



Managing Heat Waves in Affordable Housing

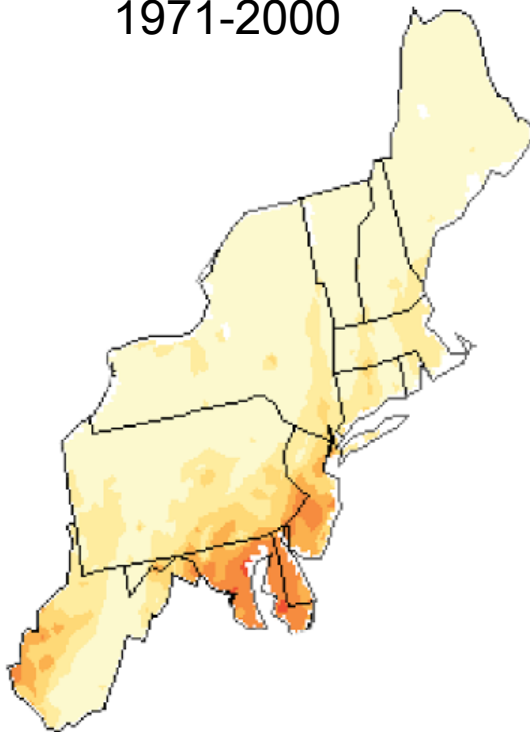
**EDRA 49- Oklahoma City
Creating Sustainable Cities for an Aging Population
Friday, June 8th 2018**

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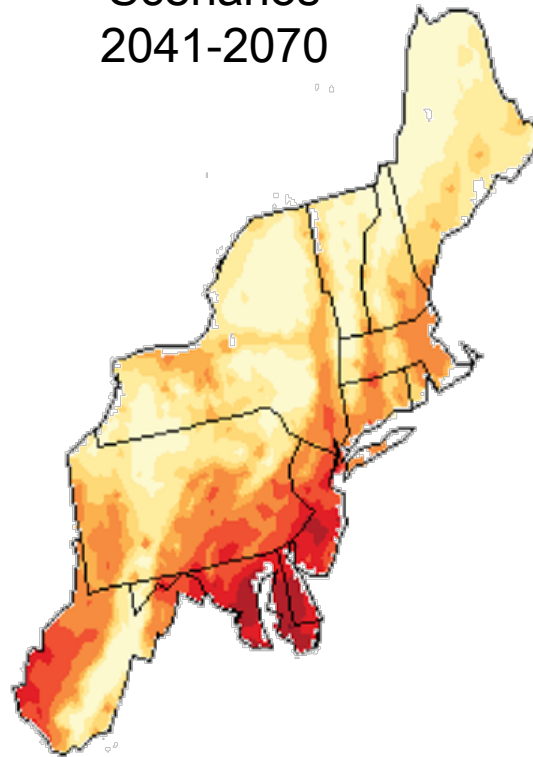
Funded by NSF Grant AGS-1645786
(PI: C. Andrews)

New Jersey's Changing Climate

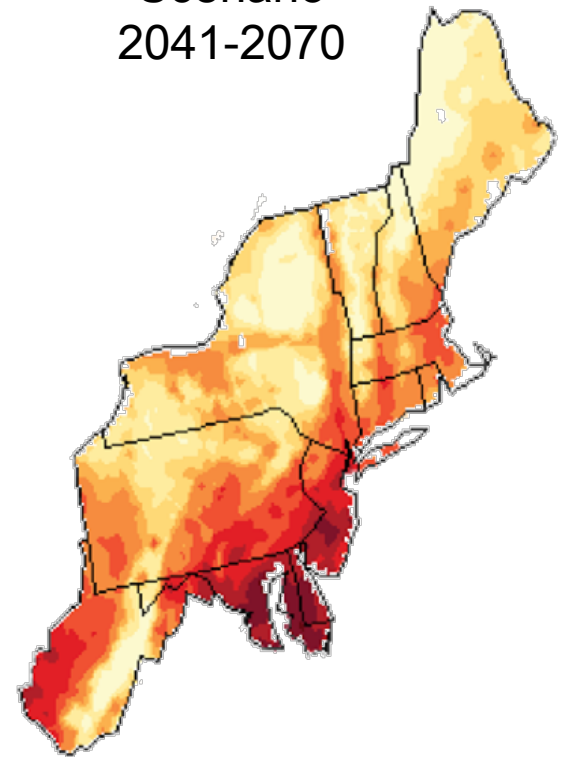
Historic
Climate
1971-2000



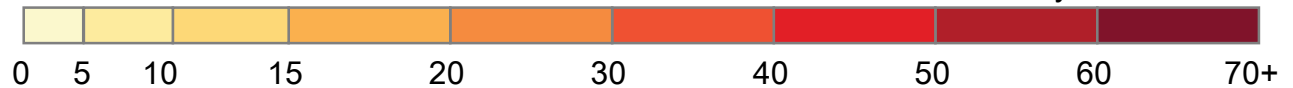
Best Case
Scenarios
2041-2070



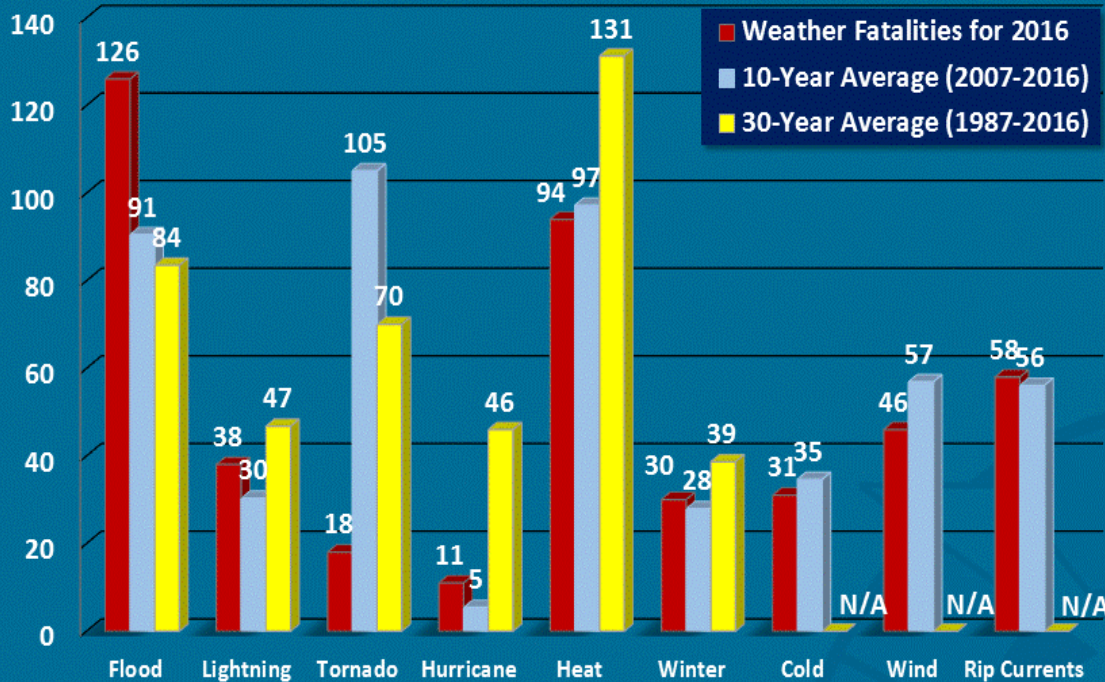
Worst Case
Scenario
2041-2070



Number of Days Above 90°

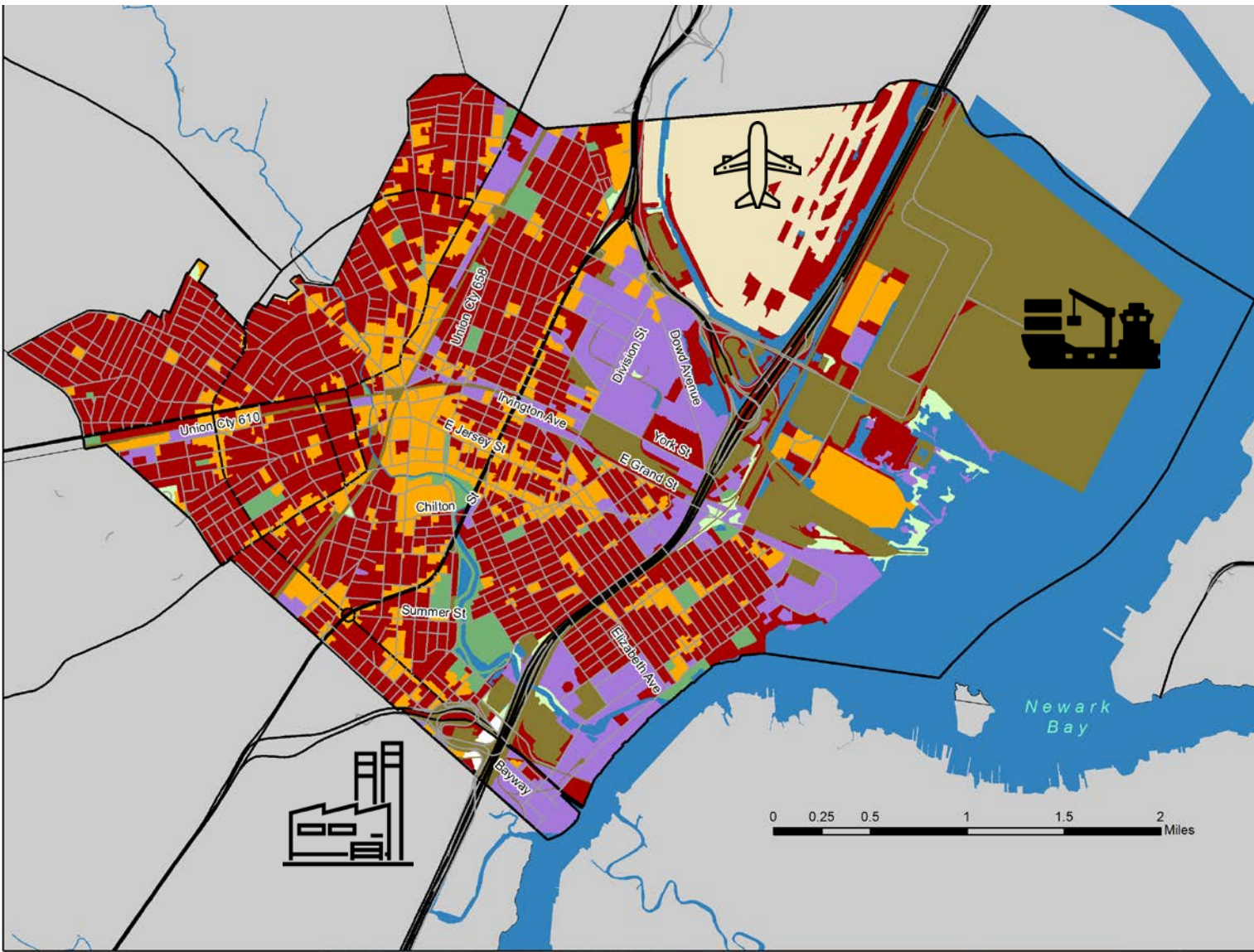


Weather Fatalities 2016



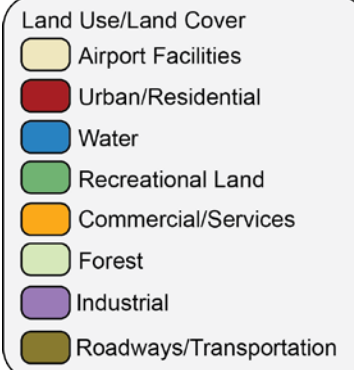
“On average, 130 people in the U.S. die from heat each year, according to the National Weather Service, based on data from a 30-year period. This is more than any other weather event.”

Study Site: Elizabeth, NJ

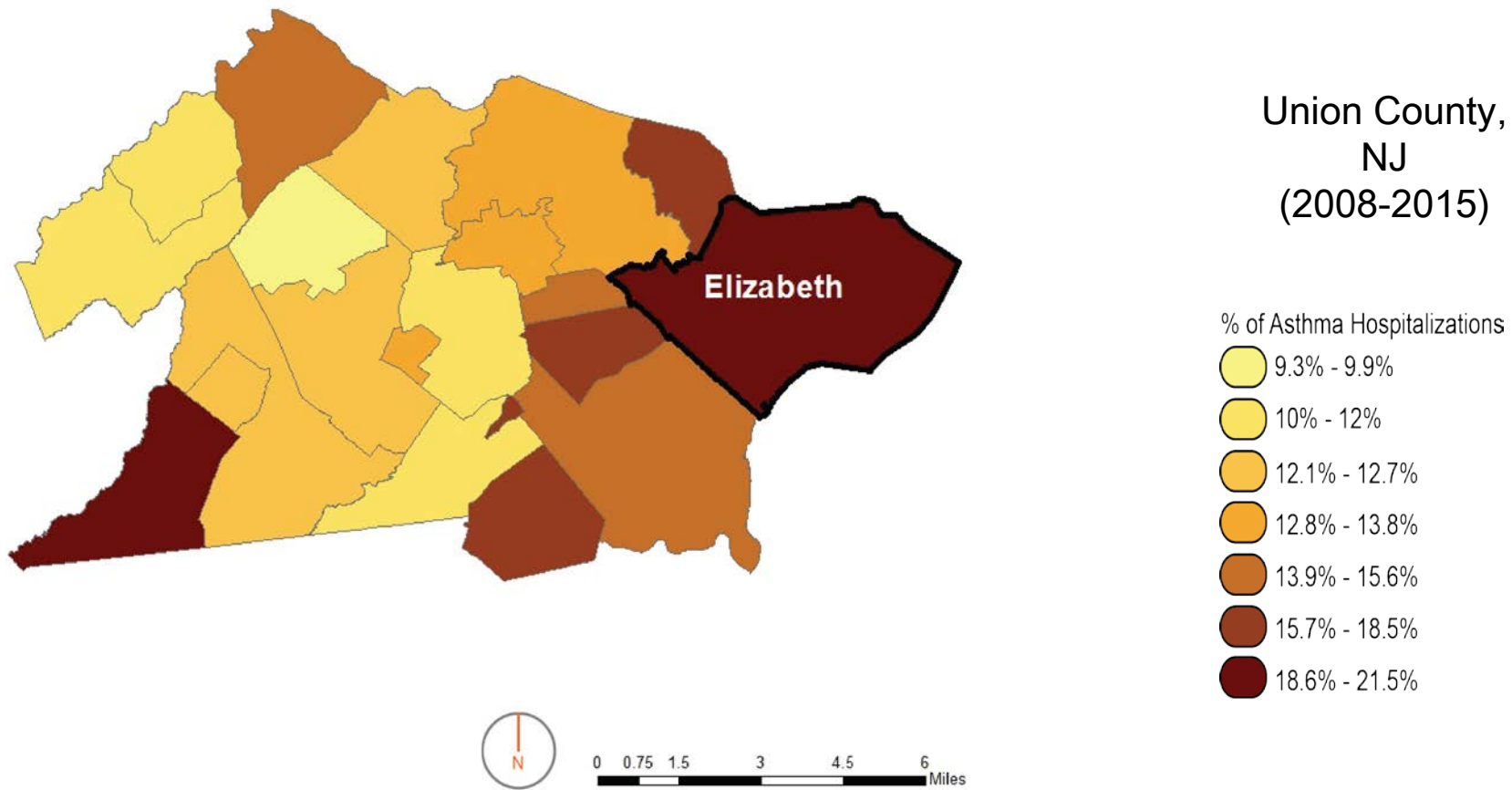


Close proximity to:

- Newark Airport
- Port Newark
- Marine Terminal
- Chemical refineries
- Highways

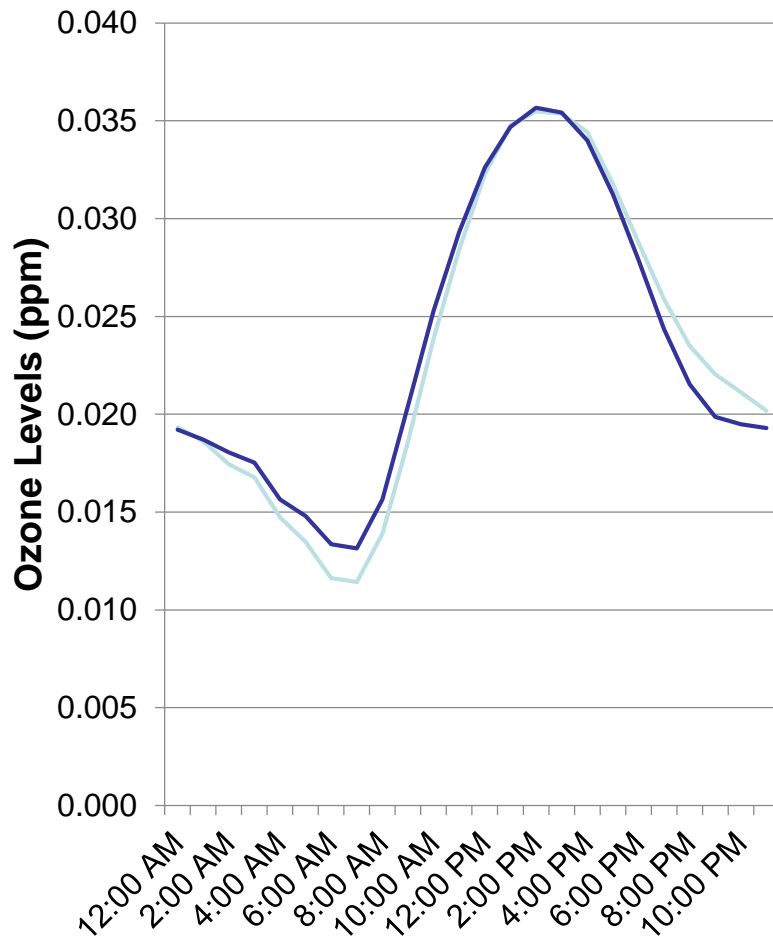


Elizabeth, NJ: High % of total hospitalizations that are due to asthma



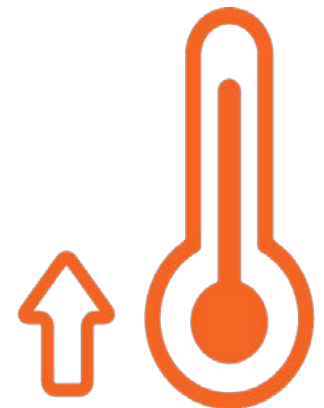
Heat Waves + Air Quality

Average Hourly Ozone (2016)



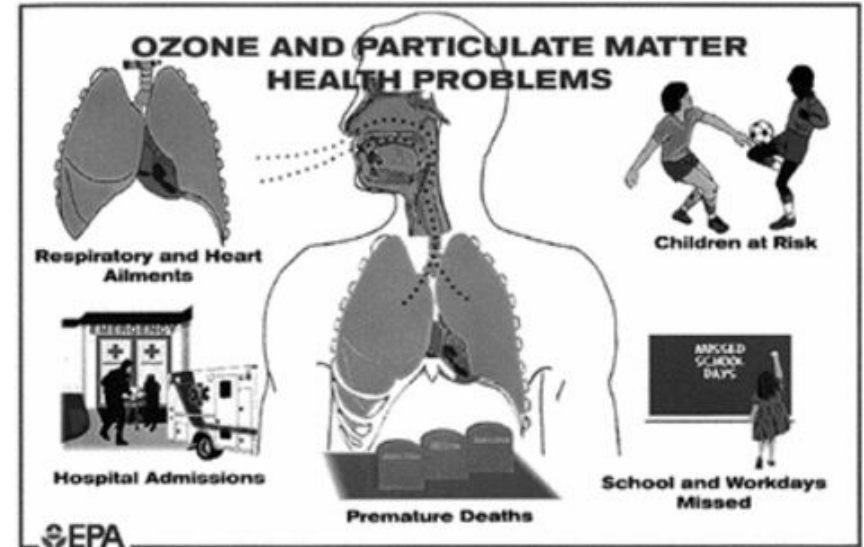
- High temperature associated with higher levels of ozone
- Ozone, PM_{2.5}, PM₁₀, CO₂ + high temperature have **negative effects on health**

— Bayonne
 — Newark Firehouse
Monitoring Stations



Indoor Air Quality + Health

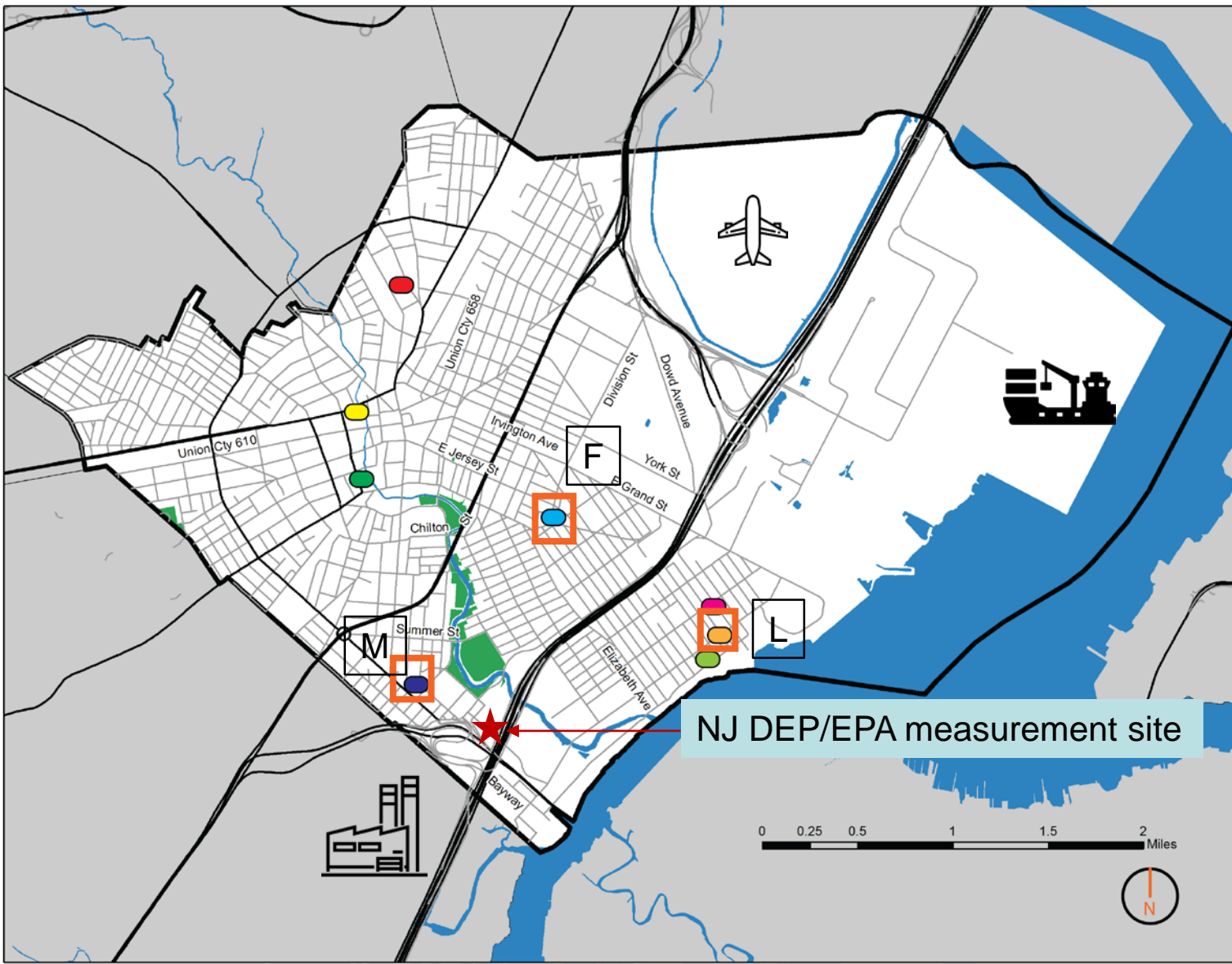
- Outdoor air quality \approx f(emissions, weather)
- Indoor air quality \approx f (outdoor air quality, building design, occupant behavior)
- People spend 90% of time indoors, so indoor exposures to air pollutants contribute to health effects
- No standards for indoor PM
- Individual health outcomes vary, even for similar exposures



Study design – read with next slide/s

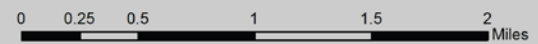
- Location: Elizabeth, NJ; 24 households in Housing Authority of the City of Elizabeth (HACE)
 - 3 different buildings
- Baseline interviews on SES, health, coping strategies, etc.
- Follow-up interviews; especially during heatwaves
- Continuous outdoor measurements using sensors
- Continuous indoor measurements (24 apts) using sensors
- Empty apartment: continuous measurements using sensors
- Study timeframe: July 1 – September 30

Housing Authority of the City of Elizabeth



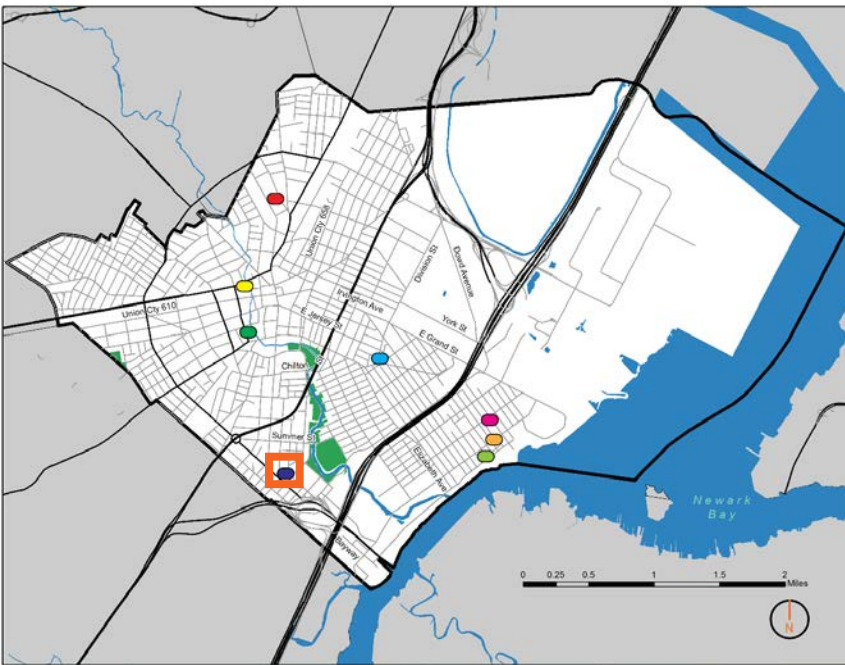
- HACE Properties**
- O'Donnell Dempsey Towers
 - Kennedy Arms
 - Farley Towers
 - Ford Leonard Towers
 - Mravlag Manor
 - Heritage Village
 - 205 1st St
 - Marina Village

NJ DEP/EPA measurement site



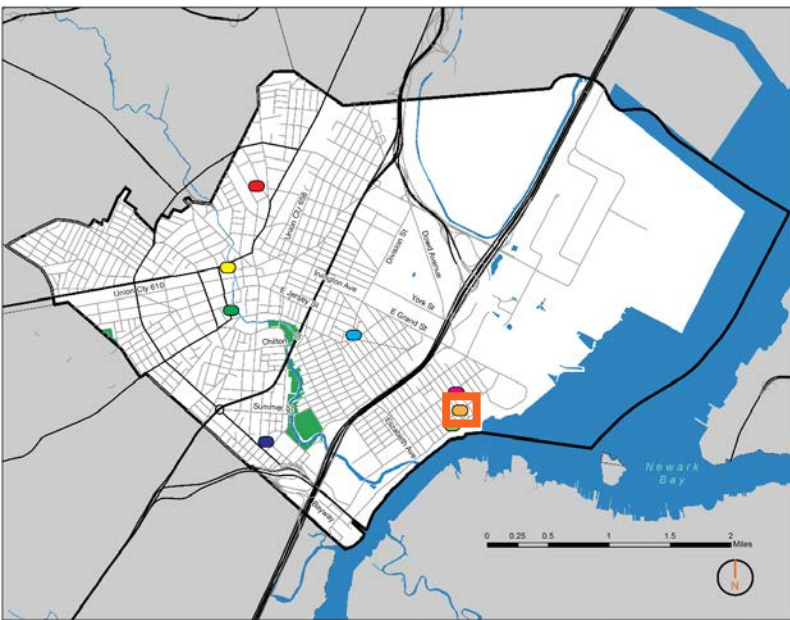
Mravlag Manor (Site M)

- 421 Units in 15 three-story walk-ups
- New roofs, fire escapes, heaters + bathrooms
- On-site community room and event space
- Social + financial support services



205 First Street (Site L)

- 30 Senior-only units
- Newest HACE property
- LEED Gold
- All units have access to central air



Social, Economic and Health Characteristics of Residents

Question	Answer	% of responses
Gender	Female	84%
	Male	16%
Age	55-64	34%
	65-74	45%
	75-84	21%
Education	Elementary school	4%
	Secondary school	21%
	High school	63%
Income	< 10,000	80%
	10,000-19,999	16%
	20,000-39,999	4%

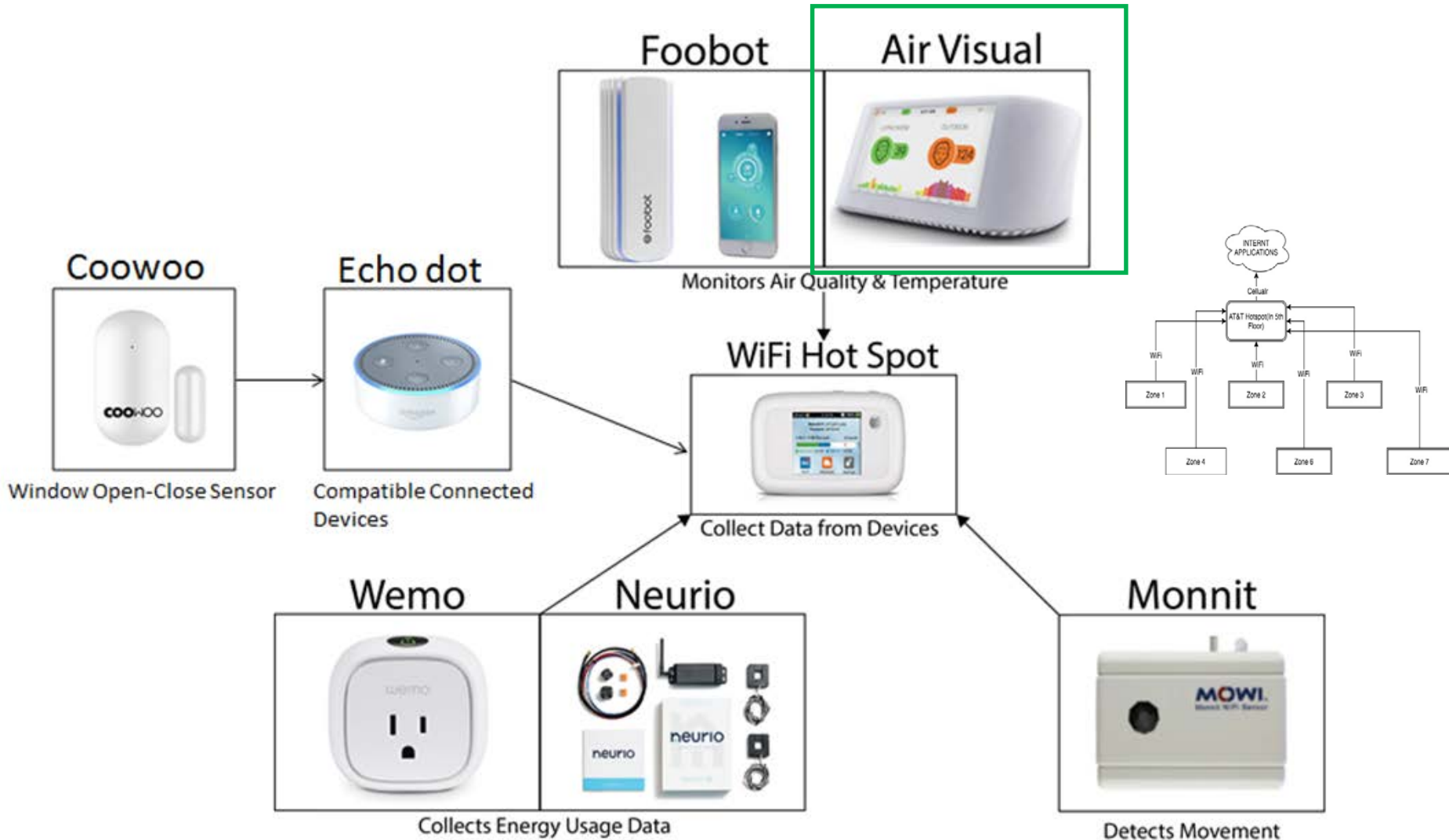
Question	Answer	% of responses
Overall Health	Very Poor	4.25%
	Fair	54%
	Good	37.5%
	Somewhat good	4.25%
Chronic Condition exacerbated by Heat	Yes	50%
	No	50%
Medical Care because of Heat	Yes	13%
	No	83%

Baseline interview (n = 24)

Sensor Measurements – read this next slide

- PM2.5, temperature, humidity measured by AirVisual consumer-grade devices
- Ozone (outdoors + empty apartment). POM from 2B Tech.
- Window open/close sensor
- Occupancy sensor
- AC usage sensor
- Electricity usage sensor
- All sensors connected to cloud

Consumer-grade sensors in apartments



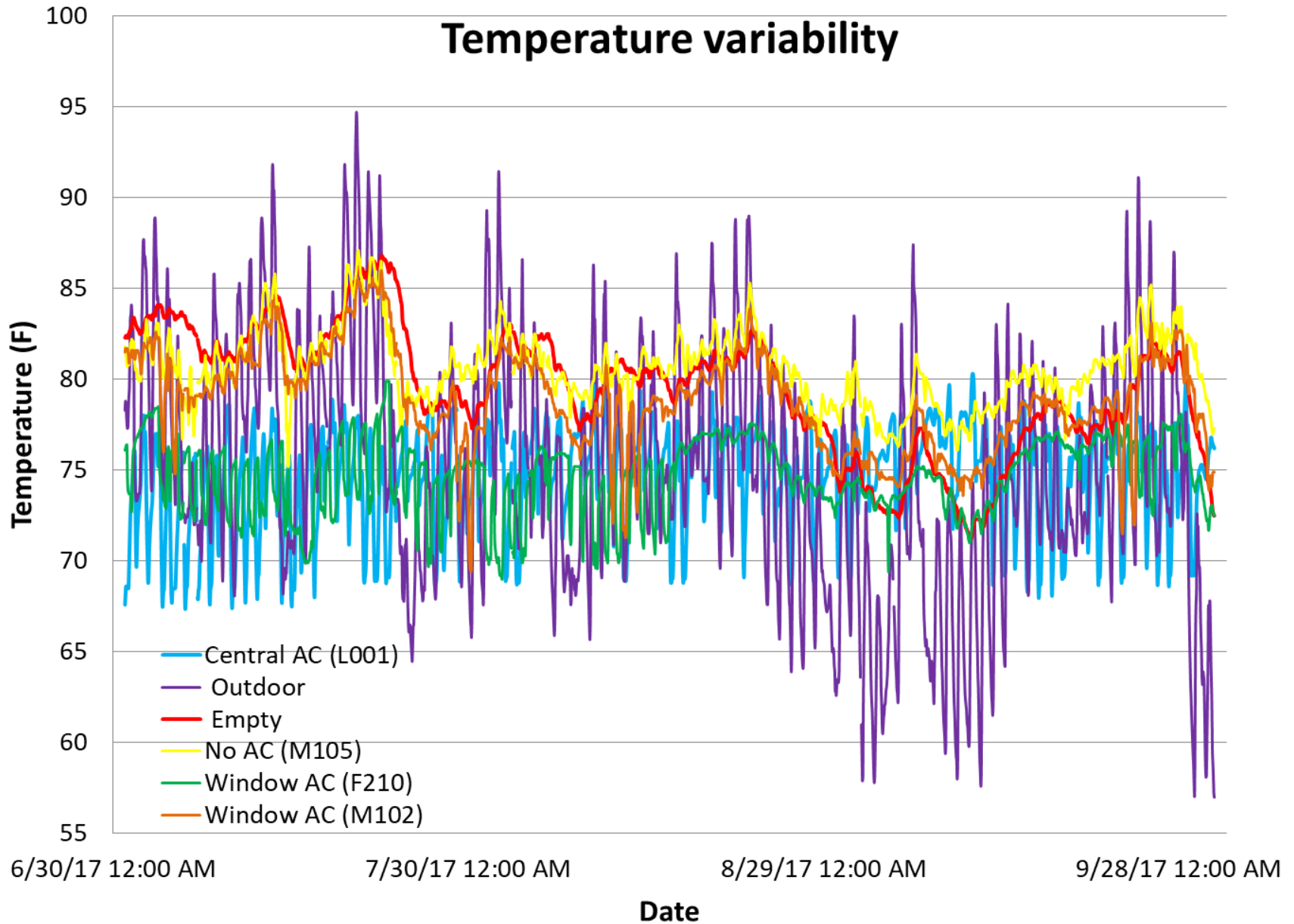
Air Quality Measurements: Outdoor site



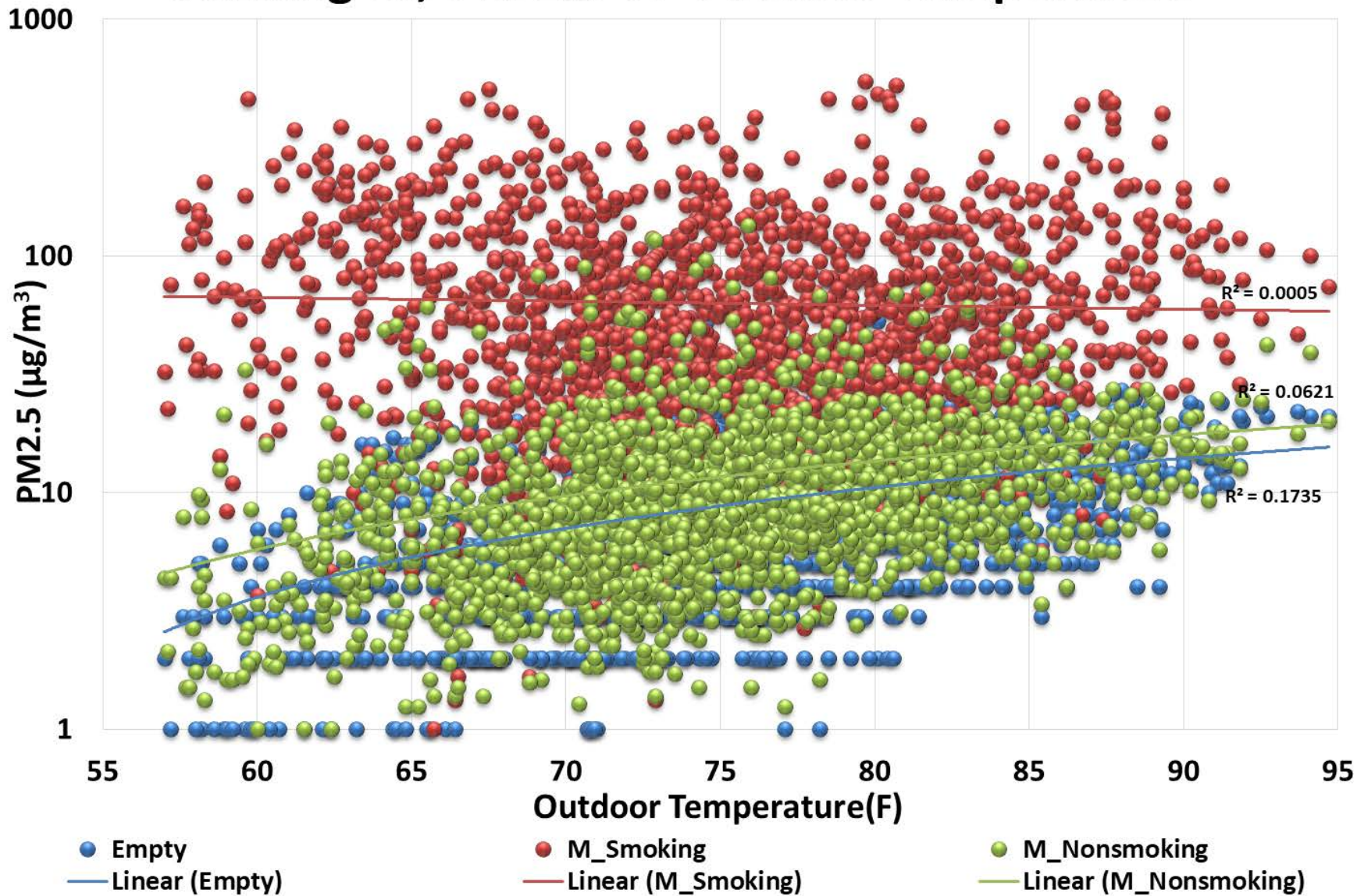
High level results – will be read w/ next slide(s)

- T higher on heat wave days, as expected
- Highly variable PM_{2.5} and its I/O ratios among apartments
- Clear role of smoking in indoor PM_{2.5} concentrations
- Strong correlation between outdoor T and indoor ozone, especially during hot days
- Hot days have beneficial effect on IAQ?!
 - If one can afford air conditioning, or rather air filtration option

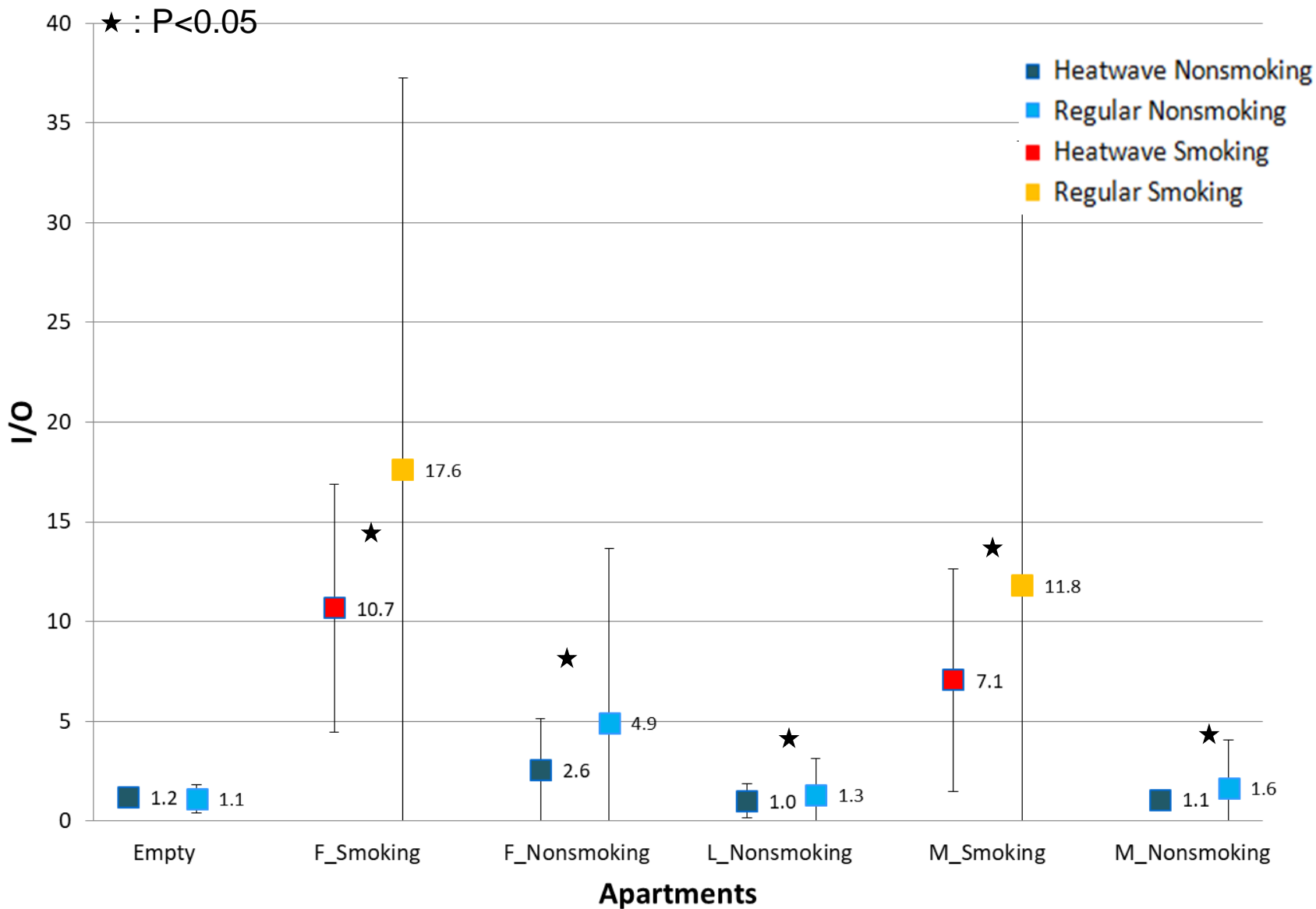
Temperature variability



Building M, PM 2.5 vs Outdoor Temperature



Heatwave and Regular Day, Avg. Indoor/Outdoor Ratio (Stdev)

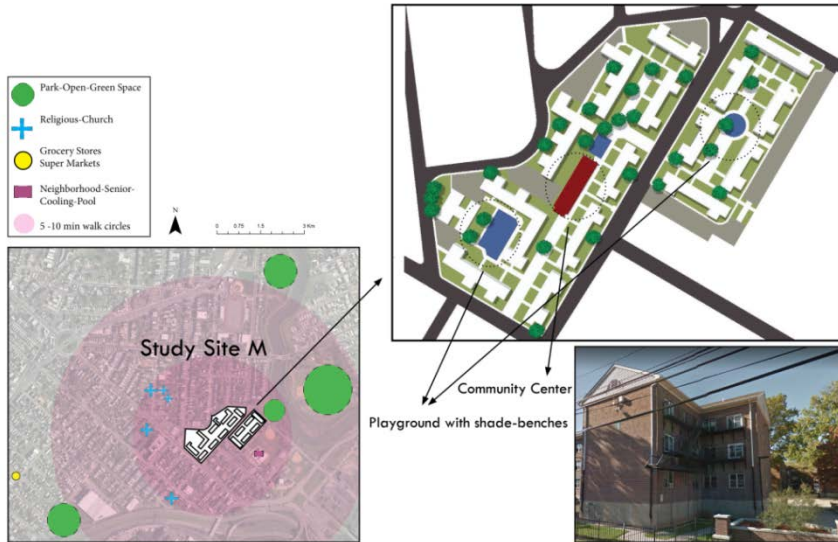


How do seniors living in public housing cope with heat waves ?

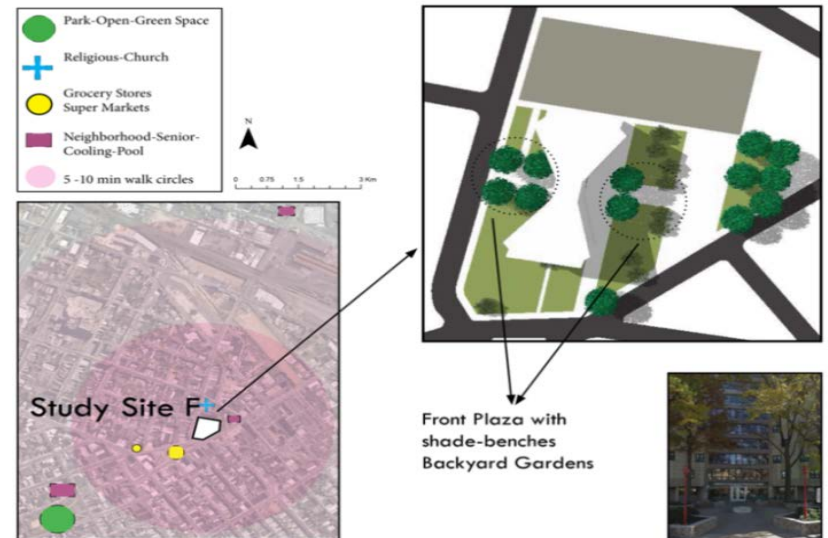
- Cool drinks, wet clothes, open windows, use fans, leave apartment?
- Alternatives accessed through formal and informal group affiliations?
- Other adaptive actions?



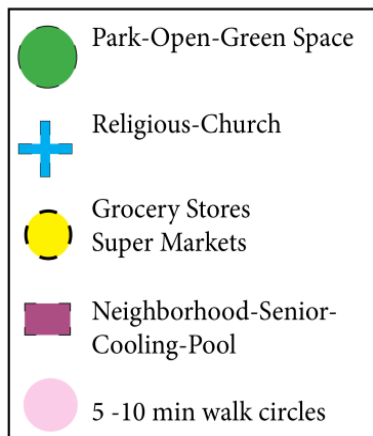
Physical characteristics of the study sites



Study Site M and its Surroundings ((NJGIN), 2016; Maps, 2017)



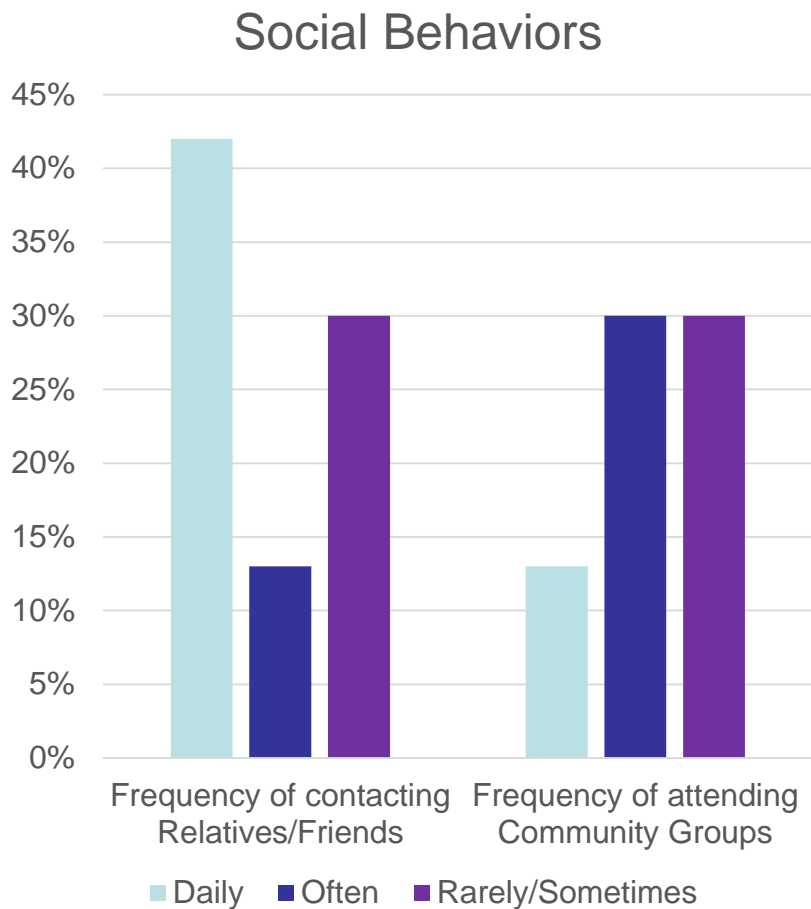
Study Site F and its Surroundings ((NJGIN), 2016; Maps, 2017)



Study Site L and its Surroundings ((NJGIN), 2016; Maps, 2017)



Social Behaviors of Residents (Baseline Conditions)



70% of respondents participate in Community Groups

Baseline interview (n = 24)

Frequencies of Adaptive Actions During Heat Waves

	Baseline (N=24)	Heat Wave Days (N=96)
Adjustable Fan	75%	75%
Open Windows	46%	67%
Close Windows	83%	91%
A/C	79%	81%
Clothing Adjustment	63%	48%
Avoid Oven	--	51%
Avoid Stove	--	22%
Avoid Candles	--	16%
Avoid Smoking	--	12%
Leave Apartment*	80%	63%



Baseline Interviews vs. Actual Heat Waves Summer 2017

*Not necessarily in search for a cooler place (only 5% left in search of a cooler place)

Adaptive Actions by Study Site

	M (N=49)	F (N=7)	L (N=4)
Adjust Fan	82%	57%	50%
Close Windows	82%	100%	100%
A/C	91%	100%	50%
Clothing Adjustment	73%	29%	25%
Avoid Oven	91%	57%	25%
Avoid Stove	73%	14%	25%
Avoid Candles	45%	0%	0%
Avoid Smoking	45%	0%	0%
Leave Apartment*	91%	71%	100%

Reported during the heat wave of July 17-21, 2017 (n = 96)

*Not necessarily in search for a cooler place (only 5% left in search of a cooler place)



Gas stove at Building M

Adaptive Options -- Building Environs

Sample (N=96) Outdoor Adaptive Actions	
Within HACE	Lobby/Community Room-Center
	Outdoor Yard
	Community Gardens
Outside HACE	Visit Relative/Friend
	Shopping Store
	Senior Center
	City Cooling Room
	Park Nearby
	Library
	Public Pool
	Movie Theater
	Church
	Doctor/Hospital/Nursing
	Home/Pharmacy
	Food Pantries
	Walks around the Block
Festivals	



Resident preferences and suggestions for improvements

Use of amenities outside of HACE Comments
Exit Interviews (N=24)

	F	L	M
Parks	People rob and they need to be safer, but nice 3-4 small ones nearby.	Rosele Park	
Churches	Baptist in the corner	At East Jersey	
Libraries	A nice one in the area		Some library in the area would be good.
Senior Centers	Have nice activities	Senior Center Presbyterian, Steve Sanson Center, Ana Center, it is also a Cooling Center	Jefferson Square Town
Groceries	Nice and plenty within 5 min walk. New one in the division strtt, Casablanca, Super-Super, also Walmart, IKEA, Jersey Gardens Mall, Super Market in Old Bridge. But more and bigger super markets would be nice.	ShopRite at Linden and Elmore, Jersey Gardens Mall	Colmado, Shop Rite in Elizabeth and Linden and Emerald Ave in Elizabeth, Jersey Gardens, Supremo, BJ's, Sam's, Walmart in Linden, Twin City, DDonuts
Pharmacy	Nice one in the corner when needed.		

Resident preferences and suggestions for improvements

Use of Indoors (apartments) and Outdoors (within HACE boundaries) Comments from Exit Interviews (N=24)			
	F	L	M
Apartments	Need better A/C, more windows, too much dust,		Better windows; there is too much air draft. Heaters in winter do not warm up the apt, summer inside is very hot, too much asbestos work in the buildings, sanding in preparation to get new windows,
Yards	Nice gardens, smoking, interacting, more flowers, sitting spaces and greenery would be good. Good when it is hot, but same people every day is boring and they get nosy and need bigger space		Shady areas are nice and used, but more trees and greenery are needed, also crazy mentality of people in the area scares a lot. But gardens are nice
Lobby/Cooling/Community Center	They close it early; it is the same as staying in the apartment.		It is for people without families and without A/C, or it is outside the buildings and needs walking. Community center is nice when it has food events.



Hypotheses and Findings: Behaviors of Seniors in Affordable Housing Settings

Hypothesis	Finding
1. Heat waves push residents to act and change key behaviors.	Supported <i>All residents changed activity patterns during heat waves.</i>
2. Background physical and social conditions constrain residents' actions.	Partially Supported <i>Increased outdoor temperatures push residents to act, however, considering limited funds, mobility issues and others, they cannot go far, making them highly dependent on the few nearby amenities and on other people for transportation.</i>
3. Apartment and building systems constitute the primary choice environment within which residents live and operate, and it is constraining.	Supported <i>The majority of residents reported staying indoors for most of the heat wave day, using A/C and closing windows. However, not all study sites have the same characteristics, with some supplying central A/C and others not, and with quite different building envelopes.</i>
4. Supportive social networks may offset possible infrastructure inadequacies.	Supported <i>Organizations such as Proceed played a very important role since they installed A/C units in apartments that didn't have them. Friends and families checked on each other.</i>
5. Residents are the primary agents in a heat wave situation. They pick their actions from a list of available options dependent on infrastructural systems, supportive networks, and nearby amenities, however they may not always act towards adaptation.	Supported <i>The residents themselves initiated most or all activity. Their actions defined how well or not they adapted, and was seen, they sometimes smoke inside, light candles, or house pets without caring or even realizing the health consequences.</i>

Thank you!

Back-up Slides

Lifelong Elizabeth Survey Findings*

How far are you willing to walk from your home to a park or other destination?

Answer	Response	%
About a block	77	17%
2-3 blocks	119	27%
5-10 minute walk	102	23%
10-20 minute walk	89	20%
More than a 20 minute walk	62	14%
Total	449	100%

About 45 percent of respondents are willing or able to walk **no more than a few blocks** to a destination, but more than a third would take a walk greater than 10 minutes to reach a destination.

Lifelong Elizabeth Survey Findings*

How concerned are you about your personal safety related to crime in your neighborhood?

Answer	Response	%
Very concerned	206	45%
Somewhat concerned	167	36%
Not very concerned	69	15%
Not at all concerned	16	3%
Total	458	100%

A relatively high percentage of respondents are concerned about personal safety, with **more than 80 percent at least somewhat concerned** and close to half the sample “very” concerned.