West Virginia Spill: 
Surface Water Facility Resilience

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September 17, 2015

Acknowledgements
Karen Casteloes, Jake Hawes, 
Xiangning Xuan, LaKia McMillan, Matt 
Connell, Keven Kelley, Jeff Gill, Kevin 
White, Mahmoud Alklahout, Fredrick 
Avera, Caroline Novy, Alex Beebe

Special thanks to ...
West Va. homeowners 
Rob Goodwin, WV Clean Water Hub 
Maya Nye, PCACS 
Krista Bryson, Ohio State Univ. 
Dr. Bill Cooper, NSF 
West Va. Governor and agency staff 
WVTAP colleagues 
Laura Linn, Dauphin Island Sea Lab 
Dr. Randi Brazeau, Metro State Univ. 
Dr. Omur-ozbek, Colorado State Univ. 
Dr. Rahul Gupta, KCHD

Funded by: 


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The Whelton Group

Our Team Operates at the Interface of the Environment-Infrastructure-Public Health

Education Actions
- Polymer in Infrastructure & the Environ.
- Environ. Eng. Design
- NESCC and ILSI Expert Panels
- Industrial workshops & conferences

Research
- Infrastructure materials
- Polymer degradation
- Aquatic chemistry
- Water distribution
- Water quality & treatment

Resilience

\( \text{\textbackslash ri\textquotesingle zil\textquotesingle yen(t)s\textbackslash} \)

The ability to recover from or adjust easily to misfortune or change
West Virginia

The “Mountain State”
Seceded from Virginia in 1863
Population 1,850,000

State capital: Charleston
Legislature meets once a year
Industries: tourism, chemicals and coal mining

January 9, 2014, 8:16am
Resident tells West Va. DEP and stated “something in the air at the 77-79 split each morning when he comes into work. He said it is coating his wife’s throat.”

11:15am – West Va. DEP finds spill
12:05pm – Freedom Industries reports spill to WV DEP hotline
12:00-12:30pm – Water utility notified, PAC feeding begins
4:00pm – Water plant overwhelmed, water enters distribution system
5:36pm – Do Not Use order issued
Freedom Industries Spill
January 9, 2014

No plant shutdown:
Public safety concerns

300,000 people
9 counties
15% of West Va. pop.

2,200 mi. water mains
107 water tanks
>90,000 buildings

8 days after the spill:
366 miles downstream

The Liquid Spilled was a Complex *Mixture*

**Crude MCHM & Stripped PPH**

2,500 gal initial estimate, then **>10,000 gal**

**17+ ingredients**, most lacked toxicity data

Most ingredients lacked water sampling and analysis methods

Utility, State, Federal agencies keyed in on
**4-methylcyclohexane methanol (MCHM)**
isomers, but other chemicals were present
Officials Did Not Fully Characterize the Spilled Liquid or Fully Understand what was in the Water

<table>
<thead>
<tr>
<th>Chemicals in Tank 396 Liquid</th>
<th>MSDS EastM 1/98</th>
<th>FDM 1/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-MCHM (a.k.a. MCHM)</td>
<td>68 to 89%</td>
<td></td>
</tr>
<tr>
<td>4-MMCHM</td>
<td>4 to 22%</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>4 to 10%</td>
<td></td>
</tr>
<tr>
<td>MMCHC</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>DM14CHDC</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Methanol</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>1,4-CHDM</td>
<td>1 to 2%</td>
<td></td>
</tr>
<tr>
<td>Polyglycolethers (9d after spill)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

McMillan et al. 2015

Jan. 9: West Va. DHHR Asked the CDC to Determine the Safe Drinking Water Level for 4-MCHM

Concerns from the Public:
Infants, expectant mothers, immunocompromised persons, toddlers, healthy adults, pets, livestock, fish, deer, birds

Ames assay for mutagenic activity on cells (Crude MCHM)
Rat, 14 day acute oral studies (pure MCHM)
Guinea pig, 48 hr acute dermal study (pure MCHM)
Rabbit, acute dermal irritation (eye) study (pure MCHM)
Rat, 14 day acute dermal study (pure MCHM)
Rat, 28 day acute oral study (pure MCHM)

Minnow, 48 hr acute toxicity (Crude MCHM)
Daphnia, 48 hr acute toxicity (Crude MCHM)
Environmental biodegradation (Crude MCHM)
COD, BOD (Crude MCHM)

Adams et al. 2014.
“...I would appreciate it if we could wrap this thing up...”
January 10, 2014, 5:30 pm

“...Occasionally we have had reports of an odor previously....”

MCHM Levels were Monitored at the Affected Water Treatment Plant

"One hour before I was to bathe they announced the water was not safe, they had bathed my new born baby ...."
Guidance issued to school staff only

“Avoid contact”

“Minimize your exposure by leaving areas while lines are being flushed”

January 13, 2014

Guidance issued to school staff only

“Avoid contact”

“Minimize your exposure by leaving areas while lines are being flushed”

January 13, 2014
Scores reporting symptoms

Health officer recommends people make own decisions about using water

Bottled water still in high demand

Area ER visits increase

100-plus people exposed to Elk leak cite eye irritations, rashes and more

‘Nobody is going to say it’s safe’
On the Ground... in Affected Homes

Resident interviews
In-home water testing
Home flushing

7 Days After the Spill (Jan 17): We drove to West Va. and Teamed with NGOs

The day we arrived
The Whelton Group

Plumbing Systems Were Complex (plastics, metals, glass, hot, cold, tanks …)

Medical Data Showed Residents Became Ill When Plumbing System Flushing was Recommended

By Conducting Rapid In-Home Tests We Were Able to Understand Resident Experiences and Exposures

“...after you have flushed each hot water faucet for 15 minutes, your water heater will be safe for use.”
- West Virginia American Water, 2014

CDC’s “safe” ingestion level
“…if the water is at nondetectable levels for MCHM, it is safe to drink, bathe in and clean with, and this would include for pregnant women.” - CDC, late Feb 2014

Incident definition of nondetectable: Changed with time! < 10 ppb, < 6 ppb, < 2 ppb, < 0.5 ppb

The Water Company Flushed its Distribution System and the National Guard Flushed Government Buildings

Jan 21: Freedom Ind. Stripped PPH
Jan 22: Our team departs
Jan 29: Marshall Univ. Prof testifies residents “breathing formaldehyde gas” from breakdown products
Jan 31: 2nd Freedom Ind. Site spill occurs
Feb 1: 5 schools report licorice odors
Feb 5: CDC uses the word “safe” for the first time
Feb 5: 16 schools closed due to odors/health impacts
Feb 10: WV Gov. authorizes the WVTAP scientific investigation
Feb 25: USGS finds MMCHC in drinking water
WVTAP was Authorized because of Unexplained Illnesses, Chemical Levels, and Odors

Environmental Impacts Remain Poorly Understood Due to the Lack of Testing

Team:
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And the Expert Health Effects Panel

Freedom Spill Site
CSB WWTP [Downstream]
WVAW Intake
Elk Valley WWTP [Upstream]

What level can you smell?
Break Down Compounds
What levels are occurring in your homes?
What level is Safe?

WVTAP was Authorized because of Unexplained Illnesses, Chemical Levels, and Odors
The Whelton Group

“At the end of the day, there can be no risk. We just can’t have it.”

November 13, 2014
Sec. Randy Huffman, WV DEP

Spill site STORM WATER:
4-MCHM: 76 – 190 mg/L
PPH: 1.6 – 95 mg/L

Spill site GROUND WATER:
4-MCHM: 0 – 0.014 mg/L
PPH: 0 – 0.022 mg/L

SOIL:
Contamination up to 20 ft depth
4-MCHM: Up to 15,000 mg/kg
PPH: Up to 9,000 mg/kg

Other Chemicals Found:
4-methyl cyclohexanecarboxylic acid (MCHCA)
4-methyl methyl ester, cyclohexanecarboxylic acid (MMCHCA)
1-hydroxymethyl-2-methyl-1-cyclohexane (HMC)
Citizens and businesses organized to protect water supplies
Maya Nye, People Concerned About Chemical Safety

Senate Bill 373, The Water Resources Protection Act
March 2014
Multiple tanks leaking before January 9, 2014
Chemical Safety Board, 2014

Inside out: Daylight!

Your Upstream Neighbors ... States away... can Cause You Problems

- Huntington WV: 4-MCHM finished water level = 9 ppb
- Numerous communities downstream
  - Shut their intakes
  - Conducted odor monitoring of their raw and drinking waters

Novy et al. 2015. In Prep.
Rapid testing

Spilled liquid 4-MCHM only

Raw water 4-MCHM only

Treated water 4-MCHM only

Byproducts not considered

No premise plumbing water tests

Did not know where physical / chemical property data were

Inhalation exposure not considered, only ingestion

14 day drinking water limit established

Chemical fate in water pipe systems not considered

Created plumbing flushing protocol without any basis

Indoor air chemical exposure not considered

Tested utility water only, no indoor water or air testing

Developed and implemented utility asset decon plan with some follow-up validation testing

Residents told to flush, then experienced side effects, some homes not cleaned

**West Virginia Spill Response, Jan 9 to Feb 10, 2014**

**Response Phase**

**GCMS only**

**Re·sil·i·ence**

\ri-'zil-yen(t)s\n
The ability to recover from or adjust easily to misfortune or change
Reporters were critical to influencing information disclosure and making it available to the public

Charleston Gazette: Ken Ward, Jr. David Gutman
Charleston Daily Mail: David Boucher
Associated Press: Jonathan Matteise
NPR All Things Considered: Melissa Block
West Va. Public Radio: Ashton Marra, Dave Mistich
CBS Evening News: Jeff Pegues
WOWK: Alanna Autler
WCHS: Kallie Cart
And many more…
You don’t have to be a responder to contribute to the recovery

Volunteer through NGOs
Letters to the Editor
OP-ED

Dayton Carpenter: Is the water safe to drink?

Here I sit 16 days after the MCHM spill and water crisis. Four days ago, Daily Mail headlines read: “Public getting mixed messages: Utility head reassures customers” and “Tomblin won’t say tap water ‘absolutely’ safe to consume.”

On top of that, I have flushed my home plumbing system according to the water company’s instructions and I still smell the licorice odor in my tap water. My family and friends say, “You design water treatment plants — is the water safe to drink?”

Along with the majority of the 300,000 consumers affected, I have become extremely frustrated with the water crisis. I am an engineer and a chemist and have spent 37 years designing water treatment plants. I should be able to tell my wife, children, grandchildren and friends whether the tap water is safe. When the licorice odor waited from our kitchen sink earlier this week, I decided to take what I know about this crisis and apply the same data-driven approach I have used in my career in the water industry.

The Elk River Spill Catalyzed Action Across the US including in Washington, D.C.


Indiana
SENATE ENROLLED ACT No. 312

First Regular Session 107th General Assembly (2015)

Printed with funds appropriated by the General Assembly of the State of Indiana

An Act to amend the Indiana Code concerning environmental law.

Be it enacted by the General Assembly of the State of Indiana:

SECTION 1. IC 13-11-2-6.5 is added to the Indiana code as a new section to read as follows [effective July 1, 2015].

SECTION 2. IC 13-11-2-6.5 is added to the Indiana code as a new section to read as follows [effective July 1, 2015].

SECTION 3. IC 13-11-2-6.5 is amended to read as follows [effective July 1, 2015].

SECTION 4. IC 13-11-2-6.5 is amended to read as follows [effective July 1, 2015].
The Frequency of Water Contamination Incidents is Increasing

Washington, DC
370 buildings
December 2014

Glendive, MT
5,500
January 2015

Quebec, CN
230,000
January 2015

Toledo, OH
500,000
September 2014

Various Indiana Waterways
2015

Nibley City, UT
5,000
April 2015

Silverton, CO
40,000
August 2015

Many locations, LA
20,000+
2015
How can Indiana communities become more resilient?

INDIANA
Approximately 10,000 known chemical tanks
Thousands very close to drinking water intakes
More than 2 million people served by surface water
Economy relies on these sources

10 LARGEST SYSTEMS
Indianapolis, Fort Wayne
Gary-Merrillville
Evansville, Hammond
Muncie, Bloomington
Kokomo, Richmond
Michigan City
1. Get the Right People on the Bus

Expert Indiana Science Cell for State Level Support

Characterization Methods for Environmental Samples

Environmental Monitoring & Sampling

Water Treatment & Distribution

Premise Plumbing

Risk Assessment & Public Health

Risk Communication

2. Co-Train LEPCs and Water Utilities, Mutual Aid

LESSONS LEARNED
from drinking water disaster and terrorism exercises

WHELTON ET AL. | PEER-REVIEWED | JHJ • JOURNAL OF AIR | AUGUST 2006

BY ANDREW J. WHELTON,
PATTI KAY WISNIEWSKI,
STANLEY STATES,
SARA E. BIRKMIRE, AND
MICHAEL K. BROWN

Whelton et al. (2005)
We Have a free Excel Based Program that Can Be Used to Estimate Flushing Time

3. Identify and Prioritize Water Supply Threats
4. Water Supply Resilience vs. “Public Interest”
Mobile, AL; 300,000 people; 1 crude oil pipeline

Nov 2013: MAWSS vs. Plains Southcap, Inc.

5. Get the Data We Need
Bench- and Pilot-Scale Testing Essential

1. How do we reliably screen waters for unknowns?

2. Where do the contaminants go in water systems? Petroleum products, high priority chems, etc.

3. How can we quickly and safely clean piping, tanks, and plumbing?

4. How do we handle all that contaminated water?

5. How effective are in-home treatment devices?
Water Infrastructure Testing & Evaluation (T&E) Facility

Recreate field conditions, Evaluate system design and contamination scenarios, Explore material-contaminant interactions, Challenge decontamination aide effectiveness

Resilience

The ability to recover from or adjust easily to misfortune or change
NSPE Engineer's CREED:
Hold paramount the safety, health, and welfare of the public.

Within Indiana…
- We have an unprecedented opportunity
- Most people try to do the right thing
- Question the scientific validity of all advice
- Provide decision makers scientifically relevant data
- Point out questionable data, statements, and unknowns
- Do not wait for someone else to help Hoosiers. Act now.

Thank You!
Visit www.WheltonGroup.org

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