



Infrastructure and History

Or: Who we are determines what we build (or don't) and who we serve (or don't)

Karen Merritt, PhD MPH

Outline – Technical

- Snapshot of *the now*
- History of *the then*
- Technical implications of *the then* for *the now*
- Implications of *the now* for your professional futures (*the when*)



Outline – Socio-Technical

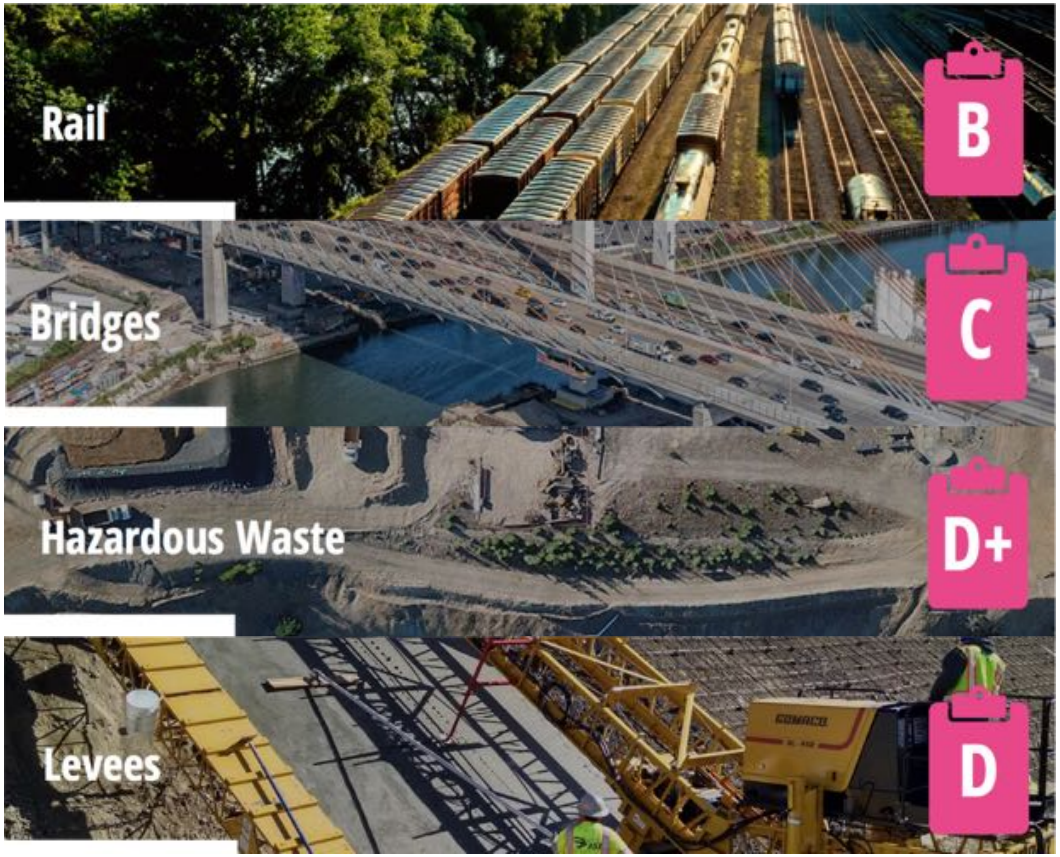
- Snapshot of *the now*
- History of *the then* **(and the question of how/if *the then* becomes (a different?) *the now*… let's talk about the continuum**
- Technical implications of *the then* for *the now* – **who carried the weight?**
- Social implications of *the then* for *the now* – **who still carries the weight?**
- Implications of *the now* for your professional futures (*the when*)
- **Strategies for changing the arc of *the then* to *the when* if you want to change who carries the weight**

Report Card for America's Infrastructure

AVIATION	BRIDGES
BROADBAND	DAMS
DRINKING WATER	ENERGY
HAZARDOUS WASTE	INLAND WATERWAYS
LEVEES	PORTS
PUBLIC PARKS	RAIL
ROADS	SCHOOLS
SOLID WASTE	STORMWATER
TRANSIT	WASTEWATER

ASCE 2021

How Does that **C-** Distribute??



What is it that we *do* as civil engineers?

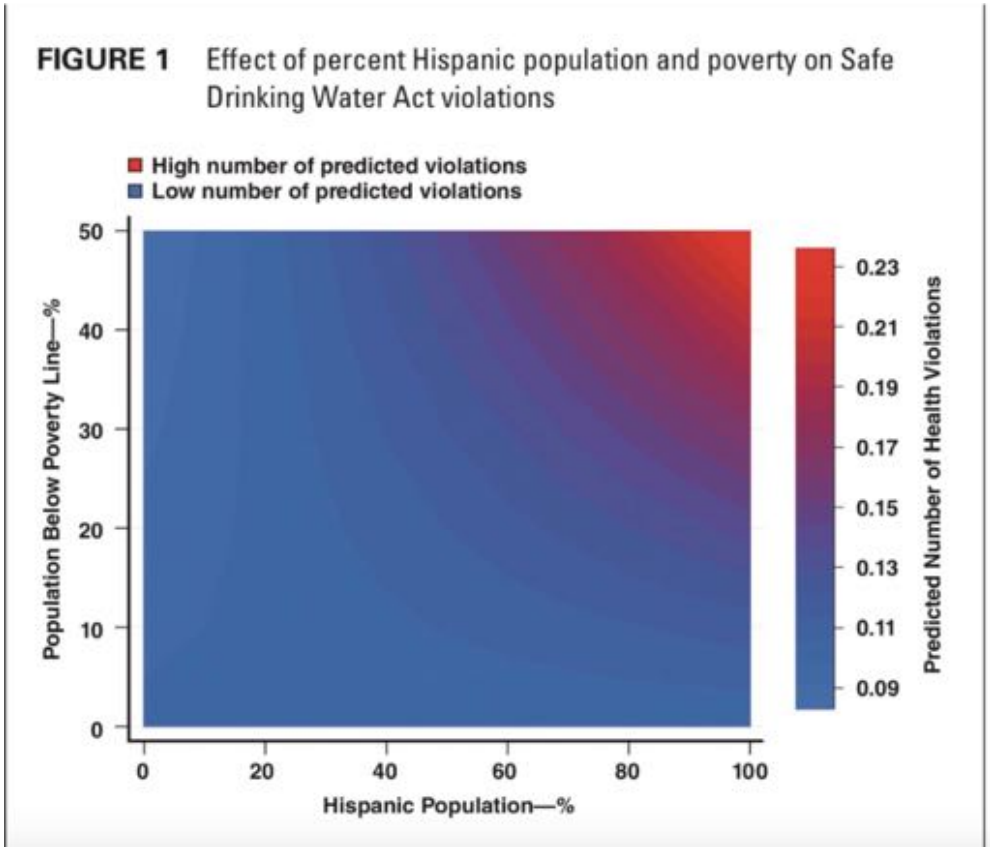
1. *Practice the disciplines of transportation, environmental, structural, water resources, and geotechnical engineering, and/or related fields.*

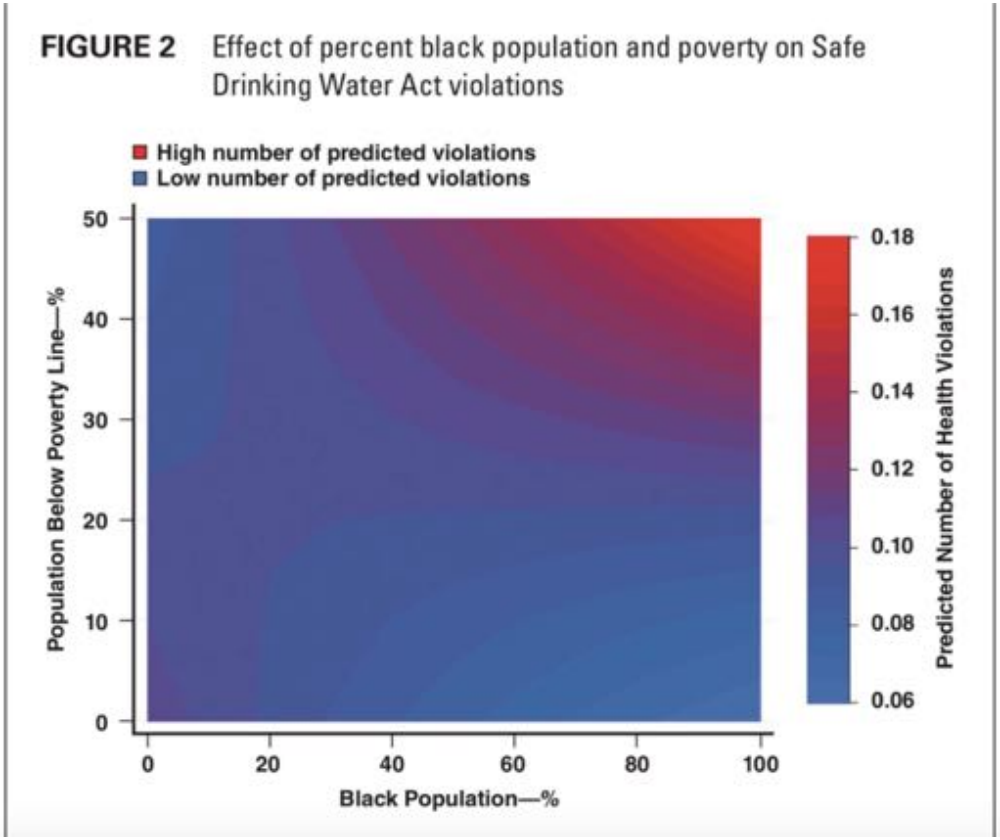
Why is it that we *do* what we do as civil engineers?

4. *Promote and advance public health and safety, and enhance quality of life.*

Who is it that we do this for (or don't)? Why (not)?

Example: Do Ethnicity or Race × Socio-Economic Status Impact Drinking Water Quality? (Switzer and Teodoro, 2017)





Social History and Technical History are Linked

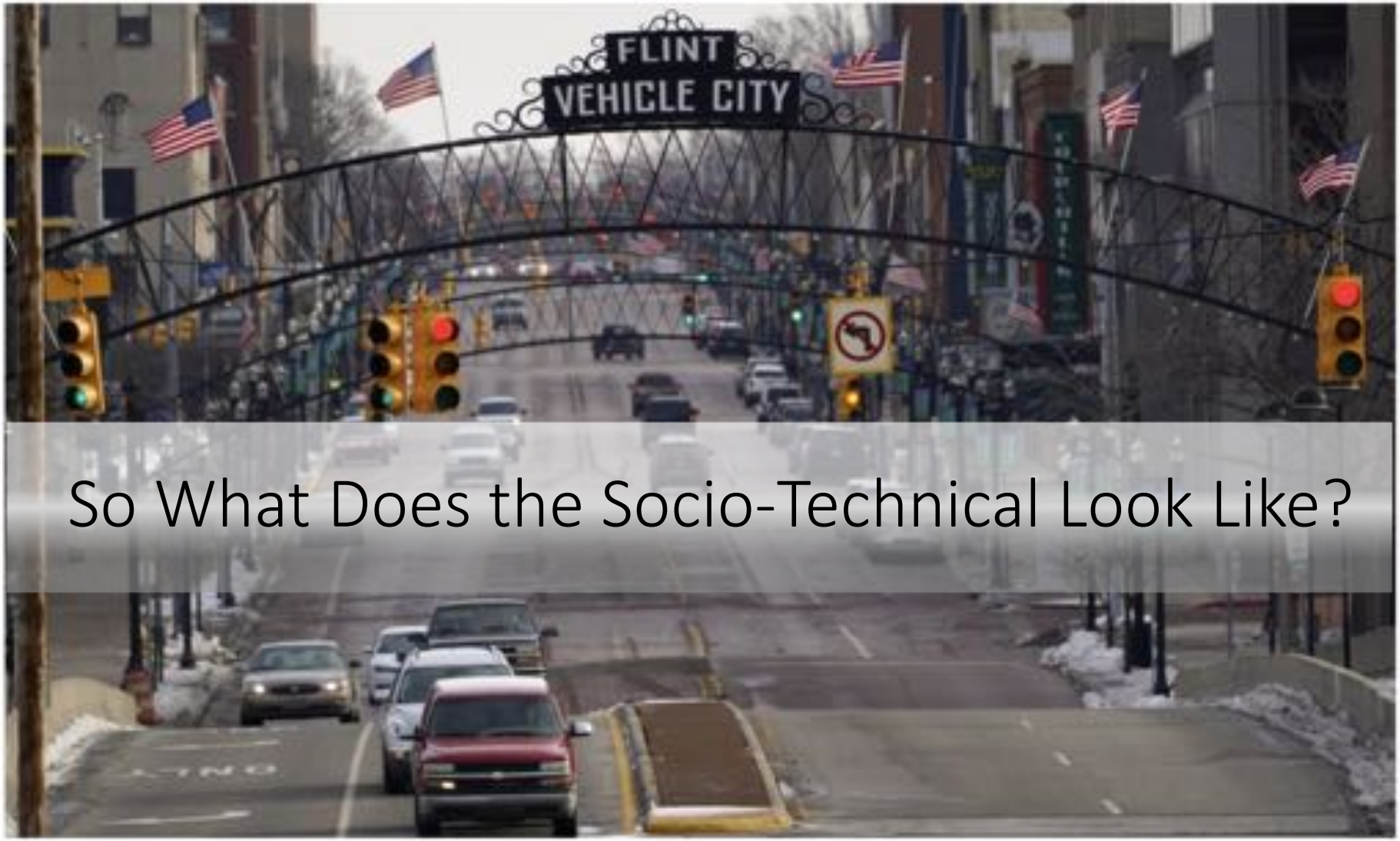
Pruitt – Igoe Housing Complex
St. Louis, MO (1956)

Social history of the 20th Century in the United States

- Industrialization – WWI and WWII and the massive ramp-up
- Racial Segregation – Jim Crow laws in the south and Black migration north
- Redlining and Restrictive Covenants – Who gets to live where and who is (not) permitted to accumulate wealth?
- White Flight | Suburbanization – yes, it was this obvious
- Job Loss - Impact of restrictive covenants × suburbanization × industrial automation on employment opportunities
- Urban Renewal and Serial Forced Displacement – 'we're really uncomfortable with the *unsightliness* of your struggle within the system we've created for our own comfort and so you need to leave (TL; DR *s*|*ns*)'
- City Shrinkage – Racial × Socio-Economic Stranding within the City
- Regionalization and Gentrification – *well, look who's back!*

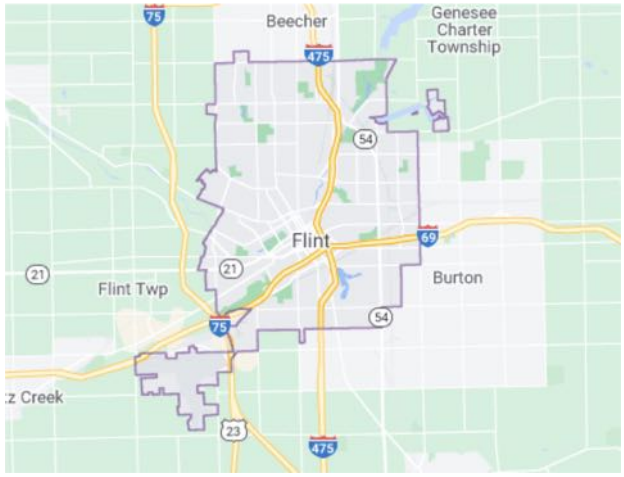
Carry this with you:

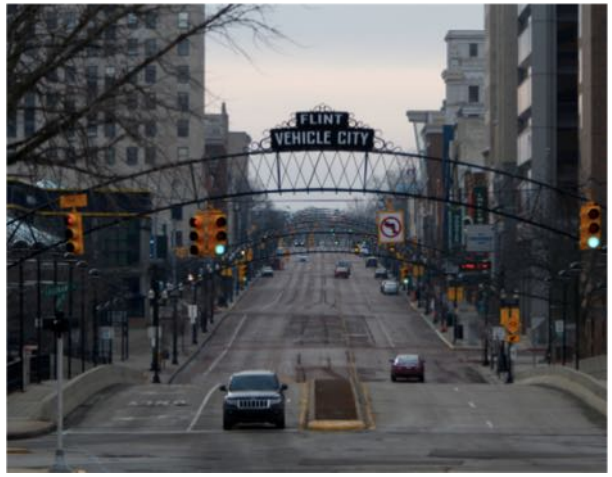
Since ~1960, the displacement of people and destruction of neighborhoods has taken place across more than 2500 Federally-funded Urban Renewal projects in ~1000 U.S. towns and cities. Approximately 75% of the people who have been displaced are people of color and 66% of those who have been forced to move in the name of Progress are Black. – M.T. Fullilove (RootShock)



So What Does the Socio-Technical Look Like?

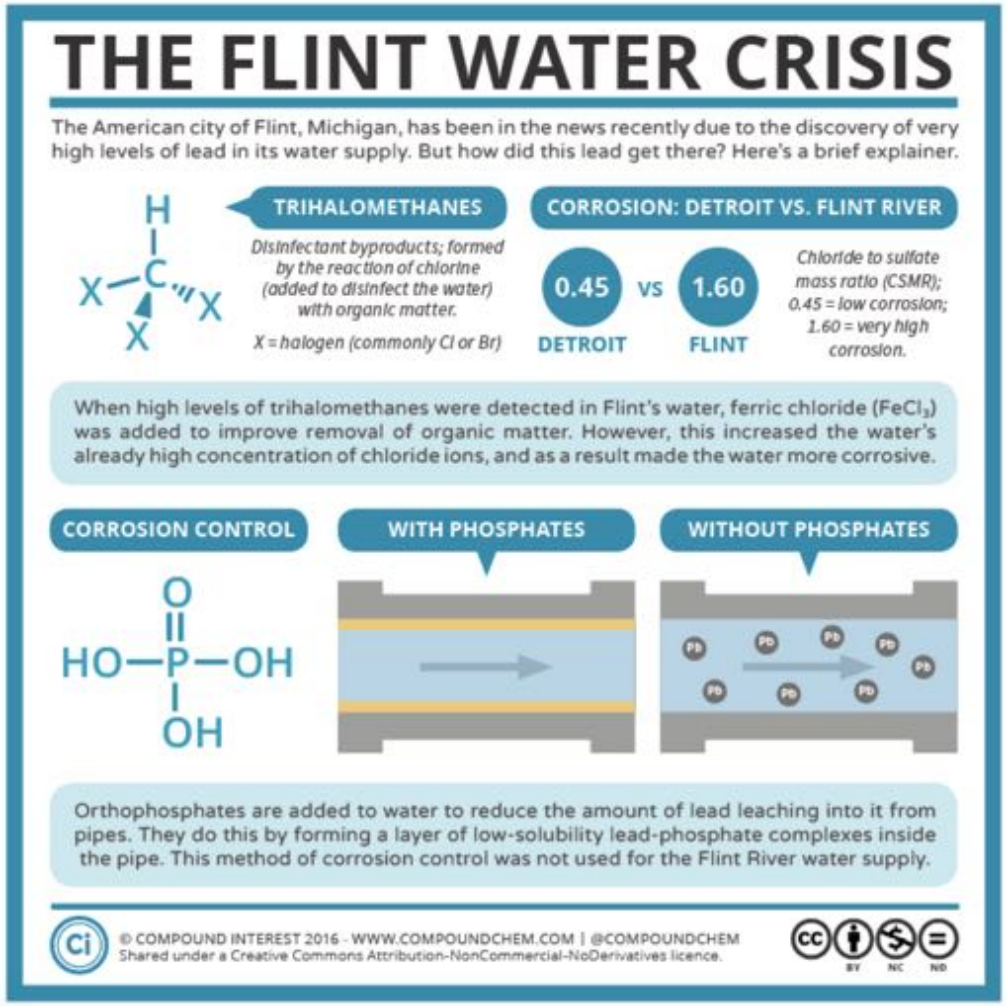

CANADA
Lake Superior
Lake Huron
WI
MI
Flint
Lansing
Lake Michigan
Detroit
IL
IN
OH
100 miles


75
Beecher
Genesee
Charter
Township
475
54
Flint
69
21
21
Flint Twp
Burton
54
75
z Creek
23
475

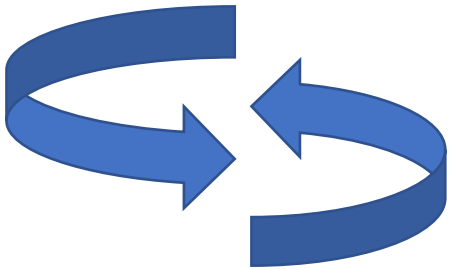

FLINT
VEHICLE CITY

Background | Timeline

- Problem began in April 2014 with the switch in the Flint city water supply from Lake Huron to the Flint River
- Change in water supply led to change in water treatment chemistry
- Change in water treatment chemistry led quickly to discoloration of drinking water, bacterial outbreaks, and ultimately leaching of lead (Pb) from homeowner water service lines
- Throughout these impacts in 2014, Flint Water District and State EPA continued to declare that Flint drinking water met Federal standards

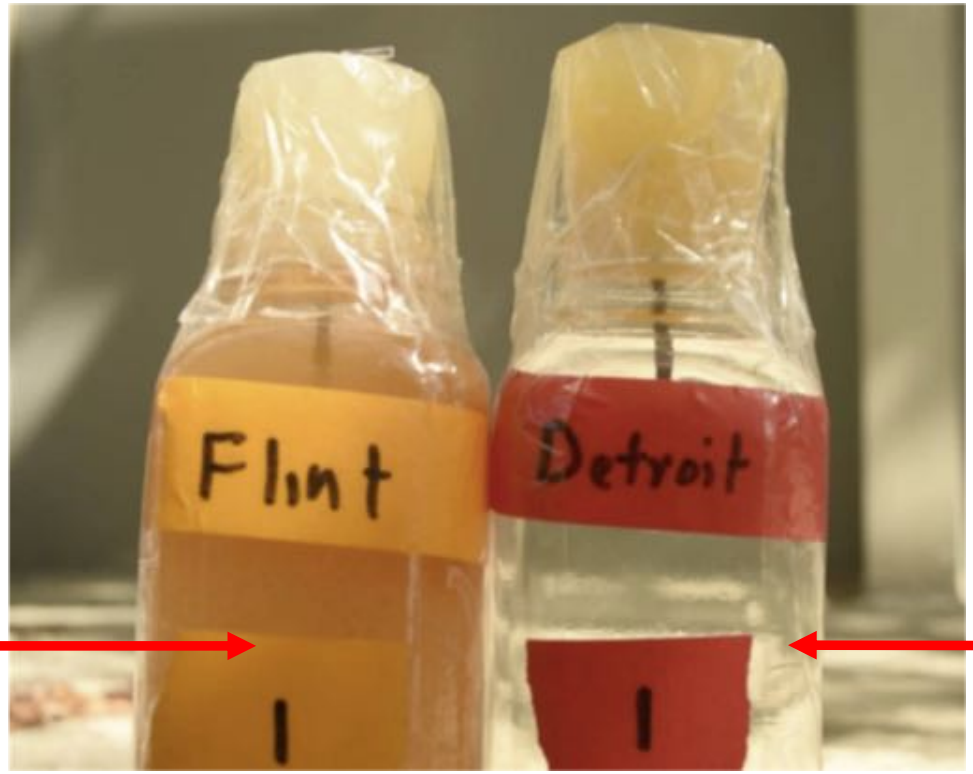


This is the technical



Don't forget the social

Flint water as drawn from Flint River and treated with chlorination and without corrosion inhibitor



Detroit water as drawn from Lake Huron and treated by the DWSD with corrosion inhibitor

Discoloration of Flint water due to iron oxides – presence of which should have been the early indication of chemical disequilibrium in service lines

Background | Timeline (cont.)

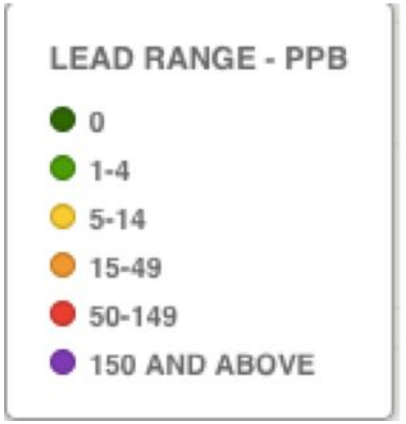
- January 2015 - MI Governor Rick Snyder declared state-level State of Emergency for the city
- This was followed by President Barack Obama declaring a Federal State of Emergency; this declaration brought Federal $$ from FEMA
- Following President Obama's Declaration, Gov. Snyder arranged for the NG to begin providing filters and bottled water to Flint citizens.
- Local citizens very reasonably responded with: *I'msupposedtodowhat?!?!why?!?! filters?! where?!?! whichkind?!?! whoisthissmileymoviestarguysayingtobuythisthingwhat?!?! howoften?! whyarethesecops/[NG]/meninuniformsatmydoor?!?!?!?*

By 2021

- As many as 10,000 children in Flint have been exposed to dangerously high levels of lead (Pb) in drinking water
- Thousands of drinking water service lines have been inspected and (if necessary) replaced
- State of MI has negotiated a $600 MM settlement with affected families, recognizing that the impacts of Pb exposure in children create significant long-term health challenges
- Indictments have been handed down against 9 local and state officials charging misconduct in office, willful neglect of duty and perjury

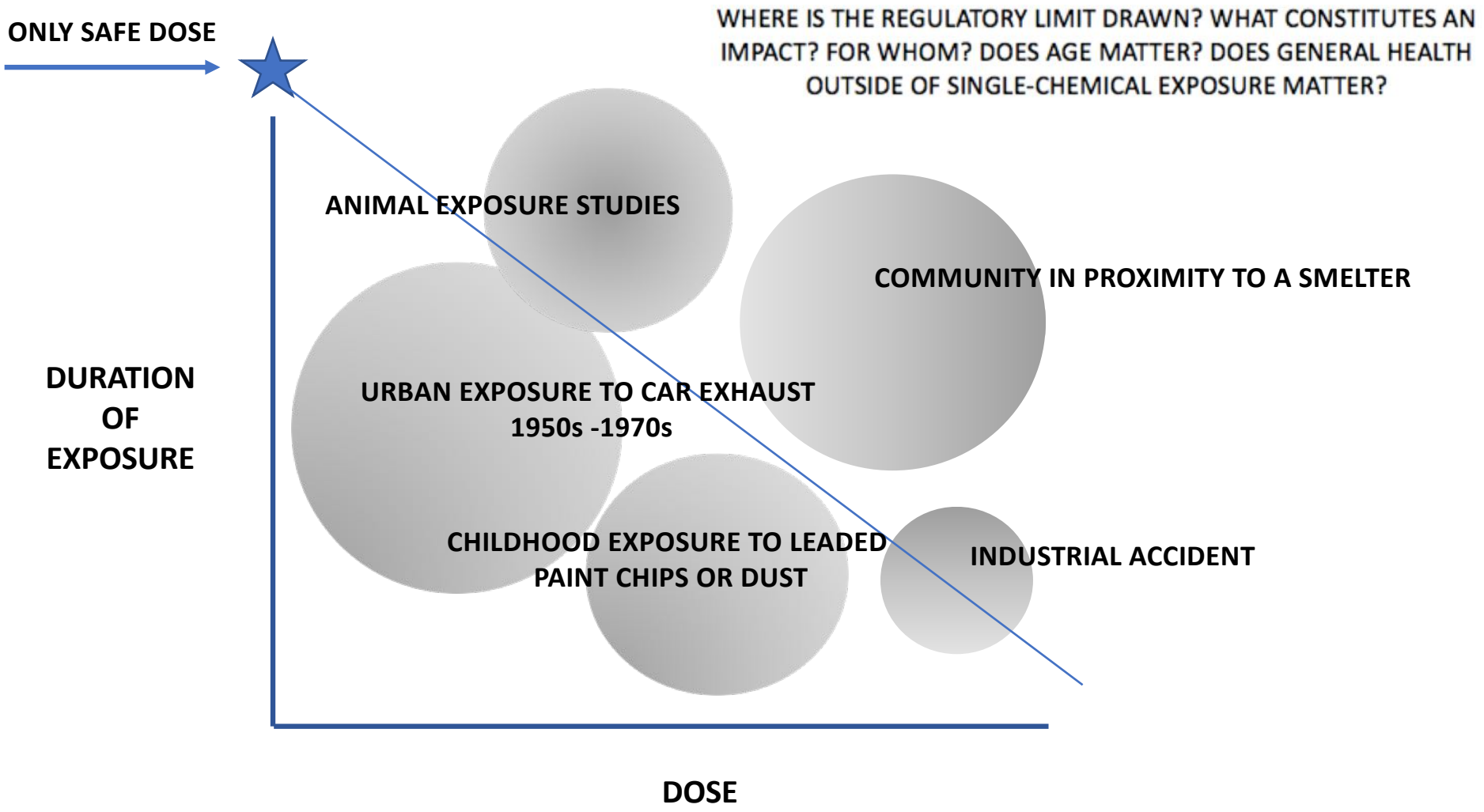
What does ‘dangerously high level’ mean?

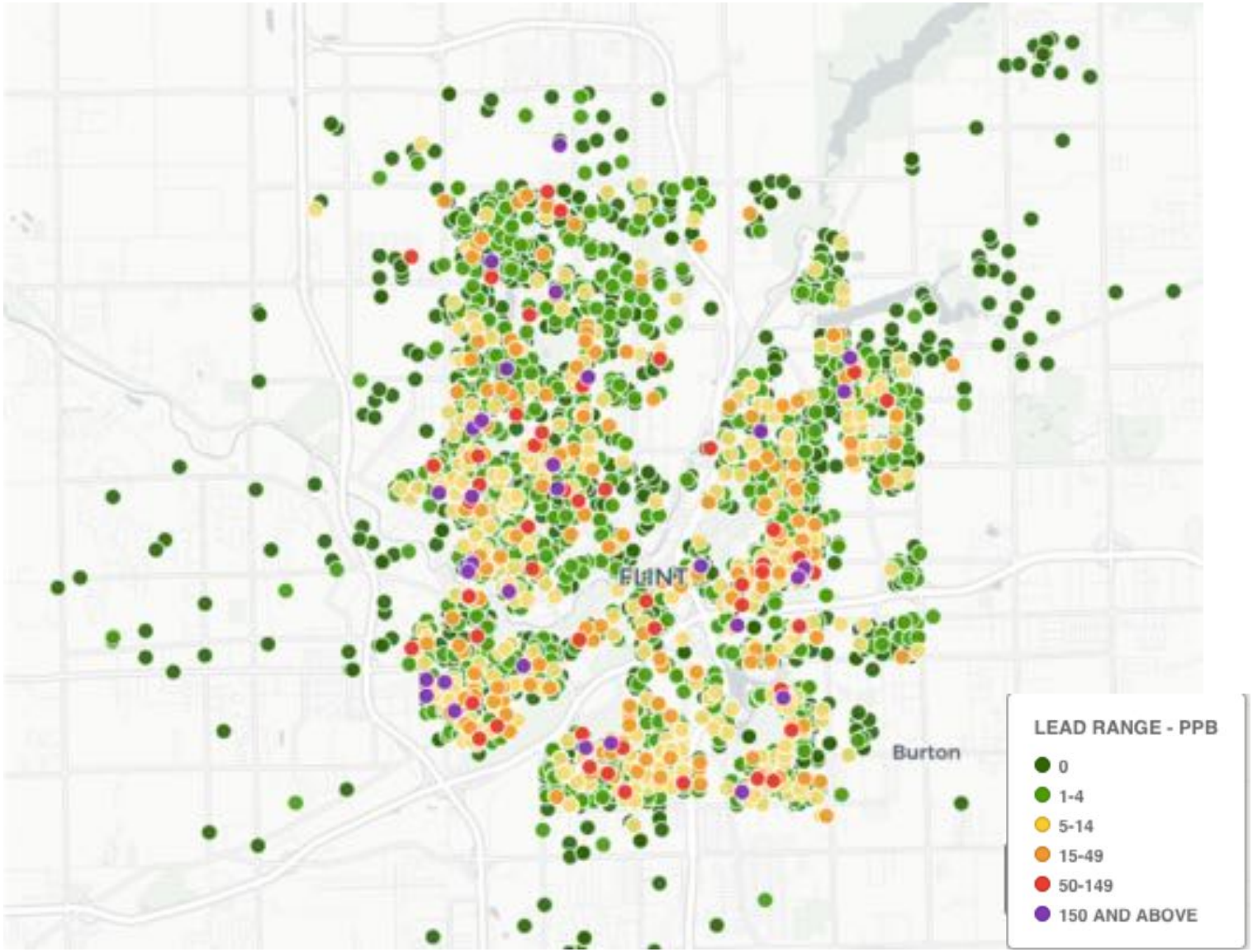
- **0 ppb** - no lead detected in the drinking water
- **1-4 ppb** - the EPA deems this range as acceptable
- **5-14 ppb** - exposure is a concern, but still below an EPA "federal action level"
- **15-49 ppb** - a range above the federal action level for lead, but can be treated by filters
- **50-149 ppb** - reaching dangerous levels, but can be treated by filters
- **150 and above** - a range at which the federal government says water filters might not work



Federal Action Level for Lead (Pb)

- Lead (Pb) in H_2O is regulated under the Lead and Copper Rule (LCR)
- [Safe exposure level for Pb in drinking water is 0 ug/L]
- Federal Action Level for Pb in drinking water is currently 15 ug/L
- Action Levels are not Safe Exposure Levels; they are based on:
  - Best Available Technology at the time
  - Balance of costs for implementation
  - Decision criteria in which a '*certain amount of exceedance is permitted*'
  - For some chemicals, the range of studies from which dose – response relationships are determined can be considerable (with varying relevance)


ONLY SAFE DOSE
WHERE IS THE REGULATORY LIMIT DRAWN? WHAT CONSTITUTES AN IMPACT? FOR WHOM? DOES AGE MATTER? DOES GENERAL HEALTH OUTSIDE OF SINGLE-CHEMICAL EXPOSURE MATTER?
ANIMAL EXPOSURE STUDIES
COMMUNITY IN PROXIMITY TO A SMELTER
DURATION OF EXPOSURE
URBAN EXPOSURE TO CAR EXHAUST 1950s -1970s
CHILDHOOD EXPOSURE TO LEADED PAINT CHIPS OR DUST
INDUSTRIAL ACCIDENT
DOSE



2016 data
4000+ homes

Is this problem *fixed*?

- Lead (Pb) is a neurotoxin that impacts brain development; exposures and their aftermath have long-term consequences for children, their families and the communities in which they live (think: schools, clinics)
- Public trust can be irrevocably damaged through duplicity and either/both the perception and/or the reality of municipal and state unwillingness to provide for all community members equally
- Almost 80 million people in the U.S. are currently served by drinking water systems that have demonstrated at least one failure of compliance with the US EPA Safe Drinking Water Act (SDWA) [NRDC, 2017]

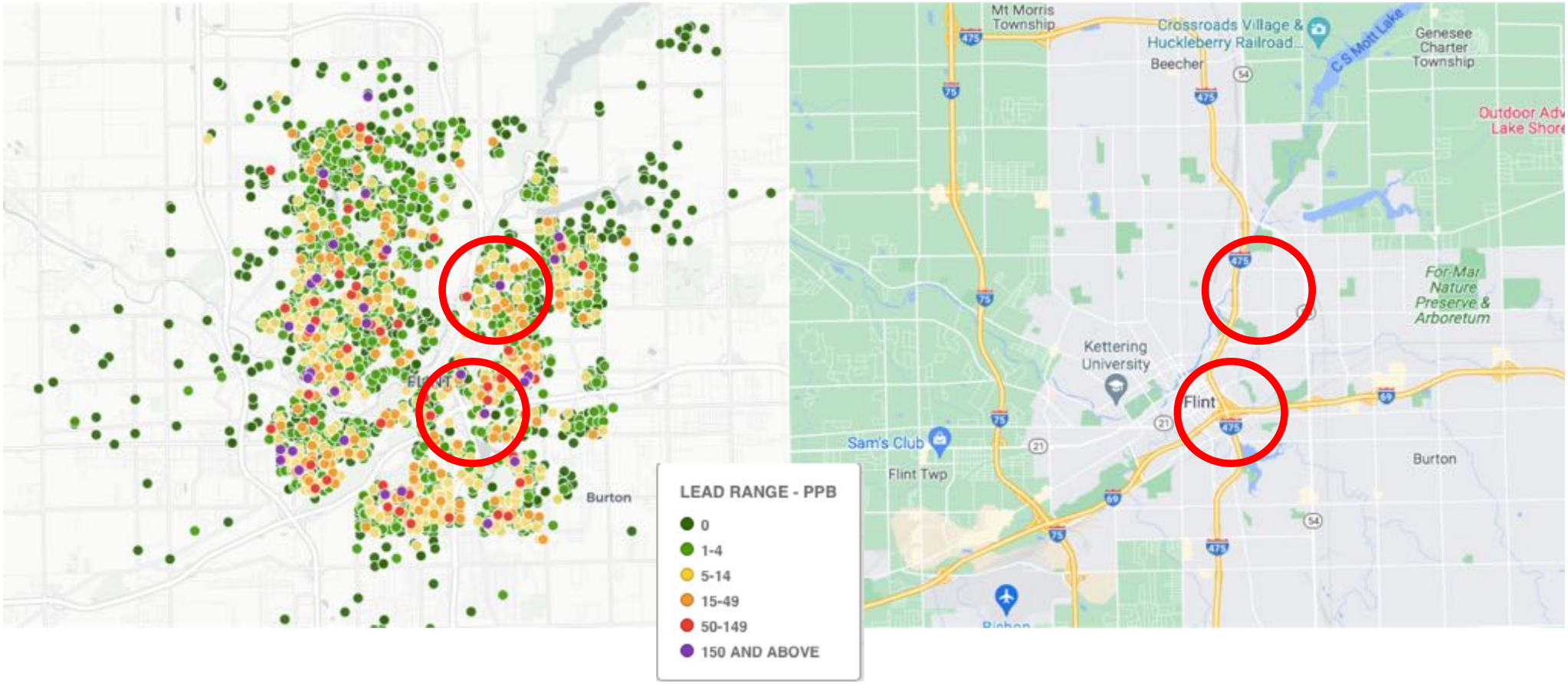
What if the problem is baked right in to the structure of monitoring and compliance?

- How samples are collected
- How regulatory compliance is assessed on the community level
- Whether the operational default leans toward action [citizen protection] or toward stasis [uninterrupted system operation]
- Whether it's possible to tell the difference between:
  - Location-specific failures in the protection of public health;
  - Broad-based shortcomings in recognition that not all communities are equally likely to be protected from systemic infrastructure failures;
  - Conspiracies (real or imagined) that undermine public trust in the safety of the resources they (we) rely upon

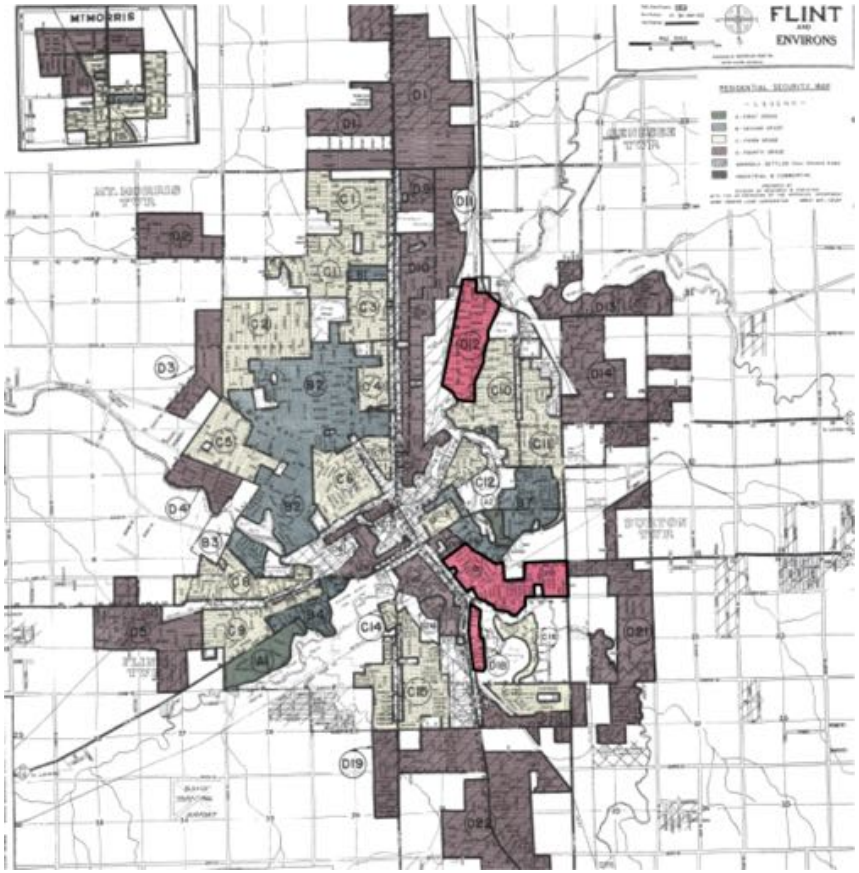
This is a problem that's getting worse not better

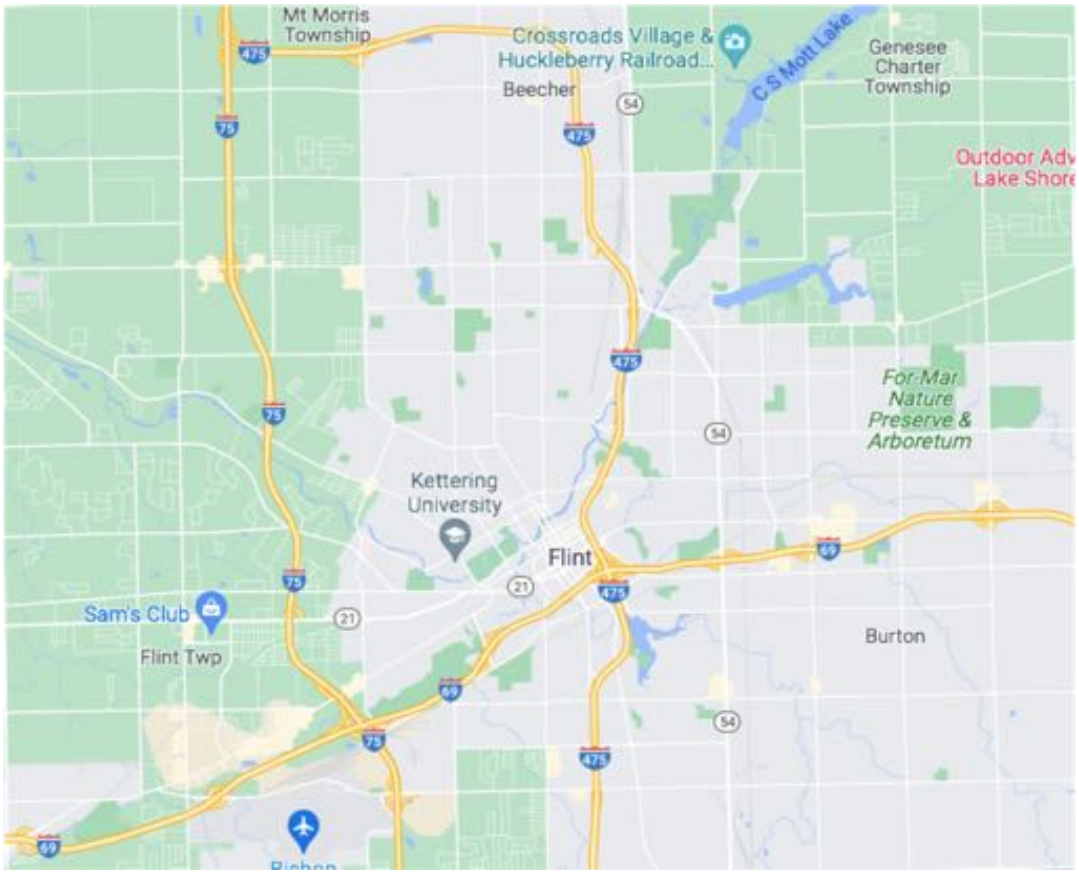
- ~19.5 million Americans are sickened yearly from pathogen exposures resulting from contamination of public drinking water supplies.
- Hookworm – an intestinal parasite that can cause impaired cognitive development, iron-deficiency anemia and growth stunting in children and is 'typically' found in resource-limited countries as the direct result of absences of sanitation service provision – has re-emerged in the United States [McKenna et al. 2017]

Diving into History – The Then | The Now

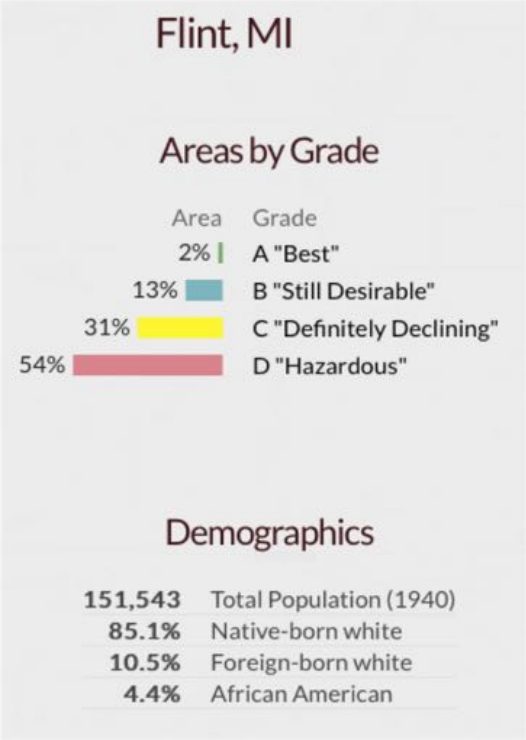


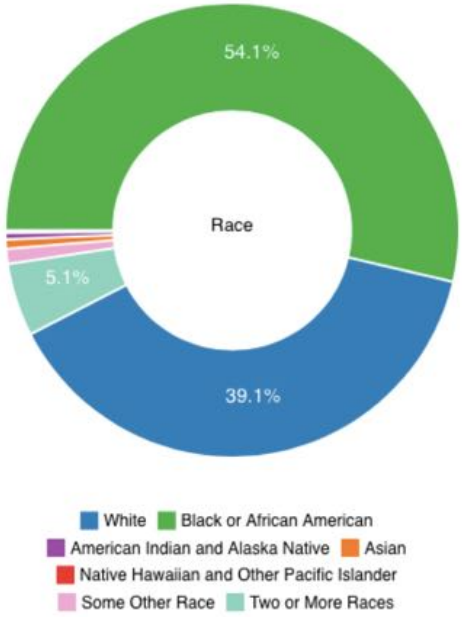
Floral Park and St. Johns Neighborhoods – Urban Renewal





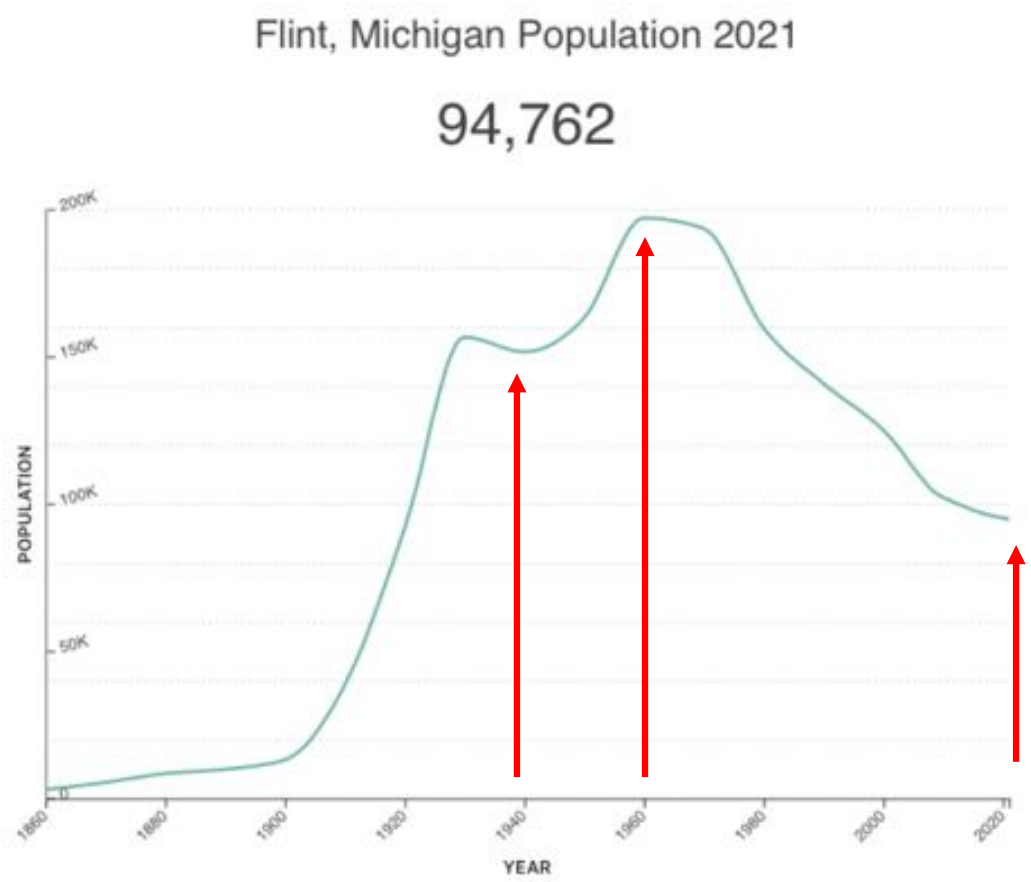
Demographics of Flint, MI – 1940 | 2021





94,736 Total Population (2021)

What does all this have to do with infrastructure?



- Who left?
- Where do they (not) contribute taxes?
- How are they pulled back into the city to spend money?
- What happens when infrastructure is scaled for a much larger population than is present?

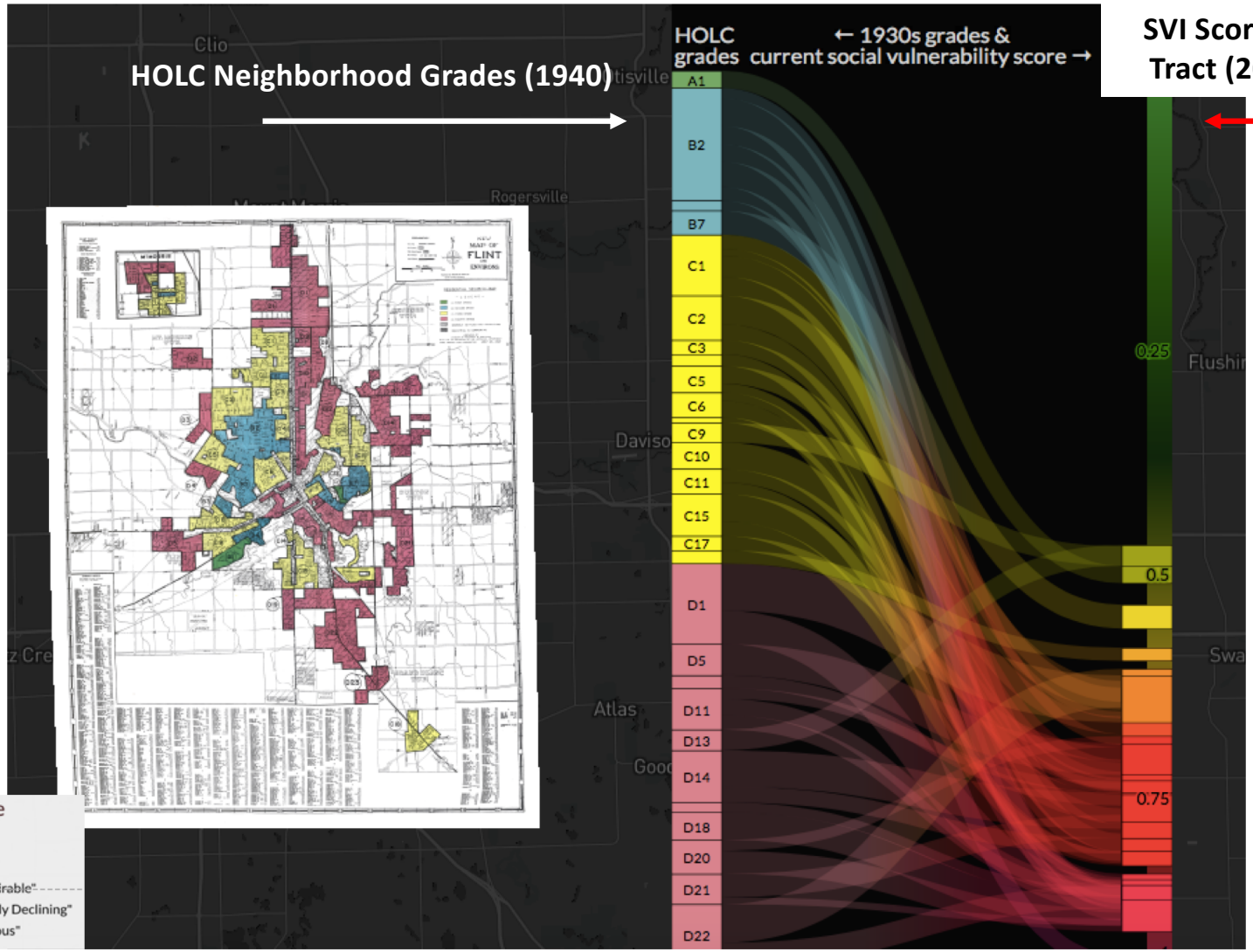
Social Vulnerability Mapping

- Employs CDC Social Vulnerability Index (SVI) by census tract.
- Assesses community capacity to prepare for, respond to, and recover from human and natural disasters.
- Social and economic resources available to a community + its underlying vulnerabilities are key components in the reality of how hard a community may be impacted by a disaster.
- Factors assessed in SVI: SES, housing and transportation, demographics, household composition, and access (linguistic and physical)

HOLC Neighborhood Grades (1940)

HOLC grades ← 1930s grades & current social vulnerability score →

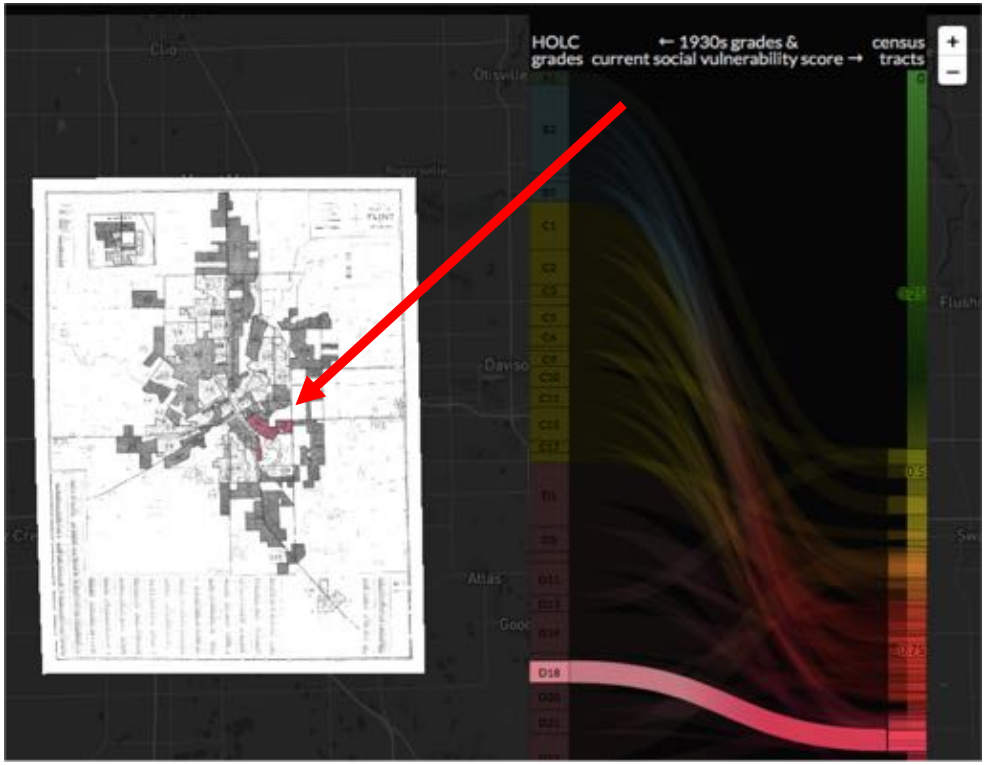
SVI Score by Census Tract (2020)

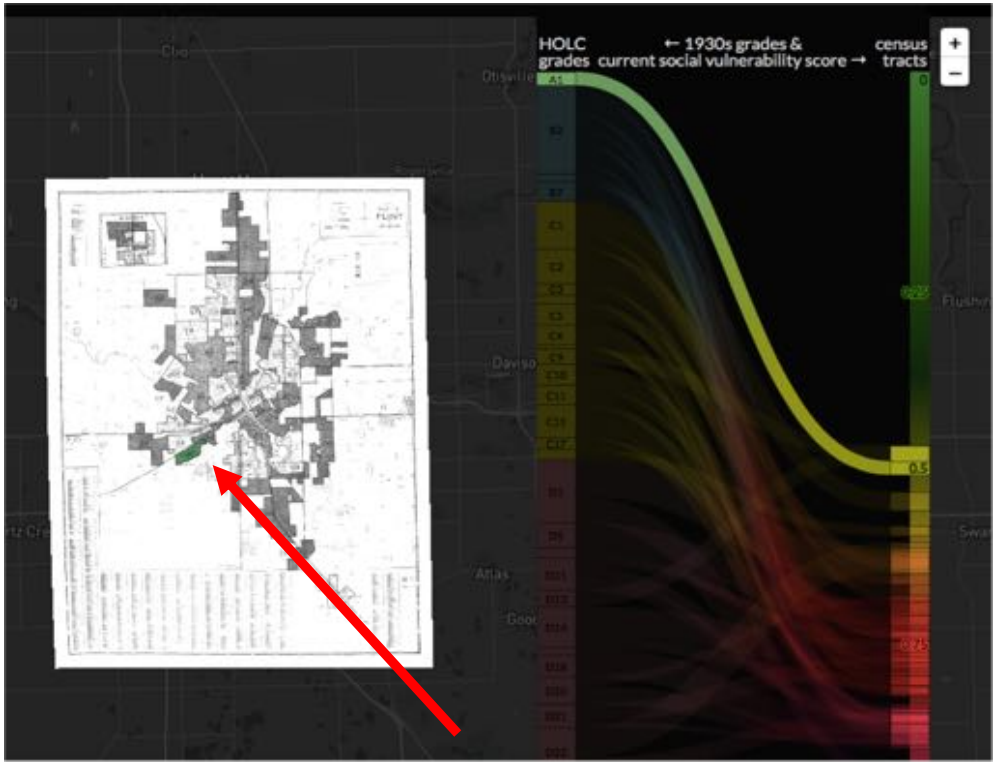


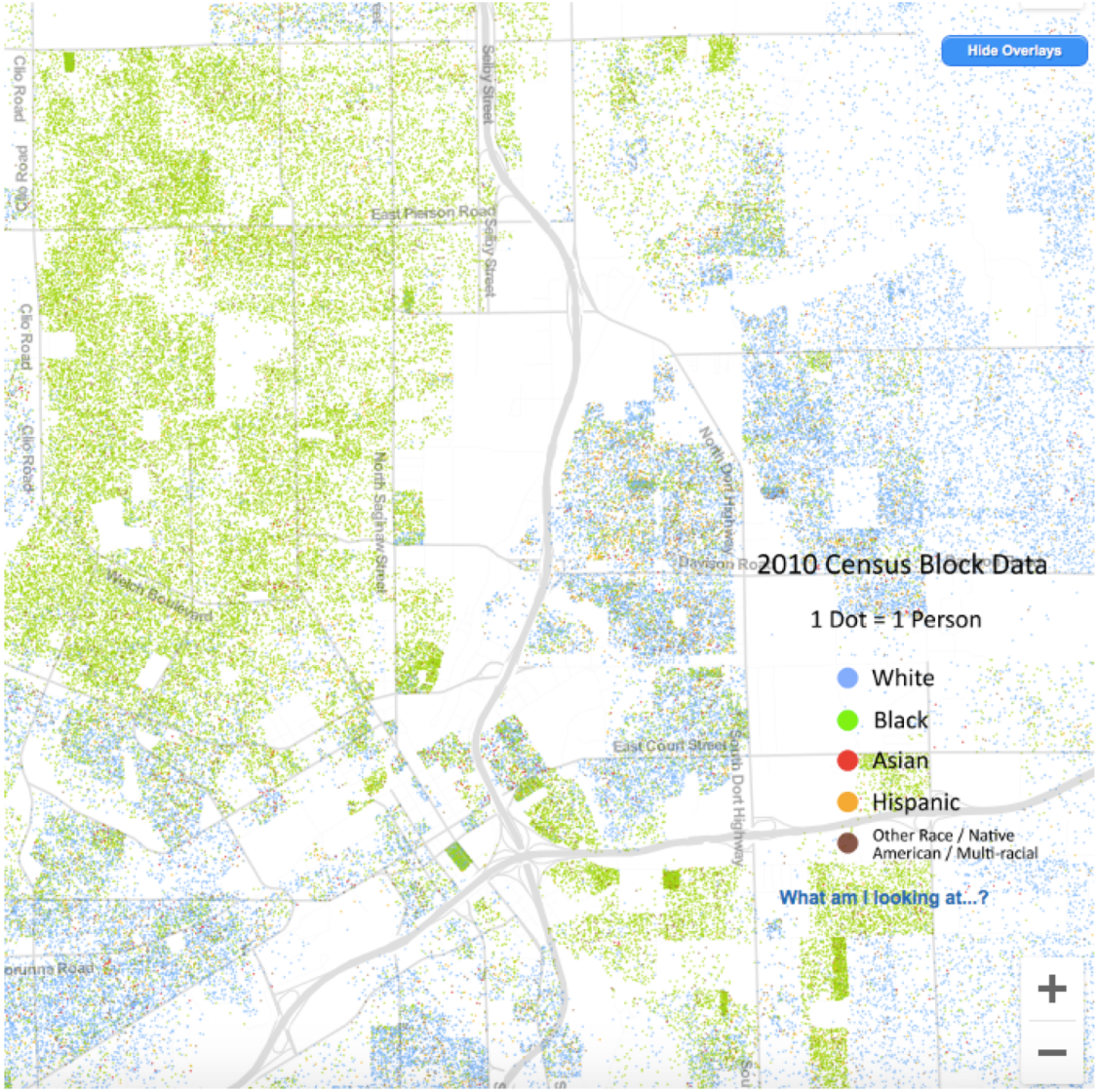
Areas by Grade

Area	Grade
2%	A "Best"
13%	B "Still Desirable"
31%	C "Definitely Declining"
54%	D "Hazardous"

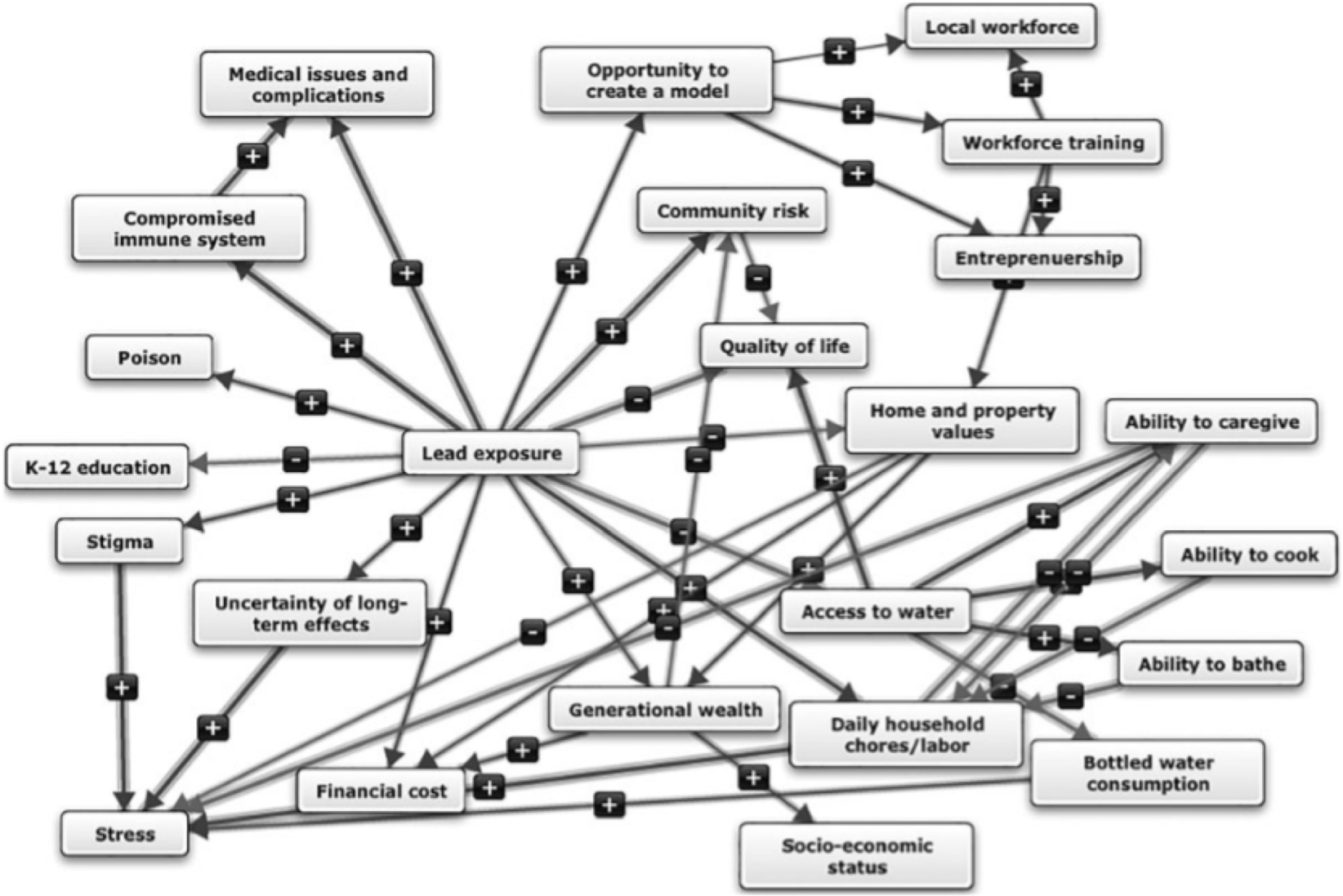
This is what the impact of the 20th Century cycle looks like







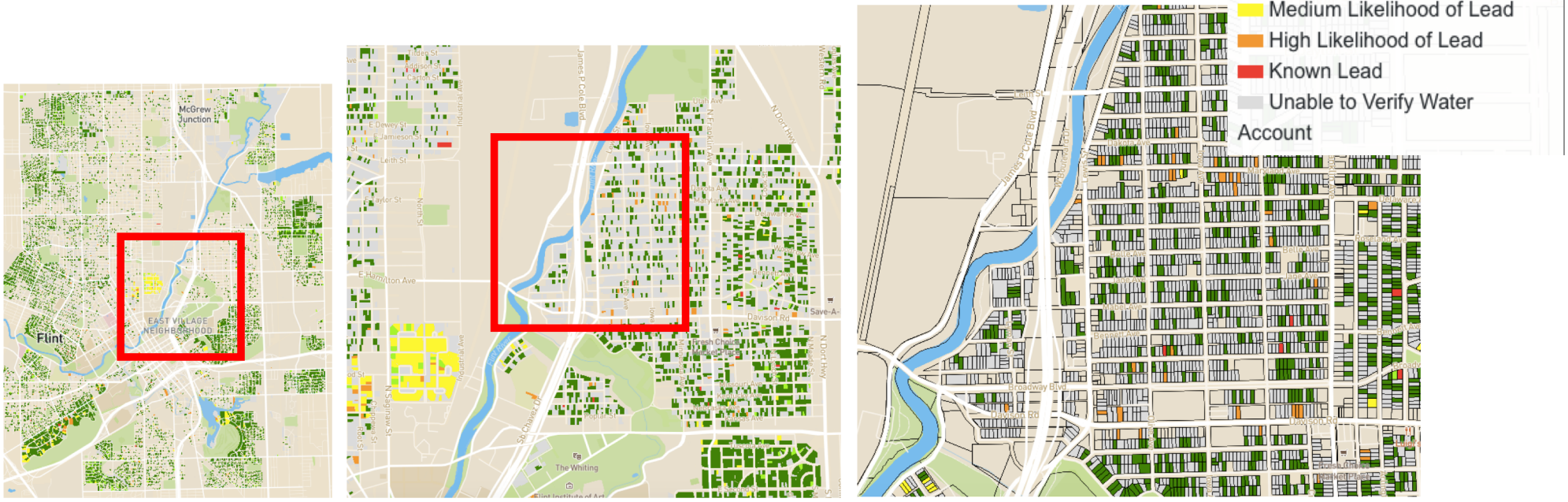
- What is the impact of this cycle of flight & return on people who don't leave?
- (Why don't they leave?)
- What have highway construction, housing quality, water service infrastructure, legacy industrial activity and lack of monitoring of air and water quality done to create unequal access to health?


Local workforce
Medical issues and complications
Opportunity to create a model
Workforce training
Compromised immune system
Community risk
Entreprenuership
Poison
Quality of life
Home and property values
Ability to caregive
K-12 education
Lead exposure
Stigma
Ability to cook
Uncertainty of long-term effects
Access to water
Ability to bathe
Generational wealth
Daily household chores/labor
Bottled water consumption
Financial cost
Stress
Socio-economic status

Absence of Evidence ≠ Evidence of Absence

Who lives where there are no available data?

Why are there no available data?



Science of the Total Environment 590–591 (2017) 139–153

Contents lists available at ScienceDirect

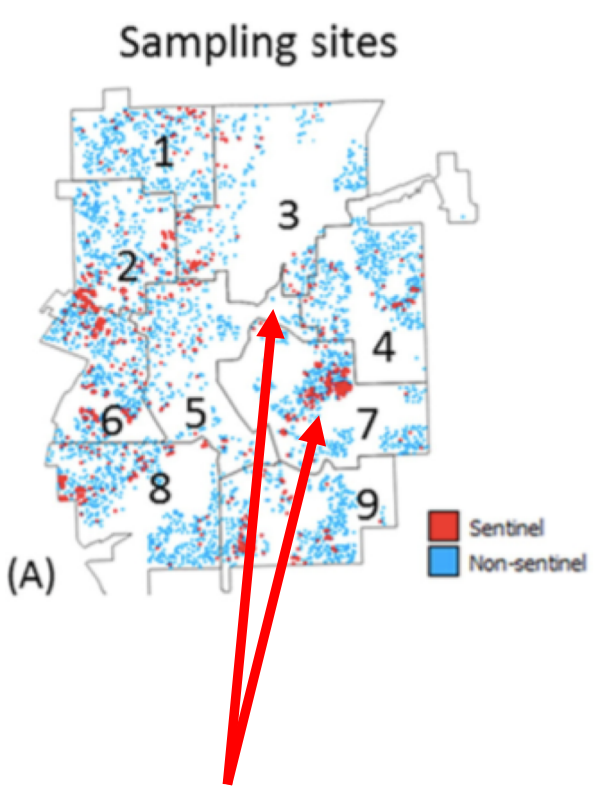
Science of the Total Environment

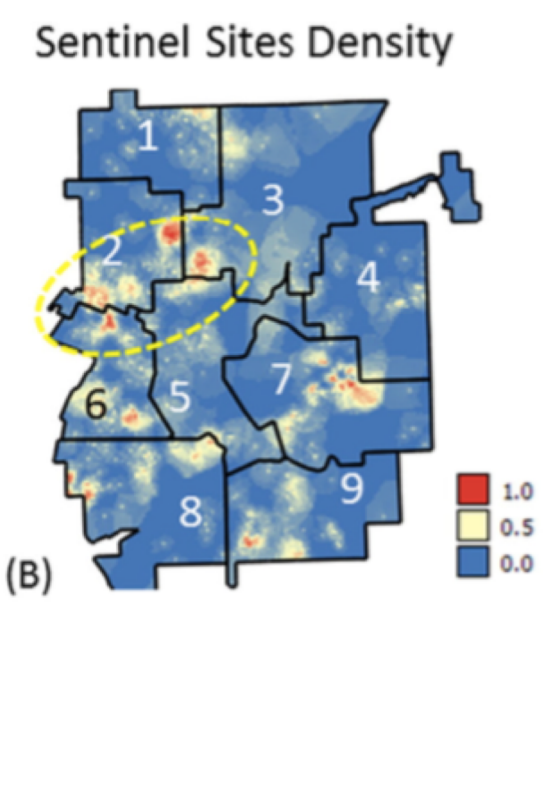
journal homepage: www.elsevier.com/locate/scitotenv

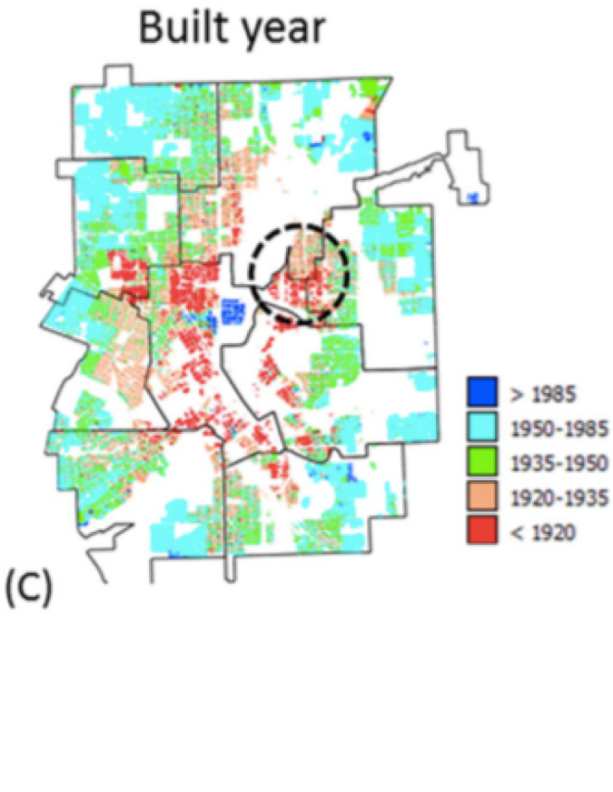
Monitoring the aftermath of Flint drinking water contamination crisis: Another case of sampling bias?

Pierre Goovaerts *

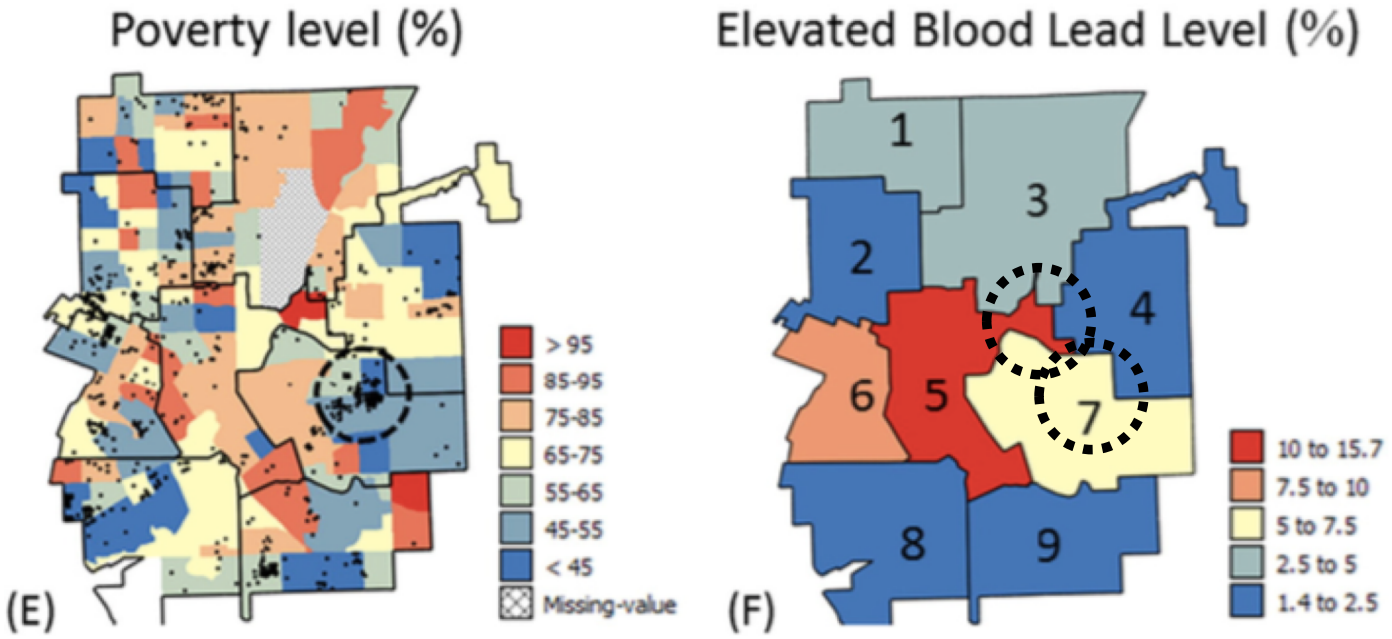
BioMedware Inc., Ann Arbor, MI 48106, USA







Pay attention to these neighborhoods


Poverty level (%)
> 95
85-95
75-85
65-75
55-65
45-55
< 45
Missing-value
(E)
Elevated Blood Lead Level (%)
1
2
3
4
5
6
7
8
9
10 to 15.7
7.5 to 10
5 to 7.5
2.5 to 5
1.4 to 2.5
(F)

A key finding of the exploratory data analysis was that the impact of lead service lines on water lead levels was mainly investigated for houses built between 1935 and 1950 in less disadvantaged areas of the city. In addition, there was no sentinel site with LSL in two of the most impoverished wards, including where the percentage of children with high blood lead levels tripled following the switch in water supply.

Let's talk about some reasons for <u>why</u> there was bias in the choice of sentinel sites

Let's keep talking about why this understanding is critical to us as engineers

What does it mean to be tasked with '*promoting and protecting public health and safety and enhancing the quality of life*'?