Repairing Infrastructure: Potential Implications to Public Health

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Standing Committee on Medical and Public Health Research During Large-Scale Emergency Events

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Keck Center of the National Academies in Washington, DC

A Large-Scale Emergency Event: 2014 Chemical Spill in West Va

Federally declared disaster – Bounded rationality

Lesson:

Need to anticipate public health challenges to head-off a large-scale disaster





Residential tap water sampling and survey for the Freedom Ind. chemical spill; Whelton et al. (2014) ES&T

The crude MCHM spill in Charleston, West Va; Rosen et al. (2014) Journ. AWWA

Decontaminating chemically contaminated plumbing; Casteloes et al. (2016) ES: WR&T

Surfactant use for plumbing decon; Casteloes et al. (2016) Journ. HAZMAT

Chemical volatilization during plumbing flushing and contaminated water use; Omur-Ozbek et al. (2015) Proc.

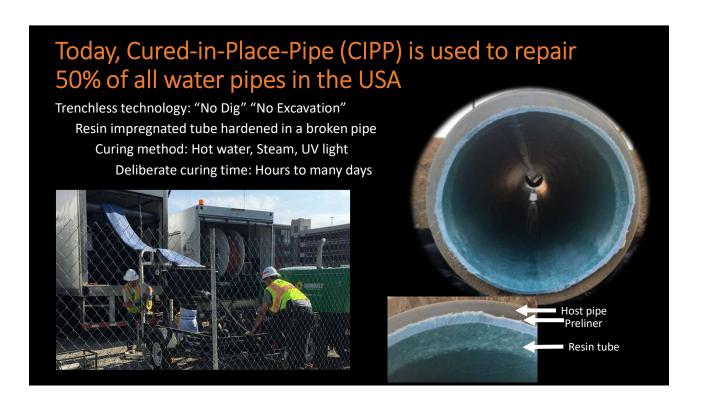
Acute toxicity differences between crude MCHM and pure MCHM on Daphnia magna. Novy et al. (2014). Thesis.

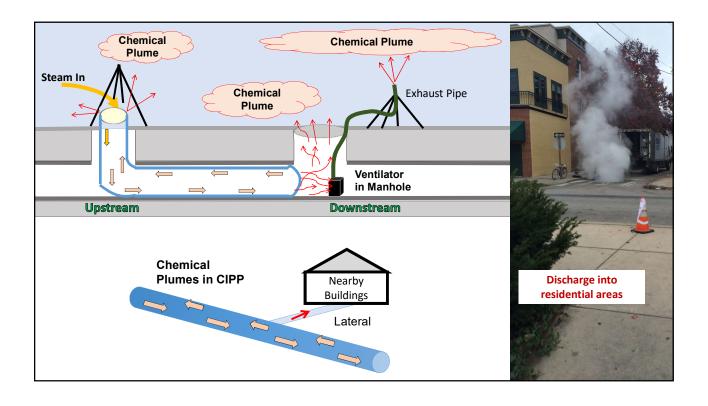
Chemical Spills Lessons Learned.; Weidhaas et al. (2016) Journ. Environ. Qual.

Sublethal toxicity of crude MCHM to Daphnia magna; ongoing with USGS (awaiting their data since 2015)

Developmental impacts on Danio rerio cause by Crude MCHM; ongoing

Case Study: West Va. chemical spill; ongoing





Sood Hope, IL, Lamphout 2016) Northeal, Quebec (Gagnon 2015) nr Steam filled the post office 4 different times, no fire department called; lateral not plugged allowed chemical plume to enter building; blew of totel worth (if month of wertillation) odor went away. Buffalo Grove, IL, (Andrews & Johnson 2015) nr Replated Grove, IL, (Andrews & Johnson 2014) nr Replated Village, KS, (Braun 2014) nr Replated	Incident Location	Styrene	Description of Events from Reference				
Funes stayed in building for 1 month, installers claimed styrene trapped underground and drifted into house, Installers installed blowers. After the 2" month (I month of well talled) or down way. Neighbor reported that they became nauseated and dizzy from chemical smell in their homes. One resident eported short of breath and headache. Another resident vert to hoted due to the sever same in their homes. They were repulsed, groggy, and confused. Neighbor seported that they became nauseated and dizzy from chemical smell in their homes. They were repulsed, groggy, and confused. Neighbor seported that they became nauseated and dizzy from chemical smell in their homes. They were repulsed, groggy, and confused. Neighbor seported that they became nauseated and dizzy from chemical smell in their homes. They were repulsed, groggy, and confused. Neighbor seported that they became nauseated and dizzy from chemical smell in their homes. They were repulsed, groggy, and confused. Nemoscaler, NY (Gagnon 2015) nr Smell of superglue in house, headaches and nostrils burning; utility contacted and told resident aports nontoxic. Windows and doors opened for vertilation, but of remained, County did not investigate and told resident head source nontoxic. Sellationer, MD (Ashho 2014) nr Neighbor seported that they became nauseated and sperimening deminical exposure symptoms; sought medical attention; Odors opened for vertilation, but of contact the contact t	West Lafayette, IN (Whelton 2016)	nr	Fumes entered campus building through floor drains; doors opened to ventilate; no fired apartment called; contractor said just odor, not harmful				
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after health agency involved. Helena, MT (Banks 2010) nr Fire department evacuated affected building because of complaints of strong odors, nausea, and headaches Arlington, VA (ARLnow.com 2010) nr Nearby CIPP installation caused odor, fire department responded Pittsburgh, PA (WPXI-TV 2009) nr Firefighters evacuated apartment buildings; initially suspected cyanide gas, but styrene was ultimately detected from nearby CIPP Somerset, United Kingdom (Wills 2007) nr Foul CIPP styrene odor permeated into residence through drain because of nearby installation Brooklyn, NY (Lysiak 2007) nr Foul CIPP styrene odor permeated into buildings through drain because of nearby installations Ditawa, CN (Bauer & McCartney 2004) 20, 115 Venting determined to be necessary to prevent air backup into nearby residences/ buildings Alexandria, VA (Gowen 2004) 500 HAZMAT team responded because of styrene vapor backup into nearby buildings, illness symptoms reported An office building that a large diameter sewer line was located under an old brewery building, All occupant complained about the strong odor. US federal health agency investigated, At least 11 employees were away from their work location for some portion of 17 days.	Pittsburgh, PA (Hayes & Biedka 2011)	nr	Elementary and high school students were evacuated for fear of gas leak; odors from nearby CIPP operation were the cause				
Arlington, VA (ARLnow.com 2010) nr Nearby CIPP installation caused odor; <u>fire department responded</u> Pittsburgh, PA (WPXI-TV 2009) nr <u>Firefighters evacuated apartment buildings</u> ; initially suspected cyanide gas, but styrene was ultimately detected from nearby CIPP Somerset, United Kingdom (Wills 2007) nr Foul CIPP styrene odor <u>permeated into residence through drain</u> because of nearby installation Brooklyn, NY (Lysiak 2007) nr Foul CIPP <u>styrene odor permeated into buildings through drain</u> because of nearby installations Ottawa, CN (Bauer & McCartney 2004) 20, 115 Venting determined to be necessary to prevent air backup into nearby residences/ buildings HAZMAT team responded because of styrene vapor backup into nearby buildings; illness symptoms reported Milwaukee, WI (ATSDR 2004) 30, 11 - 0.32 An office building that a large diameter sewer line was located under an old brewery building. All occupant complained about the strong odor. <u>US federal health approximations</u> agency investigated. At least 11 employees were away from their work location for some portion of 17 days.	Birmingham, UK (Pub. Health England 2011)	20 - 200					
Pittsburgh, PA (WPXI-TV2009) nr Fireflighters evacuated apartment buildings; initially suspected cyanide gas, but styrene was ultimately detected from nearby CIPP Somerset, United Kingdom (Wills 2007) nr Foul CIPP styrene odor permeated into residence through drain because of nearby installation Brooklyn, NY (Lysiak 2007) nr Foul CIPP styrene odor permeated into buildings through drain because of nearby installations Ottawa, CN (Bauer & McCartney 2004) 20, 115 Venting determined to be necessary to prevent air backup into nearby residences/ buildings Alexandria, VA (Gowen 2004) 500 HAZMAT team responded because of styrene vapor backup into nearby buildings; illness symptoms reported An office building that a large diameter sewer line was located under an old brewery building. All occupant complained about the strong odor. US federal health agency investigated. At least 11 employees were away from their work location for some portion of 17 days.	Helena, MT (Banks 2010)	nr	Fire department evacuated affected building because of complaints of strong odors, nausea, and headaches				
Somerset, United Kingdom (Wills 2007) nr Foul CIPP styrene odor <u>permeated into residence through drain</u> because of nearby installation Brooklyn, NY (Lysiak 2007) nr Foul CIPP <u>styrene odor permeated into buildings through drain</u> because of nearby installations Ottawa, CN (Bauer & McCartney 2004) 20, 115 Venting determined to be necessary to prevent air backup into nearby residences/ buildings Alexandria, VA (Gowen 2004) 500 HAZMAT team <u>responded</u> because of styrene vapor backup into nearby buildings; illness symptoms reported An office building that a large diameter sewer line was located under an old brewery building. All occupant complained about the strong odor. <u>US federal health</u> agency investigated. At least 11 employees were away from their work location for some portion of 17 days.	Arlington, VA (ARLnow.com 2010)	nr	Nearby CIPP installation caused odor; fire department responded				
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An office building that a large diameter sewer line was located under an old brewery building. All occupant complained about the strong odor. US federal health agency investigated. At least 11 employees were away from their work location for some portion of 17 days.	Ottawa, CN (Bauer & McCartney 2004)	20, 115	Venting determined to be necessary to prevent air backup into nearby residences/ buildings				
Milwaukee, WI (ATSDR 2004) 0.01 - 0.32 agency investigated_At least 11 employees were away from their work location for some portion of 17 days.	Alexandria, VA (Gowen 2004)	500					
	Milwaukee, WI (ATSDR 2004)	0.01 - 0.32					
	Toronto, CN (City of Toronto, 2001)	3.2	Eight houses were investigated but only two houses showed styrene due to traps engineered to be dry				

CIPP Contractors and Water Utilities Across the US Acknowledge that Workers and the General Public Are Exposed to CIPP Chemicals

"...is <u>not a human health risk</u>." – 2016, Metropolitan Water Reclamation District of Greater Chicago, IL

"...<u>styrene vapor of at most a few ppm</u>...." - 2016, Hagerstown, MD

"...do not be alarmed." - 2016, Evanston, IL

"...it is at levels significantly lower than the allowable exposure limits" - 2016, Northeast Ohio Regional Sewer District, OH

"...May notice 'chemical-like' odor. <u>Safe for people and animals</u>." – 2016, Kansas City, MO





"...styrene levels are below permissible exposure limits and will not pose any hazardous conditions" – 2015, Orange County Sanitation District, CA

"Some people are offended by this odor and are fearful of it; <u>even though the</u> <u>concentrations they smell present no</u> <u>harm</u>" – 2016, Winooski, VT

"The amount of airborne styrene the repair process produces is <u>not a human</u> <u>health risk</u>" – 2015, City of Portland, OR

7

Current Assumptions by Industry: Styrene is the Only Organic Chemical Emitted from CIPP, Few ppm is the Highest Level

A Report on the Monitoring of Styrene in Toronto Homes During the Cured in Place Pipe (CIPP) Process for Sewer Pipe Rehabilitation by Insituform

PROJECT NO. 041-6742

Prepared for
Toronto Works & Emergency Services
2700 Eglinton Avenue West
Toronto, Ontario
M6M 1V1

AirZone, Inc. (2001)

Buildings tested 7 (2000), 2 (2001) Sewer pipe layout unclear

Manholes (Single 2-8 hr samples) 0.16 to 1.5 ppm with preliner 3.2 ppm maximum without preliner

Breathing zone (Single 4-9 hr samples) 0.08 to 0.5 ppm, workers

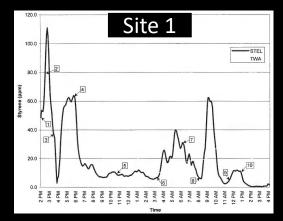
Indoors (Single ~24 hr samples)

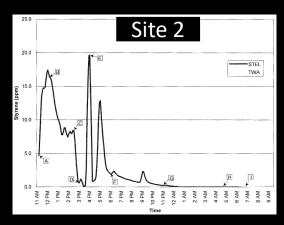
0.1 to 0.2 ppm, worst-case during the CIPP process Highest concentrations, dry plumbing traps

"...it does not appear that it is a significant source of any other VOCs...."

In 2004, CIPP PID Air Testing Study was conducted in Canada

Bauer & McCartney. 2004. Proc. No-Dig.





Observations:

PID set for styrene, but real-time measured STEL?

One air sample collected every 15 minutes (4/hr), but solid lines used

Did not start monitoring until after CIPP installed

In 2005, ATSDR Found CIPP Styrene and Other VOCs Entered Office Building through the Foundation, Chemicals Lingered for Months

Date	Total VOC, ppm	Styrene, ppm
12/10	Evacuation	Evacuation
12/13	Evacuation	Evacuation
12/13-22	nd – 1.45	Not tested
12/22	nd – 199.0	Not tested
1/12	0.5 – 30.0+	Not tested
1/13	nd – 1.77	nd – 0.30
1/18	nd – 1.60	Not tested
1/21	nd – 0.86	nd – 0.22
2/4	nd – 0.21	nd – 0.15
2/7	nd – 0.57	nd – 0.04
3/28	nd – 0.22	nd – 0.01



"...past conditions at the site are classified as a public health hazard."

Styrene odor threshold < 0.1 ppm



Limitations with Existing CIPP Air Testing Studies are Significant

Very limited air monitoring data available

Air flow in sewers near buildings unclear

Monitoring conducted far from generation sites

Very few CIPP contractors and resin systems monitored

No characterization of resin or CIPP, What could be released?

Air monitoring began after installation, hours to days to months

Nonstyrene contaminants may have sorbed to sampling materials

Multi-hour sample misses more transient, higher concentration exposures

And more...



2015 Los Angeles, CA

2016 NSF RAPID Response Study

Goal

To better understand chemical emission from CIPP installations

Objectives

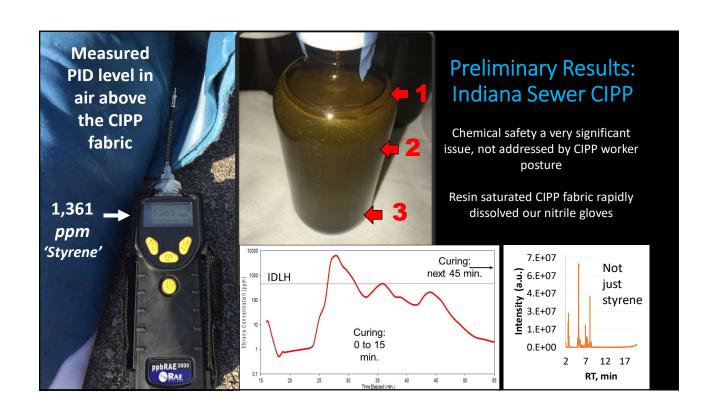
- 1) Compare different air sampling strategies
- 2) Evaluate chemical air emissions under different installation conditions
- 3) Identify chemicals emitted and their magnitudes

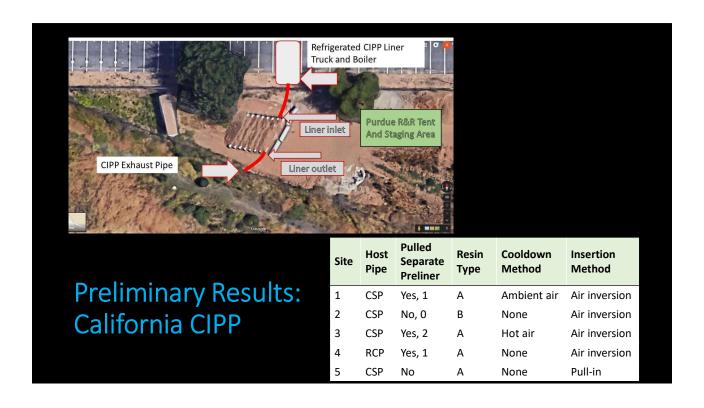




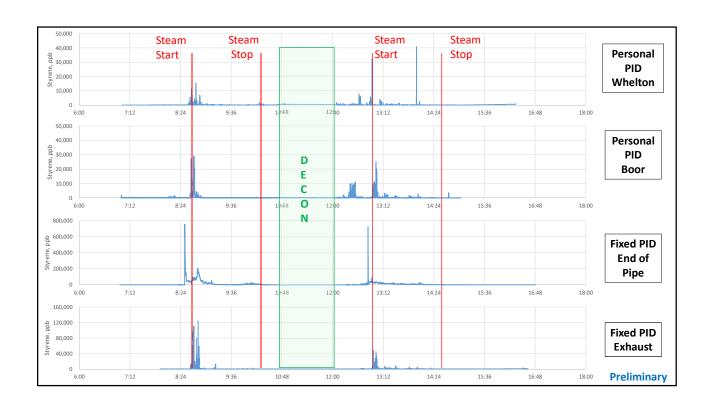
Crowdfunding











Organization & their Styrene Exposure Limit		Conditions	Value	Was Limit Exceeded at CIPP Site? (Site #)				
	Standard							
				1	2	3	4	5
OSHA PEL – Gen. Industry	TWA	8 hr	100 ppm	Υ	Υ	N	N	Y
	Ceiling	Never to exceed	200 ppm	Υ	N	N	N	Υ
	"Exception to ceiling"	Max. peak duration is for 5 min in any 3 hr	600 ppm	Υ	Υ	N	N	Υ
Cal OSHA	TWA	8 hr	50 ppm	Υ	Υ	N	N	Υ
	STEL	15 min average	100 ppm	Υ	Υ	Υ	N	Υ
	Ceiling	Never to exceed	500 ppm	Υ	N	N	N	Υ
NIOSH REL	TWA	Up to 10 hr	50 ppm	Υ	Υ	N	N	Υ
	STEL	15 min average	100 ppm	Υ	Υ	Υ	N	Υ
	Ceiling	Never to exceed	500 ppm	Υ	N	N	N	Υ
NIOSH		Exposure is likely to cause death or immediate or				\top		
	IDLH	delayed permanent adverse health effects or prevent	700 ppm	Υ	N	N	N	Υ
		escape from such an environment						
ACGIH TLV	TWA	8 hr	20 ppm	Υ	Υ	Υ	Υ	Υ
	STEL	15 min average or other	40 ppm	Υ	Υ	Υ	Υ	Υ
City of Toronto, CN	General public	1 hr, Exposure limit set by Local Health Dept.	5 ppm	Υ	Υ	Υ	Υ	Υ
TCEQ, acute reference value	General public	1 hr, Set by TX Comm. Env. Quality	5 ppm	γ	Y	Υ	Υ	γ

We are still analyzing and interpreting data.

Current Preliminary Observations

- <u>Serious health and environmental threats may exist</u> For years workers and public have been told none exist, prior CIPP air testing data not adequate, other *in-situ* pipe repair technologies not addressed
- Emissions are highly transient, high temperature, high flowrate
- Chemical plume contained multi-phase materials
- These few sites are not enough to understand variation across the U.S.

Who's at Risk?

Thousands of CIPP workers and millions of people near emissions

Relevance to Large-Scale Emergencies and Public Health

Incorrect assumptions about personal safety, more data needed
Uncertainty abounds - Formulations, contractor procedures
Odor detection means person is being exposed, not that the exposure is safe
Lack of odor means we do not know if people are being exposed
Public health officials, CIPP workers, HAZMAT, public lack the necessary data

Preliminary Next Steps

Complete data analysis
Worker and public education
Investigation of hazards to those exposed
Test many more sites
Screen tentatively identified compounds (TIC)
Conduct risk assessments

Need to anticipate public health challenges to headoff a large-scale disaster

