THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Road Impacts Report

University of North Carolina at Chapel Hill – Planning Workshop

Prepared by:

Laurina Bird
Ari Schwartz
Serena Singh

May 5, 2024

Table of Contents

ROAD IMPACTS REPORT

Introduction

Section 1

Introduction

The Bragtown Community Association (BCA) and the Merrick-Moore Community Development Corporation (MMCDC) are two non-profit organizations advocating for transportation improvements in their communities. Merrick-Moore and Bragtown are historically Black neighborhoods in Durham, North Carolina that have been negatively impacted by auto-centric development and have not received sufficient multimodal improvements to promote safe walking, transit use, or biking to areas of interest.

This report presents data describing how the roads in Bragtown and Merrick-Moore impact community members. A team of students from UNC-Chapel Hill's Department of City & Regional Planning researched best practices for air quality, vehicle speed, and noise studies. This work is an 'in-kind' contribution to the Community Connectors grant received by MMCDC and BCA. With that foundation, we conducted field visits to gather useful data that are summarized here. Field visits to Bragtown and Merrick-Moore were organized based on direct community input about where and when speeding, noise, and air quality concerns were greatest as well as background data collection.

Speed Studies

We conducted a detailed speed study across various strategic locations to evaluate compliance with posted speed limits and assess overall traffic safety conditions. Over multiple dates and peak traffic periods, we observed a troubling trend of speed limit violations. The study revealed variability in speed compliance at different areas and times of the day. Certain locations demonstrated closer adherence to speed limits during peak hours, while others consistently showed higher speeds regardless of traffic conditions. Notably, areas with variable speed limits, such as school zones, recorded speeds well above the reduced limits during sensitive times, highlighting specific zones for targeted interventions.

Noise Studies

We recorded outdoor traffic noise at multiple locations to assess where noise was possibly contributing the stress, hearing loss, and loss of community cohesion. At multiple sites, we discovered that average sound levels consistently surpass limits for residential areas, schools, and places of worship that are noise-sensitive land uses. Truck traffic, high vehicle speeds, and a lack of noise barriers contribute to high noise levels. Traffic noise at this level interferes with residents' ability to learn, socialize, work, and relax.

Air Studies

We recorded particulate matter and Volatile Organic Compound data using portable air quality monitors. Air pollution is directly linked to traffic volumes and long-term exposure triggers short-term and chronic illness. Outdoor air quality data showed high variability in particulate matter at different times of day. The majority of Air Quality Scores at measurement sites were at the highest level, reflecting good overall air quality.

Report Organization

This report is divided by road impact – Speed (Section 2), Noise (Section 3), and Air (Section 4). Each section contains separate data and discussion for Bragtown and Merrick-Moore. Findings frame existing problems faced by the communities, inform additional data gathering, and support advocacy for each neighborhood organization.

THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

Speed Study

Section 2

Background and Best Practices Research

Speed studies are a useful tool for determining speed limits for specific roadway segments ("Speed Study Data Collection | FHWA,"). Speeding in residential areas leads to five fundamental forms of harm ("Speeding in Residential Areas, 2nd Edition" 2010):

1. Instilling fear among citizens regarding the safety of children;
2. inducing fear among pedestrians and bicyclists concerning their own safety;
3. elevating the likelihood of vehicular collisions;
4. heightening the risk of injuries in case of accidents; and
5. amplifying noise due to engine acceleration and tire friction.

Residents from Bragtown and Merrick-Moore have continuously expressed these fears, showing the need for a speed study.

In addition to previously mentioned data, it was also integral to understand areas each community considered to be the most unsafe due to speeding. From our preliminary engagement meetings (2/10 and 3/9 in Bragtown, 2/21 in Merrick-Moore), we were able to gain an understanding of these areas.

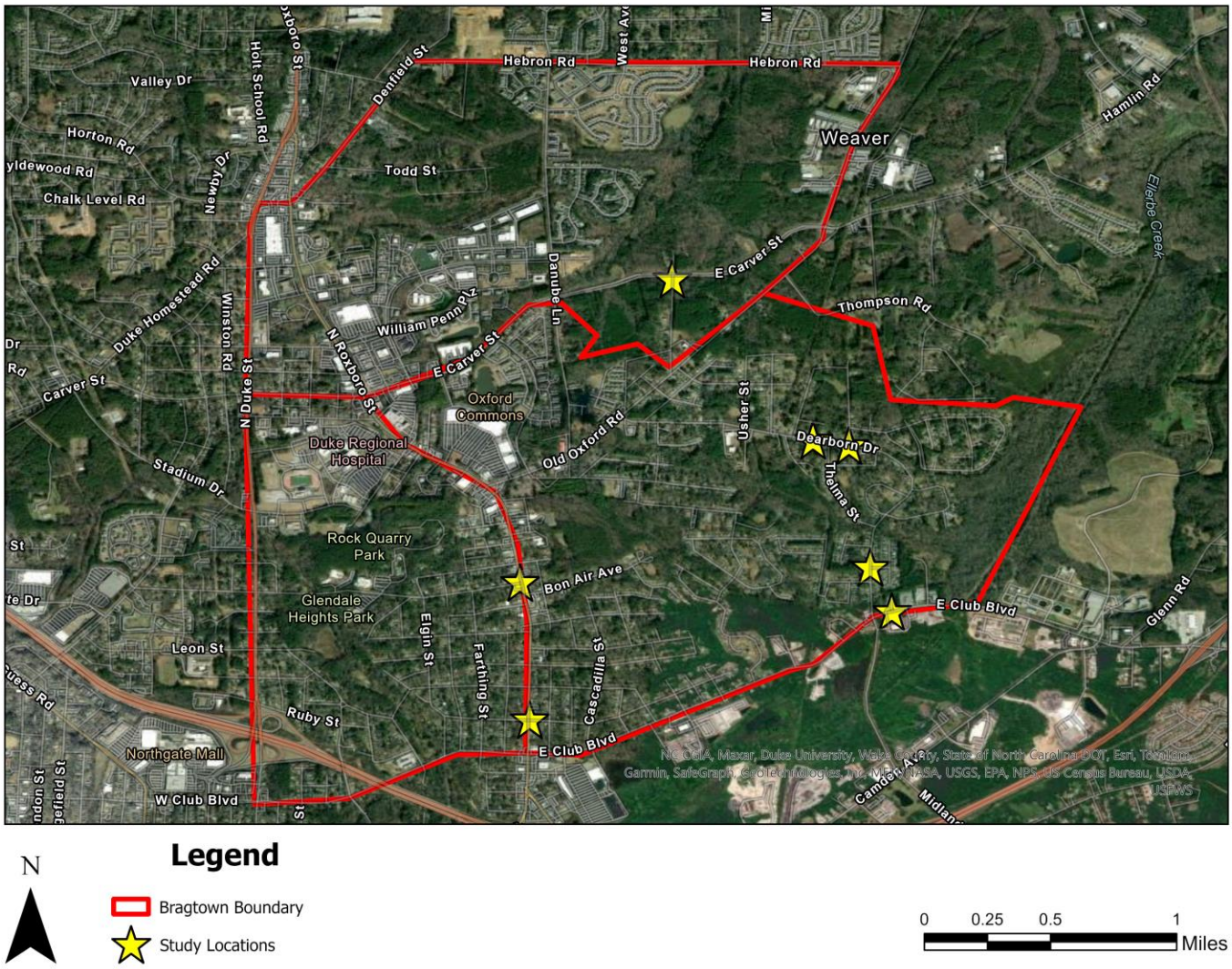
In Bragtown, community members expressed concerns with walking and biking along Dearborn Dr, Roxboro St, Meriwether Dr, Old Oxford Rd, and E Club Blvd. All of these (with the exception of Meriwether Dr) are major roads that go through Bragtown.

In Merrick-Moore, the main area of concern was Cheek Rd, as that is the singular major road that traverses the neighborhood. The locations demarcated on the following maps are a result of community concern, crash data analysis, AADT analysis, and suitability for the study conditions.

While there is no federal standard for conducting speed studies, there are guidelines from both the Federal Highway Administration (FHWA) and North Carolina Department of Transportation (NCDOT). Some jurisdictions have specific methodologies for conducting speed studies, but Durham in particular did not have any standard forms or processes available publicly. Our speed study methodology reflects the guidelines as delineated from the FHWA and NCDOT, as described below.

Prior to conducting the speed studies, it is integral to conduct a thorough data collection process of the following studies: average annual daily traffic (AADT), traffic speeds for each direction by hour of day, road design elements that may be crash factors, road lighting and traffic control devices, crash summaries/ data, plans for expected new development, and recommendations for the speed limit ("Speed Study Data Collection | FHWA,"). Due to data availability, we examined only AADT, crash data, and current speed limits.

Bragtown Measurement Locations



These are the areas that speed, noise, and air studies have already been conducted in Bragtown.

Merrick-Moore Measurement Locations

These are the areas that speed, noise, and air studies have already been conducted in Merrick-Moore.

We created a process to collect consistent speed data based on methodology for other spot speed studies ("Spot Speed"). As outlined by the FHWA, ideal speed studies:

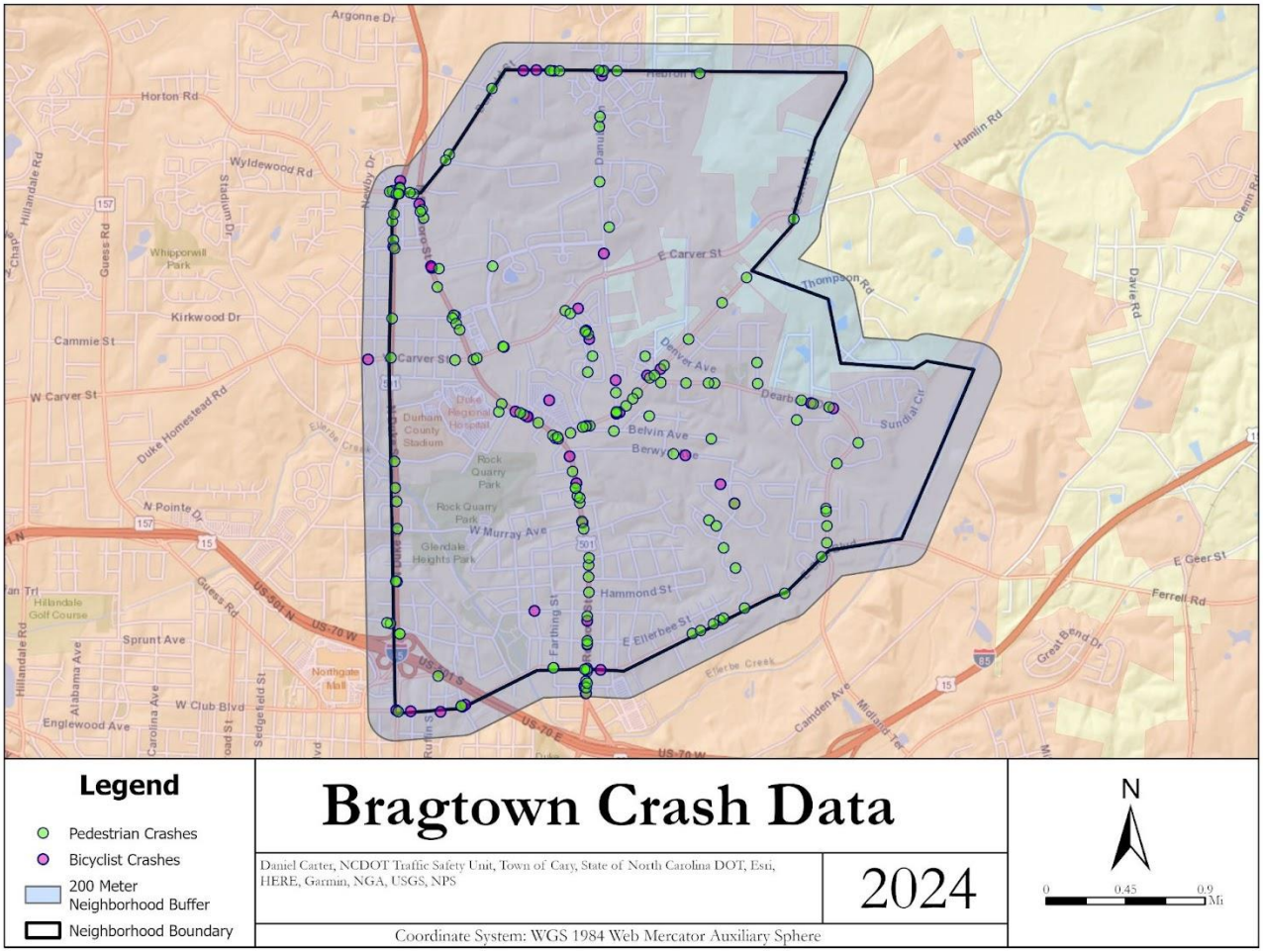
- capture traffic behavior without affecting it (data collectors must be out of view of motorists);
- collect the free flow of vehicles and ignore vehicles traveling within five seconds of the vehicle ahead;
- and collect vehicle type as well as speed to identify speed profiles for different vehicles.

The free-flow speed of vehicles is the speed at which drivers choose their own speed, rather than responding to the vehicle in front of them or other factors. Vehicles passing or turning were not counted. FHWA does not have specific guidelines for exact distance measurements, so we used our best judgment to determine free-flow speeds, considering construction and traffic lights that slow vehicles down. When possible, we chose locations that were sufficiently far away from intersections and out of drivers' sight to collect the most accurate data possible.

Crash Data

For this analysis, only bicyclist and pedestrian crashes were analyzed to coincide with each community's request of multimodal infrastructure. NCDOT provides a publicly accessible map viewer that displays the locations of pedestrian and cyclist crashes with vehicles. The map viewer includes demographic data regarding the driver and victim, as well as information regarding the injury severity, roadway conditions, timing of the crash, weather conditions, and links to the crash report (the latter only accessible with NCID login).

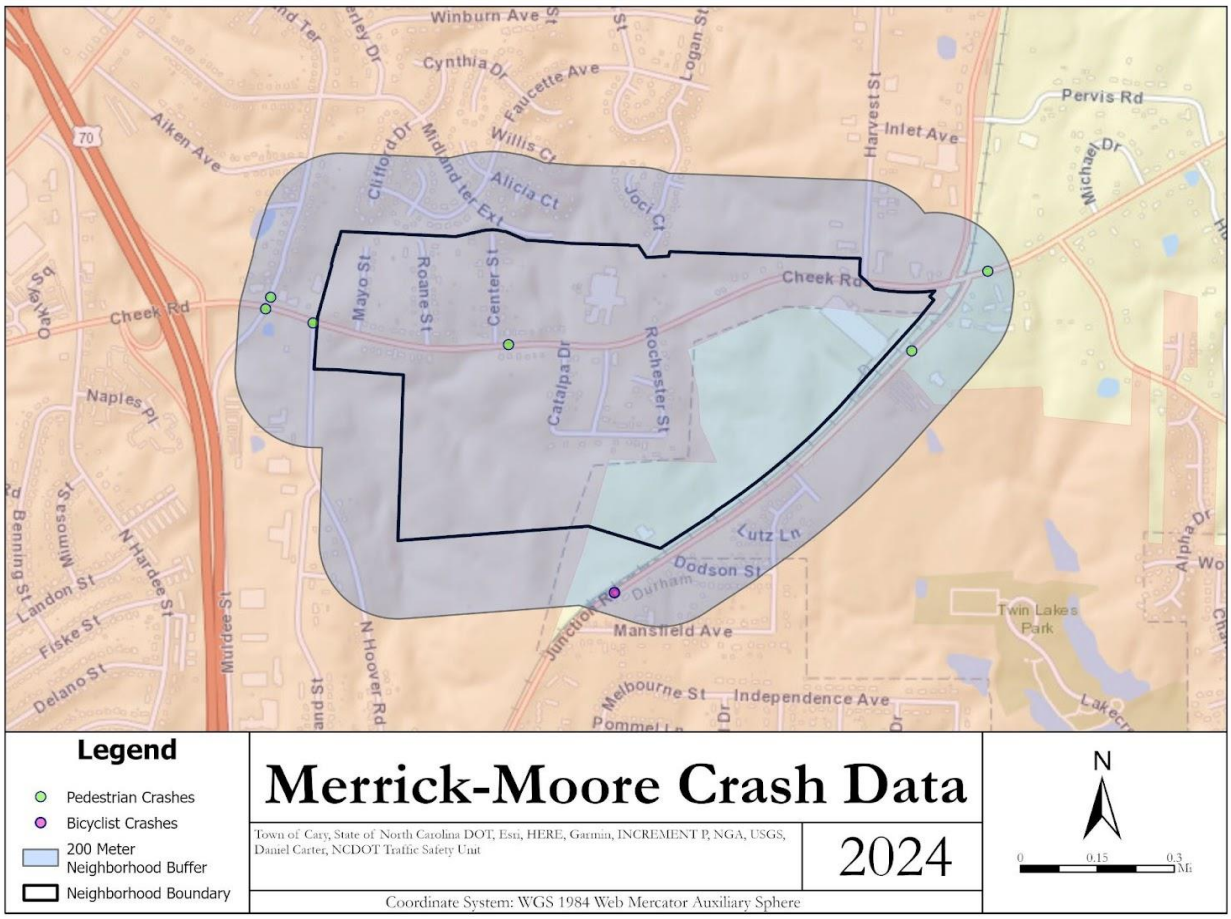
Bragtown Crash Data



The above figure, which is also in Appendix A, maps the crash data in Bragtown with a 200-meter buffer around the neighborhood boundary. This buffer was created to include crashes that occurred on or directly outside of each neighborhood's boundary, reflecting the overall safety and infrastructure in the neighborhoods.

Green circles represent pedestrian crashes with vehicles and purple circles represent cyclist crashes with vehicles.

Bragtown Crash Data



The above figure shows the same crash data as described for Bragtown, also with a 200-meter buffer around the neighborhood. The figure is also included in Appendix A.

Visualizing pedestrian and bicyclist crashes allows us to understand areas of concentrated crashes. This information, as well as areas mentioned by each community, guided study location selection. In Merrick-Moore, the few reported crashes were concentrated along Cheek Rd, supported by community engagement as a major concern for the neighborhood. In Bragtown, the crashes were concentrated along major roads, including N Roxboro St, E Club Blvd, Dearborn Dr, Old Oxford Rd, and N Duke St. Many of these areas were highlighted as areas of concern from the Bragtown community as well.

NC Vision Zero also provides a crash query tool, allowing users to tabulate and sort crash data. This tool helped us understand city-scale trends crash timing and causes. This data was especially helpful in determining trends for the days of the week and time of day of severe crashes. For pedestrian-involved crashes, afternoons and evenings on weekdays (particularly Fridays) trended higher than other days and times. Bicycle-involved crashes were more consistent throughout the week, with a slight increase from 4 to 7pm.

Average Annual Daily Traffic (AADT)

Average Annual Daily Traffic (AADT) is a measure of how busy a road is.

Average annual daily traffic (AADT) is the total vehicle volume at a site on a typical day of the year (FHWA, n.d.). There are a few different ways AADT is calculated, but essentially estimates the total traffic volume passing a point (or segment) of a road in both directions for a year, divided by the number of days in the year (FHWA, 2018). AADT can be used in traffic engineering to forecast highway maintenance, locate for new developments based on traffic congestion impacts, and calculate emissions from road traffic.

For speed studies, AADT is useful in determining the category of roadways. This helps determine what type of traffic calming measure is applicable, if traffic calming is needed. The different classifications are defined in The City of Durham's 2017 Traffic Calming Guidelines:

Arterial streets: Principal traffic artery, carrying high volumes of traffic and has an AADT measurement of approximately 8,000 vehicles per day. Arterial streets typically have a speed limit of 35 mph or higher, examples in Durham being Guess Road and Broad Street.

Guess Road, Durham (via Google Street View)

LaSalle St – example of a collector

Collector streets: Provides travel between local streets and the arterial road network, or serving multifamily development or neighborhood centers. Also carries high volumes of traffic, anywhere from 2,500 - 8,000 vehicles per day.

Liberty St – example of a residential collector

Collector streets - residential: A subtype of collector streets that is residential in nature and carries volumes between 2,500 and 5,000 vehicles per day, but can be higher. Speed limit would be 30-35 mph typically.

Local streets: Carries lower volumes of vehicles (usually less than 2,500) and acts as a starting road for residential traffic. The speed limit is 35 mph and under.

Danube Lane, Durham (via Google Street View)

Most traffic calming measures can only be implemented on local and residential collector streets, because they are residential in nature and carry low volumes of traffic. High volume roads (arterial and collector) act as through routes for vehicles to reach higher order streets, so it would be inconsistent with the intended use to implement any type of traffic calming measure on high-volume roads.

For this report, we looked at AADT from 2022 for state-owned roads in Bragtown and Merrick-Moore. The results of this analysis are included in Appendix C. These maps can assist in categorizing roads which can make it easier to determine traffic calming measures that are applicable as well as how to advocate for infrastructure like sidewalks and bike lanes. The FHWA recommends sidewalks on both sides of all urban arterial, collector, and most local roadways. For future studies, incorporating city-owned roads would be helpful, depending on data availability.

Technology Used

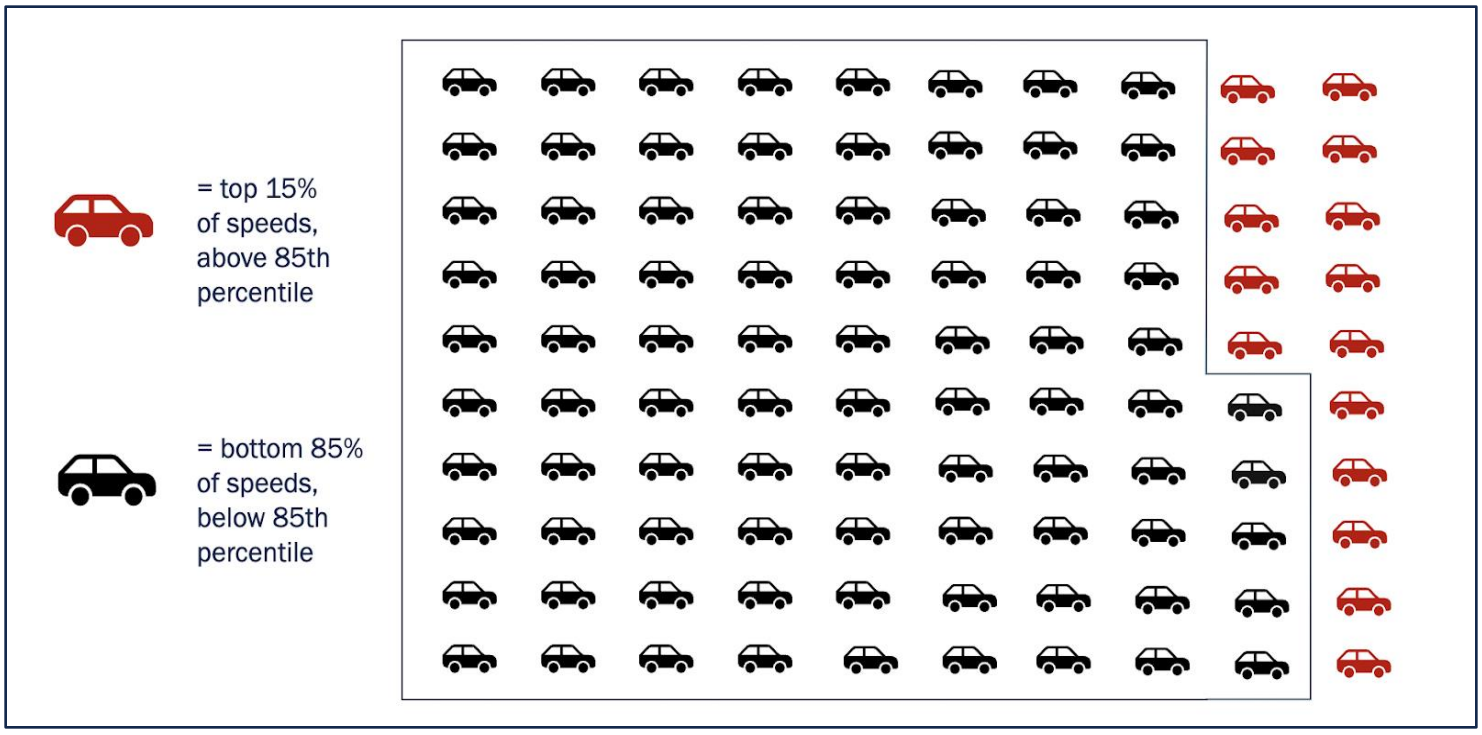
To conduct the speed studies, we used the Bushnell® Speedster III Speed Radar Gun. The Bushnell® Speedster III Speed Radar Gun is a point and shoot radar gun that operates on doppler radar to deliver mile-per-hour speed readings.

Bushnell® Speedster III Speed Radar Gun

Accuracy does not depend on the angle the measurement is taken at, as long as the angle is not perpendicular to the car being measured. The most accurate angle of the speed radar was determined by using information provided in the radar manual, as well as calibration from using multiple radar guns simultaneously.

85th Percentile Speed

The Manual on Uniform Traffic Control Devices (MUTCD) is the national standard for setting traffic control devices. The MUTCD recommends that agencies set speeds within 5 mph of the 85th percentile speed, which is defined as the speed that 85% of drivers travel at or below. The image below visualizes this concept. According to the FHWA, motorists who drive faster than the 85th percentile speed (red cars in the figure below) contribute disproportionately to the risk of crashes. The 85th percentile speed is one of the best indicators of a reasonable and safe speed.



The median or 50th percentile speed is used in recommending a speed limit when the crash risk on a particular road is significantly higher than the average for similar roads, or when other risk factors such as significant pedestrian activity are present.

In our results, we calculated both the 85th and 50th percentile speeds to be used by each community in determining if a speed reduction is necessary, and what it can or should be reduced to.

Results and Discussion

> "The speeding is ridiculous. I don't think Dearborn is the safest place. And it's so narrow too."
>
> -- Bragtown Resident

The data collected from various locations highlights significant speed trends relative to established speed limits.

In Bragtown, speed studies conducted on March 22, 2024, revealed that the 85th percentile speeds at Dearborn & Ora and near the Bragtown Library Branch exceeded the 35 mph speed limit, indicating a potential risk for traffic-related incidents. Further observations on April 2, 2024, during peak afternoon hours, showed varied results. While speeds at Roxboro & E Ellerbee and Roxboro & E Channing were below the limit, Carver & Cub Creek, and Dearborn & Club demonstrated speeds exceeding the limit, with Dearborn & Club noting a significant speed increase despite a reduction from 35mph to 25mph at the intersection.

Bragtown Speed Studies

Location	85th percentile speed	50th percentile speed	Current speed limit	Date of collection	Time of day
Dearborn & Ora	41.85	37	35	3/22/24	Morning (off-peak)
Bragtown library branch	45	39	35	3/22/24	Morning (off-peak)
Roxboro & E Ellerbee	31	25	35	4/2/24	Afternoon (peak)
Roxboro & E Channing	30.85	26	Changes from 35 to 25 at intersection	4/2/24	Afternoon (peak)
Carver & Cub Creek	42.85	38	35	4/2/24	Afternoon (peak)
Dearborn & E Club	43	38	Changes from 45 to 35 at intersection	4/2/24	Afternoon (peak)
E Club (between Stephenson & Dominion)	44	39	35	4/18/24	Evening (peak)
Bragtown library branch	45	40	35	4/22/24	Afternoon (peak)
Bragtown library branch	43	40	35	4/22/24	Afternoon (peak)

In Merrick-Moore, data from February 28, 2024 and early April showed mixed compliance. The speeds around Mt. Zoar Baptist Church and Cheek & Center generally exceed the 35-mph limit, especially during off-peak times. Notably, Mt. Zoar is in a school zone, raising concerns about safety during critical periods.

Merrick-Moore Speed Studies

Location	85th percentile speed	50th percentile speed	Current speed limit	Date of collection	Time of day
Mt. Zoar Baptist Church	40	34	35 (changes to 25 during school start/end times)	2/28/24	Afternoon (off-peak)
Cheek & Center	45	40	35	2/28/24	Afternoon (off-peak)
Mt. Zoar Baptist Church	33	28	35 (changes to 25 during school start/end times)	4/5/24	Morning (off-peak)
Cheek & Center	33	26	35	4/5/24	Morning (off-peak)
Cheek at Merrick-Moore Elementary	42	36	35	4/16/24	Evening (peak)
Cheek at Merrick-Moore Community Garden	48	44	35	4/16/24	Evening (peak)

Overall, these findings suggest a need for targeted traffic calming measures and enhanced enforcement slow down traffic, particularly in areas with variable speed regulations and near sensitive zones like schools.

We also observed significant commercial vehicle traffic in the areas monitored, particularly near industrial and construction zones. The infrastructure that exists is not well implemented. Poorly marked crosswalks and inadequately positioned bus stops show a need for safety and accessibility improvements.

These findings highlight the importance of continuous monitoring and planning to address the evolving needs of these neighborhoods, ensuring both traffic management and pedestrian safety are prioritized.

THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

Noise Study

Section 3

Background and Best Practices Research

Noise from road traffic is linked to stress, sleep interruptions, cardiovascular issues, and other physical and mental health factors (Gilani, Ahmed, & Mir 2021; Roswall et al 2015; Stansfeld et al 2021). Noise interferes with our ability to work, learn, play, and socialize, contributing to a loss of community cohesion. Merrick-Moore and Bragtown residents say that as the major roads in their neighborhood become wider and vehicles travel faster, noise has also increased.

Noise studies typically occur when a road improvement is proposed (e.g., lane widening, restriping, change in elevation). Noise mitigation must be considered if the noisiest hour of the day has an average sound level beyond the allowed level for the land uses around the road (North Carolina Department of Transportation 2021, 4). The average sound level, Leq, is reported in decibel (dB) units. For residential and school uses, this limit is 67 dB measured outside (Ibid., Table 1). Persistent noise above 70 dB causes hearing damage (Centers for Disease Control and Prevention 2022).

The Federal Highway Administration establishes key considerations and study components for examining existing traffic noise levels. When measuring existing noise directly, measurements are taken at representative points at the "worst noise hour" when the pavement is dry, it is not windy, and traffic is free-flowing (Federal Highway Administration 2018). The worst noise hour may occur during off-peak times when more trucks are on the road or vehicles are traveling faster. To capture a representative noise sample, measurements should be no less than 8 minutes long. Fifteen-minute measurements are standard. Along low-volume highways, longer measurements up to an hour may be necessary (Federal Highway Administration 2017).

We examined existing traffic noise in Bragtown and Merrick-Moore based on representative locations identified by community members as sensitive receptors and sources of noise. These are areas containing residences, schools, libraries, or other areas where people gather outside and would be impacted by noise.

Technology Used

At each of these locations, we recorded on average 6 minutes of continuous noise measurements using the smartphone app Decibel X. Using the paid upgrade version of the app, data was exported from each site visit into a csv file where data analysis was performed. The app applies A-weighting of the sound data to better reflect how sound is experienced by the human ear.

Site visits were conducted on clear days without wet pavement or wind. Measurements were taken outside at road level, 15 feet or less from the roadway. Measurements were taken from a handheld smartphone from a height of 1.5m. While measuring noise, we also counted trucks and conducted air and speed studies.

Results and Discussion

The tables below present preliminary existing noise condition data at representative points in Bragtown and Merrick-Moore. Average sound level is equivalent to Leq, and the maximum value is the highest sound level recorded. The time field represents the approximate time where the 6-minute sound recordings were conducted. These data can be supplemented by additional site visits at different times, days, or recording lengths.

Bragtown Noise Studies

Location	Average sound level (dB)*	Maximum (dB)	Time	Date
Dearborn Drive & Ora Avenue	71	91	9:50am	3/22/24
N Roxboro Street & E Ellerbee Street	70	85	4:20pm	4/02/24
N Roxboro Street & E Channing Ave	75	92	4:50pm	4/02/24
E Carver Street & Cub Creek Road	59	77	5:50pm	4/02/24
Dearborn Drive & E Club Boulevard	69	86	6:10pm	4/02/24
* Noise above 70 dB for a long period of time causes hearing damage				

Dearborn Drive & Ora Avenue; and N Roxboro Street & E Ellerbee Street are both residential areas near commercial sites. At N Roxboro and E Ellerbee, a church and homes would be sensitive to noise. The sensitive receptors are exposed to high traffic volumes, but traffic lights in the vicinity may reduce noise by slowing traffic at peak times. At both sites, noise was measured at off-peak times when traffic was more free-flowing. There are no substantial noise barriers between the road and residences. Both sites are near other high-traffic roads that may contribute to background noise levels.

The vehicle mix is mostly light-duty automobiles, but delivery box trucks and dump trucks were common. The average sound levels at these sites are above the limit for residential uses (67 dB).

N Roxboro Street & E Channing Ave; and Dearborn Drive & E Club Boulevard are commercial areas near major intersections with more automobile traffic. Noise was measured at slightly off-peak times. There is no statutory limit on noise in commercial areas, but persistent sound above 70 dB begins to cause hearing damage.

Noise at N Roxboro St & E Channing Avenue was significantly above this threshold. The sidewalks and school along this stretch of road means that people are likely experiencing negative impacts from traffic noise. At Dearborn Drive & E Club Boulevard, the lower Leq may be explained by the traffic light at the intersection causing vehicles to slow. Measuring noise at an intersection is not ideal because traffic is not free-flowing, but the community highlighted this as a particularly noisy intersection where pedestrians are exposed to noise.

At E Carver Street & Cub Creek Road, parcels are currently undeveloped or under construction for multifamily residential. No heavy construction activity was occurring during our noise measurements. Trees have been clear-cut along Carver, removing noise barriers. As development continues in this area, traffic and associated noise is expected to increase.

Measurements from 4/2/2024 were taken on a clear day with light winds and temperatures between 63°F and 86°F. Measurements from 3/22/2024 were also taken on a clear day with no wind, with temperatures between 41°F and 69°F.

The average sound levels at Bragtown sites align with what the community told us about consistent vehicle traffic along Dearborn Drive and N Roxboro Street. At three of the sites, the Leq value is at or above the level that would cause hearing damage over time. This noise level causes physiological problems and contributes to stress.The truck mix in Bragtown is also a critical piece to characterizing noise, since heavy-duty vehicles are significantly louder than light-duty vehicles. We observed an approximate 12 trucks per hour from our field visits, mostly comprised of box/large delivery trucks and dump trucks. Truck traffic was notably higher along N Roxboro and near the Bragtown Library branch.

Bragtown contains commercial development but is still largely residential. The neighborhood contains several noise-sensitive land uses where people are expected to be outside such as schools, residences, and a library. The high Leq observed at several sites shows that noise may be impacting people's ability to use these spaces comfortably. Traffic noise is a hazard to those living and working in the area who are exposed to these noise levels for extended periods of time.

The average sound levels at Bragtown sites align with what the community told us about consistent vehicle traffic along Dearborn Drive and N Roxboro Street. At three of the sites, the Leq value is at or above the level that would cause hearing damage over time. This noise level causes physiological problems and contributes to stress.The truck mix in Bragtown is also a critical piece to characterizing noise, since heavy-duty vehicles are significantly louder than light-duty vehicles. We observed an approximate 12 trucks per hour from our field visits, mostly comprised of box/large delivery trucks and dump trucks. Truck traffic was notably higher along N Roxboro and near the Bragtown Library branch.

Bragtown contains commercial development but is still largely residential. The neighborhood contains several noise-sensitive land uses where people are expected to be outside such as schools, residences, and a library. The high Leq observed at several sites shows that noise may be impacting people's ability to use these spaces comfortably. Traffic noise is a hazard to those living and working in the area who are exposed to these noise levels for extended periods of time.

Merrick-Moore is a smaller neighborhood than Bragtown and is built around Cheek Road. For these reasons and based on community concerns about traffic on Cheek Road, we conducted multiple observations at the same site.

Merrick-Moore Noise Studies

Location	Average sound level (dB)*	Maximum (dB)	Time	Date
Center Rd & Cheek Rd	67	86	9:55am	4/05/24
Mt. Zoar Church at Cheek Rd	72	94	3:20pm	2/28/24
Mt. Zoar Church at Cheek Rd	71	91	9:05am	4/05/24
* Noise above 70 dB for a long period of time causes hearing damage				

We took noise measurements at Mt. Zoar Church at Cheek Road from the church's parking lot. The church and Merrick-Moore Elementary School across the street are noise-sensitive land uses. East of the church, there is an active construction site. On 2/28/24, traffic was restricted to one lane as work crews directed construction-related truck traffic, slowing overall vehicle flow. There are no significant noise barriers at this site.

As the central road through Merrick-Moore with access to I-85 and I-70, Cheek Road carries substantial traffic. At off-peak times in the morning and afternoon, noise levels were above the limit for school and places of worship (67 dB) and would cause hearing damage over long periods of time (North Carolina Department of Transportation 2021, Table 1). Truck traffic was significantly higher during afternoon off-peak, with 54 trucks per hour observed (versus 26 trucks per hour at the same site after 9AM). The higher truck traffic may have counteracted the construction-related traffic calming.

Moving west, Center Road & Cheek Road includes residential land uses still close to industrial uses and highways. There are more trees that can absorb noise. After the morning peak time, the average sound level at this site is at the limit for residential areas (67 dB). This noise level may interfere with outdoor activities and contribute to health issues. Truck traffic is relatively lower at this intersection, at a rate of 27 trucks per hour. Lower noise volumes could be caused by a narrow road shoulder that calms traffic, decreased truck traffic, and some sound absorption by vegetation.

Measurements taken on 4/05/2024 were taken on a clear day with light winds and temperatures between 38°F and 60°F. Measurements taken on 2/28/2024 were also taken on clear days with light wind, with temperatures between 44°F and 67°F. Wind and precipitation did not interfere with noise measurements.

The noise measurements align with what we heard from the community during in-person meetings -- speeding vehicles and truck traffic due to nearby industrial uses produce increased traffic noise. There are few alternative routes for vehicles to move through Merrick-Moore, so Cheek Road has consistently high traffic noise levels.

To mitigate noise, organizations can advocate for traffic calming measures such as adjusting the timing of traffic signals and other interventions that would reduce speeds. Limiting truck access can also significantly reduce traffic noise. More data is needed before we can identify effective noise reduction measures, but the data presented in this report suggests that traffic noise is harming sensitive receptors in both Bragtown and Merrick-Moore.

The noise study is limited by technology and timing of measurements. Decibel X is an app, meaning that measurements are not made on a stationary device and smartphones with different microphones may produce different measurements. We did not know that there were settings to autosave data and prevent the device from going to sleep while recording noise data. With those settings enabled, longer measurements would be possible. While recording, if the phone recording noise went into sleep mode, all data collected up to that point would be deleted. The app does drain the phone battery quickly, so a portable charger may be necessary for future measurements.

Future measurements should be at least 15 minutes long to an hour. The app could be calibrated using another sound recording device and windscreens or tripod may reduce interference. Measurements were taken during assumed off-peak times for traffic, Capacity limitations meant that we could not take multiple measurements for most sites, and may not have captured the worst noise hour.

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Air Study

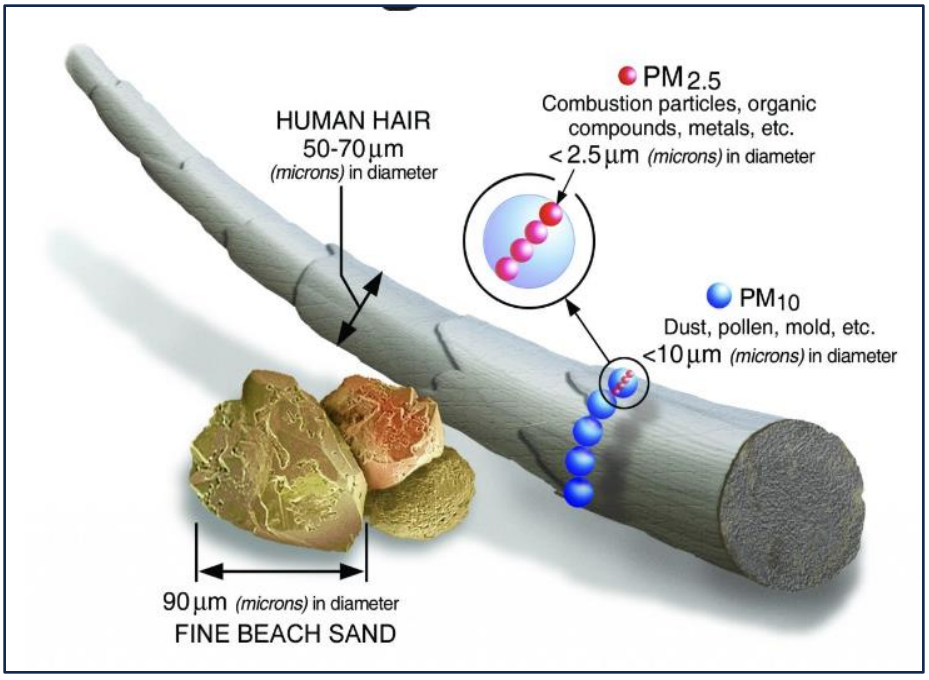
Section 4

Background and Best Practices Research

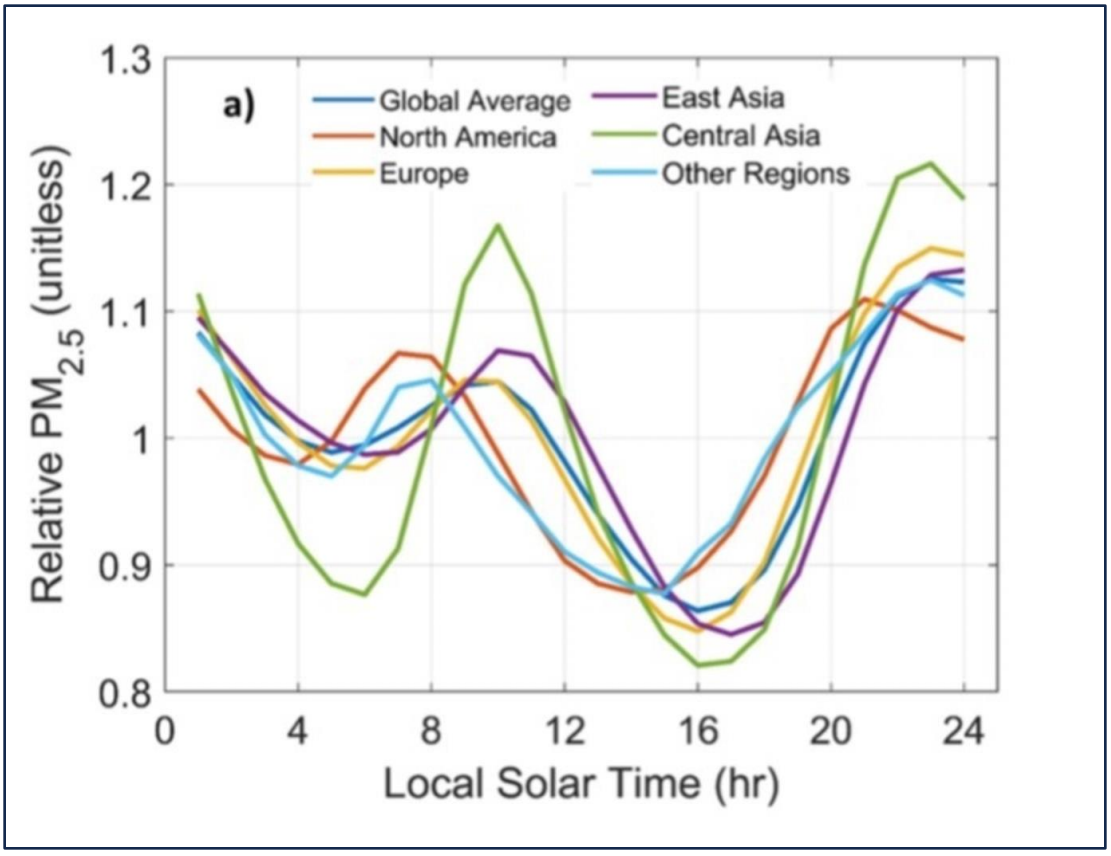
Air quality monitoring is important because of the direct impacts of poor air quality on human health. Long-term exposure to particle pollution (particulate matter) results in short-term illness such as dry eyes and throat, chronic respiratory illness like asthma, as well as long-term illness that can be as serious as lung cancer ("Neighborhood and Built Environment - Healthy People 2030").

Racial and ethnic minorities as well as low-income individuals are more likely to live in neighborhoods with higher risk of exposure to pollutants (American Public Health Association). The disproportionate impacts of environmental externalities is a human rights issue as it impacts the ability of neighborhoods to grow and stabilize in a long-term, healthy way in both rural and urban settings (Ibid).

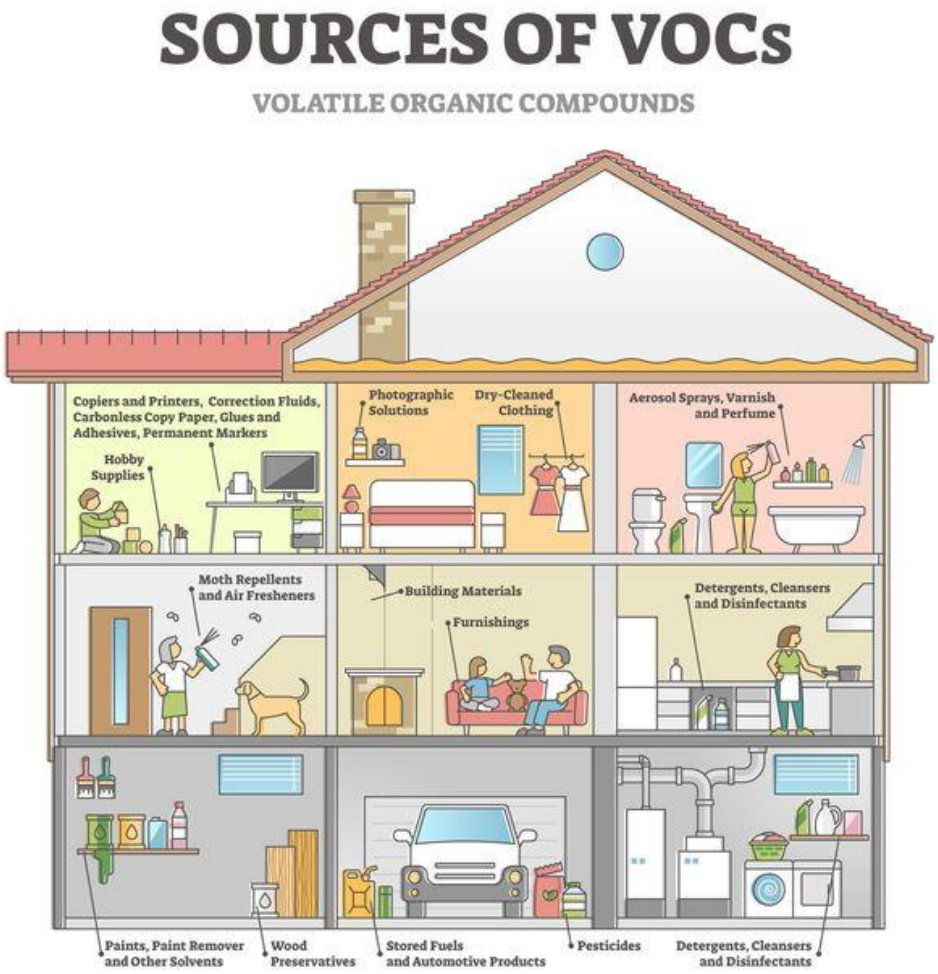
Particulate matter is a "mixture of solid particles and liquid droplets found in air (US EPA 2016). Different sizes of particulate matter contain different types of pollutants. For example, smaller sized particulate matter (PM1 and PM2.5) are not able to be seen with the human eye and contain pollutants such as combustion particles, organic compounds, and metals. Larger sized particulate matter (PM10) includes pollutants that can be seen in the air like dust, pollen, mold, and soot. The smaller the particle, the more dangerous it is. This is because smaller particles have the ability to enter our lungs and spread to our bloodstream, resulting in adverse health impacts from even short-term exposure (IQAir).



Time of day is another important aspect of measuring particulate matter. Particulate matter tends to be highest during the morning (between 7:00 am and 10:00 am) and night (between 9:00 pm and 11:00 pm). Conversely, particulate matter tends to be lowest in the afternoon (from 3:00 pm to 5:00 pm) (Talhelm 2024). This is important to consider when interpreting the results of our study, because low readings for particulate matter may reflect the overall trend of particulate matter peaks and troughs throughout the day.



Volatile organic compounds (VOCs) were also included in the air study data collection. VOCs are "human-made chemicals that are used and produced in the manufacture of paints, pharmaceuticals, and refrigerants" ("What Are Volatile Organic Compounds (VOCs)? | US EPA," n.d.). Measurements for VOCs tend to be two to five times higher indoors than outdoors, regardless of whether the home was located in a heavily industrialized or rural area.



Technology Used

AtmoTube Pro® Air Quality Monitors

To conduct our air quality measurements, we used AtmoTube Pro® air quality monitors. These are small, portable air quality monitors that measure particulate matter (PM), volatile organic compounds (VOCs), a total air quality score (AQS), temperature, humidity, and barometric pressure. The particulate matter measurements included PM_1, $PM_{2.5}$, and PM_{10}. The data collection process is passive, meaning the device works on its own by sitting out in the air. We chose to do the air studies at the same time as the speed studies for efficiency.

Results and Discussion

The following tables present the preliminary findings for the air studies at representative points in Bragtown and Merrick-Moore. As previously mentioned, the variables measured include: PM_1, $PM_{2.5}$, PM_{10}, VOCs, a total air quality score (AQS), and the date and time of the measurement.

Bragtown Air Studies

Location	PM_1 ($\mu g/m^3$)	$PM_{2.5}$	PM_{10}	PM (total)	VOC (ppm)	AQS	Date & Time
E Club & Dearborn	4.0	5.4	6.6	16.0	0.00	94 (good)	3/22/24 9:24 am
Dearborn & Ora	3.8	5.2	6.2	15.2	0.15	94 (good)	3/22/24 10:02 am
E Carver & Cub Creek	16.3	18.4	19.6	54.3	0.33	78 (moderate)	4/2/24 5:46 pm
E Ellerbee & N Roxboro	7.2	8.7	9.9	25.8	0.18	86 (good)	4/2/24 4:20 pm
E Channing & Roxboro	11.3	13.1	14.1	38.5	0.25	85 (good)	4/2/24 4:50 pm
E Club & Dearborn	21.7	24.0	25.4	71.1	0.09	73 (moderate)	4/2/24 6:10 pm

The highest and lowest measurements for total particulate matter was taken at E Club Blvd & Dearborn Dr at different times of day. This range shows that time of day plays a significant effect on air quality. Additionally, it is possible that Durham in general may have had a poorer air quality day on the day with higher particulate matter measurements. More data collection should be done in order to extrapolate patterns of areas with repeated high measurements of particulate matter and volatile organic compounds. In future studies, temperature can also be included to compare to other parts of the city to provide evidence of the urban heat island effect in Bragtown and Merrick-Moore.

The data for Merrick-Moore was more limited than Bragtown due to delayed access to technology during the data collection period. Higher levels of particulate matter were observed on April 23rd at 8am. More data collection at different times of day can help determine when air quality tends to be the best and worst in a 24-hour period.

Location	PM1 ($\mu g/m^3$)	$PM_{2.5}$	PM_{10}	PM (total)	VOC (ppm)	AQS	Date & Time
Mt. Zoar Baptist Church	1.0	2.5	3.2	6.7	0.20	87 (good)	4/5/24 9:01 am
Cheek & Center	1.0	2.1	3.5	6.6	0.03	98 (good)	4/5/24 10:32 am
Mt. Zoar Baptist Church	4.8	6.3	7.3	18.4	0.00	94 (good)	4/23/24 8:03 am

Conclusion and Next Steps

Section 5

Conclusion and Next Steps

This report presents existing conditions along major roads in Bragtown and Merrick-Moore, quantitatively describing the lived experiences of residents living in close proximity to near-road air pollution, speeding vehicles, and traffic noise.

Leaders of BCA and MMCDC identified the most critical areas where we should measure these road impacts, however several of these places with high traffic felt unsafe for collecting data. In Merrick-Moore and Bragtown, we did not want to park on or near private property, limiting the possibilities for measuring speeds on long stretches of continuous road where the road design may encourage speeding. Standing outside the car or parking near the intersection may prompt vehicles to slow down, impacting our speed data. But we also wanted to be visible so that we would not get hit by a motorist.

Furthermore, we were not comfortable conducting noise studies at night since we would have to be outside where drivers may not see us. West of Merrick-Moore Elementary School, more industrial uses prevail, but there was not a safe place to pull over without impeding traffic or being on private property. While the community voiced that Cheek Rd & Hoover Rd experiences a lot of traffic conflicts, we did not feel safe parking in the shoulder at that intersection.

In Bragtown, many dangerous areas identified by community members, such as the curve of Dearborn Drive and the marshy area at Dearborn and Midland Terrace, do not have areas for us to pull off and take measurements safely. Further coordination with BCA and MMCDC to identify safe areas to collect data near the problem spots may mitigate these concerns.

We identified process improvements and next steps for data collection on noise, air, and speed metrics.

For noise data, additional capacity and proper equipment for taking longer readings at each location. Equipment should be capable of recording for an hour along low-traffic roads. Decibel X is a viable option for this research, but app settings should be explored to easily save large datasets. Future noise studies should follow the guidance in Chapter 3 of the FHWA Noise Measurement Handbook.

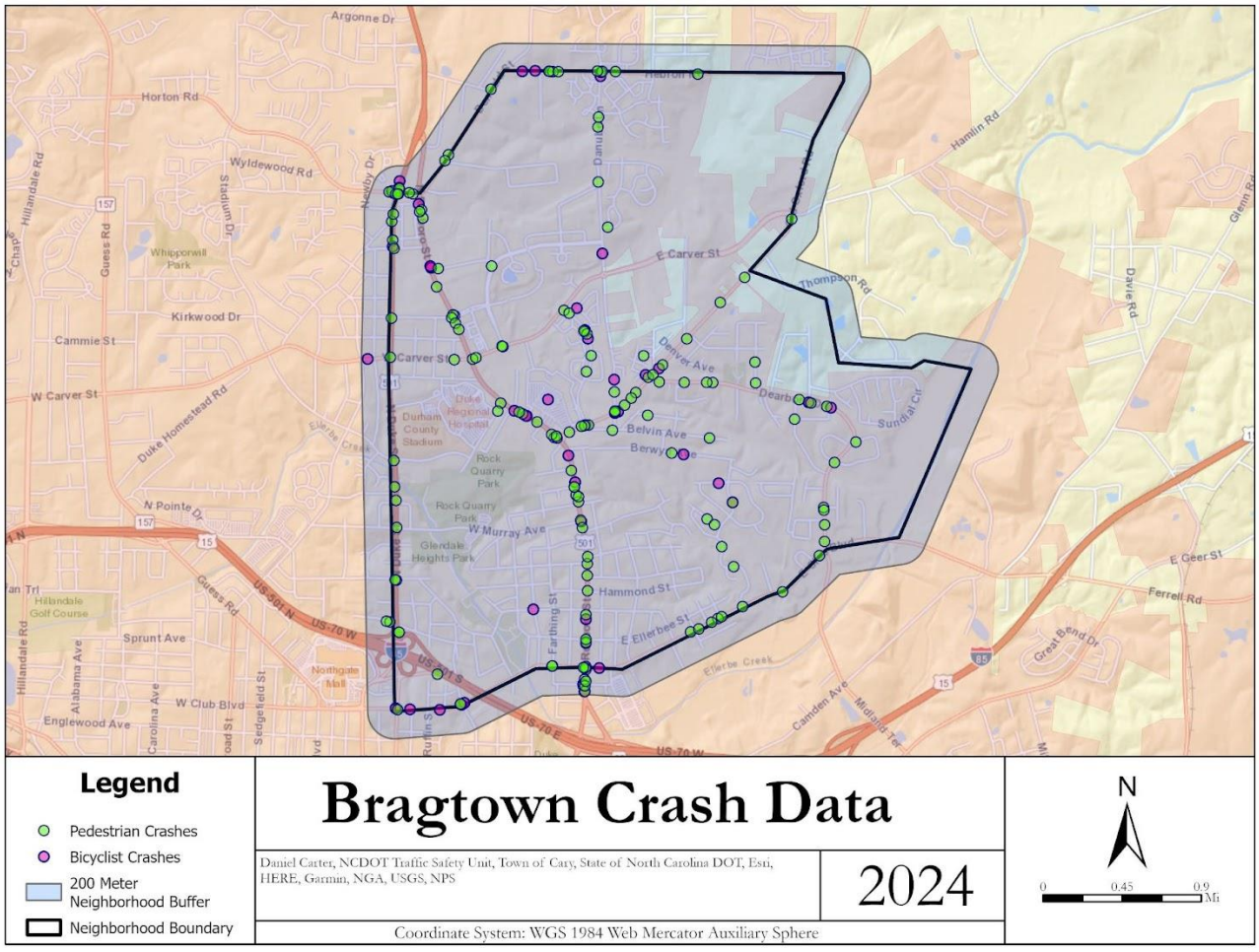
The next phase of air measurements should compare temperature and air quality Bragtown and Merrick-Moore with data from other areas of Durham to identify disparities. Measurements should also consider the time of day when air quality trends are worst.

For the speed study, revisiting locations at different times of day and different days can describe how road conditions change within a day or a week. Consistent data reporting and collaboration with BCA and MMCDC will make these data products more useful for their advocacy.

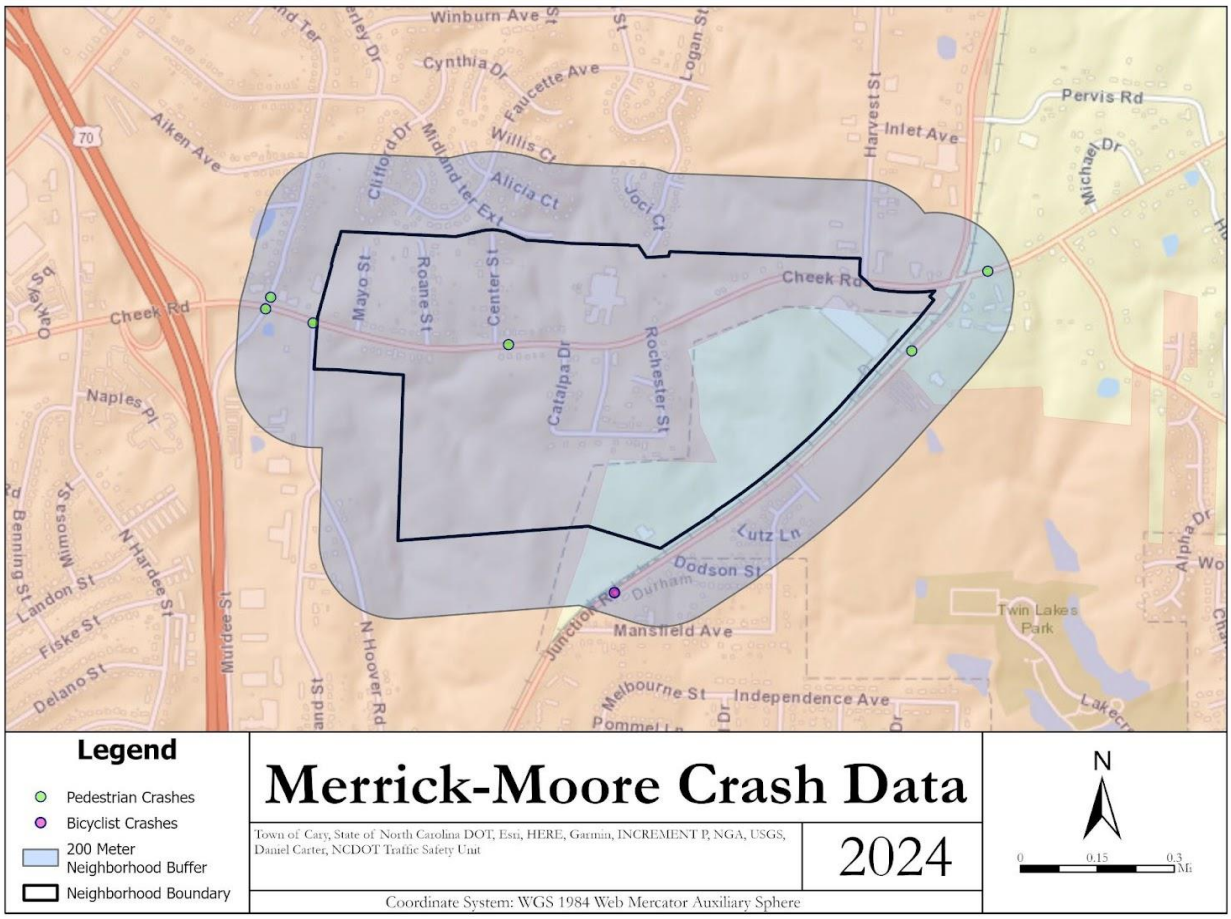
Appendix A: Crash Data

Section 6

Bragtown Crash Data



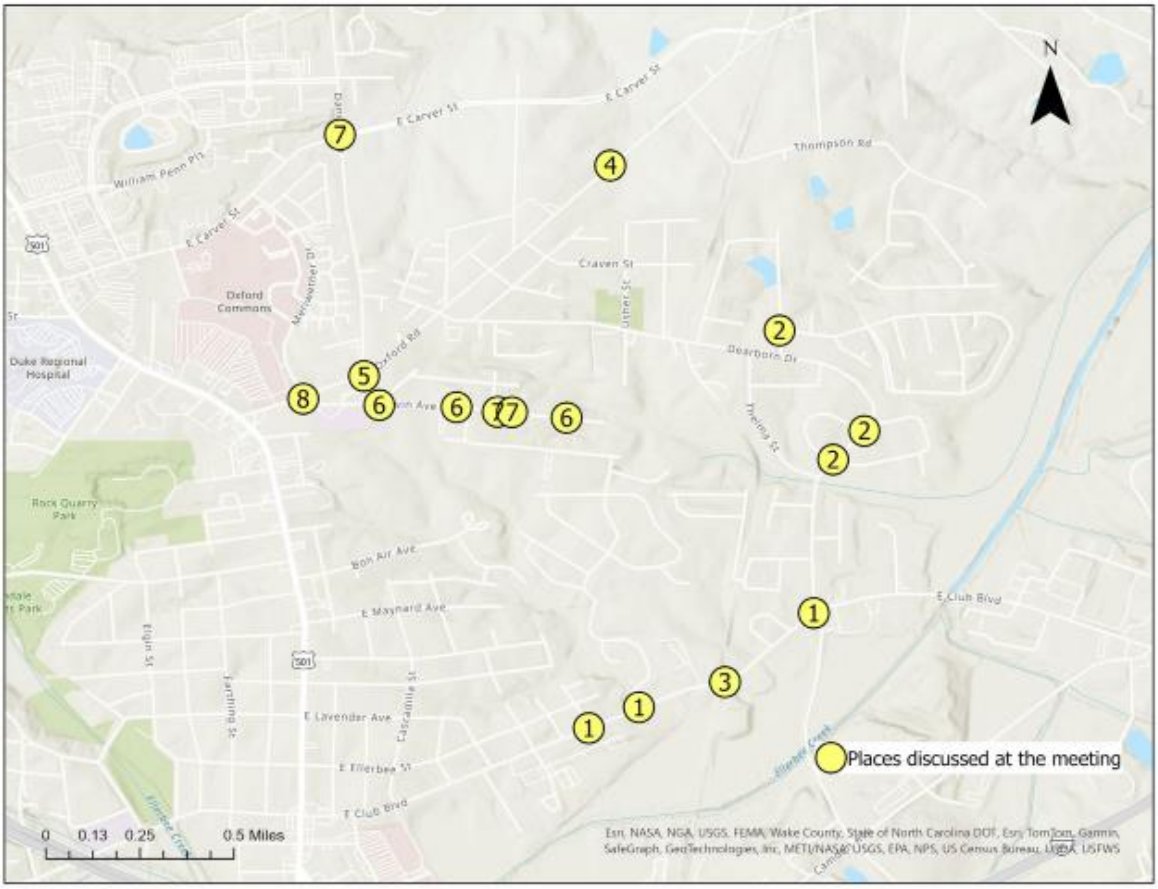
Merrick-Moore Crash Data



Appendix B: 3/9 Meeting Notes

Section 7

Bragtown Suggested Measurement Locations



1. **Both sides of Club Boulevard going through Bragtown**
   a. Sidewalks stop at Bragtown Library, more are needed.
   b. The area needs flashing lights—there is low visibility.
   c. Cars drive off into the creek.
2. **Dead Man's Curve**
   d. Needs guard rails, not just signage.
   e. Safety needs extends to bottom part of Maplewood Drive, close to creek.
3. **Heavy trucks do go over the speed limit on Club Road**
4. **Old Oxford Road**
   f. Many people walk along this road, alongside the road where its a dirt path.
   g. This is a site that needs a speed study.

5 and 6. The area where Danube, Merriweather and Old Oxford meet

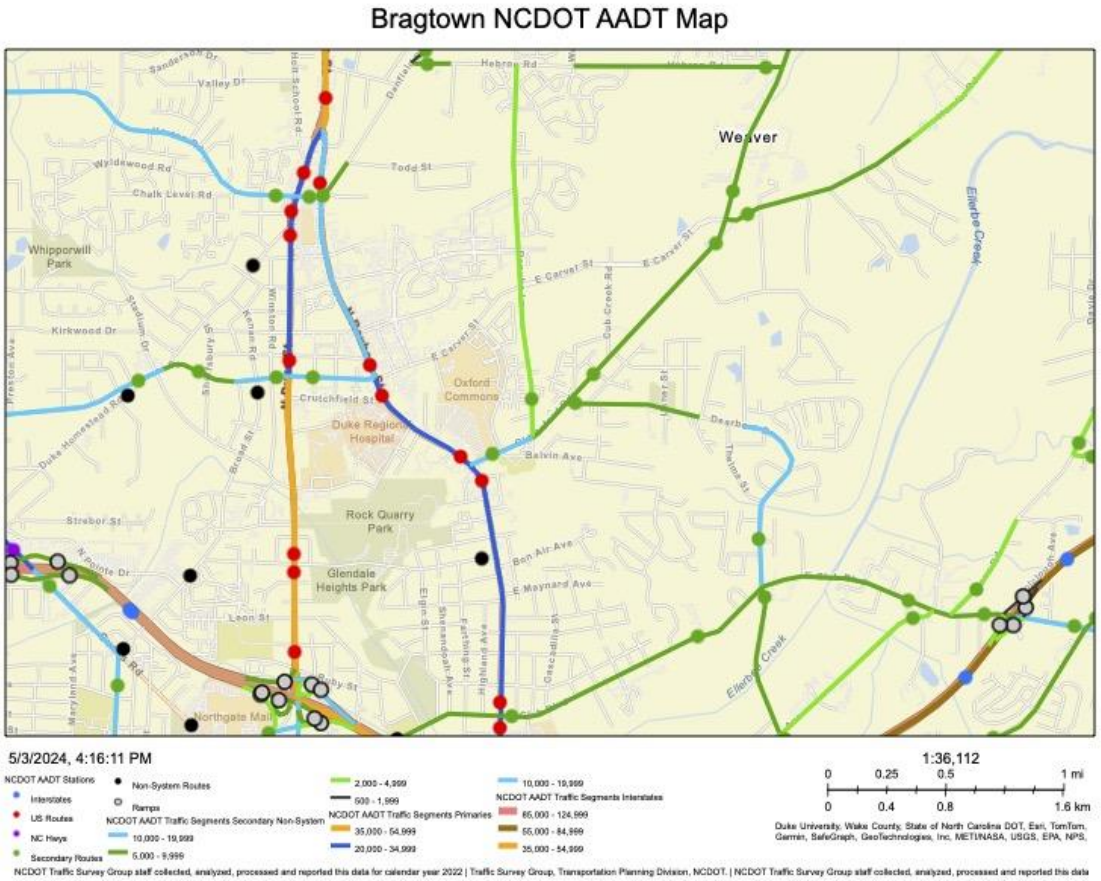
   h. This area has inconsistent sidewalks.
   i. The streets in these areas can be crooked.
   j. Residents asked for curbs, but the city just put in white strips.
   k. People are frequently seen walking along Belvin Road.

7. **Carver and Danube**
   l. Residents identified these as streets that would be pleasant to have sidewalks on.
8. **For speed study: Old Oxford from Merriweather to the creek**

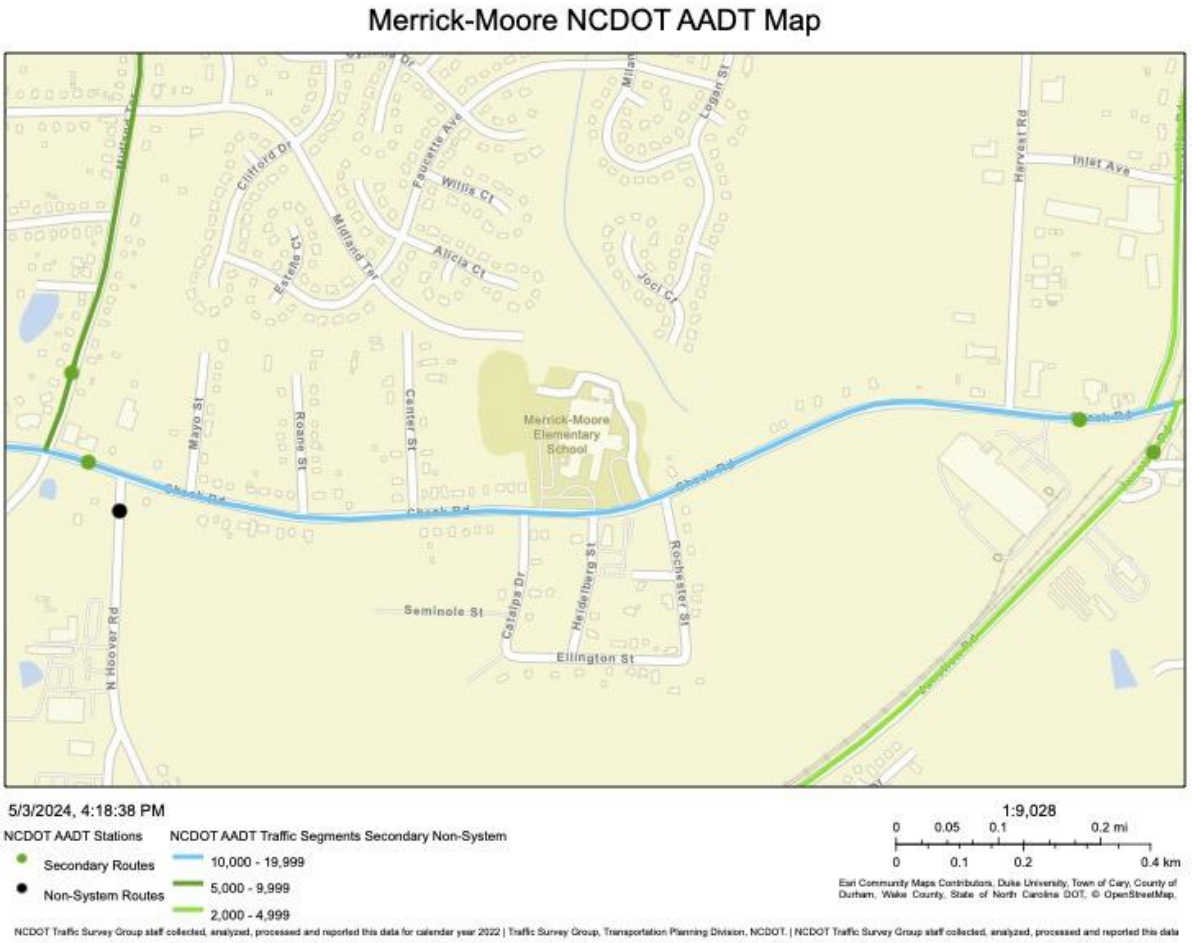
Appendix C: AADT Maps

Section 8

Bragtown NCDOT AADT Map



Merrick-Moore NCDOT AADT Map



References

Section 9

References

"Addressing Environmental Justice to Achieve Health Equity." n.d. Accessed May 2, 2024. https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2020/01/14/addressing-environmental-justice-to-achieve-health-equity.

Centers for Disease Control and Prevention. 2022. "What Noises Cause Hearing Loss?" Environmental Health. November 8, 2022. https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html.

Federal Highway Administration. 2017. "Highway Traffic Noise Analysis and Abatement Policy and Guidance." August 24, 2017. https://www.fhwa.dot.gov/environMent/noise/regulations_and_guidance/polguide/polguide04.cfm.---. 2018.

---. "Techniques for Reviewing Noise Analyses and Associated Noise Reports." FHWA-HEP-18-067. https://www.fhwa.dot.gov/Environment/noise/resources/reviewing_noise_analysis/#toc494123462.

Gilani, Towseef Ahmed, and Mohammad Shafi Mir. 2021. "A Study on the Assessment of Traffic Noise Induced Annoyance and Awareness Levels about the Potential Health Effects among Residents Living around a Noise-Sensitive Area." *Environmental Science and Pollution Research* 28 (44): 63045–64. https://doi.org/10.1007/s11356-021-15208-3.

"Informational Guide on Data Collection and Annual Average Daily Traffic (AADT) Estimation for Non-Federal Aid-System (NFAS) Roads." n.d.

"Neighborhood and Built Environment - Healthy People 2030 | Health.Gov." n.d. Accessed May 2, 2024. https://health.gov/healthypeople/objectives-and-data/browse-objectives/neighborhood-and-built-environment.

North Carolina Department of Transportation. 2021. "2021 Traffic Noise Policy." F.35.0103. Division of Highways, Traffic Noise and Air Quality Group. https://connect.ncdot.gov/resources/Environmental/EAU/TNAQ/Documents/2021%20Traffic%20Noise%20Policy.pdf.

"PI18027_traffic_data_pocket_guide.Pdf." n.d. Accessed May 3, 2024. https://www.fhwa.dot.gov/policyinformation/pubs/pl18027_traffic_data_pocket_guide.pdf.

Roswall, Nina, Vibeke Høgh, Pernille Envold-Bidstrup, Ole Raaschou-Nielsen, Matthias Ketzel, Kim Overvad, Anja Olsen, and Mette Sørensen. 2015. "Residential Exposure to Traffic Noise and Health-Related Quality of Life—A Population-Based Study." Edited by Qinghua Sun. *PLOS ONE* 10 (3): e0120199. https://doi.org/10.1371/journal.pone.0120199.

"Speeding in Residential Areas, 2nd Edition." 2010. ASU Center for Problem-Oriented Policing. January 1, 2010. https://popcenter.asu.edu/content/speeding-residential-areas-2nd-edition.

"SpotSpeed.Pdf." n.d. Accessed April 29, 2024. https://popcenter.asu.edu/sites/default/files/learning/speeding/SpotSpeed.pdf.

"Swless13.Pdf." n.d. Accessed May 3, 2024. https://safety.fhwa.dot.gov/ped_bike/univcourse/pdf/swless13.pdf.

Stansfeld, Stephen, Charlotte Clark, Melanie Smuk, John Gallacher, and Wolfgang Babisch. 2021. "Road Traffic Noise, Noise Sensitivity, Noise Annoyance, Psychological and Physical Health and Mortality." *Environmental Health* 20 (1): 32. https://doi.org/10.1186/s12940-021-00720-3.

Talhelm, Thomas. 2024. "What Time of Day Is Air Pollution Lowest?" Smart Air (blog). February 29, 2024. https://smartairfilters.com/en/blog/when-is-pm-2-5-the-lowest/.

SECTION 9: REFERENCES

Tom's Mechanical. Reducing Exposure to VOCs In Your Home?. 5 Dec. 2023, https://www.tomsmechanical.com/blog/reducing-exposure-to-volatile-organic-compounds-vocs-in-your-home.

"Ultrafine Particles | IQAir." n.d. Accessed May 2, 2024. https://www.iqair.com/us/newsroom/ultrafine-particles.

US EPA, OAR. 2016. "Particulate Matter (PM) Basics." Overviews and Factsheets. April 19, 2016. https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.

"What Are Volatile Organic Compounds (VOCs)? | US EPA." n.d. Accessed May 2, 2024. https://www.epa.gov/indoor-air-quality-iaq/what-are-volatile-organic-compounds-vocs.