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Lead and Demolition

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GHHI Meeting

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What is Lead Poisoning?

- Lead is a home health and safety hazard that harms a child's brain, causing *lifelong learning and behavior problems*.
- When lead dust is ingested or inhaled, even in miniscule amounts, it can cause significant and irreversible brain damage as well as other health problems.
- Lead dust equivalent of only *three granules of sugar* can begin to poison a child.[1]
- The CDC has recommended that public health actions be initiated in children under age 6 with blood lead levels above 5 micrograms per deciliter (µg/dL).[2]

1. Olden, K., PhD. "Environmental Risks to the Health of American Children." *Preventative Medicine* 22 (1993): 576-578.
2. CDC: Lead (http://www.cdc.gov/nceh/lead/)

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What are the sources of lead in Detroit?

- There are three main sources of lead within cities – paint, water pipes and soil particulates. In Detroit, most childhood lead poisoning comes from old lead-based paint.
- Homes built before 1978 have a good chance of containing lead-based paint. In 1978, the federal government banned consumer uses of lead-containing paint, but some states banned it even earlier. Lead from paint, including lead-contaminated dust, is one of the most common causes of lead poisoning.[3] Approximately *94% of all houses in Detroit* were built before 1980.[4]

3. United States Environmental Protection Agency. (2013). http://www2.epa.gov/lead/protect-your-family#sl-home
4. U.S. Census Bureau Selected Housing Characteristics, 2007-2011 American Community Survey 5-Year Estimates, Detroit city, Michigan (http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP04)

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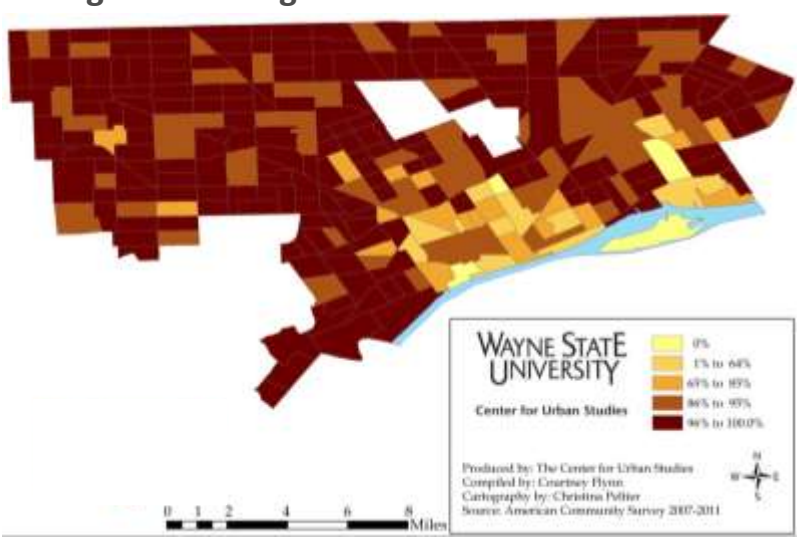
Percentage of Housing Stock Built Before 1980 in Detroit



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What are the sources of lead in Detroit?

- Lead in soil is particularly found around older buildings contaminated by flaking external paint, and adjacent to industrial facilities using (or previously having used) lead or demolished buildings.[5]
- Lead was found in soil *92 years* after deposition.[6]
- A recent study in Detroit indicated increased lead poisonings of children annually in the summer is partially attributable to lead dust stirred up by summer winds.[7]

5. Department of Housing and Urban Development, Office of Healthy Homes and Lead Hazard Control. "Healthy Home Rating System—Operating Guidance." http://portal.hud.gov/hudportal/documents/huddoc?id=operating_guidance_hhrs_v1.pdf
6. Artifact weathering, anthropogenic microparticles and lead contamination in urban soils at former demolition sites, Detroit, Michigan, Howard, J. et al.
7. Linking Source and Effect: Resuspended Soil Lead, Air Lead, and Children's Blood Lead Levels in Detroit, Michigan, Zahran, S. et al

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How do kids get poisoned?

- **Deteriorating lead-based paint (peeling, chipping, chalking, cracking, damaged, or damp) is one of the key causes of lead poisoning. It is especially hazardous when found on surfaces that children can chew or that get a lot of wear-and-tear, such as windows and window sills, doors and door frames, stairs, railings, banisters, and porches. Toddlers who crawl through dust laden floors are particularly vulnerable.[8]**
- Air-borne lead paint particles can also be **inhaled as dust**. Demolition of houses built prior to 1978 that do not use lead-safe practices to keep lead dust out of the air can cause significant lead poisoning to children nearby simply by breathing in the air in or around their home. This dust can also settle in nearby soil and on porches, windowsills and stairs and can therefore also increase risk of being ingested by children as they crawl or play.[9] **Babies and young children can also be more highly exposed to lead because they often put their hands and other objects that can have lead from dust or soil on them into their mouths.[10]**
- Lead can also be ingested through drinking water that has been contaminated as a result of lead pipework or lead-based solder.[11]
- Lead is particularly dangerous to children because their growing bodies absorb more lead than adults do and their brains and nervous systems are more sensitive to the damaging effects of lead.[10]

8. United States Environmental Protection Agency. (2013). http://www2.epa.gov/lead/protect-your-family#sl-home
9. Farfel, M., Orlova, A., Lees, P., Rohde, C., Ashley, P., and Chisolm, J. "A Study of Urban Housing Demolitions as Sources of Lead in Ambient Dust: Demolition Practices and Exterior Dust Fall." Environmental Health Perspectives Vol. 111, Issue 5 (2003): 1228-1234).
10. United States Environmental Protection Agency. (2013). http://www2.epa.gov/lead/learn-about-lead#lead
11. United States Environmental Protection Agency. (2013). http://water.epa.gov/drink/info/lead/

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What are the consequences of lead poisoning?

In children, the main target for lead toxicity is the nervous system. Even very low levels of lead in the blood of children can result in:

- **Permanent damage to the brain and nervous system**, leading to behavior and learning problems, lower IQ, and hearing problems
- Slowed growth
- Anemia
- In rare cases, ingestion of lead can cause seizures, coma and even death.[12]

Lead poisoning can also result in:

- **Inattentiveness, hyperactivity, disorganization, aggression, and increase risk of delinquency**
- Headaches, loss of appetite, agitation, clumsiness, or somnolence[13]

A lead poisoned child is:

- **7 times more likely** to drop out of high school[14]
- For every 5 µg/dl increase in blood lead levels at six years of age, **the risk of being arrested for a violent crime as a young adult increased by almost 50%.**[15]
- **50% more likely** to do poorly on the MEAP[13]
- **More than half of the students** tested in Detroit Public Schools have a history of lead poisoning, which affects brain function for life, according to data compiled by city health and education officials. About **60% of DPS students** who performed below their grade level on 2008 standardized tests had elevated lead levels.[14]
- Groups of children that have been followed from womb to adulthood show that higher childhood blood lead levels are consistently associated with **higher adult arrest rates for violent crimes.**[16]

12. United States Environmental Protection Agency. (2013). http://www2.epa.gov/lead/learn-about-lead#lead
13. Zubrzycki, J. "Lead-Exposure Problems Spotlighted in Detroit." *Education Weekly* Vol. 32, Issue 5 (2012): 6-9.
14. Lam, T. and Tanner-White, K. "High lead levels hurt learning for DPS kids." *Detroit Free Press* (May 16, 2010).
15. Wright, J. et al. "Association of Prenatal and Childhood Blood Lead Concentrations with Criminal Arrests in Early Adulthood."
16. Drum, K. "America's Real Criminal Element: Lead." Mother Jones (Jan. 3, 2013).

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Prevalence of Lead Locally and Nationally

- Although only 20% of Michigan's children younger than 5 years old lived in Detroit in 2010, childhood lead poisoning in **Detroit has consistently accounted for more than 50% of the state's total lead burden**.[17]
- In 1998, **15,769 children** under 6 tested in Detroit had elevated levels of lead in their blood (> 5 µg/dL).[18]
- In 2012, **6,522 children** under 6 tested statewide had elevated levels of lead in their blood. In Detroit **2,260 children** had elevated levels of lead (> 5 µg/dL).[19]

17. Zhang, N., PhD, Baker, H., MPH, Tufts, M., MPH, Raymond, R., MS, Salihu, H., MD, PhD, and Elliott, M., PhD. "Early Childhood Lead Exposure and Academic Achievement: Evidence From Detroit Public Schools, 2008–2010." *American Journal of Public Health* 103.3 (2013): 72-77.
18. Robert Scott, Michigan Department of Community Health (2013).
19. Michigan Department of Community Health Healthy Homes and Lead Poisoning Prevention Program 2012 Data Report on Blood Lead Testing and Elevated Levels, Childhood Lead Poisoning Data Facts All Counties in Michigan — Calendar Year 2012 — Children less than Six Years of Age: http://www.michigan.gov/documents/mdch/2012AnnualDataReportOnBloodLeadLevels_419508_7.pdf

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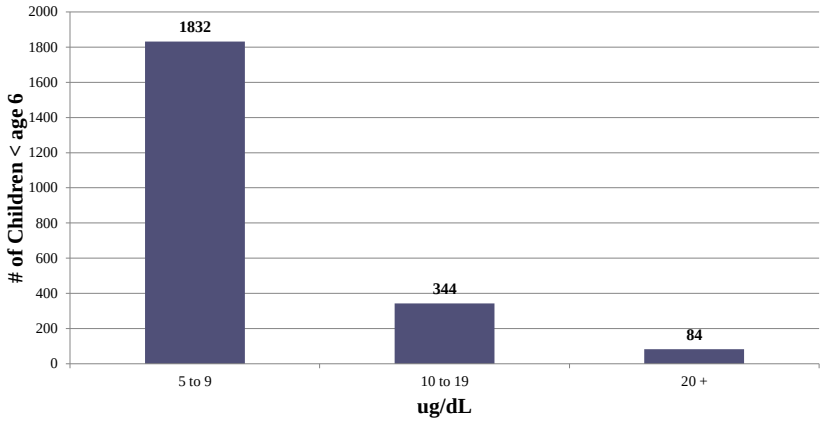
The Prevalence of Lead Poisoning in the City of Detroit for Children Under Age 6

For the City of Detroit in 2012, this chart shows the number of children under age six who had a blood lead level of 5-9 µg/dL, 10-19 µg/dL and greater than 20 µg/dL MDCH data.



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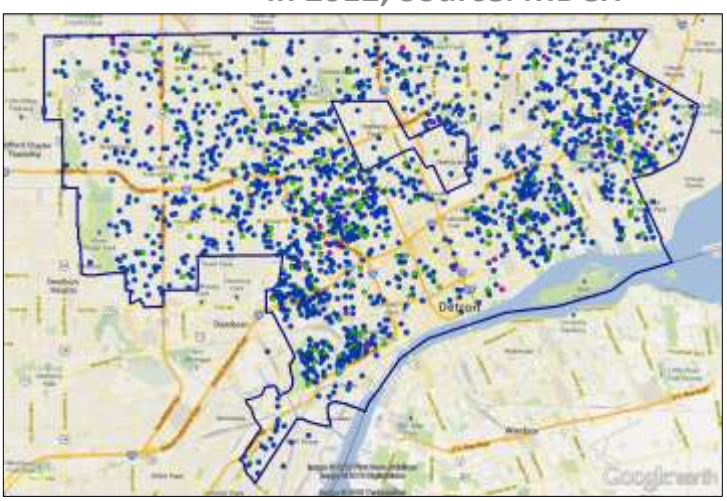
Cases of Elevated Blood Lead Levels (5 ≥ µg/dL) in Detroit in 2012; Source: MDCH



Blue= EBL 5-9 µg/dL
Green= EBL 10-19 µg/dL
Pink= EBL 20 ≥ µg/dL

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Lead Hazards and Demolitions

- **Demolition can produce huge increases in lead dust:** A study conducted in Baltimore, Maryland, assessed the ambient dust lead levels associated with demolitions of blocks of older lead-containing row houses. The study found that daily lead dust fall during demolition exceeded the U.S. EPA floor standard by **6-fold** on average and as much as **81-fold** on an individual sample basis. During this study the researchers observed children and adults walking through the site and on the debris pile during and immediately after the active work phase. It was also observed that residents left windows open and left pets outside during demolition, which likely reflected a lack of advance notification and health education to the community about measures to protect themselves.[20]
- **Lead in dust fall dispersed during demolition can increase the risk of lead exposure even after the work phase**, especially for young children, by increasing lead loadings of settled ambient dust. This dust is also a concern because it can be tracked into houses on shoes or blown in by the wind.[20]
- Another Baltimore study found that demolition was associated with increased dust lead loadings in neighboring houses, **especially when demolition was done without wetting.**[20]

20. Farfel, M., Orlova, A., Lees, P., Rohde, C., Ashley, P., and Chisolm, J. "A Study of Urban Housing Demolitions as Sources of Lead in Ambient Dust: Demolition Practices and Exterior Dust Fall." Environmental Health Perspectives Vol. 111, Issue 5 (2003): 1228-1234).

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Lead Hazards and Demolitions

- Studies in St. Louis and New Orleans have linked demolition activities to increased lead exposure in children.[21, 22]
- A study in Baltimore considered if dust suppression could reduce lead exposure.[23]
- A 2013 study in Chicago,[24] provides metrics of exposure by comparing demolition sites to controlled sites, similarly situated and without additional sources of lead exposure. Here were the results:

	Demolition Events	Controls
Total Dustfall	2,202 µg/ft^2/hour	129 µg/ft^2/hour
Total Lead Dust	6.01 µg/ft^2/hour	0.19 µg/ft^2/hour
Lead Concentration	2,800 ppm	1,500 ppm

17-fold increase in dust;
31-fold increase in lead dust;
109 percent increase in lead concentration

21. Blumenthal, HT, R Mayfield. 1995. "An Update on Blood Lead Levels in Pediatric Patients of a Neighborhood Health Center and an Analysis of Sources of Exposure." Journal of the National Medical Association. V 82, no. 2 pp. 99-104.
22. Rabito, FA;; S Iqbal, CF Shorter, P Osman, PE Philips, E Langlois, LE White. 2007. "Association between demolition activity and children's blood lead levels." Environmental Research. Vol. 103 pp. 345-351.
23. Farfel, M., Orlova, A., Lees, P., Rohde, C., Ashley, P., and Chisolm, J. "A Study of Urban Housing Demolitions as Sources of Lead in Ambient Dust: Demolition Practices and Exterior Dust Fall." Environmental Health Perspectives Vol. 111, Issue 5 (2003): 1228-1234).
24. . Jacobs, DE, S Cali, A Welch, B Catalin, SL Dixon, A Evens, AP Mucha, N Vahl, S Erdal and J Bartlett. 2013. "Lead and other Heavy metals in dust fall from single-family housing." Public Health Report. V 128, no. 6, pp. 454-62.

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Other metals in demolition dust[25]

Heavy Metal	Percent above reporting limit	Epidemiology from CDC (ATSDR)
Lead	92.1	Cardiovascular, developmental, gastrointestinal, hematological, musculoskeletal, neurological, ocular, renal, reproductive
Manganese	65.9	Neurological, pneumonia, respiratory
Iron	59.3	Not listed in ATSDR
Copper	30.1	Dermal, respiratory, gastrointestinal, hepatic, renal
Arsenic	17.5	Dermal, gastrointestinal, hepatic, neurological, respiratory, carcinogen
Chromium	14.3	Immunological, renal, respiratory, carcinogen
Selenium	2.6	Dermal, developmental, reproductive, carcinogen
Cadmium	4.7	Cardiovascular, developmental, gastrointestinal, neurological, renal, reproductive, respiratory, carcinogen
Silver	0.5	Renal, reproductive

* EPA Laboratory Reporting Levels are the levels at which public water is considered safe for human consumption. Numbers exceeding these levels are considered unsafe.

25. Jacobs, DE, S Cali, A Welch, B Catalin, SL Dixon, A Evens, AP Mucha, N Vahl, S Erdal and J Bartlett. 2013. "Lead and other Heavy metals in dust fall from single-family housing." Public Health Report. V 128, no. 6, pp. 454-62.

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Demolition Methods Discussed

- **Dry demolition:** Standard Practice of demolition without dust suppression activities or wetting
- **Wet demolition:** Local level of enforcement, requires that a hose be used during demolition activities but not on debris
- **Wet-Wet demolition:** Method of using a hose during demolition activities and then wetting debris to suppress dust during debris removal
- **Baltimore Protocol:** Method used in Baltimore that included Wet-Wet demolition, worker training, hiring of a dust suppression manager, plastic-covered fencing, street and sidewalk cleaning and supplying residents with tack mats and HEPA vacuums for neighboring residents.

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Baltimore Protocol[26]

- Wet-Wet demolition
- Deconstruction
- Worker training related to lead
- Dust suppression manager on site
- Training/Employing site monitors
- Fencing wrapped in plastic around site
- Plastic wrapping top of debris trucks
- Street and sidewalk cleaning after debris removal
- Replacing 2" of topsoil
- Vacuums and tack mats for neighbors
- Notification to neighbors and posting on building

26. Annie E. Casey Foundation. 2011"The East Baltimore Revitalization Initiative: Responsible Redevelopment: Responsible Demolition: A Baltimore Case Study with National Implications." http://www.aecf.org/~/media/Pubs/Topics/Community%20Change/Neighborhood%20Development/ResponsibleDemolitionABaltimoreCaseStudy/AECFResponsibleDemolitionReport.pdf

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Levels of exposure from residential demos[27, 28]

	Dry Demolition/ No Mitigation (Chicago)	Wet Demolition/ Wetted Debris (Chicago)	Complete Dust Suppression Protocol (Baltimore)
Lead Dust Fall	14.18 µg/ft^2/hour	5.48 µg/ft^2/hour	0.25 µg/ft^2/hour

- Standard demolition produces 2.6 times the lead dust over nearby areas than does "wet-wet demolition"
- Standard demolition produces 56 times the lead dust over nearby areas than does the Baltimore protocol for dust suppression.

27. Jacobs, DE, S Cali, A Welch, B Catalin, SL Dixon, A Evens, AP Mucha, N Vahl, S Erdal and J Bartlett. 2013. "Lead and other Heavy metals in dust fall from single-family housing." Public Health Report. V 128, no. 6, pp. 454-62.
28. Farfel, MR, AO Orlova, PSJ Lees, C Rohde, PJ Ashley and J Chisholm, Jr. 2003. "A study of urban housing demolition as sources of lead in the ambient dust: demolition practices and exterior dust fall." Environmental Health Perspectives vol. 111, pp. 1228-1234.

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Applying outside knowledge to Detroit scenarios

Using ALOHA software[29], we determined the distance lead could travel from a single residential home, not including transportation and tracking of dust to new locations on vectors. Using this software, dust fall zones were determined. Lead is not an ALOHA chemical, so mercury, which is heavier is used as a proxy.[30]

29. ALOHA 5.4.4, Office of Emergency Management, EPA and Emergency Response Division, NOAA
30. The weight of lead per cubic inch is 0.39 lbs; the weight of mercury is 0.49 lbs. per cubic inch.

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Applying outside knowledge to Detroit scenarios

The following exposure zones were estimated by the ALOHA model, based on the distance that the amount of lead dust generated can travel. Exposure in the zone is neither certain nor uniform, and these number represent averages.

Total Dust Fall= 933.5 yards
Lead in Dry demolition= 190.5 yards
Lead in wet-wet demolition= 112.0 yards
Lead in Baltimore protocol= 19.6 yards

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Applying outside knowledge to Detroit scenarios

Several models were run on a single two-story house across a range of seasonal weather conditions, and the following chart shows the summary statistics for the model.

	Model Average	Model Median	Model Range
Total Dust fall	933.5	936.5	780-1084
Dry	190.5	221.5	54-265
Wet-wet	112.0	135.5	0-177
Baltimore	19.6	0	0-119

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Applying outside knowledge to Detroit scenarios

An actual address (undisclosed) was selected to demonstrate impact. This address was listed on the Detroit Free Press's Dangerous buildings list in 2012 as vacant and open, and thus a candidate for demolition.

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About 2928 Carrie Beth St.

- Near a bus route
- Built in 1922
- 4 beds, 4 baths, two stories
- Lot is 45 ft. x 100 ft.
- Forced-Air Furnace
- Neighborhood has a history of lead poisonings from 1988-2012
  - 38 children were lead poisoned in 21 addresses in adjacent blocks

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ALOHA Statistics

To use the ALOHA model, certain basic parameters must be set. For this model, we used:

- Urban (rough) background
- Three meters height for measurement
- Structure is 20 feet tall
- Average, still, windy and precipitation scenarios in all four seasons (16 scenarios for each estimate)
- Mercury from a direct source (heavier than lead)
- Eight hours of exposure

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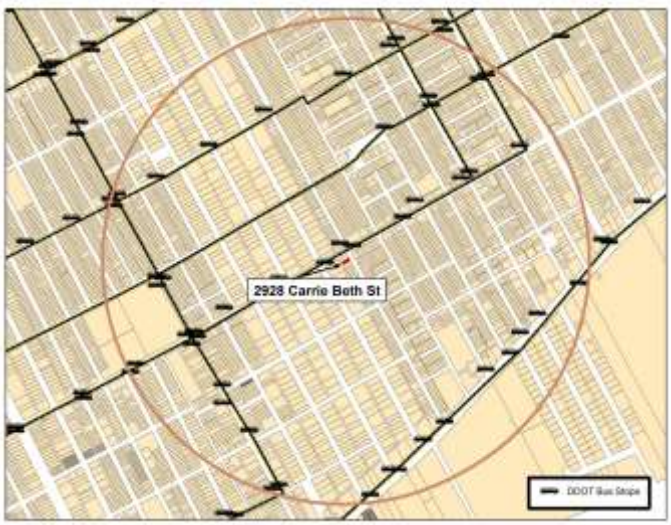
Total dust exposure zone



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2014 25

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Lead dust exposure zone from dry demolition
(Average of 16 scenarios)

2014 26

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Lead dust exposure zone from wet-wet demolition

2014 27

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Lead dust exposure zone from Baltimore protocol demolition

2014 28

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How many residents might be exposed to lead dust from this demolition?

Using MARPLOT software[31], the number of residents and houses exposed from the demolition of 2928 Carrie Beth St. was determined for the dry and wet-wet demolition exposure zones, using Census 2010 data.

31. MARPLOT 4.2.3, Office of Emergency Management, EPA, Emergency Response Division, NOAA

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	Total Dust (Chicago)	Dry Demolition/ No Mitigation (Chicago)	Wet Demolition/ Wetted Debris (Chicago)	Complete Dust Suppression Protocol (Baltimore)
Lead Dust Fall	2,202 μg/ft^2/hour	14.18 μg/ft^2/hour	5.48 μg/ft^2/hour	0.25 μg/ft^2/hour
Exposure Zone	933.5 yards	190.5 yards	112.0 yards	19.6 yards
Homes in zone	4,136	107	41	2
Residents in zone	2,516	66	28	6

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Using the same methodology, the vacant and open structures located on adjacent blocks were analyzed to see how their demolition might complicate exposure.

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Dry demolition of all visible vacant and opens

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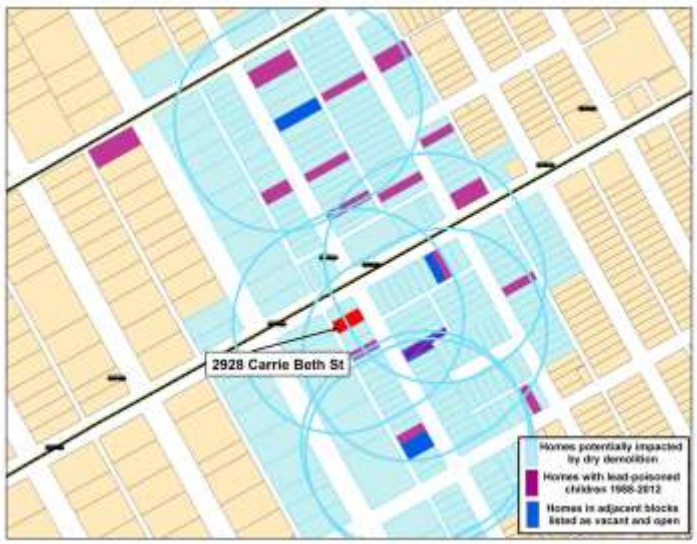
Wet-wet demolition of all visible vacant and opens



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Baltimore protocol demolition of all visible vacant and opens

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Overview of potential impact

	Distance	Total Area	Lots
Dry	190.5 yards	52.9 acres	416
Wet-Wet	112.0 yards	30.8 acres	254
Baltimore	19.6 yards	5.9 acres	51

Likely impact is likely to be to the northeast of each site due to dominant wind patterns

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Other considerations

- Transportation of debris
- Controlling access to the site
- EBL linked to demolition in studies in Baltimore, St. Louis and New Orleans
- Baltimore study indicated that lead dust settled after about 30 days.
- No federal laws mandate communication to neighbors or non-working bystanders

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Forms of mitigation of lead dust during demolition identified in the literature:

- Wetting during demolition
- Wetting debris
- Covering debris
- Pre-cleaning and wet methods
- HEPA vacuuming site
- Backfill or gravelling lot
- Tenting or shrouding
- Deconstruction in advance of demolition
- Fencing off site until debris is removed
- Advance notification to neighbors
- Tall fencing during demolition
- Post-demolition street and sidewalk cleaning
- Removing 2 inches of soil after demolition
- Providing residents with tack mats
- Using a Negative Air Machine

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Two options to test low-emission demolition in Detroit:

- Deconstruction
- Fencing and misting

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What is deconstruction?

Removing valuable or dangerous material from a structure prior to demolition

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Why deconstruct?

- Reduce toxic materials in demolition dust
- Reduce toxic materials in debris
- Create low-skill jobs

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Deconstruction in Detroit

- Next Energy is deconstructing or partially deconstructing 10 homes in the Springwells area of Detroit
- Tests of soil and air are conducted in advance of deconstruction and during and after demolition to determine if deconstruction impacts lead content and distribution related to construction
- Results pending (anticipated February)

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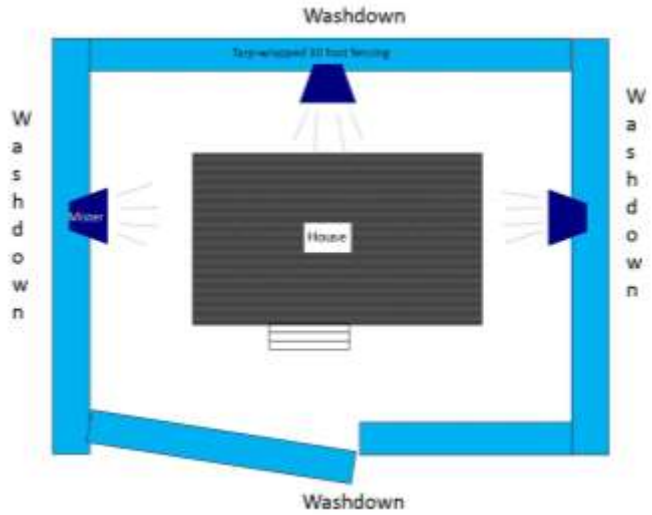
Fencing and Misting



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A Detroit Protocol?

Pre-Demolition activities

1. Determine safest areas
   - Areas with fewer children
   - Areas with high vacancies
2. Identify test houses
3. Pre-Test house, neighboring houses and soil on lots
4. Hire dust suppression manager and train staff about lead-safe practices
5. Notify neighbors and post date of demolition on house
6. Provide HEPA vacuums and tack mats to impacted neighbors for use during and for 30 days after demolition

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A Detroit Protocol?

Demolition activities

1. Deconstruction to remove lead and other toxic elements
2. Monitor site during demolition
3. Measure air-borne lead dust during demolition
4. Use Wet-Wet procedures, hosing during demolition and after
5. Use “high walls” or “tenting” with fine netting or plastic to catch debris during demolition. Three sided walls 30 feet high.

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A Detroit Protocol?

Post- Demolition activities

1. Cover debris trucks.
2. Keep site secure with fencing until site is mitigated.
3. Use misters from top of fencing to suppress debris dust.
4. Wash down neighboring houses and streets afterward.
5. Remove 2” of topsoil
6. Post Test air and soil on site
7. Measure Cost
8. Adapt and try again

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