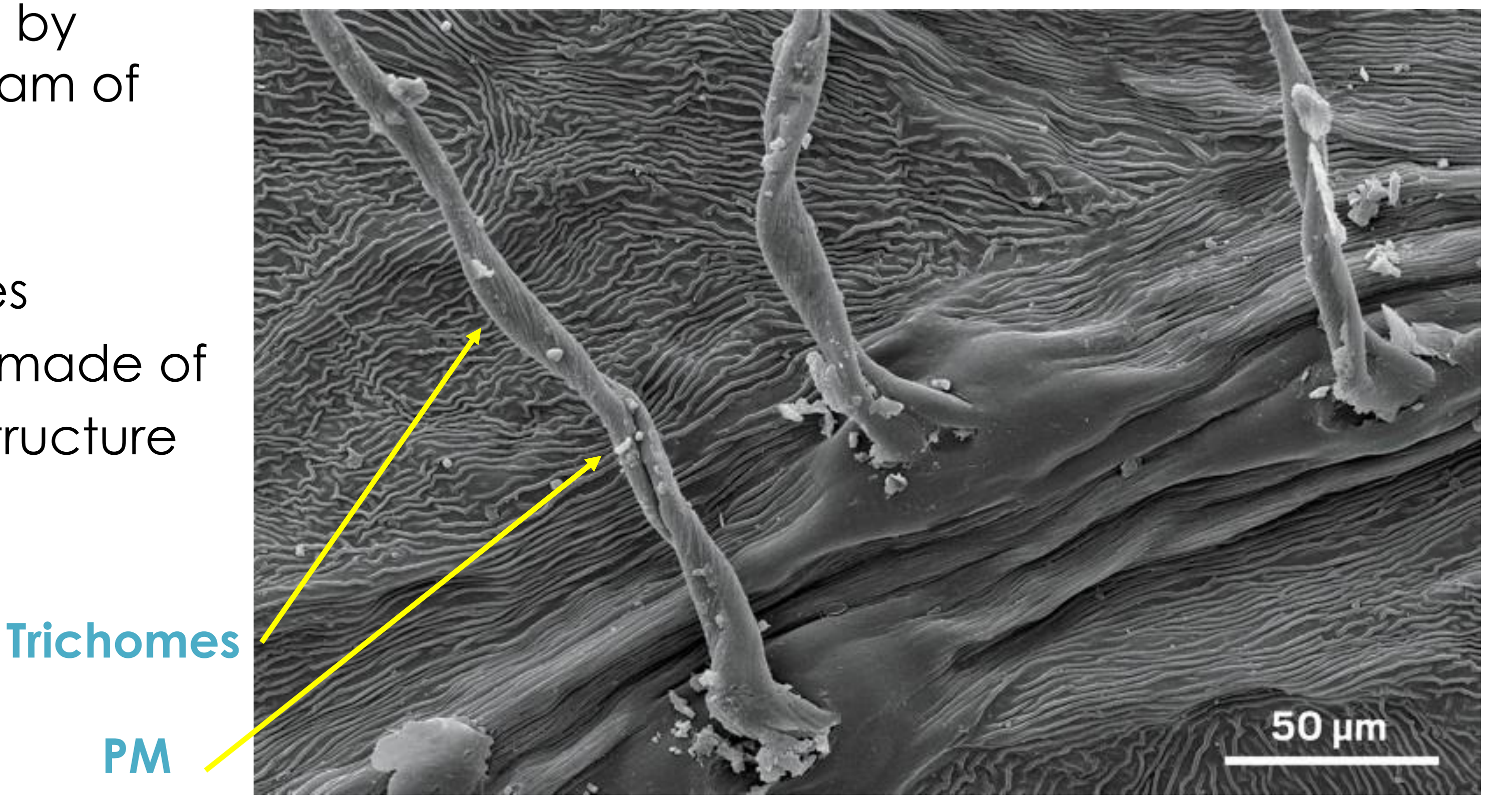
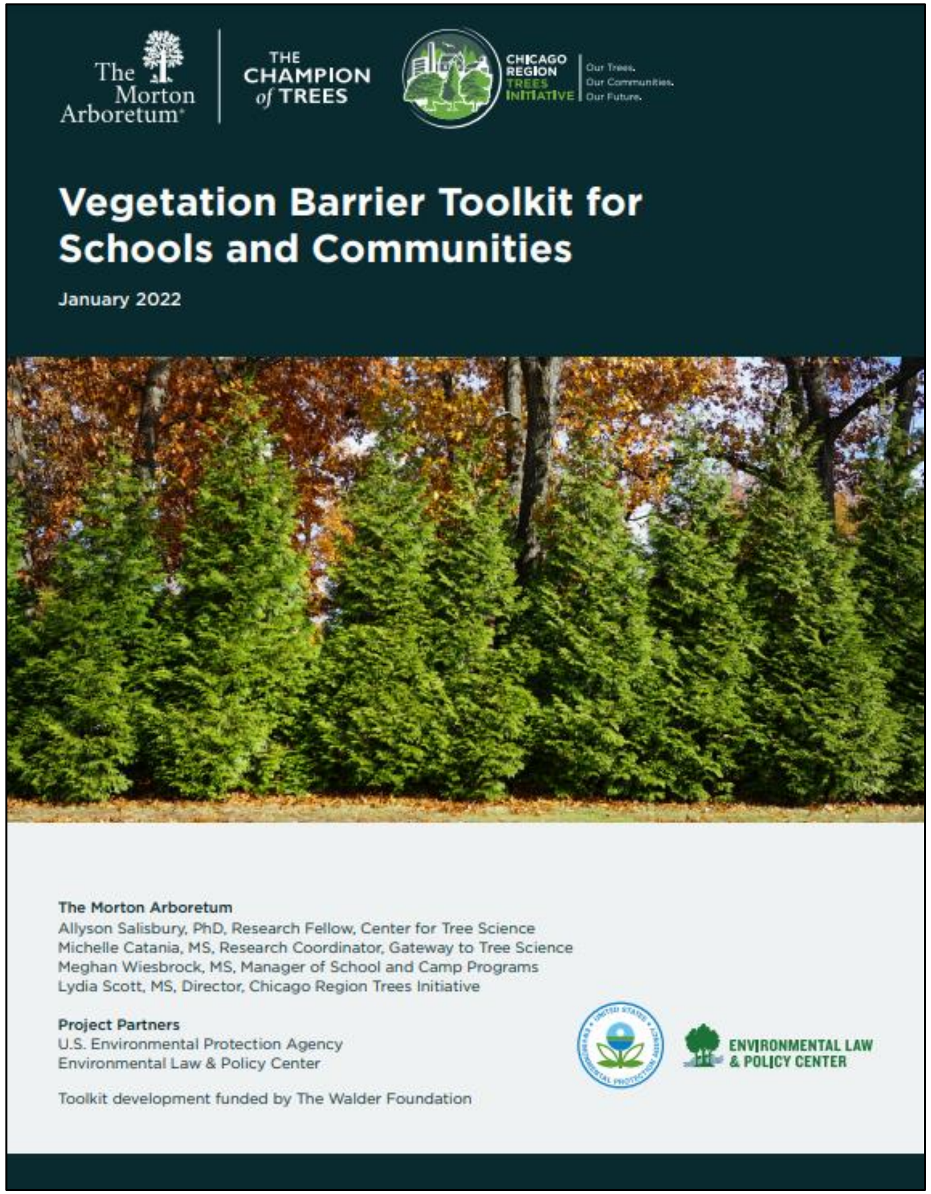


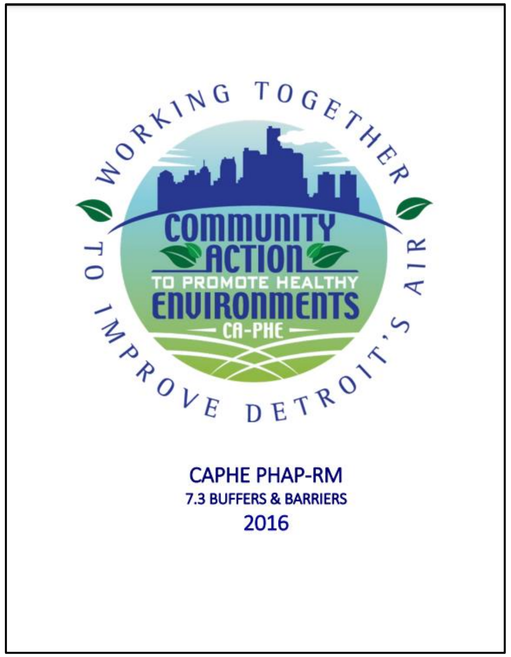
Image: SEM silver birch leaf (Wang et al, 2019)

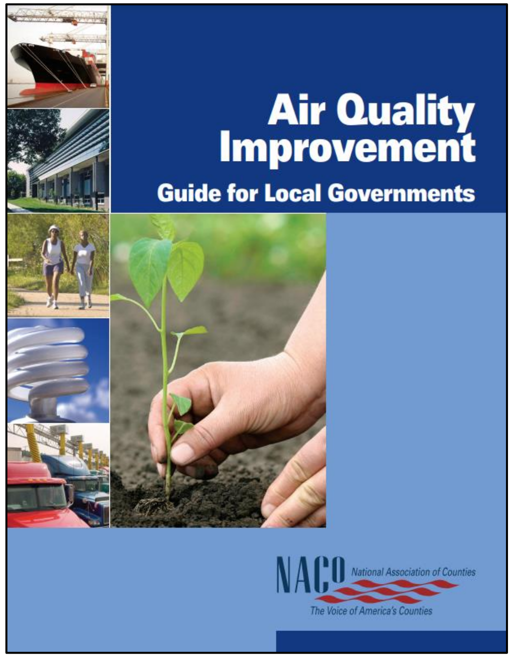
VEGETATIVE BARRIER TOOLKIT FOR SCHOOLS & COMMUNITIES

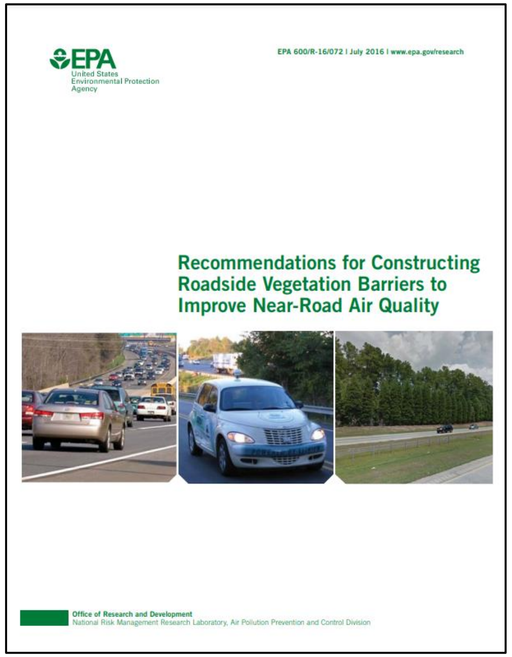


Many guides exist to --

Improve Air Quality

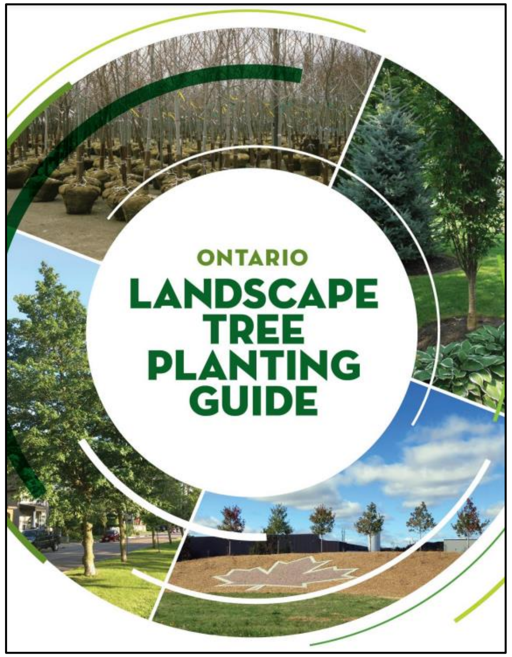




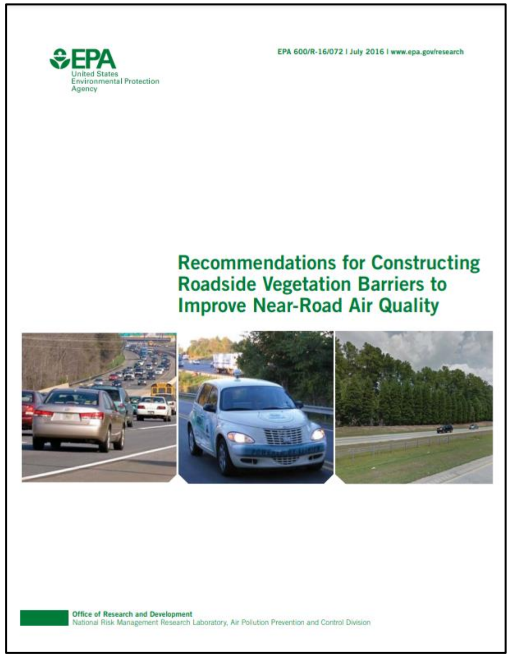


Lacks in-depth, tree-focused step-by-step detailed directions to help community members through the process

Install Trees



Directed at industry, too technical


EPA
United States
Environmental Protection
Agency
EPA 600/R-16/072 | July 2016 | www.epa.gov/research
Recommendations for Constructing
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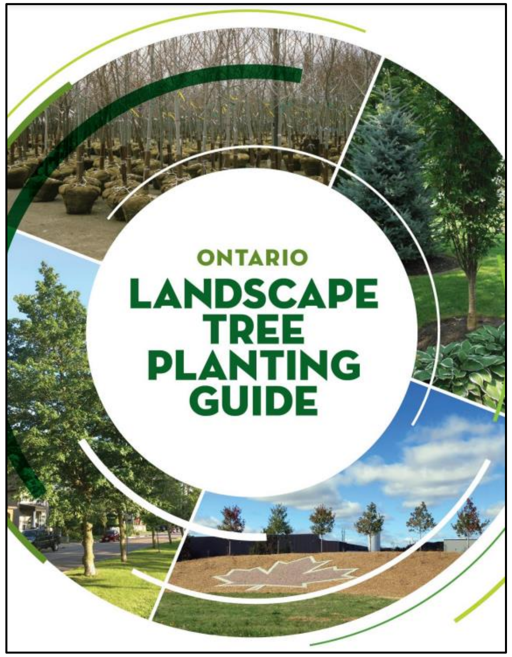
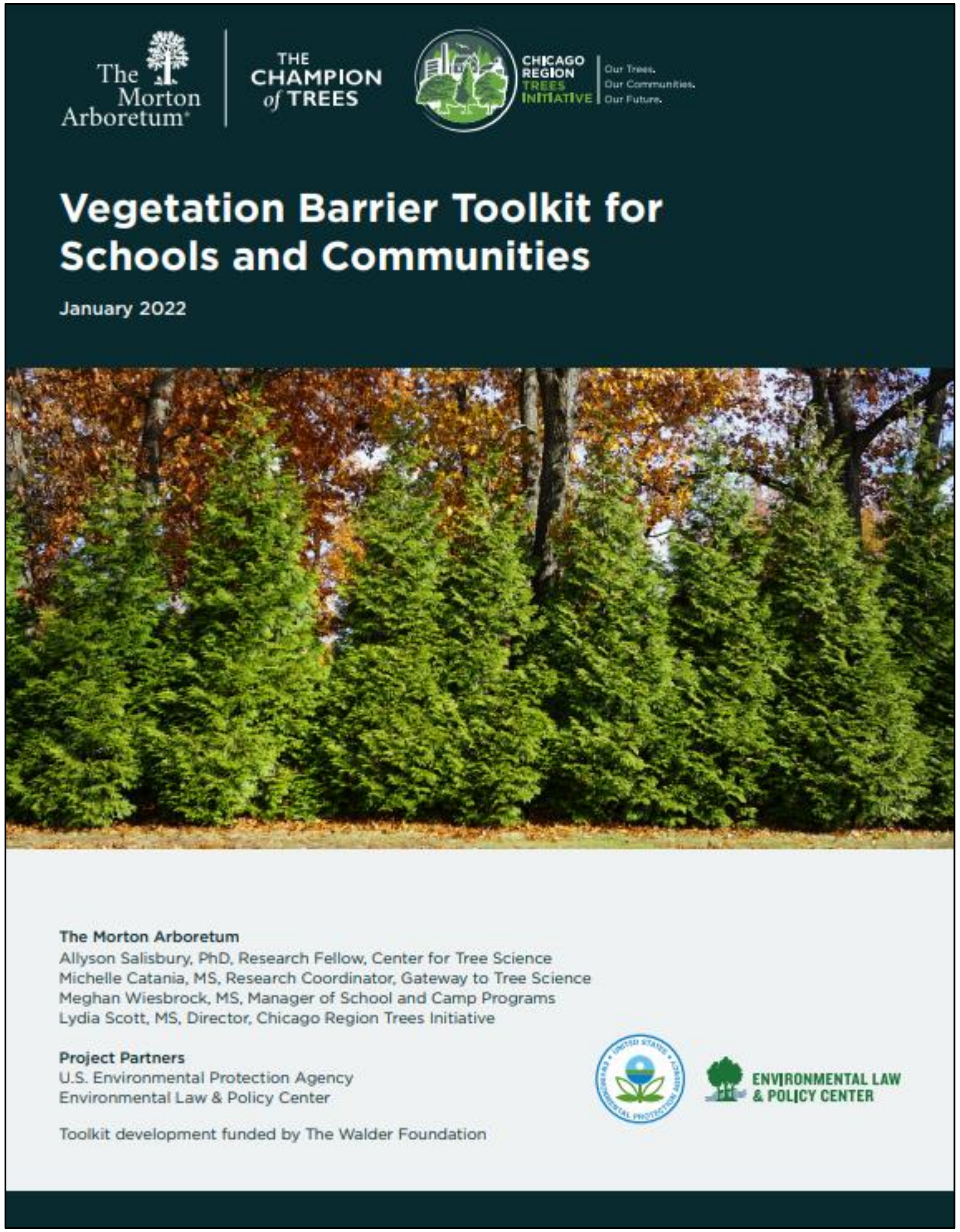

ONTARIO
LANDSCAPE
TREE
PLANTING
GUIDE

GOAL:

Take a community group step-by-step through the process of planning, creating, & caring for a vegetation barrier in addition to using vegetation barriers as part of science curricula.


The Morton Arboretum
THE CHAMPION of TREES
CHICAGO REGION TREES INITIATIVE
Our Trees. Our Communities. Our Future.

Vegetation Barrier Toolkit for Schools and Communities

January 2022

The Morton Arboretum
Allyson Salisbury, PhD, Research Fellow, Center for Tree Science
Michelle Catania, MS, Research Coordinator, Gateway to Tree Science
Meghan Wiesbrock, MS, Manager of School and Camp Programs
Lydia Scott, MS, Director, Chicago Region Trees Initiative

Project Partners
U.S. Environmental Protection Agency
Environmental Law & Policy Center

Toolkit development funded by The Walder Foundation

ENVIRONMENTAL LAW & POLICY CENTER

What's in the Toolkit?

The Morton Arboretum | THE CHAMPION of TREES | CHICAGO REGION TREES INITIATIVE — Our Trees. Our Communities. Our Future.

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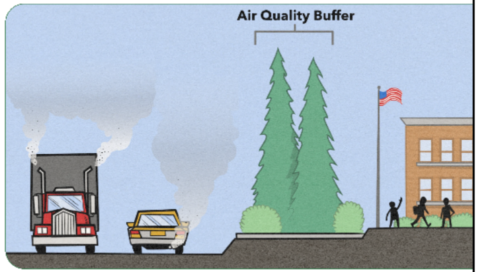
GUIDE #1

What's the Best Place for a Vegetation Barrier?

To reduce air pollution, a vegetation barrier will be most effective if it is downwind of and close and parallel to a ground-level source of pollution, such as a busy roadway. This way, the wall of trees or shrubs intercepts the wind that would bring polluted air onto a site. The methods described in these guides are typically used for open areas. While vegetation barriers can be designed for streets between crowded buildings in cities, those conditions are much more complex and consequently more challenging to ensure the vegetation barrier will work effectively.[1]

Vegetation barriers are generally made of a few rows of trees and/or shrubs. These plants grow to form a living wall or hedge that can trap air pollutants or direct polluted air away from the area you want to protect. Vegetation barriers planted near an actual wall or solid fence also provide effective air pollution improvements. As the plants grow, their branches should be close enough so the barrier does not have any gaps near the ground or between the trees. Gaps in the vegetation barrier can act like a funnel for air pollutants and let them through to the other side. The vegetation barrier can also be more than functional: You can add more decorative plants around and below the barrier. (See the Additional Plants to Complement Vegetation Barriers section.)

If there are already some trees or large plants between the road and the area you want to protect, it is preferable NOT to remove those plants to make a new barrier. Those plants are probably providing other benefits and are already mature. If you have existing trees where you think a vegetation barrier should go, it could be helpful to work with an arborist to determine if those trees are healthy and should be saved. If you do want to keep existing trees at your site, you can add vegetation barrier species around existing planted areas to enhance its ability to improve air quality.



Vegetation barriers should be planted between the source of ground-level air pollution, such as a road, and the area you want to protect, such as a playground.

Think about where you might want to put a vegetation barrier; this is your planting area. Take a walk around your site and look at it with an online map. Use your observations to answer the questions in Field Sheet #1.

If you answered "Yes" to all of the questions in Field Sheet #1, proceed to Guide #2 to start making measurements that will help you figure out if your planting area has enough space to grow vegetation barrier trees and shrubs. If your location doesn't have a good place for a vegetation barrier, the Additional Resources section can direct you to other practices that can help improve local air quality.

If you answer "No" to question #4, a vegetation barrier could still be planted in some circumstances. In this case, the vegetation barrier should be higher than the pollution source to be effective. For example, imagine a planting area that is 7 feet lower than a nearby highway. The vegetation barriers would need to grow at least 23 feet tall so that the trees extend 16 feet higher than the road.

Cited sources
1. Abhijith, K.V., Kumar, P., Gallagher, J., McNabola, A., Baldauf, R., Pilla, F., Broderick, B., Di Sabatino, S. and Pulvirenti, B., 2017. Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments–A review. Atmospheric Environment, 162, pp.71-86.

FIELD SHEET #1

What's the Best Place for a Vegetation Barrier?

Bring this field sheet with you to your potential vegetation barrier location.

Materials

- Field Sheet #1
- Pen or pencil
- Phone or separate camera (can be helpful to take pictures of areas you think could be a good space for a vegetation barrier)

Estimated time

1 hour

Observations

While walking around the area you want to shield from ground-level pollution, use your observations to answer the questions in the table below. Using online maps and aerial photos can also help you answer these questions.

Is your potential vegetation barrier planting area....	Yes	No
1. Parallel and downwind to a ground-level pollution source such as a busy road?		
2. Separating the source of ground-level air pollution from areas where people spend time outside?		
3. Longer than the area you want to protect?		
4. At the same elevation or above the pollution source?		
5. Not located in between two pollution sources such as a busy roadway and a side street where cars and buses idle? (This situation can trap air pollution on the side of the vegetation barrier where people are located.)		

Other notes:

Guides

GUIDE #5

Get to Know Your Soil

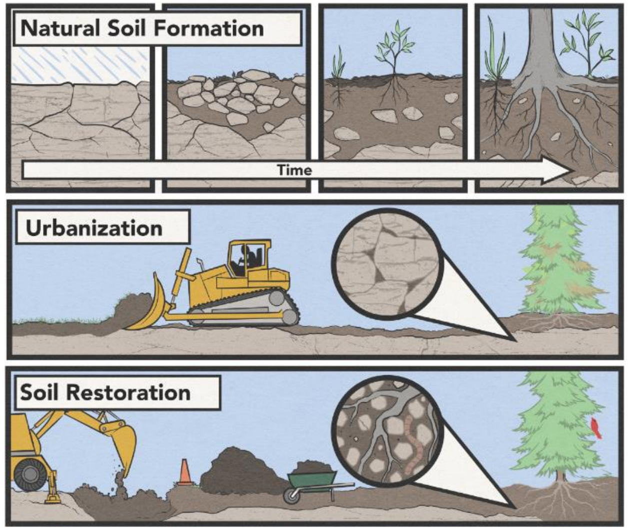
If you want to grow healthy trees and plants, you need healthy soil. Trees and other plants get water and essential nutrients from soil and rely on soil to hold them in place. This guide provides background about soil and helps you check for several common soil problems that can be found near roadways and other places affected by construction. Use Field Guide #5 to record your observations about the planting area soil.

Background: Healthy trees need healthy soil

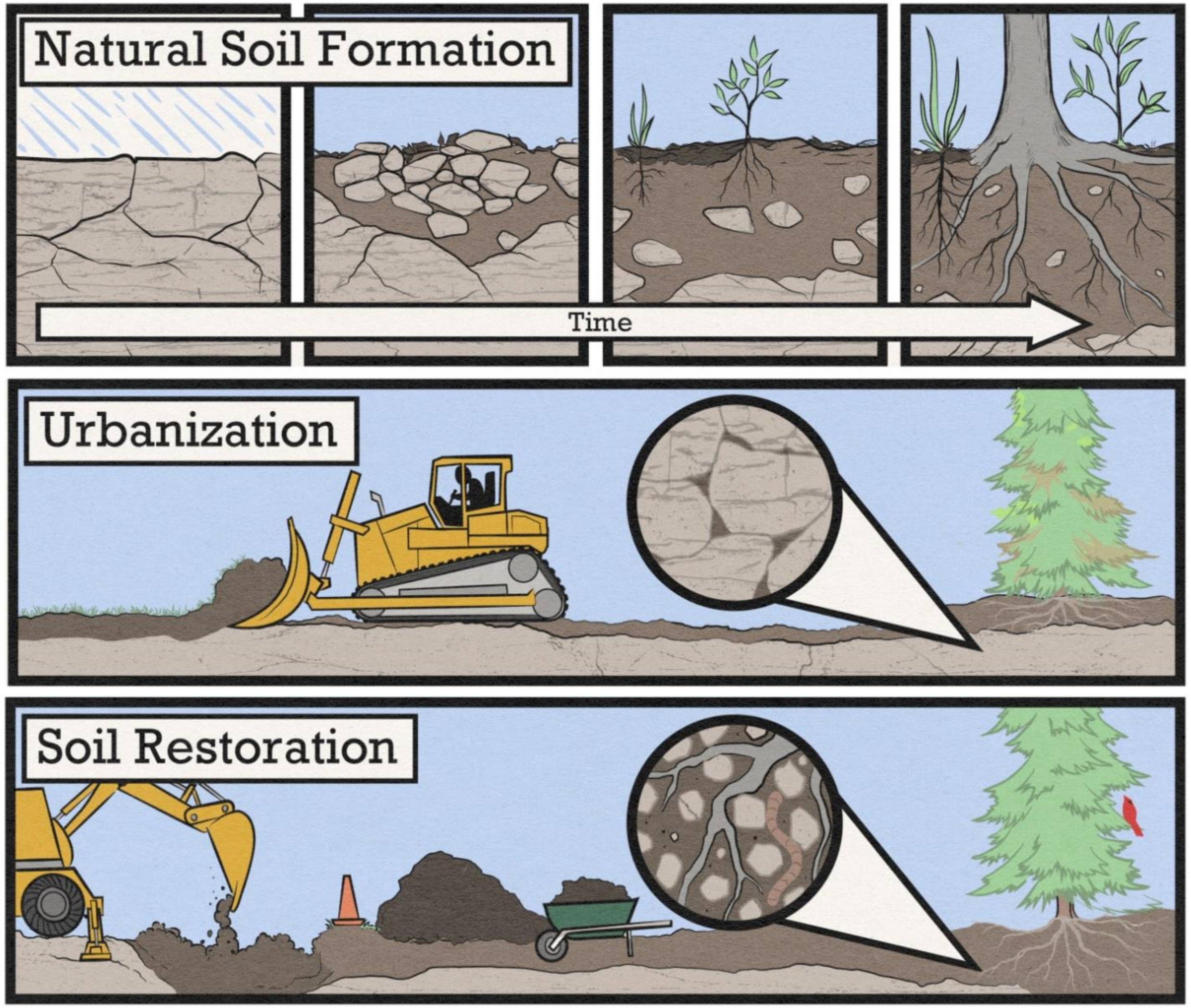
Healthy and happy trees start with healthy soil. Soil is a collection of tiny rock and mineral particles, organic matter, water, and air. Soils are unique: They vary from place to place, and they are constantly changing over time. Soil is fundamental for the growth of plants on land. It helps store and filter water, breaks down dead materials and wastes so their nutrients can be reused, and is a home for many creatures. Ideally soil is about 5% organic matter (the remains and wastes of plants and animals) and 45% tiny rock fragments. The rest is empty space between the solid pieces that can be filled with the air and water plants and soil critters need to live.

Have you ever wondered where soil comes from? The answer is not a bag from the hardware store. In nature, soil forms slowly over time as weather, plants, animals, and microbes break rocks into smaller and smaller particles and add organic matter. In some parts of the world, it can take 100 years to form an inch of rich, organic topsoil.

Unfortunately, removing or damaging good-quality soil can happen quickly. Construction activities usually remove topsoil — an upper layer of soil that can be rich in nutrients and good for plant growth.



Soil forms from bare rock over very long periods of time with the help of microbes, insects, fungi, plants, and animals. Construction severely changes soil by removing topsoil rich in organic matter and compacting the soil. Soil restoration can improve the condition of soil after construction so it is more suitable for growing trees and other plants.



Guides -- Field Sheets

FIELD SHEET #5

Get to Know Your Soil

Bring this field sheet with you to your potential vegetation barrier location.

Materials for all soil tests

- Field Sheet #5
- Pen or pencil
- Phone or separate camera
- Tape measure or yardstick that can get wet
- Shovel/soil auger
- Water source and bucket/hose
- Resealable plastic sandwich bags
- Permanent marker
- Wire probe (description below)
- Squirt or spray bottle (optional)

Soil Test #1 – Soil profile assessment and drainage

Record your observations about each soil profile you remove.

	Sample #1	Sample #2
Example	Soil is brown, deeper soil is darker. Grass roots grow about 10 cm deep. Soil forms larger clumps 10-20 cm deep.	Top 10 cm of soil is brown, forms large dens clumps. 10-20 cm is ligh tan color, mostly sand and gravel.
Observations (number of soil layers, colors, gravel, smell, other notes)		
Causes for concern: gray soils, buried human-made materials such as asphalt, rotten smell		

Record your measurements of the soil drainage test. Remember to save the soil f a bucket for the other soil tests.

Poor drainage – less than 4 inches per hour
Moderate drainage – 4 to 8 inches per hour
Excessive drainage – more than 8 inches per hour

Sample location	Depth of hole	Initial water height	15 min. water height	Change (initial minus 15 min.)	C 1 (x
Example	12 in.	10 in.	8 in.	10-8 = 2 in.	2 8
#1					
#2					
#3					

Soil Test #2 – Soil texture

Soil texture type determined by the texture-by-feel method (for example, "silty lo

Soil texture	Category	Notes
• Sand • Loamy sand • Sandy loam	Coarse	Water flows through ver Difficult to compact Not good at holding nut
• Sandy clay loam • Loam • Silt loam • Silt	Medium	Water flows through at r Somewhat easy to comp Good at holding nutrien
• Silty clay loam • Clay loam • Sandy clay • Silty clay • Clay	Fine	Water flows through ver Easy to compact Very good at holding nu

Soil Test #3 – Organic matter

Estimate the amount of organic matter by matching your soil sample color to the chart below.

Soil color	Organic matter	Soil sample
	>10%	•
	5%–10%	•
	3%–4%	•
	1%–2%	•
	<1%	•

Soil Test #4 – pH

Record the results of your soil pH test here: ____________

Soil Test #5 – Soil compaction

After each penetration test, check off if a sample location had severe, moderate, or acceptable soil compaction.

How deep did the wire go?	Soil compaction	Sample location #1	Sample location #2	Sample location #3
Less than 4 inches	Severe	•	•	•
4 to 12 inches	Moderate	•	•	•
More than 12 inches	Acceptable	•	•	•

Curriculum Toolkit for Educators – STEM based lessons

Lesson Plans

The following set of lesson plans using problem-based learning and citizen science approaches are available from The Morton Arboretum's Education Department in both PDF and Word document forms. Materials such as portable air quality sensors can also be available for classrooms to borrow. Connect with The Morton Arboretum's Education Department at registrar-ed@mortonarb.org.

Curriculum outline and lesson progression (Strategy-based: problem-Based learning & citizen science)

- **Setting the stage**
  - Introduction Activity – Anticipation Set- Find the Fiction – Air Quality Headlines Activity
  - Vocabulary Build: Vocabulary Story – Air Quality and Trees
- **Investigating the problem**
  - Observation: Measuring the Air Quality at Your Site, How to Use the Sensors, and Understanding Air Quality.
    - Additional resources: U.S. Environmental Protection Agency (Air Sensor Loaning Resource) (only available as an appendix in toolkit's printed resource)
  - Connect: Trees, Shrubs and Air Quality – Science Notebook Activity
- **Designing a solution**
  - Action Planning Worksheet
  - Planning Your Vegetation Buffer
  - Investigating Soil on Your Schoolyard
  - Choosing the Trees for Your Barrier – Final Planning Activity
  - Bringing It All Together – Planting Design Proposal

The Morton Arboretum | THE CHAMPION of TREES | CHICAGO REGION TREES INITIATIVE Our Trees. Our Communities. Our Future.

Vegetation Barrier Lesson Plans

January 2022

Separate document for Educators

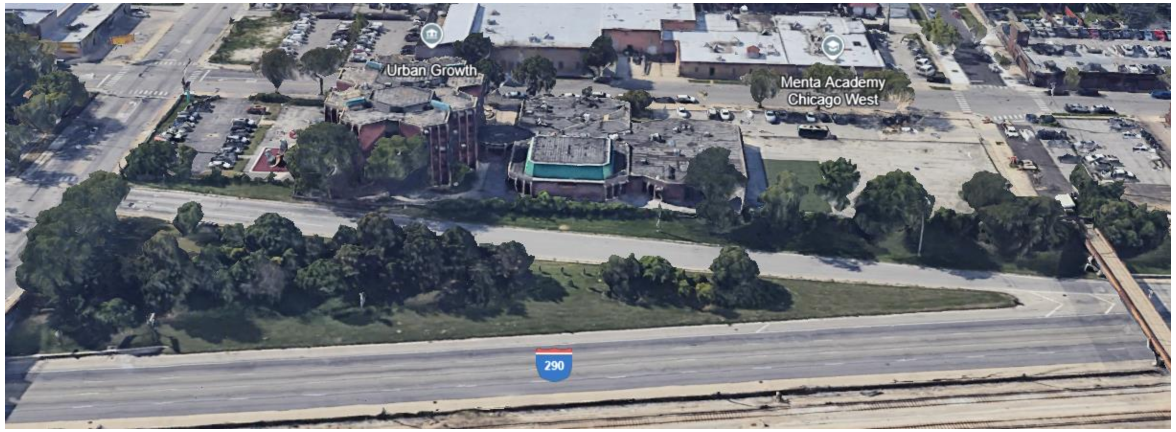
Toolkit education loaning resources

- Learning objectives
- Curriculum outline & lesson progression
- <u>**Toolkit education loaning resources**</u>

Bin contents

- Binder with printed toolkit and jump drive (digital content)
- Soil probes and/or shovels (qty: 3-5)
- Clipboard(s) (qty: 3-5)
- Large tape measure (qty: 3-5)
- AirBeam2 sensor (EPA Loaning Resource, quantity determined by educators during toolkit registration)
- Mobile device for sensor (EPA Loaning Resource, quantity determined by educators during toolkit registration)

PILOT SITES



Jens Jensen Elementary

Perspectives High School of Technology

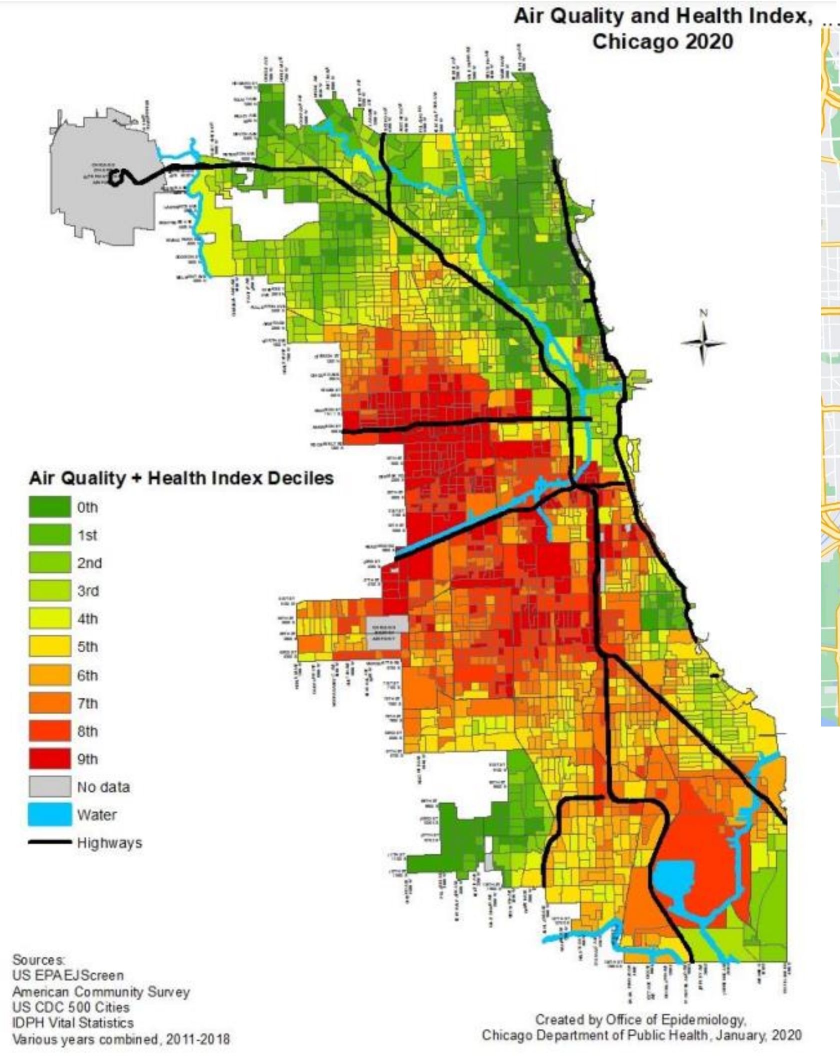
Huff Elementary School

Chicago & Suburbs, Illinois, USA

- 235 sq miles (606 km^2), 597 ft asl. (182 m asl)
- **2.7 million people** in city -- 3rd biggest US city
    - **9.6 million people in metro**
- Lake Michigan -- lake breeze & lake-effect snow
- Humid continental climate, 4 distinct seasons
- Average ppt **42”** (16 cm) -- rain and snow
- Plant hardiness **zone 5 -- zone 6** close to lake

Three Levels of Screening

Schools within 500 ft (152 m) of source



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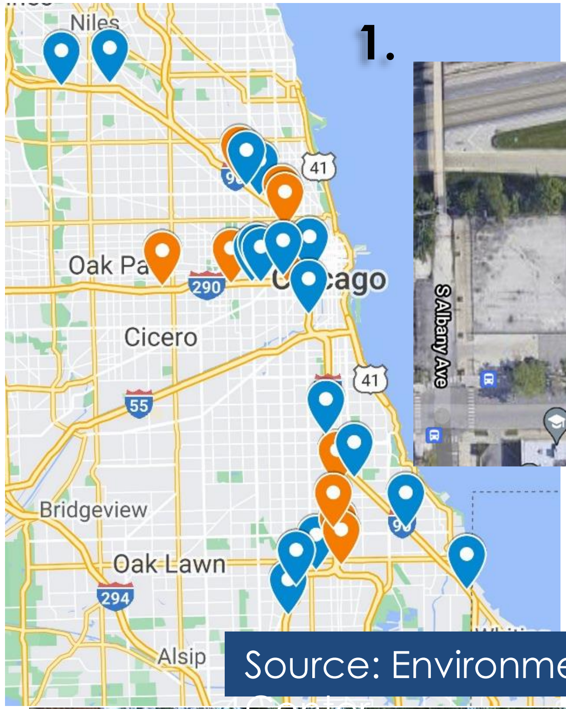
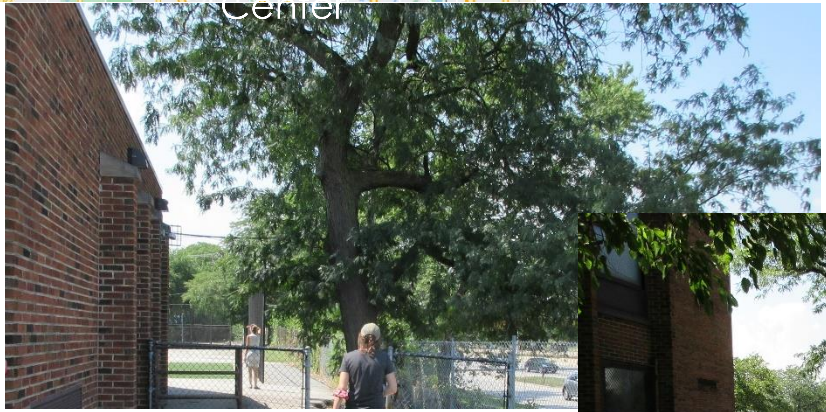


2.

Source: Environmental Law and Policy Center

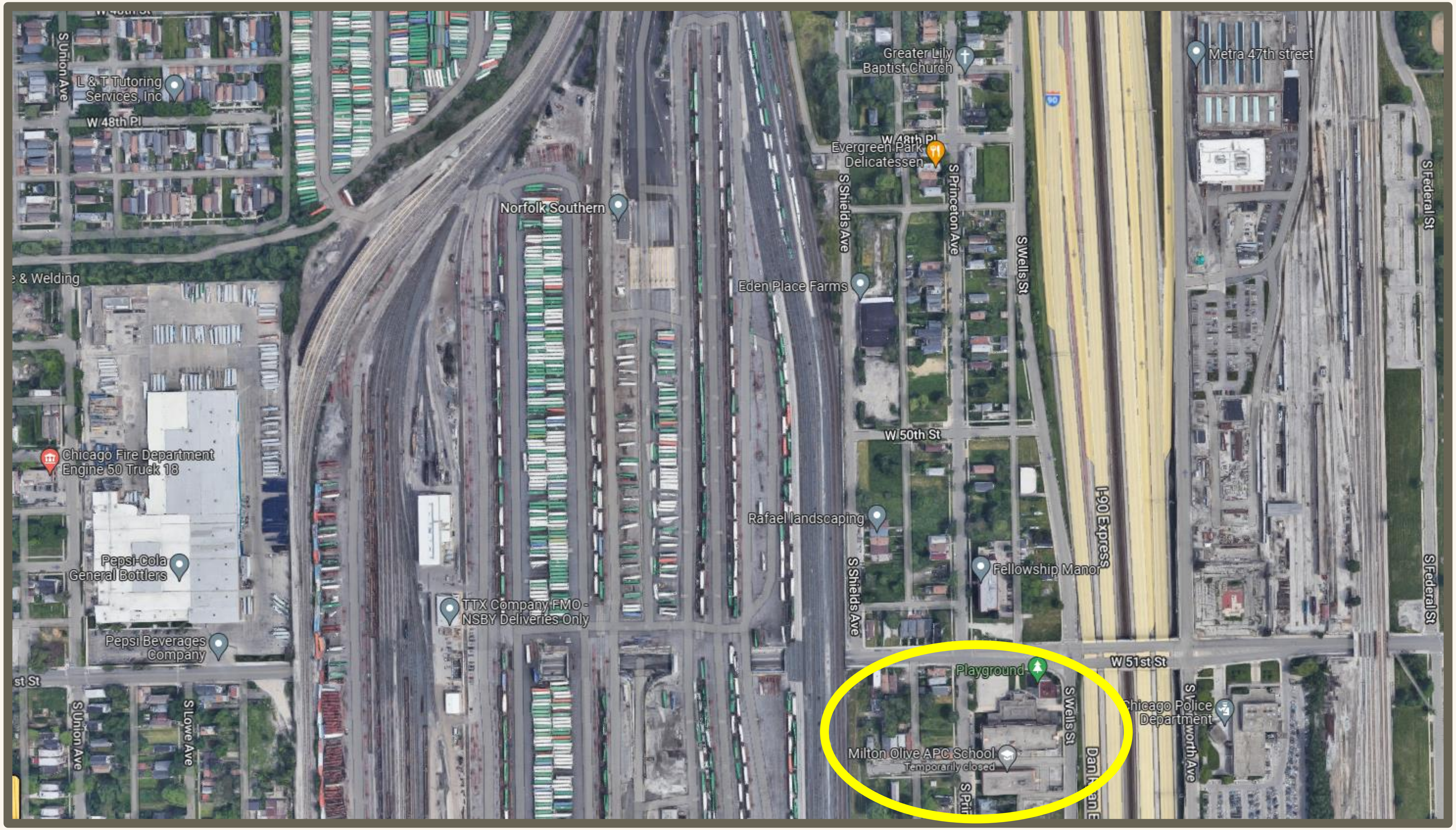


3

Source: U.S EPA

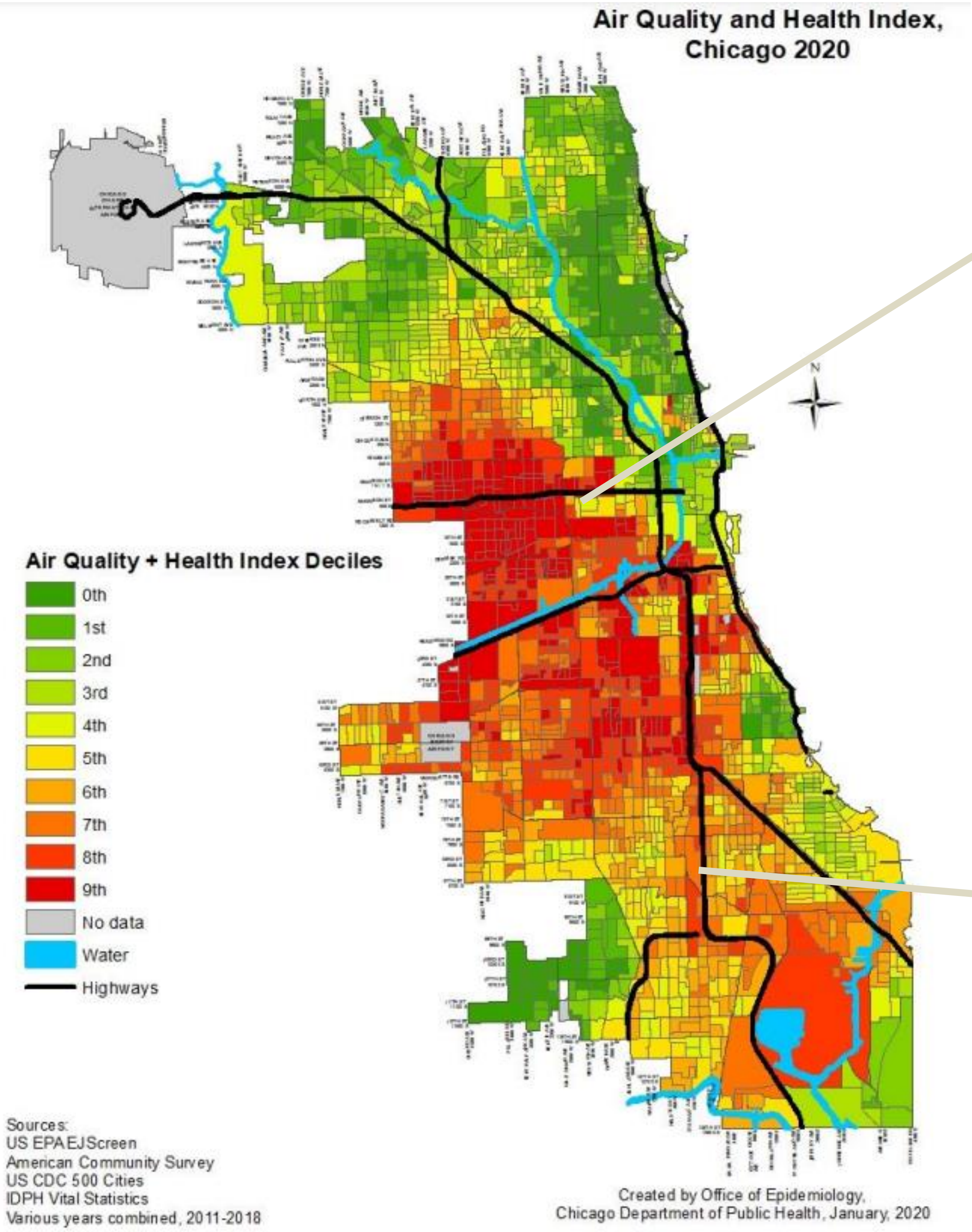
1. BROAD – Identified 28+ Schools (ELPC)
2. INTERMEDIATE – 15, down to 10
3. ON-THE-GROUND – Site visit to 10 schools

Slide credit: EPA

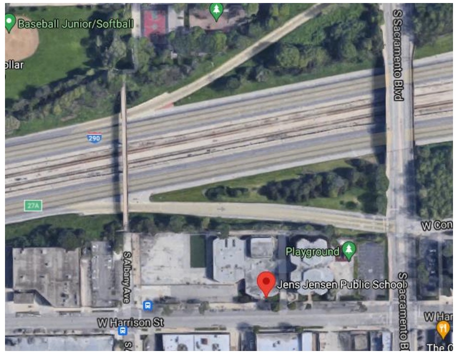


W 48th St
S Union Ave
L & T Tutoring Services, Inc
W 48th Pl
Norfolk Southern
Greater Lily Baptist Church
Metra 47th street
Evergreen Park Delicatessen
W 48th Pl
S Shields Ave
S Princeton Ave
S Wells St
S Federal St
& Welding
Eden Place Farms
W 50th St
Chicago Fire Department Engine 50 Truck 18
Rafael landscaping
I-90 Express
Pepsi-Cola General Bottlers
Fellowship Manor
TTX Company FMO - NSBY Deliveries Only
Pepsi Beverages Company
W 51st St
Playground
st St
Chicago Police Department
S Union Ave
S Lowe Ave
Milton Olive APC School
Temporarily closed

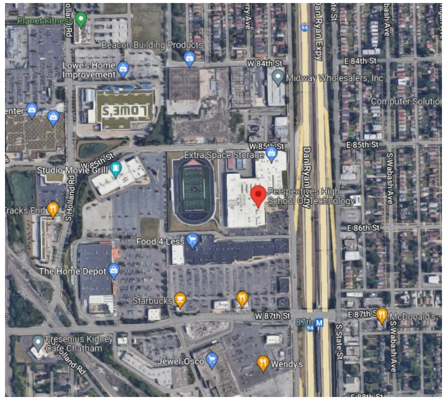
2 SITES CITY OF CHICAGO



Jens Jensen Elementary



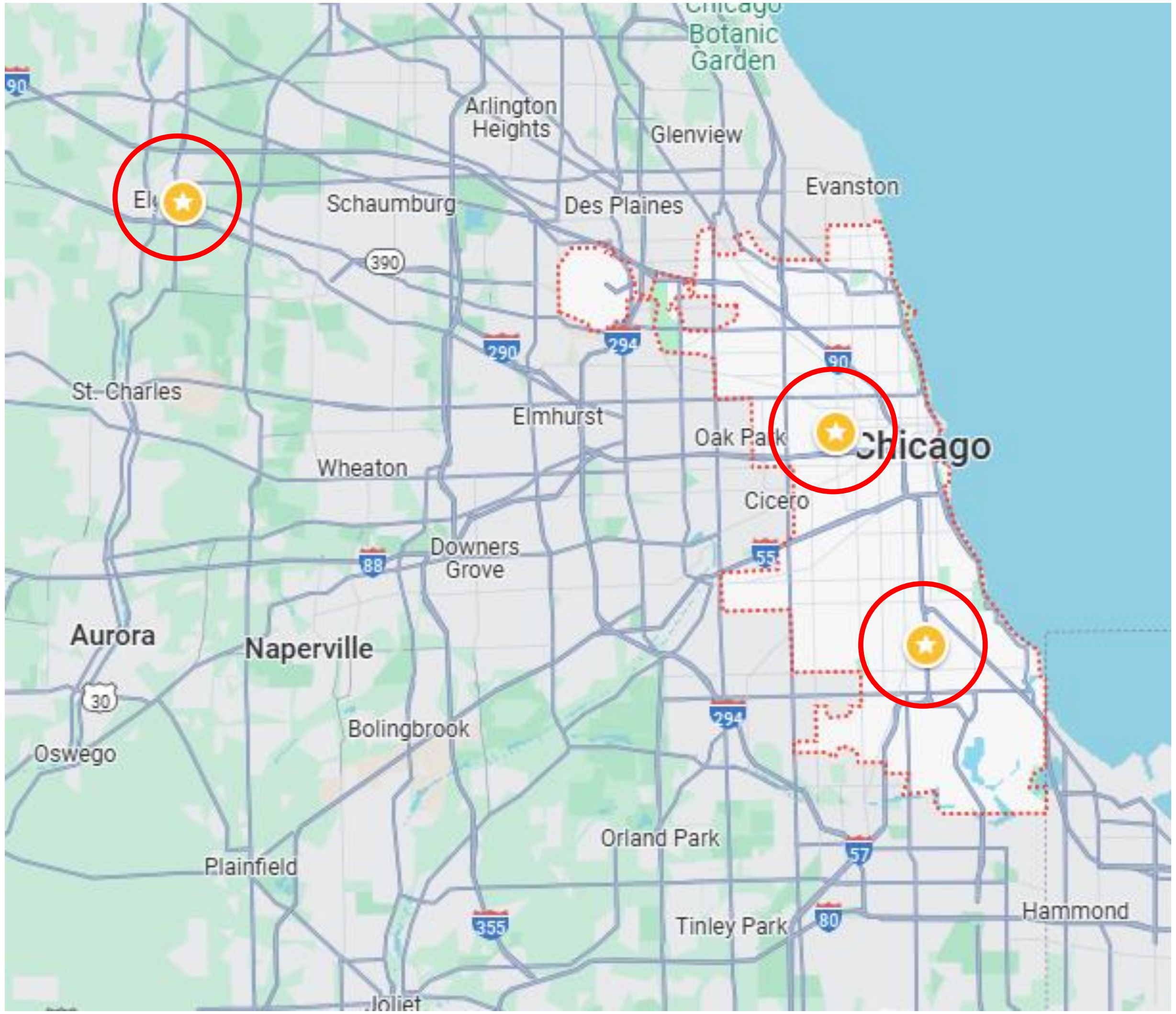
Perspectives H.S. of Technology



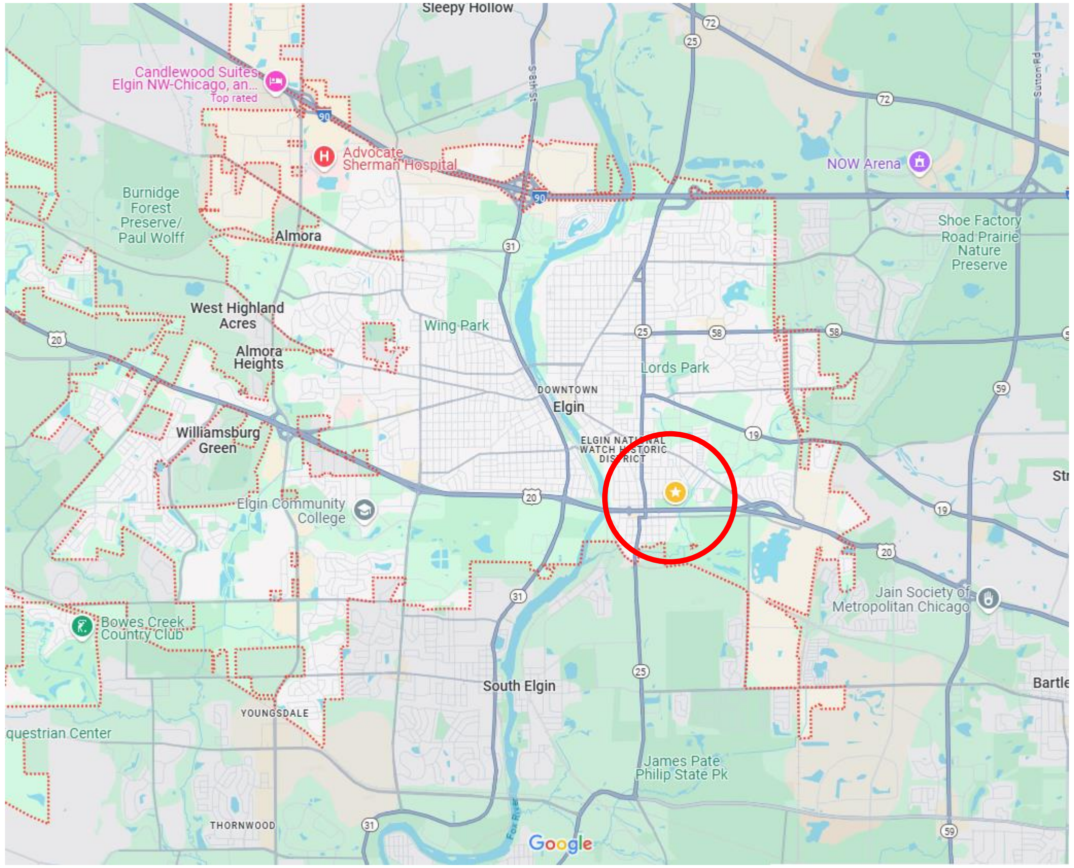
CDPH
Chicago Department of Public Health

Slide modified from EPA

2 SITES CITY OF CHICAGO



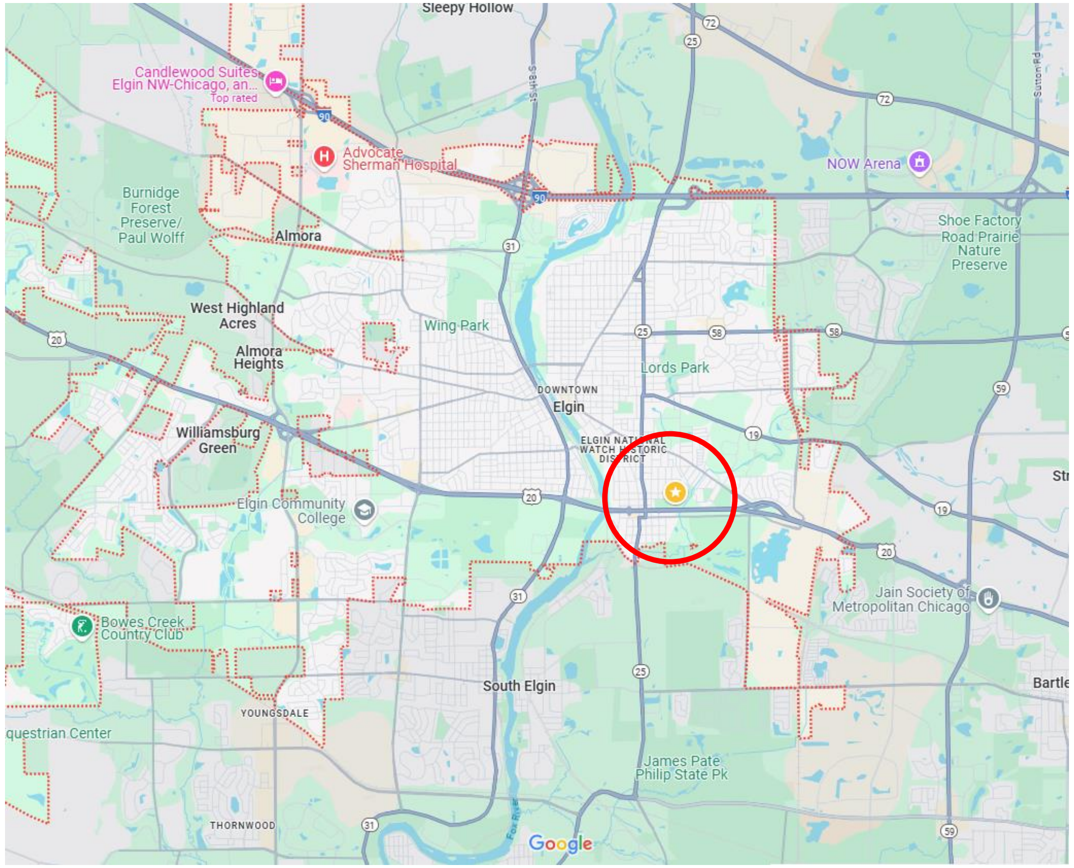
1 SITE ELGIN

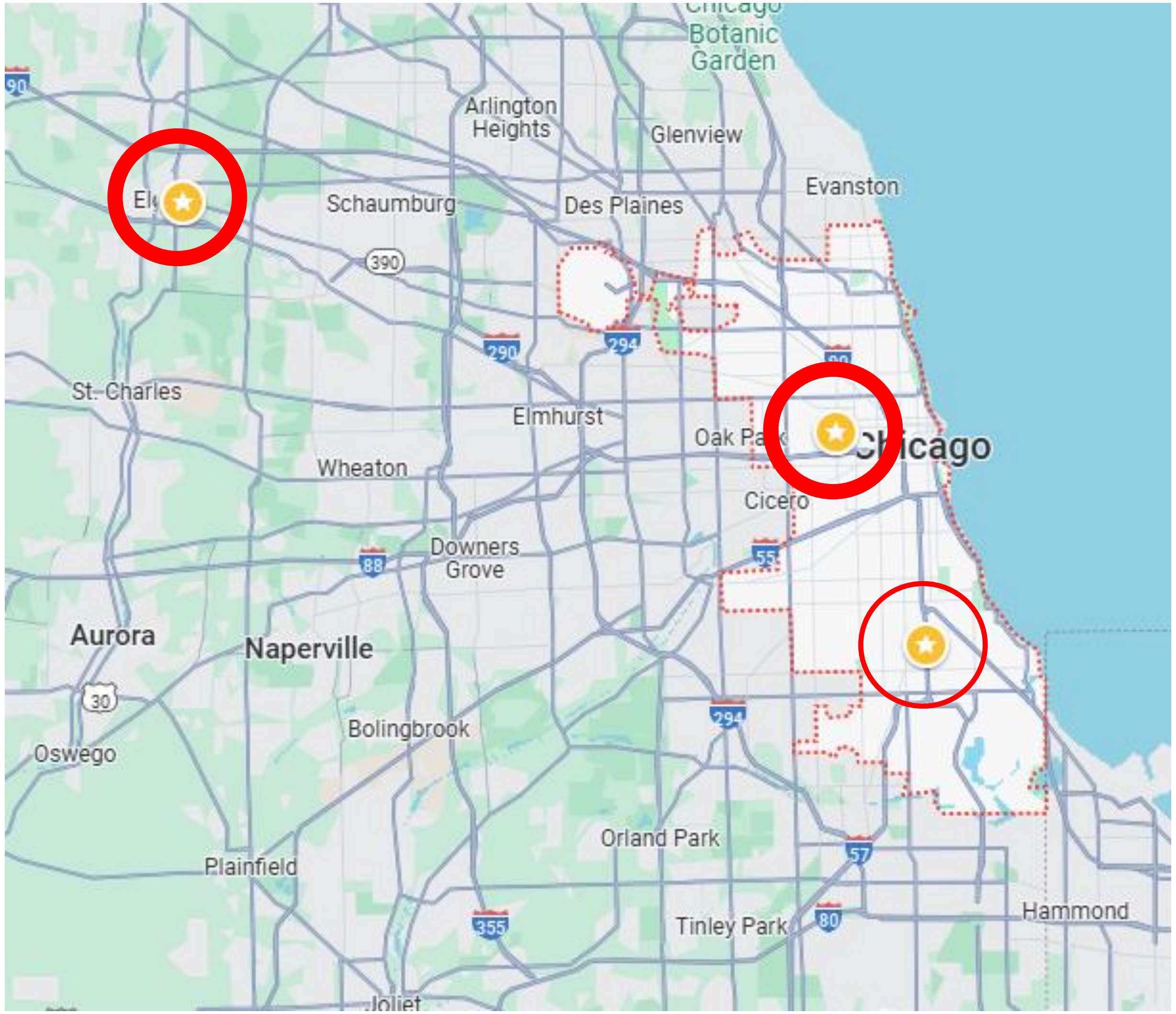


HUFF ELEMENTARY SCHOOL

2 SITES CITY OF CHICAGO

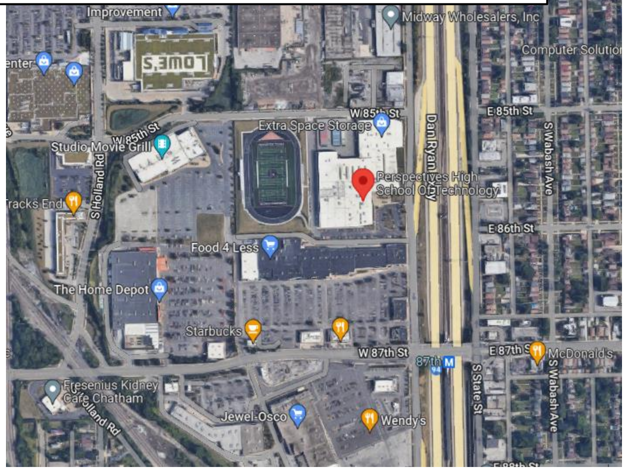
1 SITE ELGIN

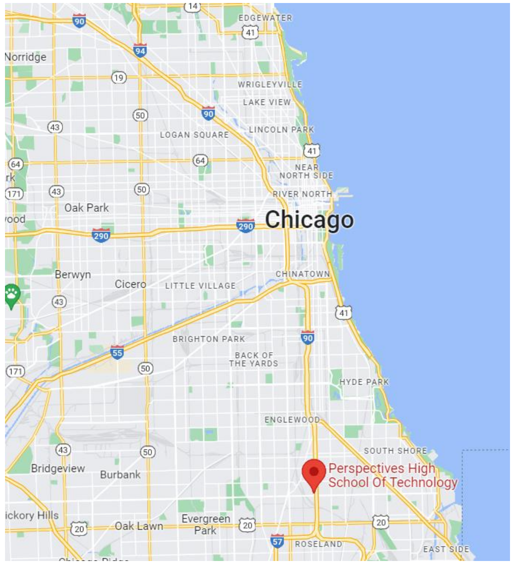


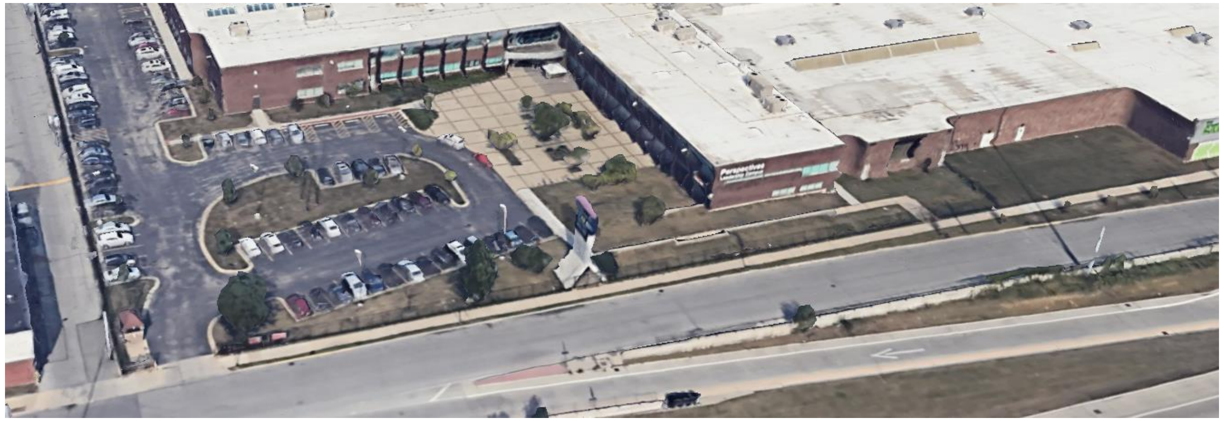


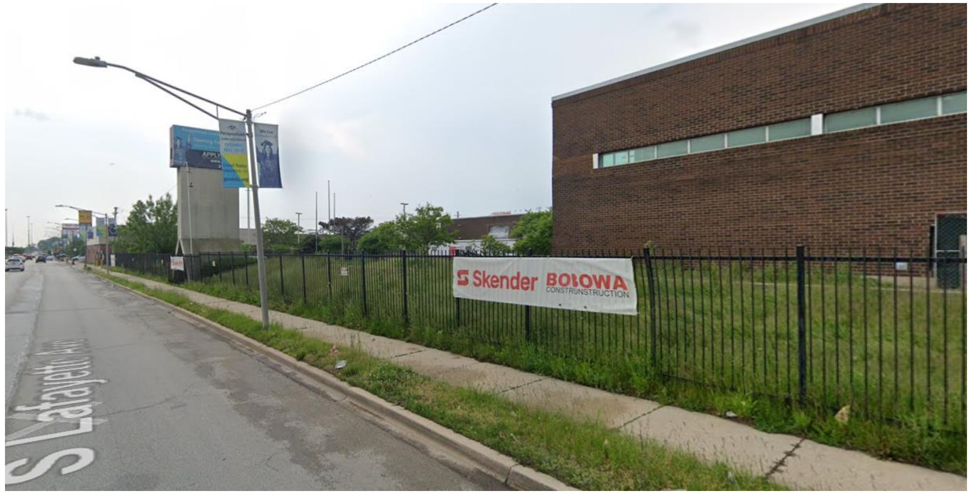
FOCUS ON ELEMENTARY SCHOOLS

PERSPECTIVES H.S. OF TECHNOLOGY







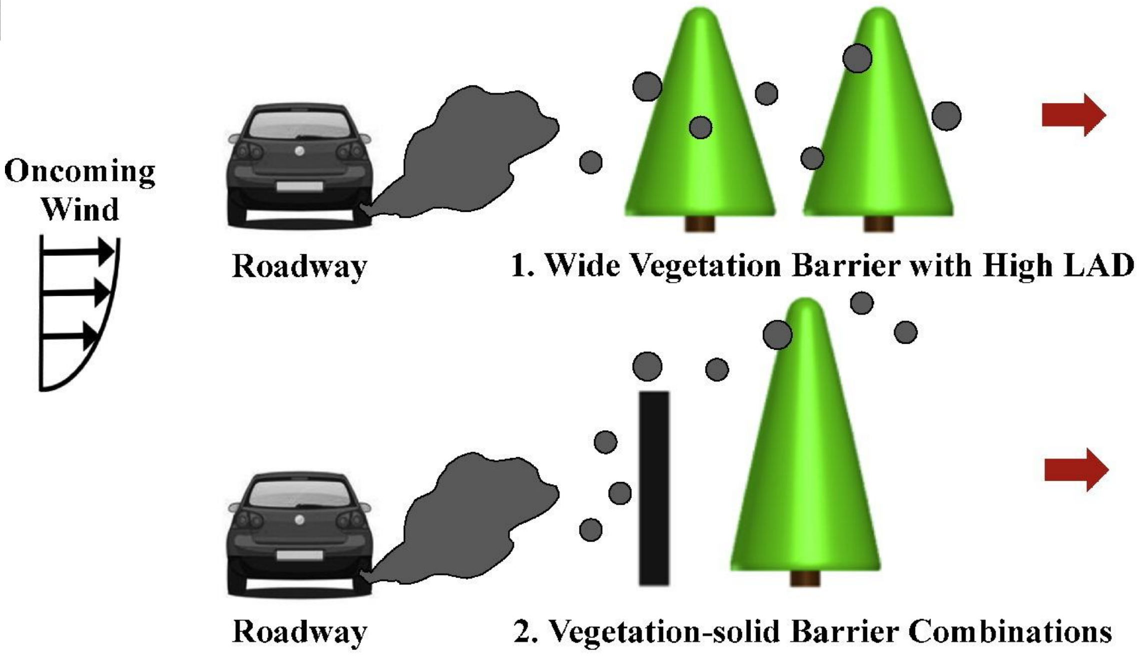


Distance from highway to planting site	137 – 165 ft (42-50 m)
Distance from highway to school	180 ft (55 m)
Annual avg daily traffic count (2019)	247,600
Annual avg daily heavy commercial -- 6+ tires (2020)	16,000
School elevation compared to source	Higher at 9.8 ft (3 m)

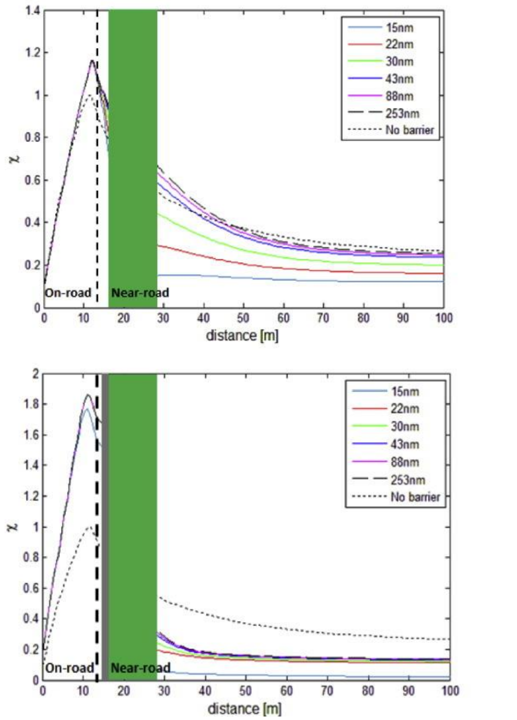
Students served (2021)	336
% low income	93
% homeless	na
% black	99.1

PHASE 1 TREE PLANTING SCHDULED FOR NEXT WEEK!

Two Viable Roadside Barrier Designs



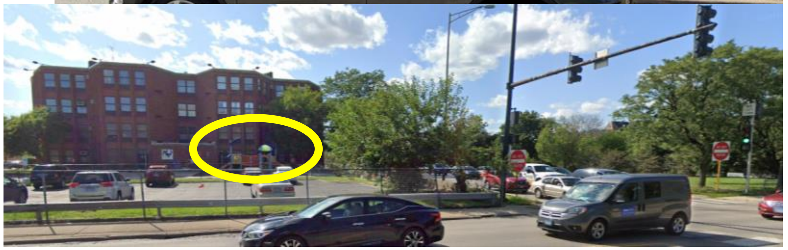
Horizontal Gradients of Particle Concentration

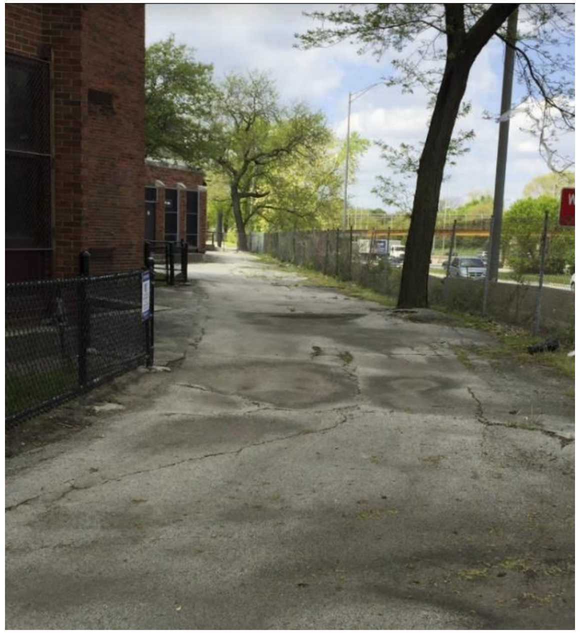


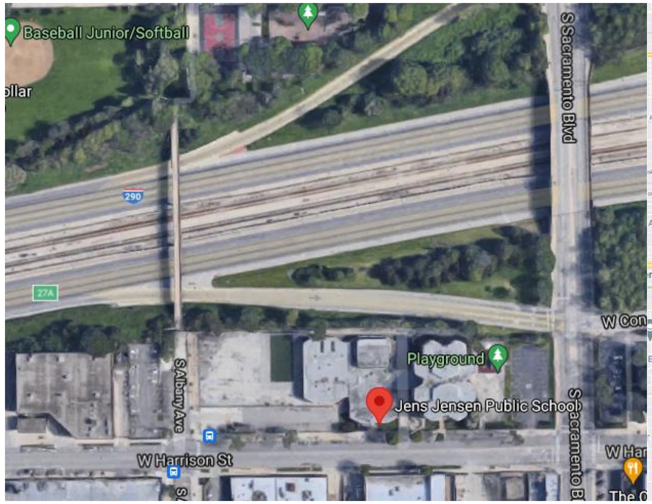
Fantastic potential for hybrid!

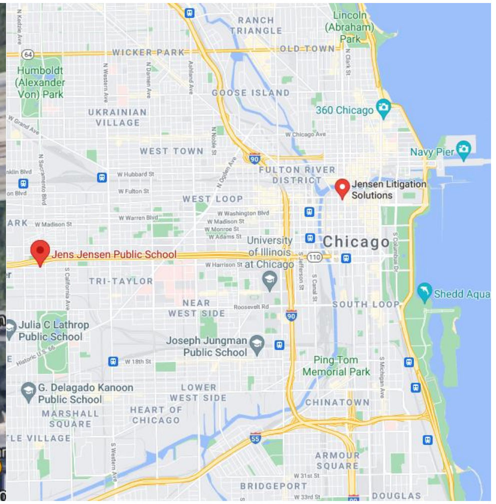
(Graphic) Tong, Baldauf…et al., 2016, Science of The Total Environment (EF

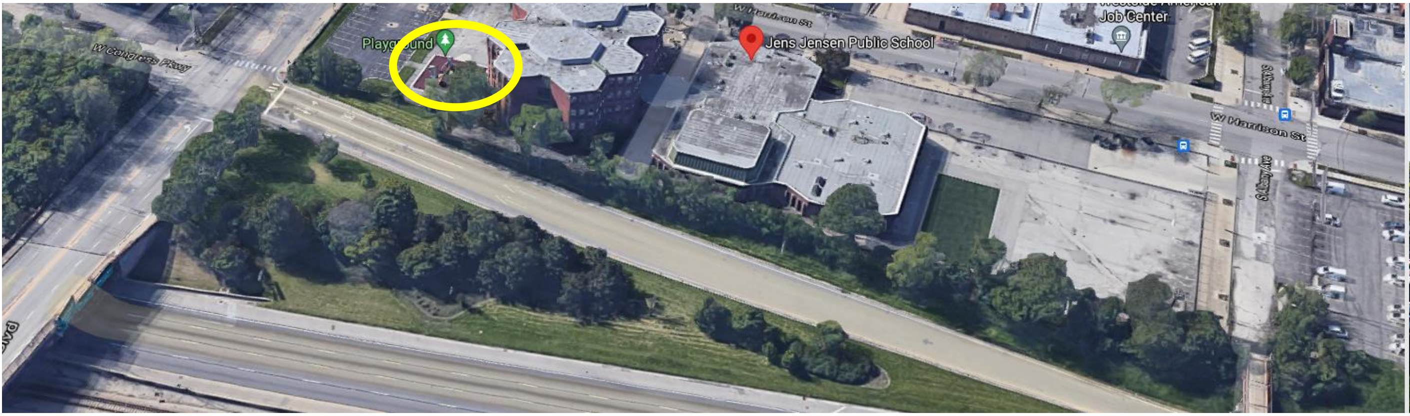
JENS JENSEN ELEMENTARY

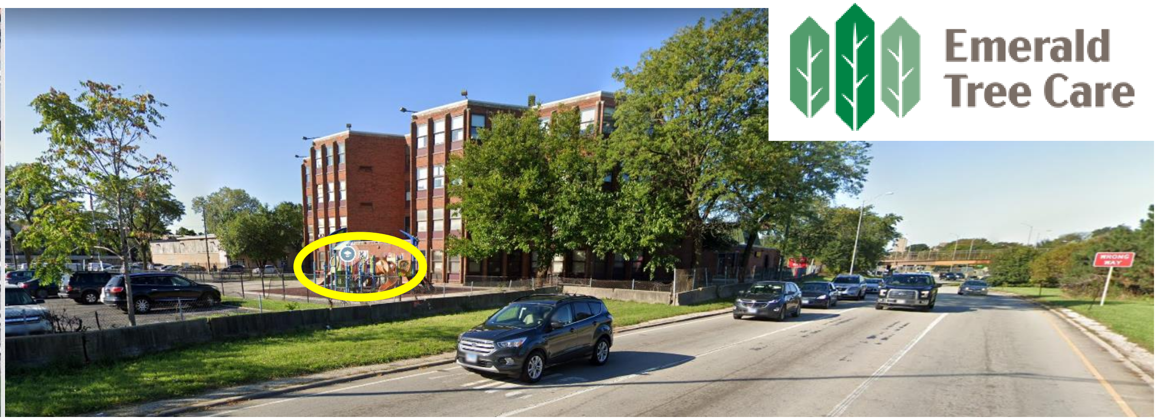












Emerald Tree Care

Distance from highway to planting site	40-200 ft (12.2-61 m)
Distance from highway to school	160 ft (48.8 m)
Annual avg daily traffic count (2019)	193,700
Annual avg daily heavy commercial -- 6+ tires (2017)	8,000
School elevation compared to source	Higher at 11.3 ft (3.4 m)

Students served (2019)	371
% low income	99.2
% homeless	3.8
% black	98

Emerald Tree Care

HUFF ELEMENTARY ELGIN, IL

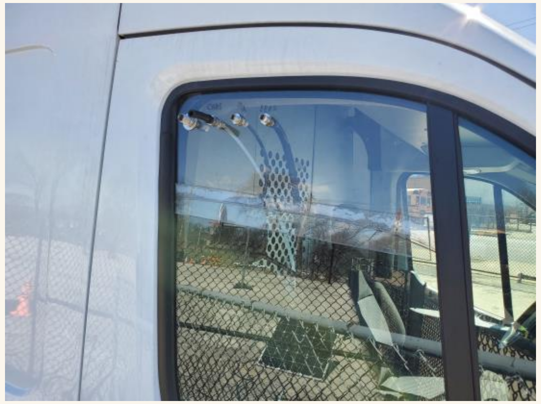
Distance from highway to planting site	60-80 ft (18.2-25 m)
Distance from highway to school	170 ft (51.8 m)
Annual avg daily traffic count (2019)	na at time of publishing
Annual avg daily heavy commercial -- 6+ tires (2017)	na at time of publishing
School elevation compared to source	Higher at 9.8 ft (3 m)

Students served (2023)	517
% low income	64
% homeless	na
% Hispanic /Latino	85.7

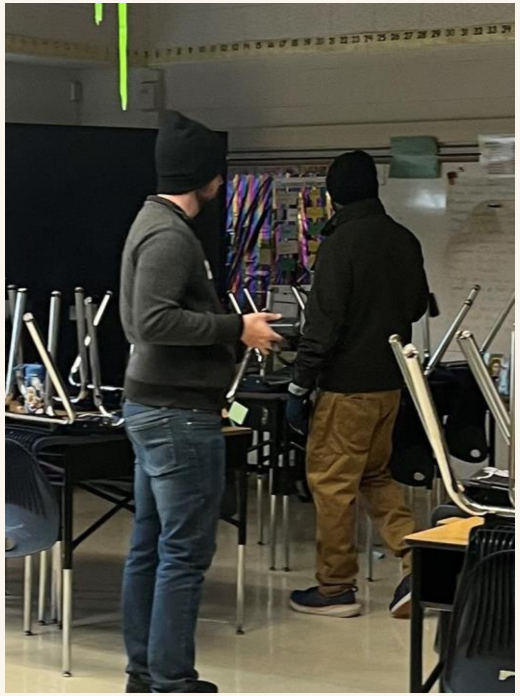
AIR QUALITY MONITORING

MARCH – APRIL 2024

Stationary
Mobile
Indoor



Mobile monitoring cart for indoor Educational Availability sessions.



Stationary meteorological equipment, black carbon, NO_2 air sensors, & noise

Indoor black carbon & NO_2 air sensors being placed in classroom.

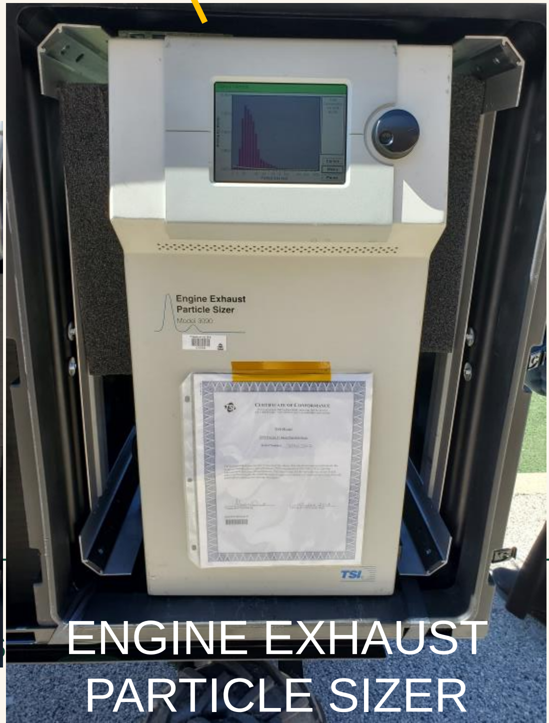
Parik Deshmukh,
VP & Senior Engineer, lead

MOBILE AIR MONITORING

YETI 1400 LITHIUM BATTERY

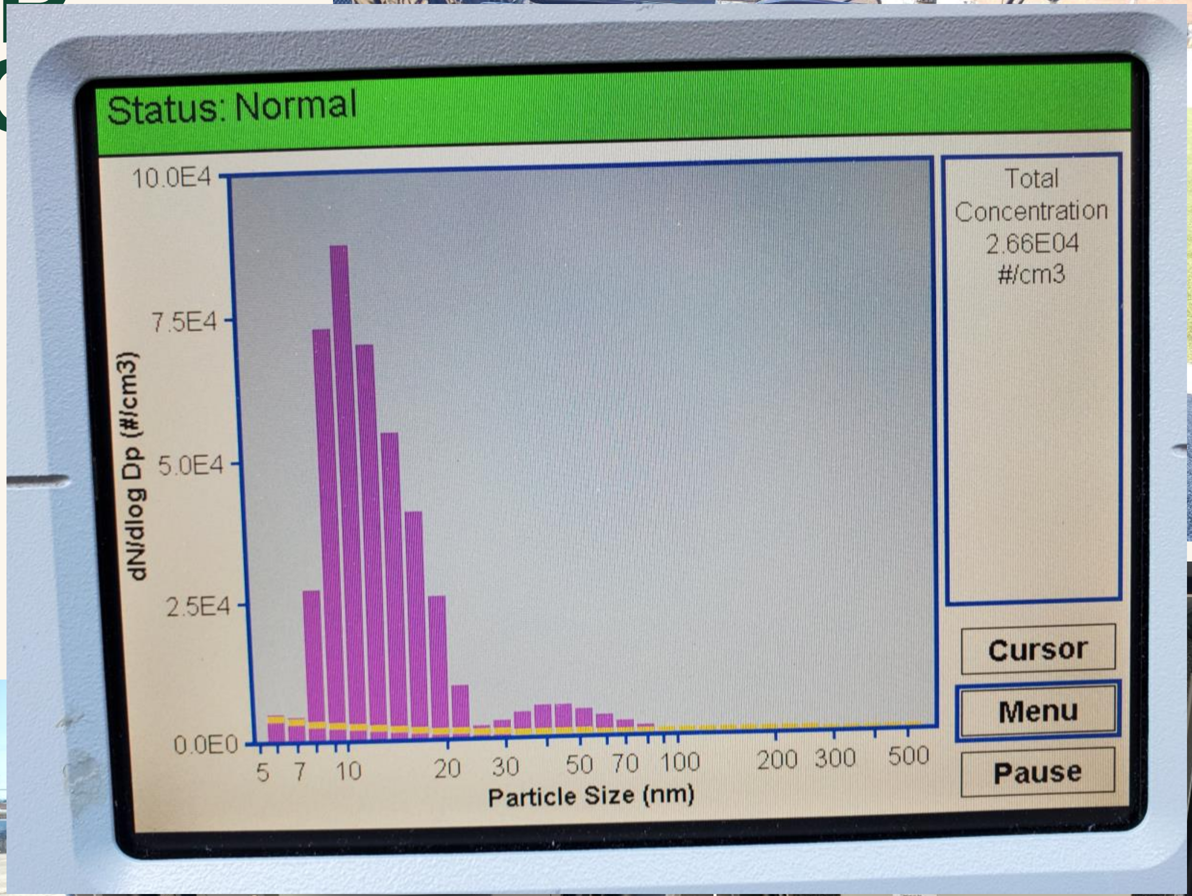
UF PARTICLE SIZE ANALYZER

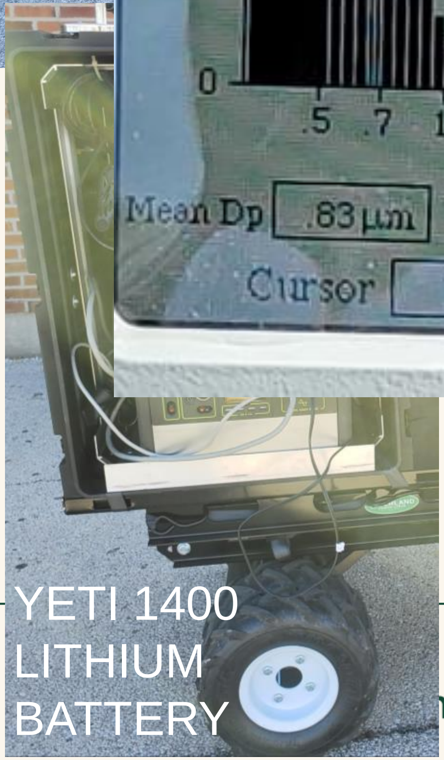
NO_2 MONITOR



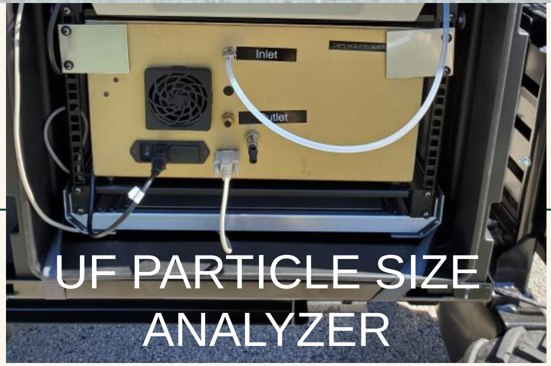
ENGINE EXHAUST PARTICLE SIZER

MOBILE AIR

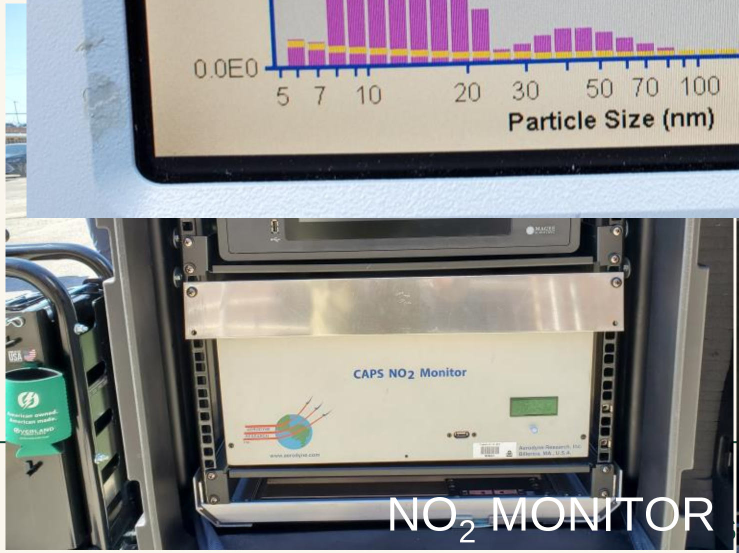




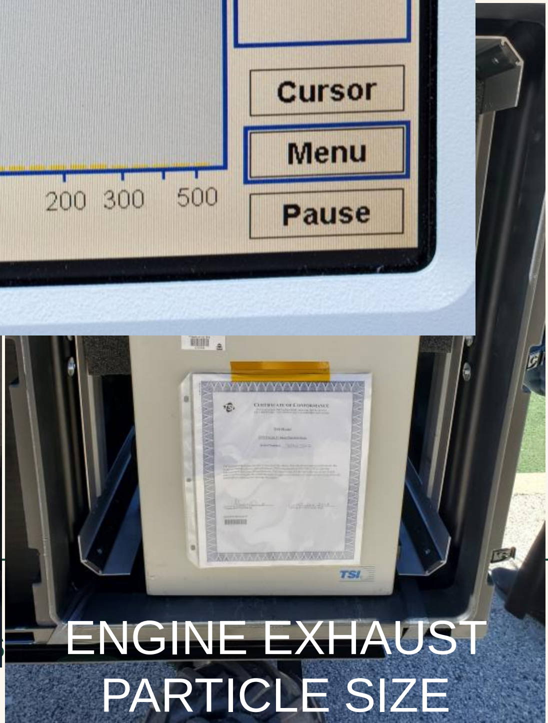
YETI 1400 LITHIUM BATTERY



UF PARTICLE SIZE ANALYZER



NO_2 MONITOR



ENGINE EXHAUST PARTICLE SIZE

AIR MONITORING AT JENS JENSEN

5 days OUTDOOR monitoring

4 days INDOOR monitoring

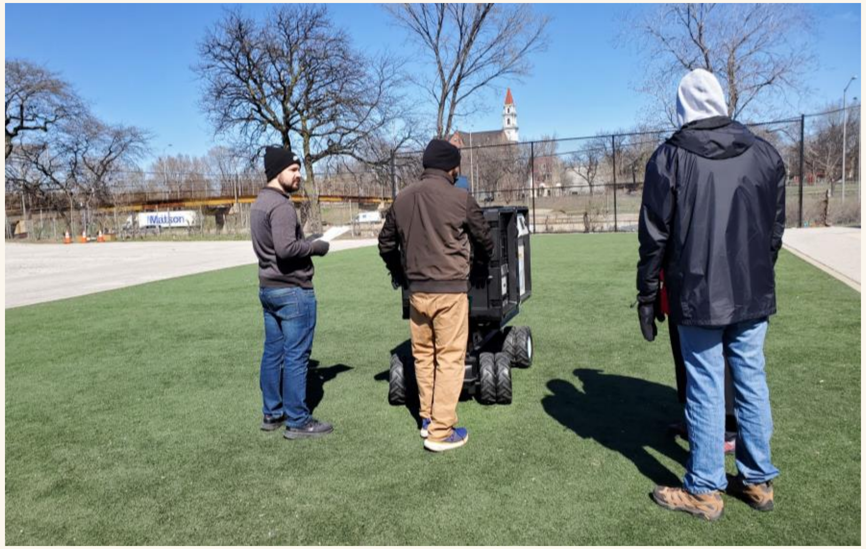
3 days NOISE monitoring

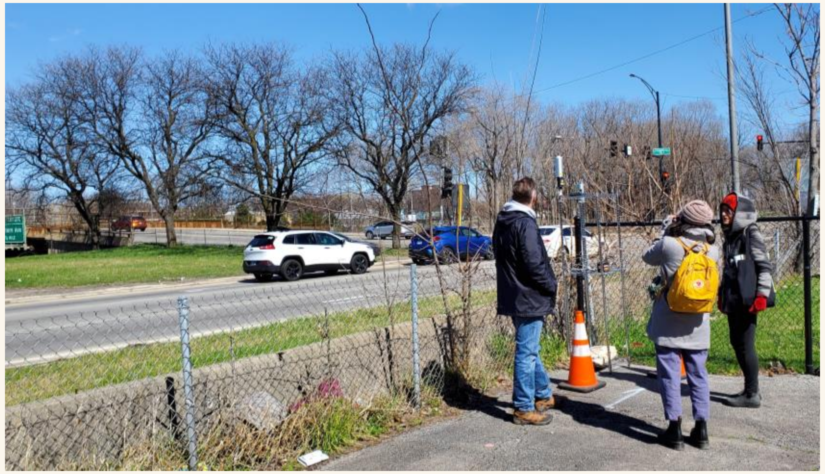
- FIXED SITE – OUTDOOR MEASUREMENT
- FIXED SITE – INDOOR MEASUREMEN
- METEROLOGICAL STATION
- MOBILE MEASUREMENTS

MARCH 2024 – APRIL 2024

NOTE: Not all days may have complete day of air monitoring outdoors due to cold and precipitation events interrupting monitoring schedule.

MONITORING & OUTREACH - JENSEN





Student interactions: 12 classes, >200 students!

AIR MONITORING AT HUFF (ELGIN)

6 days OUTDOOR monitoring

6 days INDOOR monitoring

6 days NOISE monitoring

FIXED SITE – OUTDOOR MEASUREMENT

FIXED SITE – INDOOR MEASUREMEN

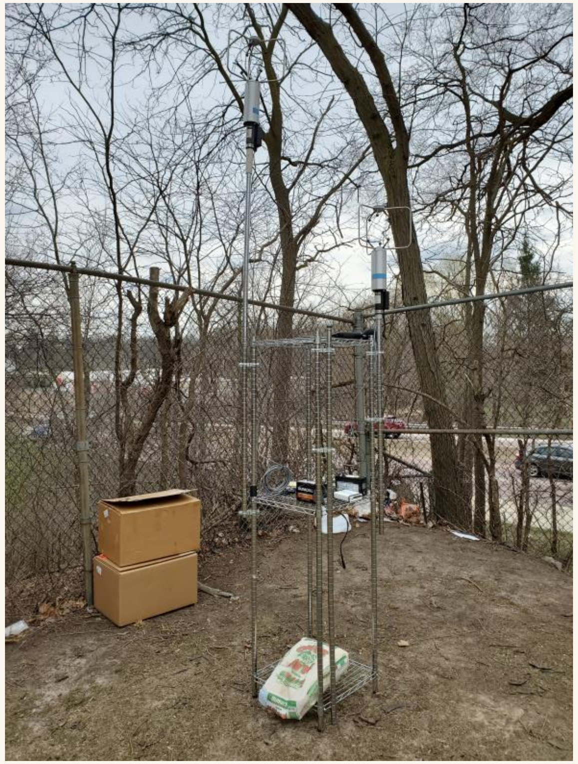
METEROLOGICAL STATION

MOBILE MEASUREMENTS

MARCH 2024 – APRIL 2024

NOTE: Not all days may have complete day of air monitoring outdoors due to cold and precipitation events interrupting monitoring schedule.

MONITORING & OUTREACH - HUFF



Student interactions: 6 classes, >100 students!

AIR MONITORING AT PERSPECTIVES

5 days OUTDOOR monitoring

3 days INDOOR monitoring

3 days NOISE monitoring

FIXED SITE – OUTDOOR MEASUREMENT

FIXED SITE – INDOOR MEASUREMEN

METEROLOGICAL STATION

MOBILE MEASUREMENTS

MARCH 2024 – APRIL 2024

NOTE: Not all days may have complete day of air monitoring outdoors due to cold and precipitation events interrupting monitoring schedule.

NEXT STEPS

DIAGRAMS
DESIGNS
DREAMS

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
College of Fine & Applied Arts
Department of Landscape Architecture

Students as Visionaries

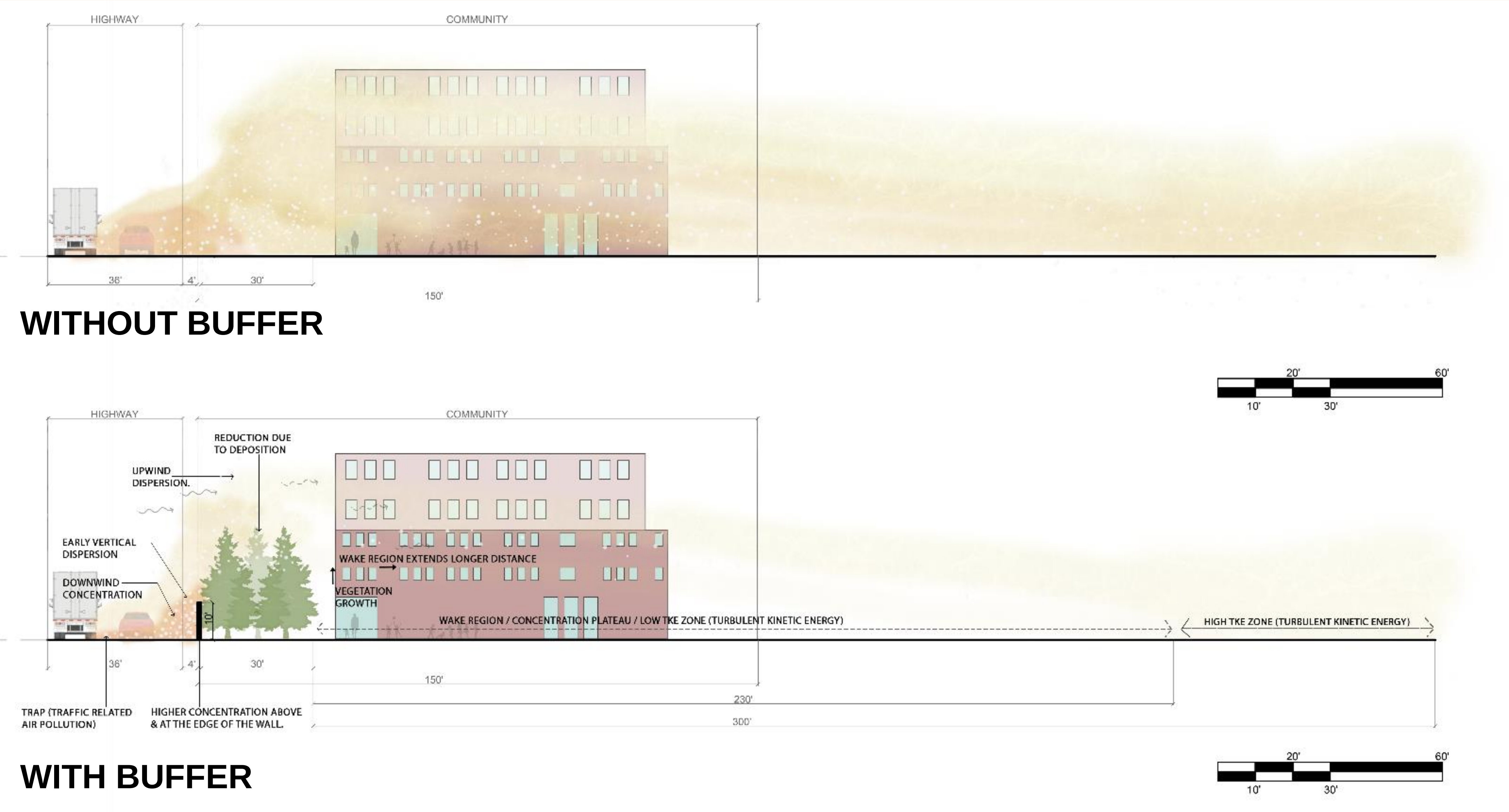
Nital Gundecha, MLA student, 2024

Anne Tong, BLA student, 2023

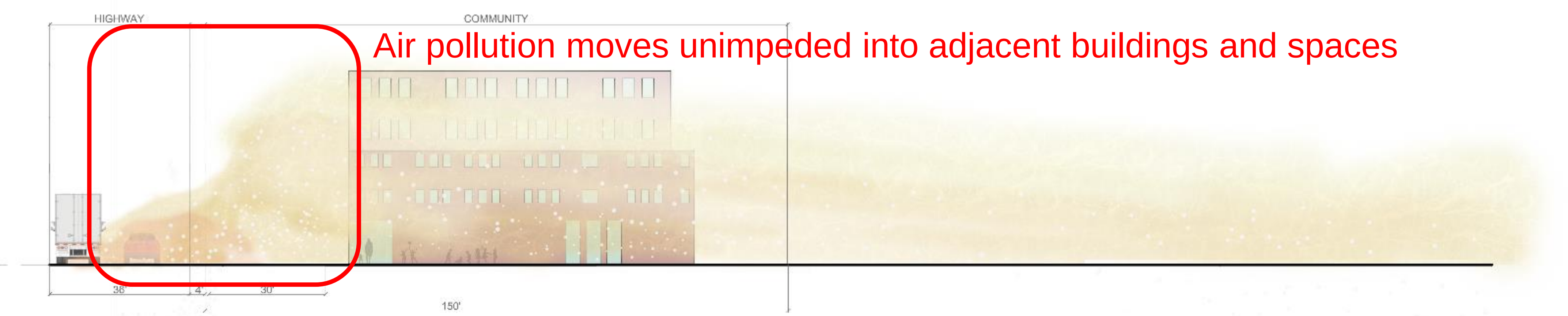
Amy Roberts, BLA student, 2023

Mentored by Mary Pat McGuire, PLA

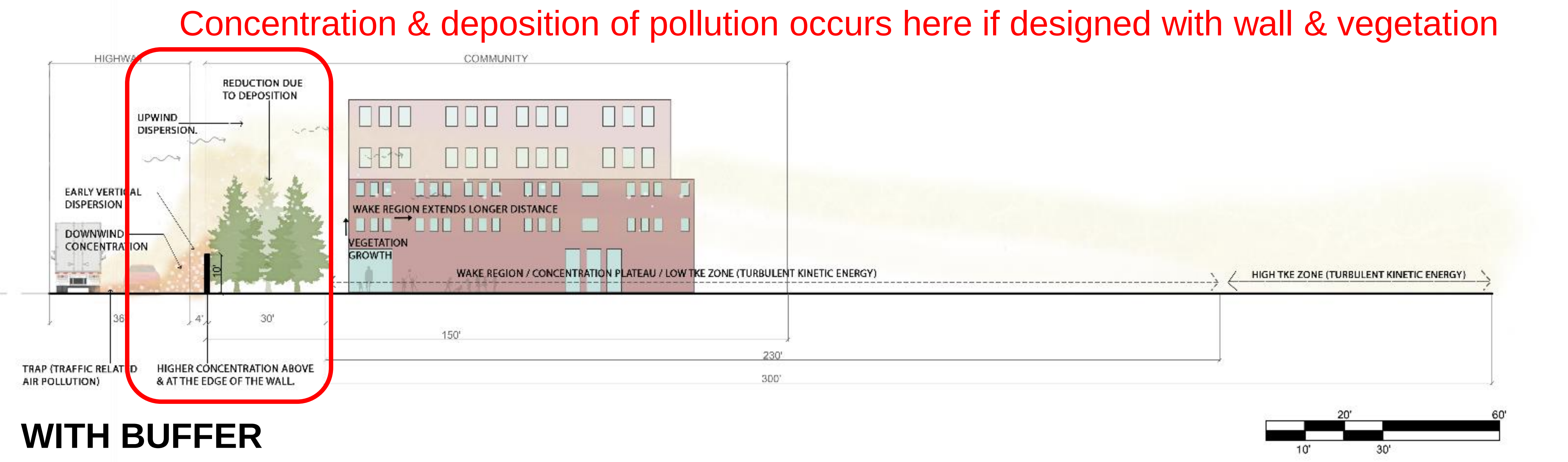
CROSS-SECTION, DOWNWIND CONCENTRATION AREAS, WAKE ZONES, ETC



CROSS-SECTION, DOWNWIND CONCENTRATION AREAS, WAKE ZONES, ETC



WITHOUT BUFFER



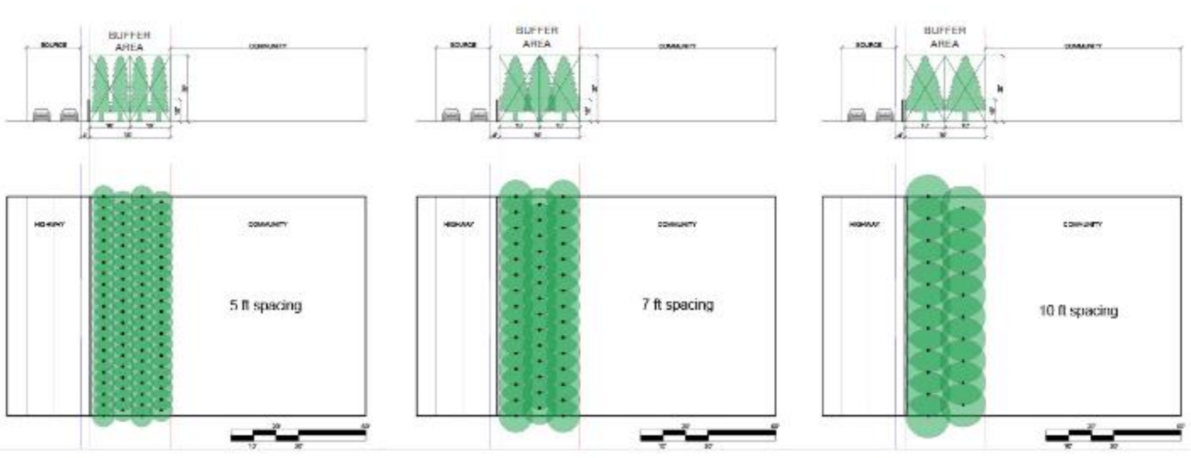
WITH BUFFER

Arbor Day Foundation

Slide modified: MPM, UIUC

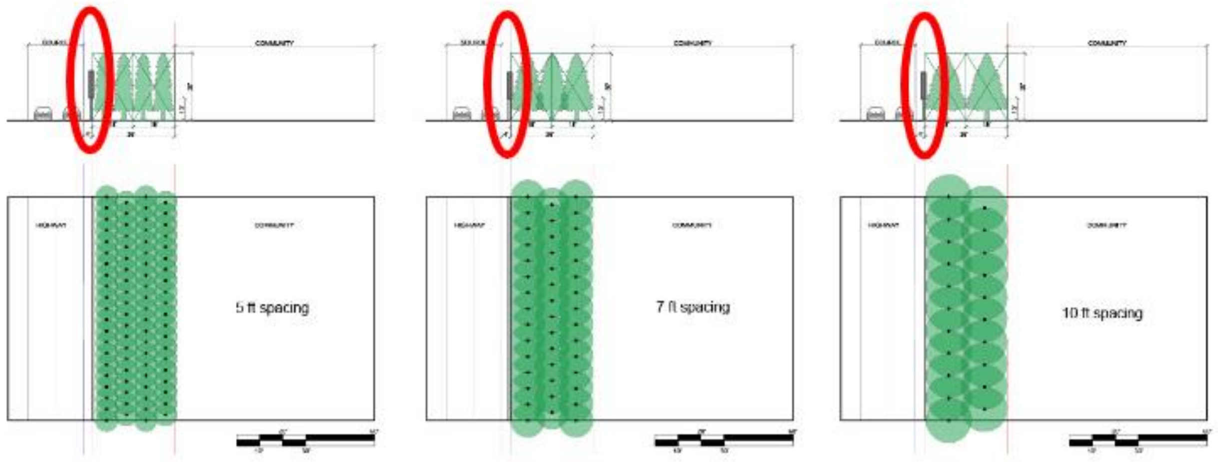
SCIENCE-BASED DESIGNS

WALL + VEGETATION - **W10**T30-NEAR Highway - Effective



Air pollution reduction over 100 m is reduced by **67% for 235*nm*** and **82% for 15*nm*** (Hashad etal. 2020)

WALL + VEGETATION - **W20**T30-NEAR Highway - Effectiveness increased

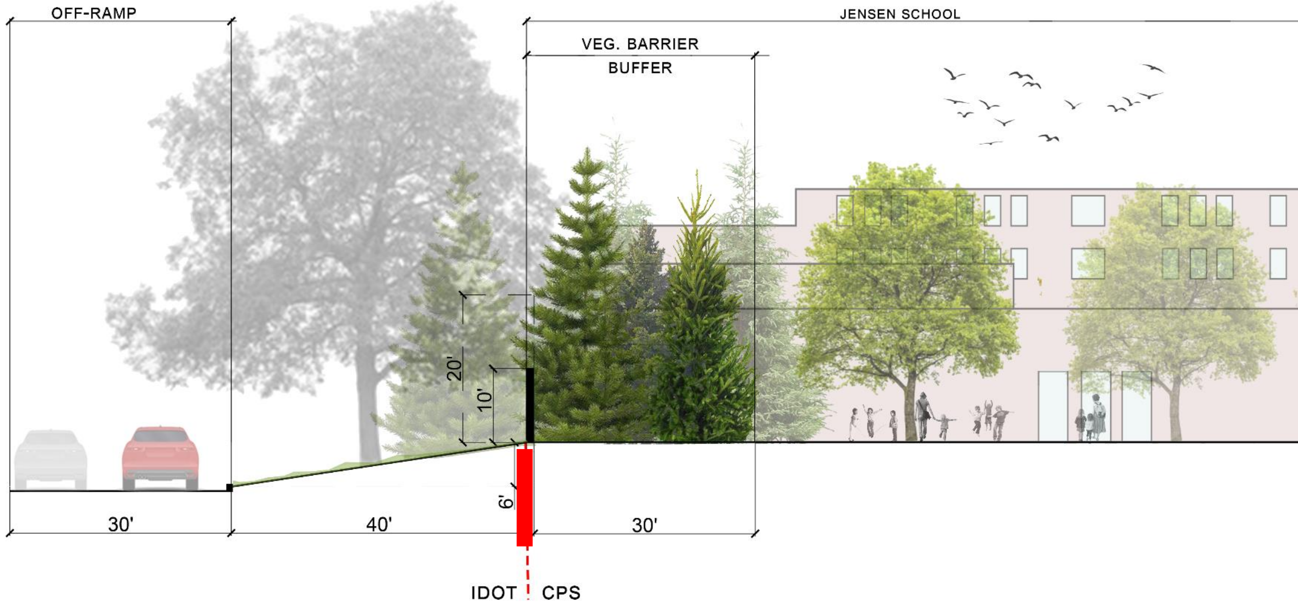


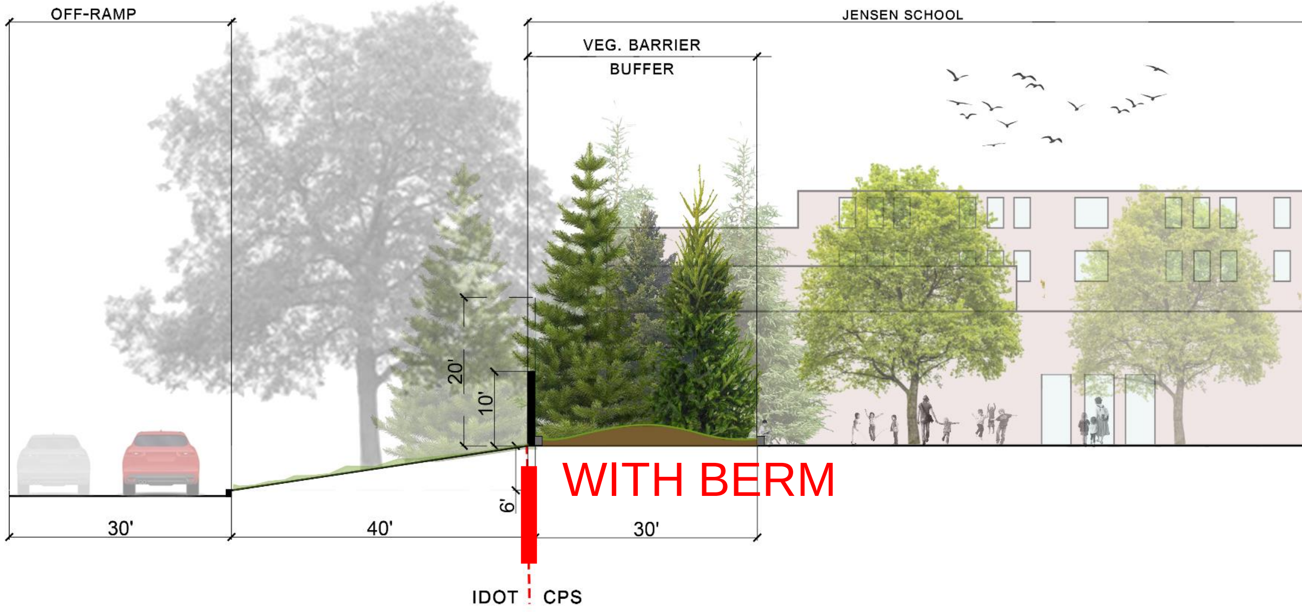
Air pollution reduction over 100 m is reduced by **79% for 235*nm*** and **89% for 15*nm*** (Hashad etal. 2020)

WEST END

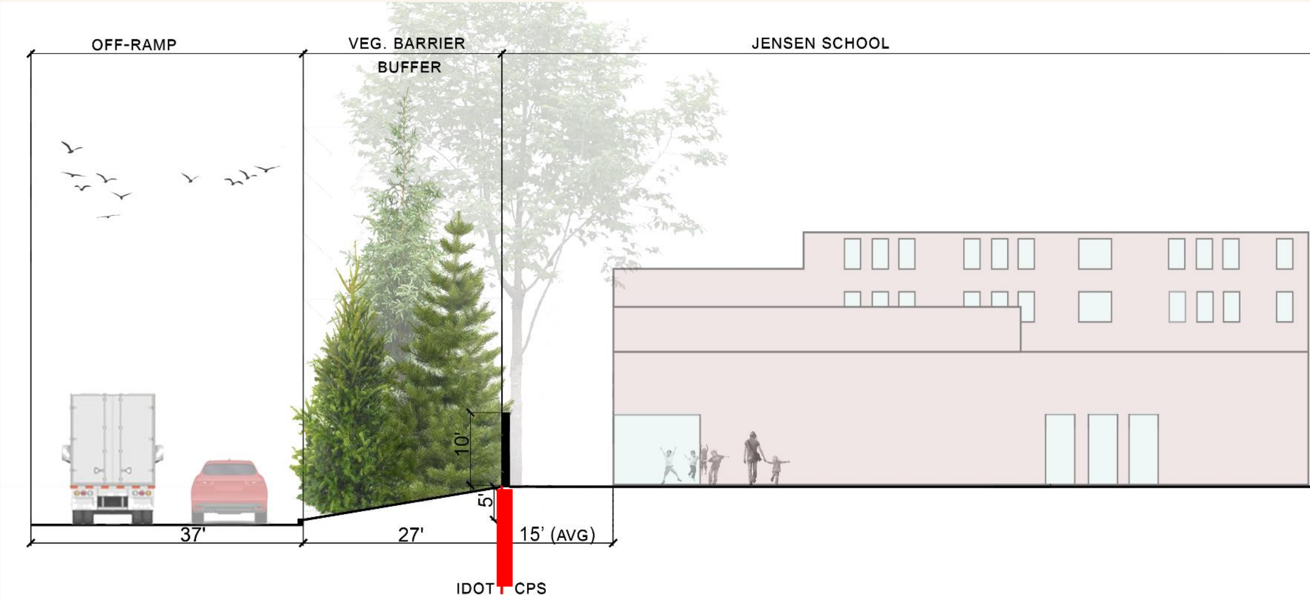

OPTION 1
CPS ONLY

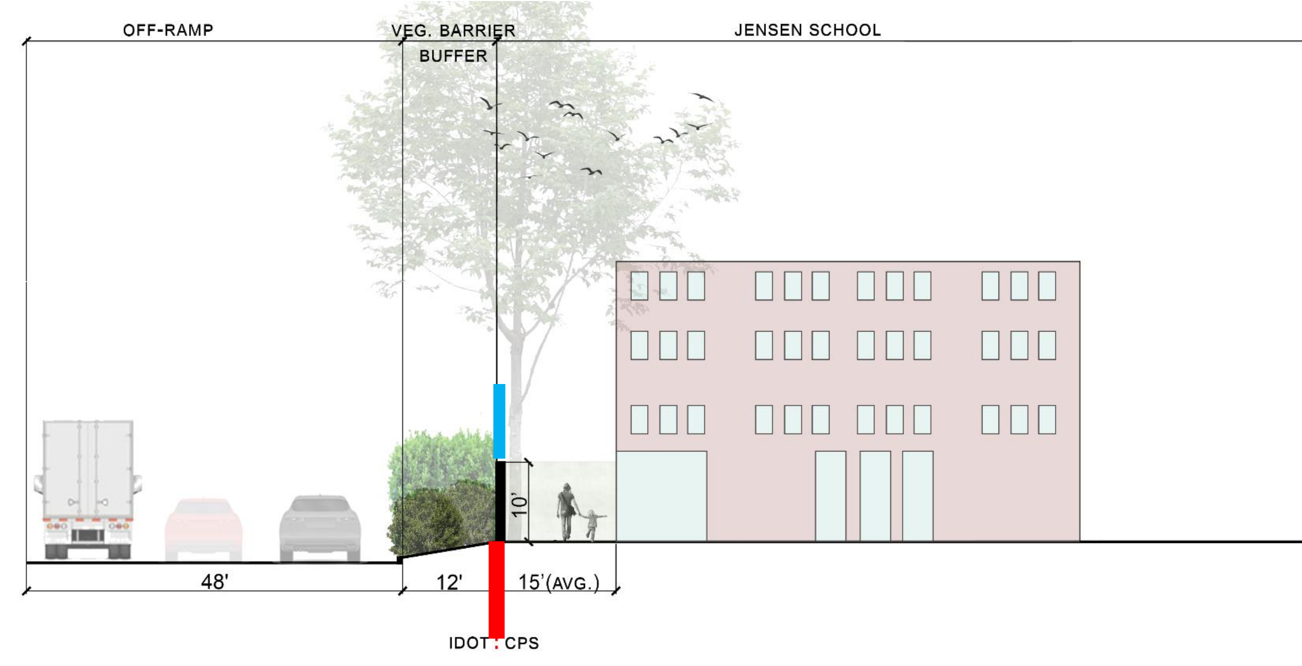

Staff parking


OFF-RAMP
JENSEN SCHOOL
VEG. BARRIER
BUFFER
20'
10'
6'
30'
40'
30'
IDOT
CPS


OFF-RAMP
JENSEN SCHOOL
VEG. BARRIER
BUFFER
20'
10'
6'
WITH BERM
30'
40'
30'
IDOT
CPS

MIDDLE

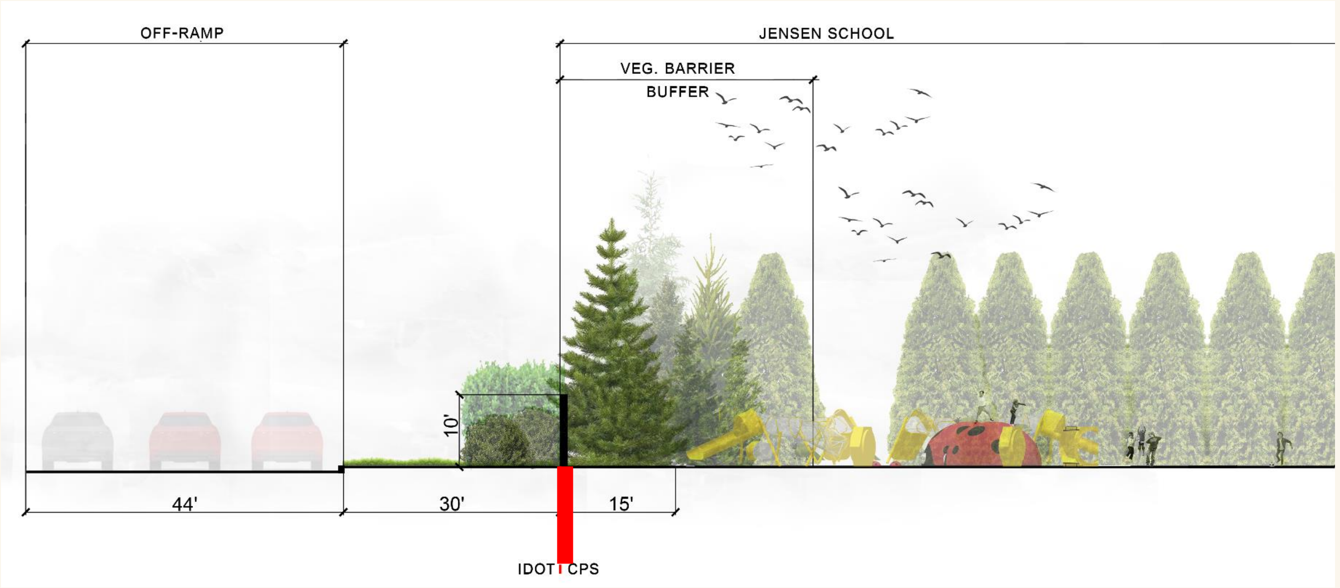


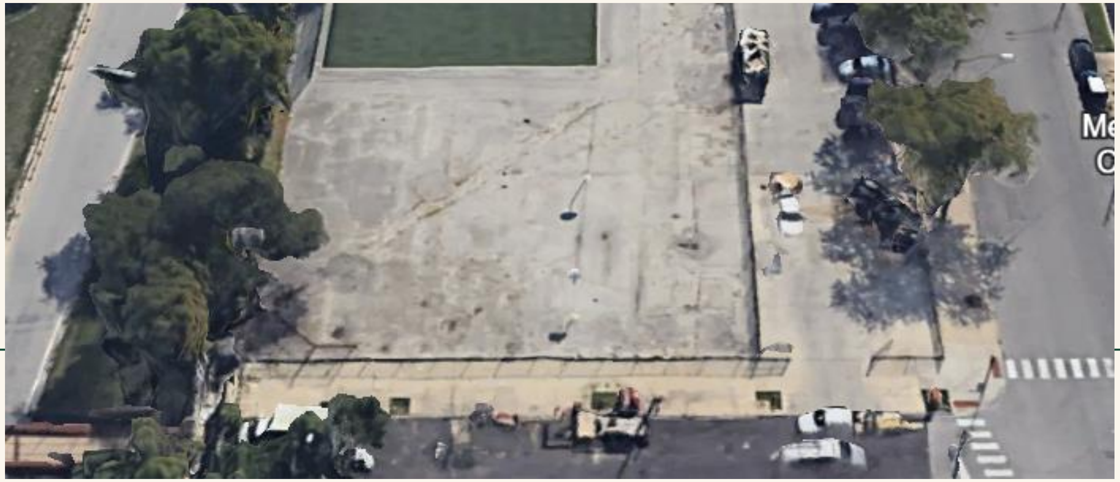


Wall design to 20'H
(where horizontal space limited for planting)

EAST END


OPTION 1
CPS ONLY

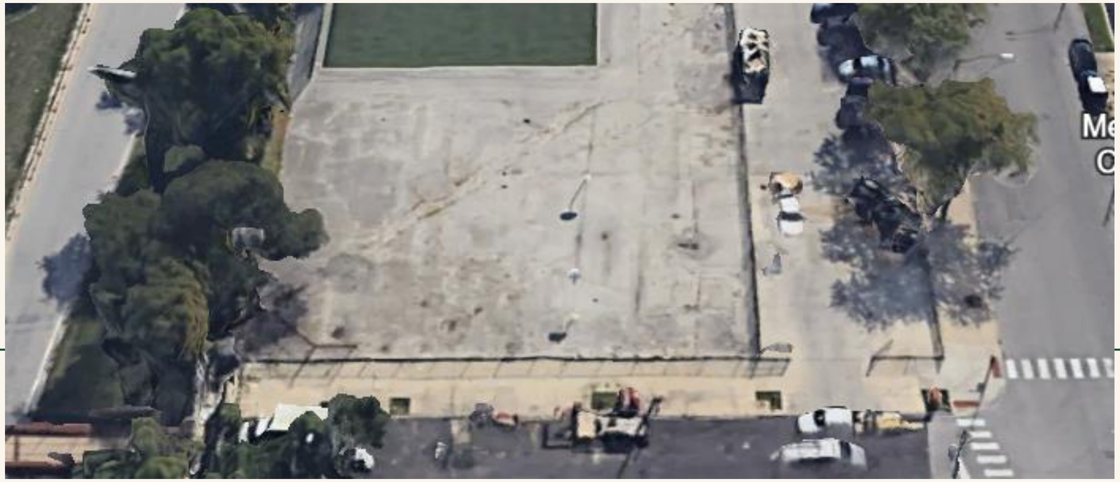

OFF-RAMP
JENSEN SCHOOL
VEG. BARRIER
BUFFER
10'
44'
30'
15'
IDOT | CPS



- Secure funding
- Continue to generate community involvement
- Build more partnerships (thank you CDOT & IDOT!)
    - **100-200 trees may be installed along IDOT**
- Host a charette to engage students & faculty, as well as community members & law enforcement
- Support CPS in securing funding for solid wall
- Remove asphalt & remediate soils
    - **Likely requires professional assistance**
- Start phased planting & maintenance of trees
    - **Likely requires professional assistance**
- Complete tree installation
- What do we hope to achieve?...


Staff parking


290

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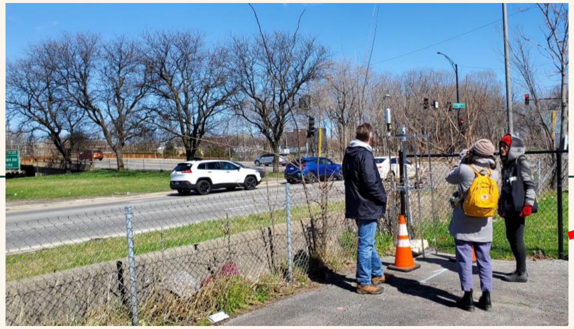
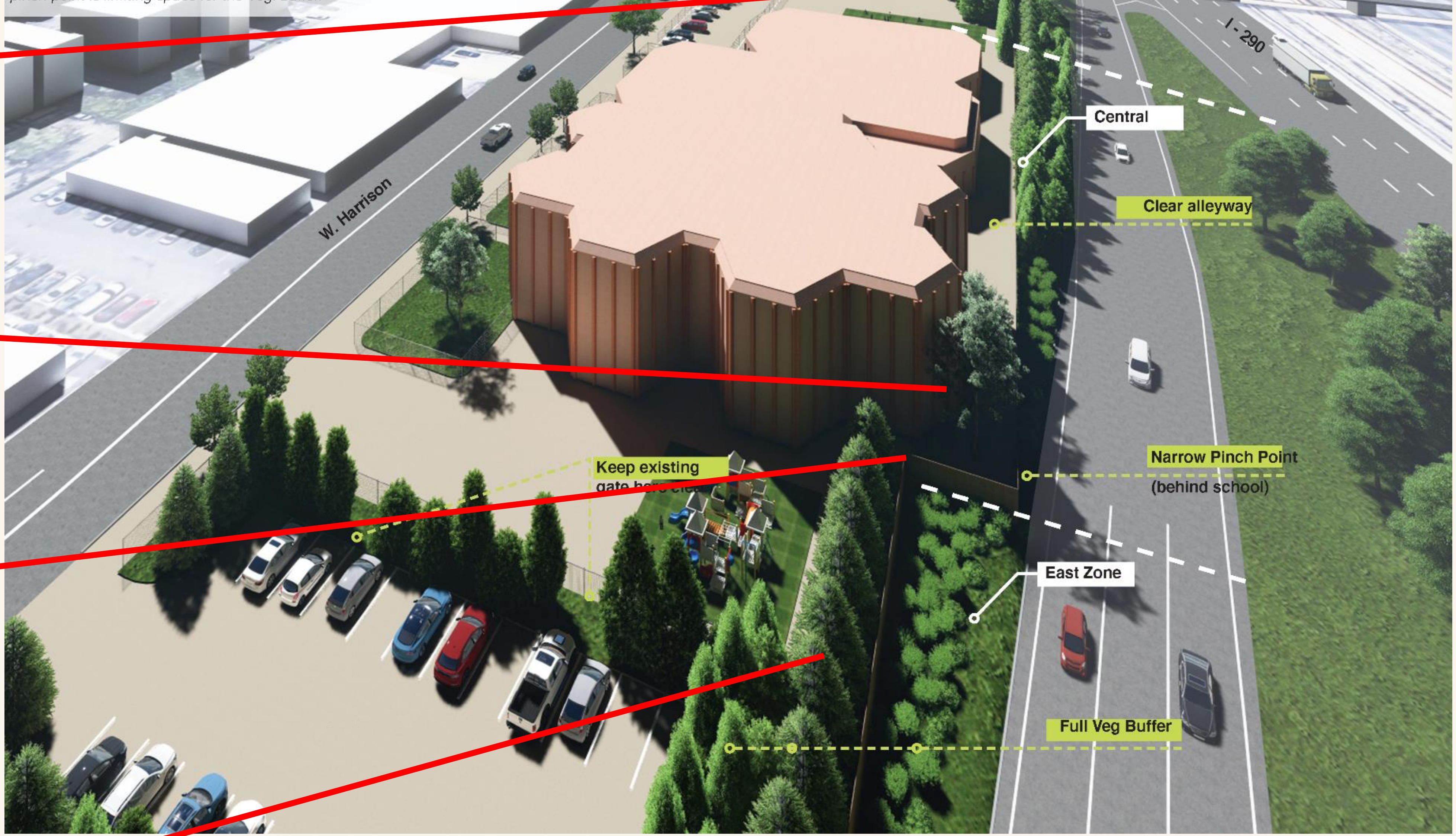
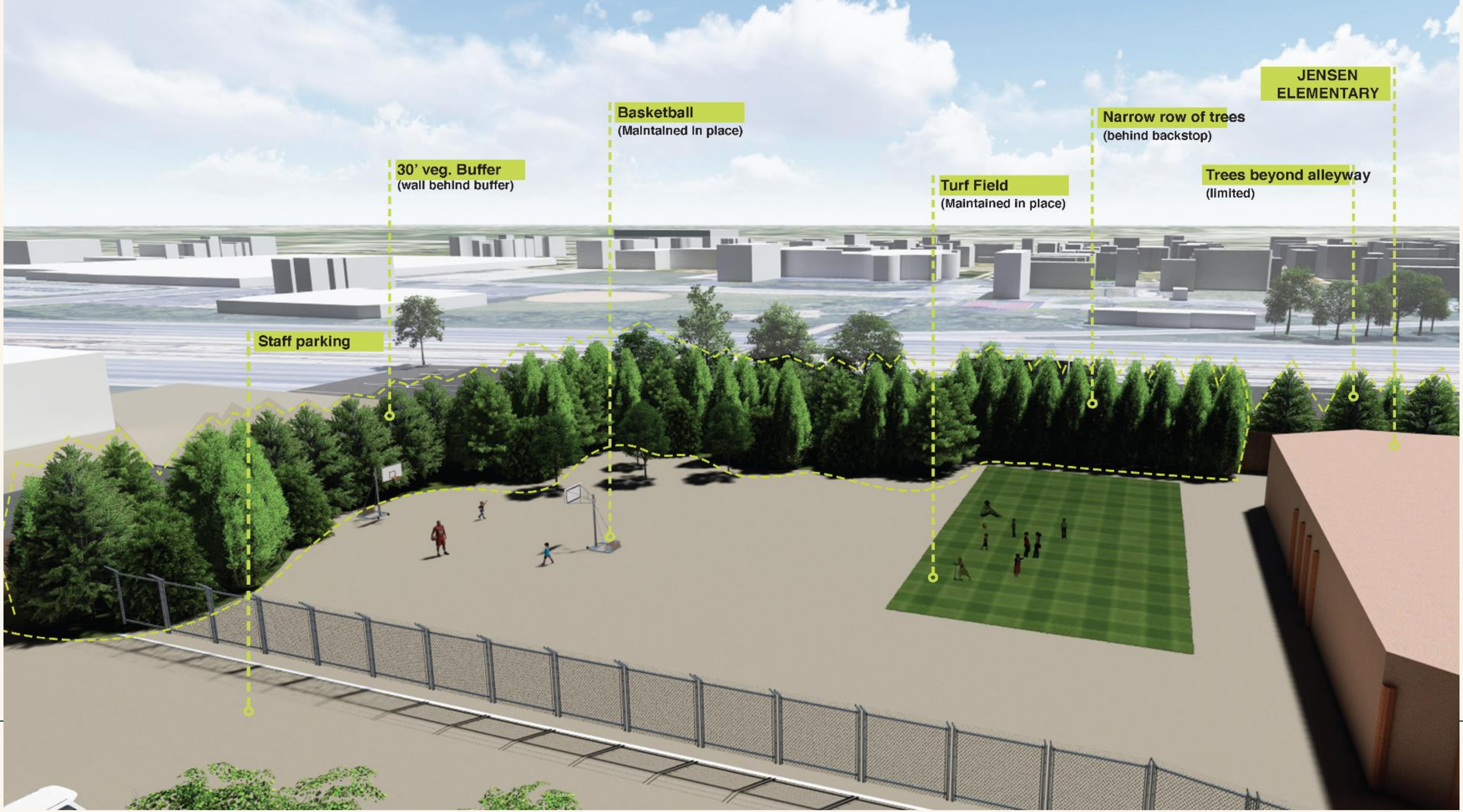
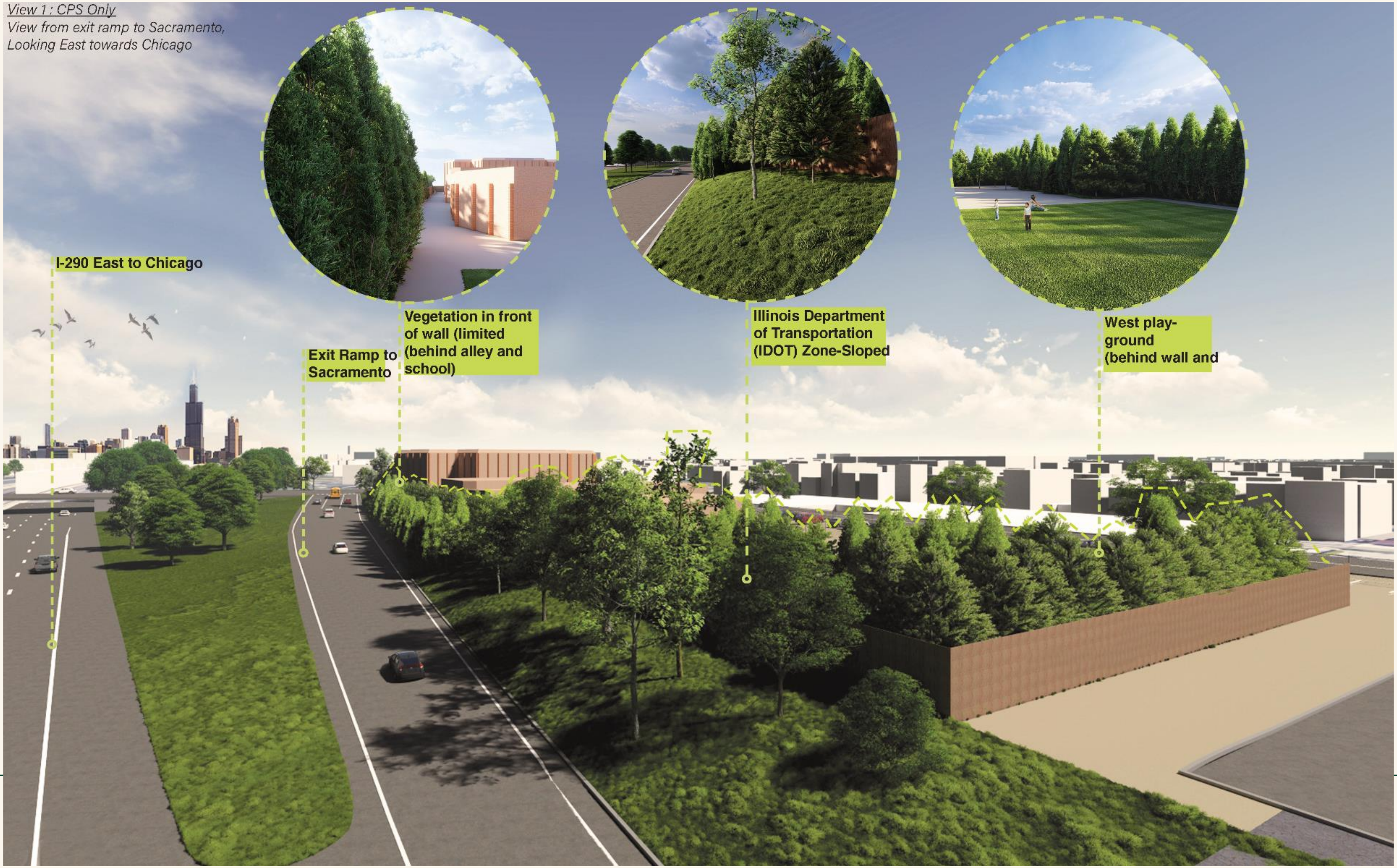


ing the location of the Veg. Buffer along the CPS property, accompanied by a protective wall.
In the Central Zone, a clear and spacious alleyway, offering unrestricted movement. However, at the junction of the Central & East Zones, a narrow pinch point is limiting space for the Veg. Buffer.



View 2 : CPS Only
View of the West Zone, Looking towards Veg. Buffer with shaded trees in playground area, Existing Basketball Hoop & Artificial Turf




View 1 : CPS Only
View from exit ramp to Sacramento,
Looking East towards Chicago
I-290 East to Chicago
Exit Ramp to Sacramento
Vegetation in front of wall (limited (behind alley and school)
Illinois Department of Transportation (IDOT) Zone-Sloped
West play-ground (behind wall and

Thank you.

MICHELLE CATANIA

mcatania@mortonarb.org

GREEN INDUSTRY

OUTREACH COORDINATOR

The Morton Arboretum | THE CHAMPION of TREES

The Center for Tree Science

Creating the scientific knowledge and technical expertise necessary to sustain trees.

CEUs

For ISA CEUs, record the code to the right for each session.
Post conference, you can submit all Your CEU codes within the Conference app.

Sign-in sheets for Society of American Foresters (SAF) CFE credits are available at the registration desk post conference.

Improving Schoolyard Air Quality with Vegetative Buffers

Speaker:

Michelle Catania

PP-24-886
.75 A, BCMA-M, MS