

The Crude MCHM Chemical Spill 10-Home Study: Tap Water Chemical Analysis

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May 5, 2014

1.0 Introduction

As part of the WV TAP project Task 3, ten households affected by the crude MCHM that was spilled into the Elk River and contaminated the Charleston, WV region's drinking water were surveyed and sampled. The objective of Task 3 was to assess concentration and variability of MCHM in homes in a focused study. Data resulting from the sampling effort will be used to support the design of a larger, more comprehensive sampling and assessment program for the nine counties affected. Households were surveyed and sampled in eight (Boone, Cabell, Clay, Kanawha, Lincoln, Logan, Putnam, and Roane) of the nine counties affected by the chemical spill and between February 11, 2014 to February 18, 2014.

No affected homes in Jackson County were visited because the Jackson County residents contacted declined participation and switched to private well water in response to the contamination incident. Jackson County had the lowest number of West Virginia American Water (WVAW) customers of the nine counties affected. A second home in Putnam County near the Jackson County line was visited in lieu of visiting a residence in Jackson County.

During each household visit, three tasks were completed:

1. Residents were interviewed by the WV TAP project team;
2. Basic chemical and physical properties (temperature, pH, turbidity, chlorine residual) were determined for tap water from kitchen faucets and bathroom fixtures; and
3. Water samples were collected for detailed analyses at commercial laboratories.

Results of the tap water chemical analyses are presented in this document. Results of the resident interviews are presented in a companion report. Together, these two documents describe results of the WV TAP 10 home study.

2.0 Methods

2.1 Field Water Sample Collection, Analysis, and Shipping

Three individuals conducted home sampling and surveying. Premise plumbing sampling was done for four tap conditions in the following order: (1) kitchen cold tap; (2) kitchen hot tap; (3) cold water from the most frequently used bathtub; and (4) hot water from the most frequently used bathtub. Onsite water quality measurements included water temperature, pH, turbidity, free and total chlorine, and odor. The physical measurements were taken at each tap before sample collection. The time was recorded at the beginning of sampling at each tap, and when each sample bottle for chemical analysis was collected.

Total and free chlorine were measured separately using the HACH® Pocket Colorimeter™ II, Chlorine (Free and Total). The *N,N*-diethyl-*p*-phenyldiamine (DPD) reagents used were as follows: for total chlorine measurements, DPD reagent A3035, expiration date, 08/2018; and for free chlorine DPD reagent A3238, expiration date 02/2018.

Water temperature and pH levels were measured using a Thermo Scientific Orion 5 Star™ portable meter. The pH meter was calibrated at the beginning of each day of sampling using Fisher pH standards at pH 4, 7, and 10. Turbidity measurements were made using a HACH® 2100Q™ portable turbidimeter. Water samples were tested immediately upon collection at the temperatures recorded. After the physical measurements were recorded, one sampler collected approximately 120 mL tap water in a 250 mL beaker and covered the sample. The sample was then shaken several times while covered and presented to one of the three samplers who smelled it and made a record of the odor. In many instances the individual asked for a second sample before recording results. Each of the three samplers recorded results independently of the others so as not to influence one another. At the conclusion of the physical measurements at each tap, sample collection for laboratory analysis began.

Nine samples were collected for each tap condition. One set of triplicate samples was sent to the commercial laboratory ALS for analysis, a second set of triplicate samples was sent to ALS for archiving and a third set of triplicate samples was sent to the commercial laboratory Eurofins for analysis. The commercial laboratories provided sample containers for all samples. ALS samples for 4-methylcyclohexanemethanol (MCHM) and propylene glycol phenyl ether (PPH) were collected in a single 1 L amber glass bottle with 1 mg sodium thiosulfate and samples for total organic carbon (TOC) analysis were collected in 125 mL or 250 mL plastic bottles with sulfuric acid preservative. Eurofins samples for MCHM/PPH were collected in 1 L amber glass bottles and TOC samples were collected in 125 mL glass bottles. Sampling and recording at each tap condition took 5 minutes to 7 minutes.

After the tap condition samples were collected, a set of matrix spike (MS) and field blank (FB) samples were collected for each analytical laboratory and for archiving. MS and FB samples were collected in the same manner as tap water samples. MS samples were prepared for kitchen cold tap and kitchen hot tap conditions. The FB was a clean sample bottle from each laboratory filled at the kitchen sink counter with laboratory-purchased deionized (DI) water that was free of the analytes of interest. Field blanks are used to assess whether contamination with the analyte of interest (MCHM or PPH) occurred during sampling.

As soon as sampling was completed the bottles were placed in coolers and transported to a local hotel for icing, repacking, and shipping to the designated laboratory. Three laboratories, ALS Environmental Laboratory (Charleston, WV), Eurofins Lancaster Laboratories (Lancaster, PA) and Eurofins Analytical Laboratories (Monrovia, CA) were selected for this project. Samples for ALS Environmental Laboratory were picked each morning by ALS staff at 7 am. Coolers for shipment to Eurofins Laboratories were sent by FedEx® overnight and received on the next business day after shipping. All samples were received within hold times at both Eurofins Laboratories. Upon sample receipt at Eurofins Laboratories, cooler temperatures sometimes slightly exceeded the recommended standard 4°C for most drinking water samples. In these cases half of the samples were hot tap water, which is not typical of drinking water samples.

2.2 Analysis Conducted by Commercial Laboratories

The three laboratories that analyzed samples for this study reported different method detection limits (MDL) and minimum reporting limits (MRL) for TOC, PPH and 4-MCHM (**Table 1**). The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte (USCFR 1986). The MRL is the minimum concentration that can be reported as a quantitated value for a target analyte in a sample following analysis. This defined concentration can be no lower than the concentration of the lowest calibration standard for that analyte, and can be used only if acceptable quality control criteria for the analyte at this concentration are met. Put simply, the MDL indicates that the analyte is present at a concentration of greater than zero, and the MRL is the level at which the concentration of the analyte can be reported with confidence.

Table 1. Minimum Detection Limits and Minimum Reporting Limits for the Two Commercial Laboratories

Contaminant ²	ALS Environmental Laboratory Charleston, West Virginia		Eurofins Laboratories ¹ Lancaster, Pennsylvania Monrovia, California	
	TOC, ppm	MDL = 0.07	MRL = 0.50	MDL = 0.04
PPH, ppb	MDL = 3.7	MRL = 5.1	MDL = 0.5	MRL = 1.0
4-MCHM, ppb	MDL = 2.7	MRL = 5.0	MDL = 0.5	MRL = 1.0

1. Monrovia, California carried out TOC testing while Lancaster, Pennsylvania conducted 4-MCHM and PPH analysis
2. Parts per million (ppm); parts per billion (ppb)

2.2.1 ALS Environmental Laboratory. WV TAP samples were analyzed for TOC, MCHM, and PPH. TOC was determined via Standard Method 5310C. Samples exceeding the calibration range were diluted and reanalyzed. The instruments used for analysis were a 1010 Analyzer coupled with a 1051 Autosampler and a 1030W Analyzer coupled with a 1088 Autosampler, both manufactured by OI analytical. Before sample analysis, the instrument was calibrated using five calibration standards.

A method blank, a laboratory control sample (LCS) and a matrix spike/matrix spike duplicate (MS/MSD) pair were analyzed to serve as batch quality control. The method blank acceptance criterion was no detection of TOC above the reporting limit. The LCS (reagent water spiked at approximately the mid-point of the calibration curve) acceptance criterion was acceptable recovery within the laboratory control limits. Both method blank and LCS criteria needed to be met for the batch to be considered acceptable. The MS/MSD recoveries were also compared to laboratory control limits, and if outside of those, the parent sample would be qualified.

4-MCHM and PPH were examined according to standard US Environmental Protection Agency (US EPA) SW-846 methods for both preparation and analysis. The water samples, (approximately 1000 mL), were extracted using method 3510C with methylene chloride as the extraction solvent under an acidic pH. The extract was initially concentrated on a steam bath using a Kuderna Danish (KD) apparatus, and brought down to a final volume of 1.0 mL using nitrogen evaporation. The extract was then analyzed using method 8270C, which is a gas chromatograph/mass spectrometer (GC/MS) analysis technique. Prior to analysis the internal standards were added to each sample per the method requirements.

Before sample analysis, the GC/MS was tuned to meet the method Decafluorotriphenylphosphine (DFTPP) relative mass abundance criteria and calibrated using a six calibration standards. 4-MCHM was calibrated from 5 µg/mL to 500 µg/mL and PPH was calibrated from 2.5 µg/mL to 250 µg/mL. Instrument performance was verified prior to each 12-hour analytical sequence by the analysis of the DFTPP tune solution and continuing calibration standards, which were compared to the initial calibration curve. ALS instrumentation used for this project was an Agilent 5890/5973 GC/MS system.

With each preparation batch (not to exceed 20 field samples), a method blank, a LCS and a MS/MSD pair were extracted to serve as batch quality control. The method blank acceptance criterion was no detection of target analytes above the reporting limit. The LCS (reagent water spiked at approximately the mid-point of the calibration curve) acceptance criterion was acceptable recoveries within the laboratory control limits for both of the target compounds. Both method blank and LCS criteria needed to be met for the extraction batch to be considered acceptable. The MS/MSD recoveries were also compared to laboratory control limits, and if outside of those, the parent sample would be qualified. All field and quality control samples were spiked with the surrogate standards listed in EPA SW-846, Method 8270C to measure extraction efficiency. The surrogate recoveries were compared to laboratory control limits and, if within those limits, the results were considered acceptable and valid to be reported.

2.2.2 Eurofins Laboratories (Lancaster and Monrovia). 4-MCHM and PPH analyses were carried out by application of the following methods. A water sample was serially extracted with methylene chloride following EPA SW-846, Method 3510. The resulting extract was reduced in volume and an aliquot was injected into a GC/MS. The GC/MS analytical system was tuned and calibrated following the principles outlined in EPA SW-846, Method 8270D. This included tuning the system to DFTPP relative mass abundance criteria and calibration using a minimum of five calibration points from 1 ppb to 60 ppb. An internal standard based initial calibration was used. The analytical system was tuned and the calibration responses checked, relative to the initial calibration responses, every 12 hours.

Field samples were extracted in batches that were not to exceed 20 field samples. With every extraction batch, a method blank, a LCS and an MRL LCS were extracted to monitor the effectiveness of the extraction batch. A method blank was free of target compounds to be considered acceptable. The LCS (which was an aliquot of laboratory water spiked at approximately the mid-point of the calibration curve) and the MRL LCS (laboratory water spiked at or near the MRL) must have demonstrated acceptable recoveries of the target compounds for the extraction batch to be considered acceptable. Additionally, every field sample, method blank, LCS and MRL LCS were spiked with a surrogate standard that also went through the extraction process. If the surrogate standard recovery was acceptable then the inference was that any target compound present in the field sample was recovered. The work was performed on an Agilent 7890 GC with an Agilent 5975 MSD.

3.0 RESULTS AND DISCUSSION

3.1 Tap Water Analysis for Basic Parameters

On-site measurements of tap water quality are summarized in **Table 2**. Tap water temperature is important because temperature influences the contaminant volatility. Volatilized compounds can contribute to resident chemical exposure and off-odors. Cold tap water temperatures ranged from

6.9°C to 21.9°C and hot water temperature ranged from 31.6°C to 58.1°C. Water pH values were within the US EPA Secondary Maximum Contaminant Level (MCL) of 6.5 to 9.5. Nearly all the tap water pH levels found in homes however, exceeded the pH levels leaving WVAW (pH 7.1 to pH 7.3). No chlorine concentrations exceeded the US EPA Primary MCL of 4.0 ppm. As expected, both total and free chlorine concentrations were greater for cold water than hot water within homes. Tap water turbidity levels were in the expected range and varied from 0.05 NTU to 1.47 NTU.

Table 2. Range of Tap Water Quality Conditions Observed Across all Ten Homes

Parameter ¹	Kitchen Sink Faucet		Bathtub Faucet	
	Cold	Hot	Cold	Hot
Temperature, °C	6.9 to 21.9	31.6 to 47.7	7.0 to 14.6	33.6 to 58.1
Water pH, unitless	7.5 to 8.3	7.0 to 7.5	7.4 to 8.1	7.0 to 7.5
Total Chlorine, ppm	2.2 to 2.8	0.2 to 2.4	2.0 to 3.1	0.6 to 2.4
Free Chlorine, ppm	2.0 to 2.9	0.1 to 2.0	2.0 to 2.9	0.6 to 2.1
Turbidity, NTU	0.05 to 1.47	0.05 to 0.65	0.06 to 1.62	0.07 to 0.54

1. NTU = Nephelometric turbidity units; Total chlorine represents free chlorine and combined chlorine results; Results represent a single measurement conducted at each tap within each home

Tap water odors were detected in all 10 homes studied. The sampling team frequently noted licorice, sweet, and chlorine odors. Musty odors were reported less frequently. Licorice odors (considered to be a typical odor of MCHM) were only reported in three of the 10 homes studied. These odors were considered “sharp” and were similar to the licorice odor detected by one team member January 17-22, 2014 during a previous tap water sampling visit to Kanawha, Lincoln, and Putnam Counties. The intensity of the licorice odors observed during the present study were significantly less than those observed in January following discovery of the contaminated tap water. Sweet odors were reported in 7 of 10 homes visited.

Chlorine odors were detected in tap water from 9 of the 10 homes studied, and were reported less frequently for cold water than for hot water samples. This finding is likely due to the fact that hot water had less chlorine present than cold water (**Table 2**). Consumers have been shown to detect chlorine odors in tap water at 25°C when chlorine is present at 0.28 ppm [pH 5] and 0.36 ppm [pH 10] (Krasner and Barrett 1984). With the exception of a single water sample, all tap water contained chlorine above both odor threshold values. Though, for the single 0.1 ppm chlorine water sample, the sampling team detected a chlorine odor likely because its temperature was 41°C and volatilized readily from the tap water. A musty odor was reported in two of the ten homes studied, but only in hot water samples and not from both taps. In some cases, licorice, sweet, and musty odors were observed even when chlorine odors were also detected.

3.2 Organic Carbon Tap Water Levels

TOC concentrations were quantified for premise plumbing because TOC is a general indicator for organic contaminants present in drinking water and has been proposed by the US EPA and others as a metric for determining if drinking water contamination exists (Murray et al., 2010; Hall et al., 2007). There are no Federal or State drinking water regulatory standards for TOC tap water levels because TOC represents many compounds (not a single contaminant), and because the compounds contributing to the TOC may be benign.

TOC concentrations across and within all homes were relatively similar and were generally between 0.72 ppm and 0.92 ppm (**Figures 1 and 2**). A very high TOC concentration was observed for a single sample (6.3 ppm, house 2, kitchen tap cold water, ALS Environmental Laboratory) and was treated as an outlier. Concentrations observed in the water samples are typical of those in finished drinking waters and provide no information regarding the extent of contamination by MCHM or other potential contaminants. At the concentrations of interest, MCHM, PPH and other potential decay products of MCHM would make up a small portion of the overall organic carbon present in the tap water. Ninety percent of all TOC concentrations were less than 0.90 ppm. Standard deviation values (an indication of how much variation in TOC there is between samples collected in the same house) were relatively small, ranging from 0 ppm to 0.18 ppm.

3.2 PPH and 4-MCHM

No PPH was detected in any tap water sample by either commercial laboratory. No 4-MCHM was detected in any tap water sample by ALS Environmental Laboratory, but the Eurofins Lancaster Laboratory detected 4-MCHM in 105 of the 120 samples analyzed. The 105 detections can be attributed to Eurofins Lancaster Laboratory’s lower MDL (**Table 1**).

4-MCHM was detected in all 10 homes, but all observed concentrations were substantially less than the 10 ppb State of West Virginia Screening Level (**Figure 3**). Ninety percent of samples had a 4-MCHM concentration equal to or less than 2.4 ppb. Home #8 had the greatest mean 4-MCHM concentration (4.4 ± 1.4 ppb), and the highest observed concentration (6.1 ppb). No consistent association was found between 4-MCHM concentrations and tap condition.

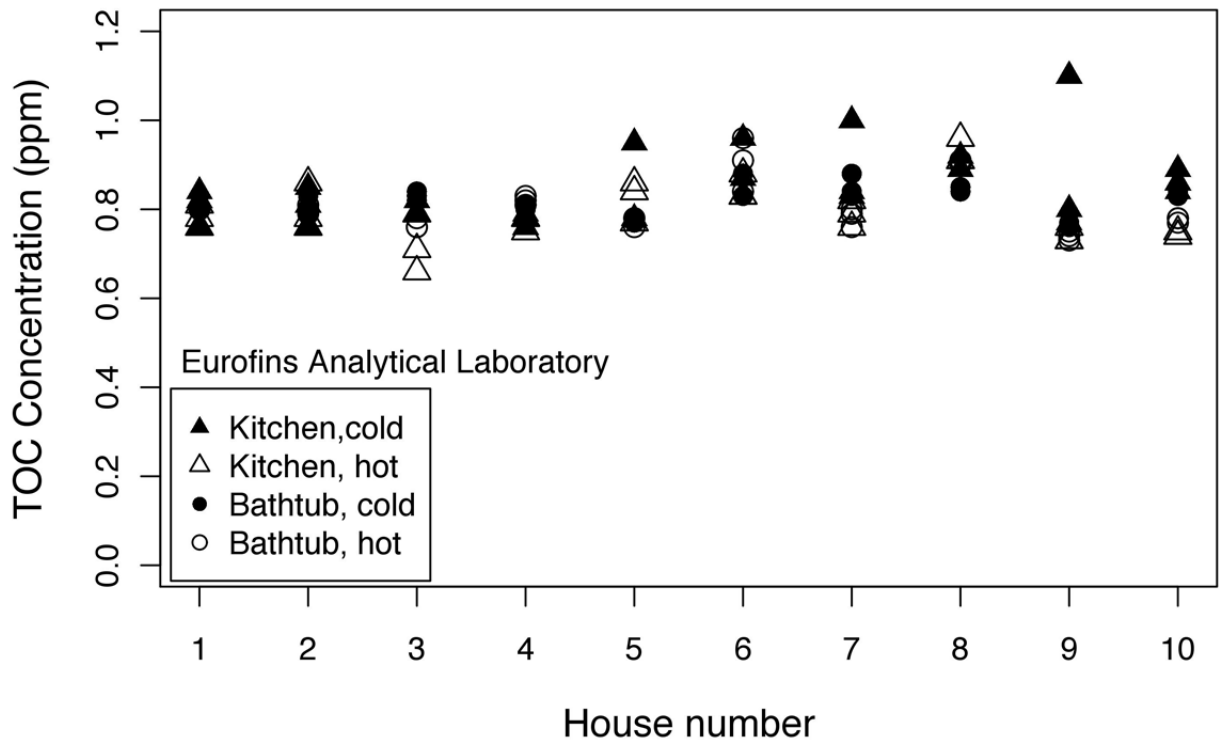


Figure 1. Mean TOC Concentration Across Homes as Reported by Eurofins Analytical Laboratory

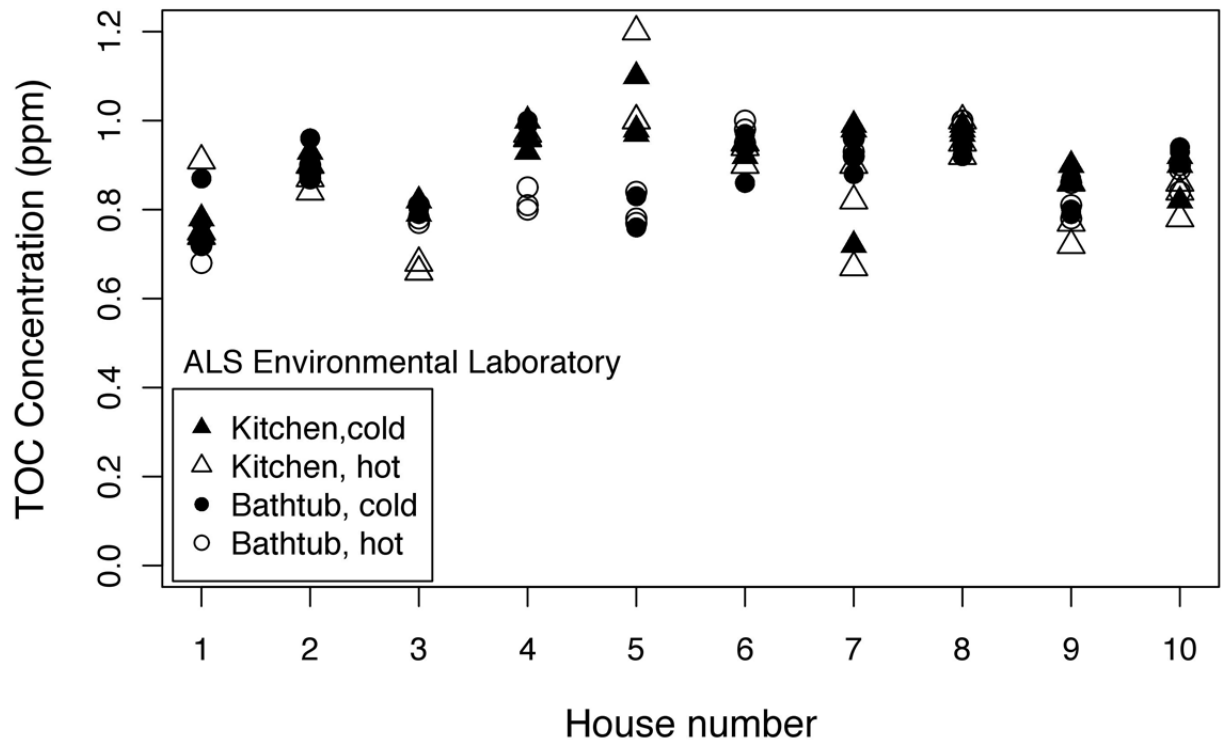


Figure 2. Mean TOC Concentration Across Homes as Reported by ALS Environmental Laboratory. A single apparent outlier (TOC = 6.3 mg/L for house 2) was omitted from the plot.

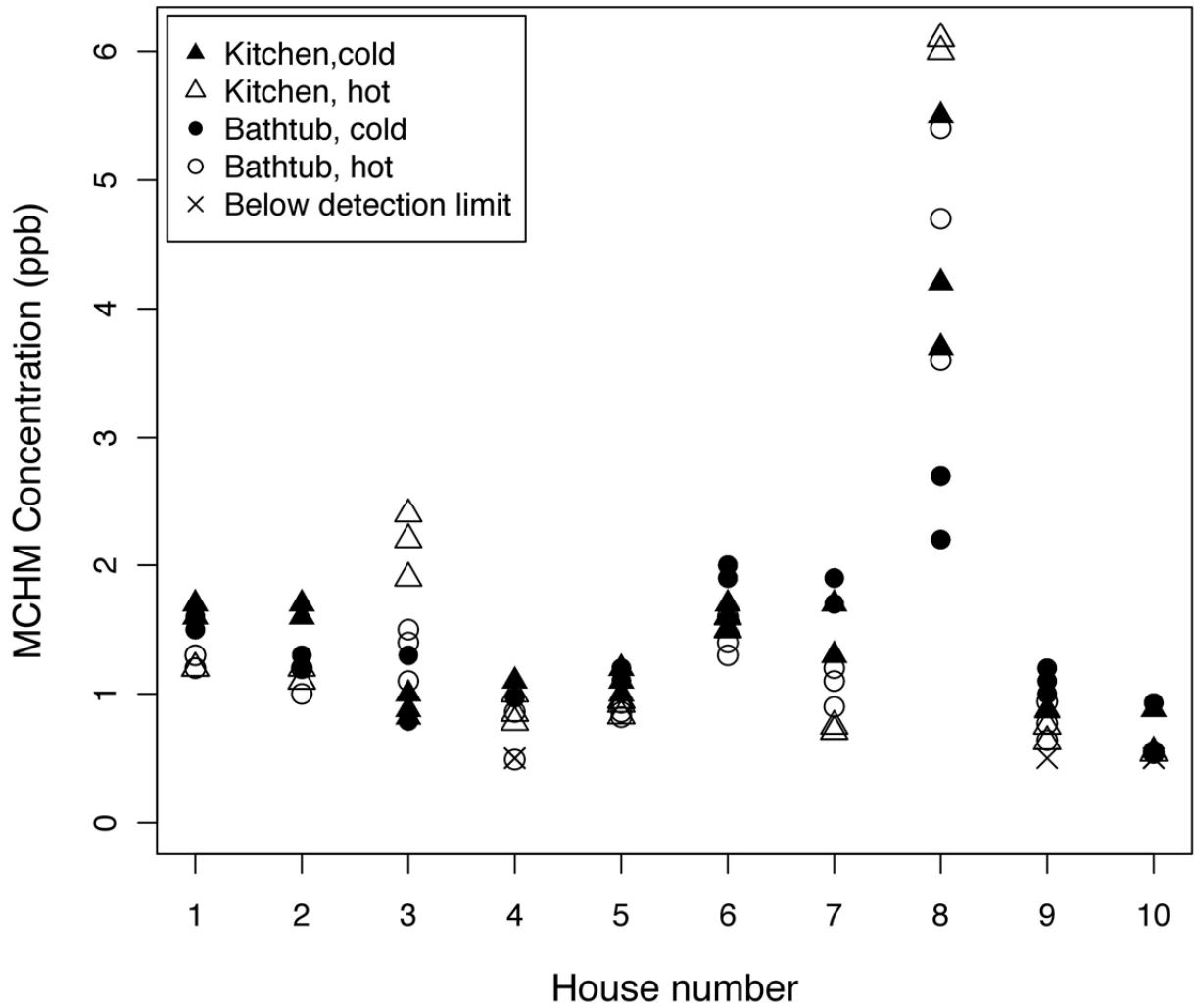


Figure 3. 4-MCHM Concentration by Home and Tap Condition. Only Eurofins Analytical Laboratory results shown because 4-MCHM was not detected in any samples analyzed by ALS Environmental Laboratory.

Table 3. Comparison of Tap Water Odor Descriptors, 4-MCHM and Free Chlorine Concentrations

Location and Water Temperature		4-MCHM, ppb	Free Cl ₂ , ppm	Licorice	Chlorine	Musty	Sweet
Home 1	Kitchen Cold	1.6	2.30	√	√	-	-
	Kitchen Hot	1.2	1.40	√	√	-	-
	Bath Cold	1.5	2.70	√	√	-	-
	Bath Hot*	1.3	1.80	-	-	-	-
Home 2	Kitchen Cold	1.6	2.60	√	√	-	-
	Kitchen Hot	1.1	2.20	-	√	-	-
	Bath Cold	1.2	2.60	-	√	-	-
	Bath Hot	1.1	2.20	-	-	√	-
Home 3	Kitchen Cold	0.9	2.60	-	√	-	-
	Kitchen Hot	2.2	0.20	√	√	-	-
	Bath Cold	1.1	3.00	-	Y	-	-
	Bath Hot*	1.3	1.10	√	-	-	-
Home 4	Kitchen Cold	1.1	2.70	-	√	-	√
	Kitchen Hot	0.9	2.40	-	√	√	-
	Bath Cold	1.0	3.10	-	√	-	-
	Bath Hot	0.7	2.40	-	-	-	-
Home 5	Kitchen Cold	1.1	2.40	-	√	-	√
	Kitchen Hot	0.9	1.80	-	-	-	-
	Bath Cold	1.1	2.80	-	√	-	√
	Bath Hot	0.9	2.00	-	√	-	-
Home 6	Kitchen Cold	1.6	2.70	-	-	-	√
	Kitchen Hot	1.5	1.60	-	-	-	√
	Bath Cold	2.0	2.40	-	-	-	√
	Bath Hot	1.4	1.90	-	-	-	-
Home 7	Kitchen Cold	1.6	2.20	-	√	-	-
	Kitchen Hot	0.7	0.50	-	√	-	√
	Bath Cold	1.8	2.40	-	√	-	-
	Bath Hot	1.1	0.60	-	-	-	-
Home 8	Kitchen Cold	4.5	2.60	-	√	-	-
	Kitchen Hot	6.1	1.90	-	√	-	√
	Bath Cold	2.5	2.70	-	√	-	√
	Bath Hot	4.6	2.00	-	√	-	√
Home 9	Kitchen Cold	0.9	2.80	-	√	-	-
	Kitchen Hot	0.7	1.90	-	√	-	√
	Bath Cold	1.1	3.10	-	√	-	-
	Bath Hot	0.8	2.20	-	-	-	√
Home 10	Kitchen Cold	0.7	2.20	-	√	-	√
	Kitchen Hot	0.5	1.50	-	-	-	√
	Bath Cold	0.7	2.00	-	√	-	-
	Bath Hot	0.5	1.80	-	-	-	√

Results for 4-MCHM data represent the mean of three discrete water samples collected from each location. Free chlorine data represent a single measurement at each location before water was collected for 4-MCHM analysis. Hyphen (-) indicates odor type was not detected by the tap water sampling team. Check mark (√) indicates an odor descriptor of "chemical" was reported by the tap water sampling team.

4.0 VALUE OF PARAMETERS MONITORED AND PATH FORWARD

4.1 Important Parameters

Among the water quality parameters assessed in tap water, only MCHM concentration, odor, temperature and chlorine concentration were useful in assessing the impact of the spill on premise plumbing. Any further sampling should be focused on those parameters. MCHM concentration and odor provide direct measures of the impact of the spill and temperature and chlorine concentration have indirect effects because they are related to odor.

4-MCHM analysis was valuable and should be included in additional studies. However, it is critically important that laboratories selected can detect and quantify low concentrations of MCHM (e.g., at the Eurofins MDL of 0.5 ppb). As time since the spill elapses, 4-MCHM concentrations are expected to continue declining in the absence of a source in the water treatment facility, distribution system, and/or premise plumbing systems.

4.2 Needed Research

This study was designed as a focused residential drinking water sampling field study that supports the design of a larger, more comprehensive characterization for the nine counties affected. The study produced sufficient data for design of the larger study, but raised numerous questions regarding tap water chemical and odor quality at affected buildings. Those questions are presented below.

4.2.1 Expansive In-Home Tap Water Sampling Study

If an expanded in-home tap water survey were conducted, the following questions could inform the sampling plan:

1. How does water age affect 4-MCHM concentration?
2. What is the variability in 4-MCHM concentration between homes within the same pressure zone?
3. Does the residence time of the tap water in premise plumbing influence the 4-MCHM concentration?
4. Do certain plumbing materials (metals and plastics) affect 4-MCHM concentrations?
5. Are there additional chemicals (either break-down products of MCHM or unrelated compounds) present causing odor?

4.2.2 Continued Source. The purpose of this study was not to identify the source of the 4-MCHM, but to characterize 4-MCHM tap water concentrations across the 10 homes studied. The finding that 4-MCHM was present in tap water from all homes studied demonstrates that customers were still being exposed to 4-MCHM contaminated tap water more than 1 month after the incident began. The source of ongoing 4-MCHM loading to the distribution system must be determined so as to predict the assets affected and decontamination actions needed. 4-MCHM could reside in plumbing systems, the WVAW distribution system, or both.

During the initial days of the incident, officials issued a Do Not Use order. This order resulted in contaminated water stagnating in place, and the consequences of this stagnation period and

subsequent flushing of contaminated water through the infrastructure remain unknown. It is possible 4-MCHM adsorbed to or permeated into materials within the WVAV water distribution system and premise plumbing systems. Under this scenario, sequestered MCHM could gradually desorb into the drinking water over time and serve as an ongoing source of contamination.

Water distribution and premise plumbing systems are complex. They are comprised of both metal and plastic water transport components, storage tanks, and hot water heaters. Future studies could include a more detailed investigation into the fate and transport of 4-MCHM and minor components of crude MCHM in premise plumbing and drinking water infrastructure. A number of factors could contribute to detention of MCHM and gradual release from drinking water infrastructure. Corrosion scales on metal pipe surfaces increase the available surface area on which crude MCHM components or breakdown products could adsorb. Biofilms are also present in both drinking water distribution pipes and premise plumbing and could absorb contaminants. Corrosion scales and biofilms could present a greater problem in premise plumbing systems which have smaller diameter pipes than distribution systems pipes and higher surface area to water volume ratios. Prior studies indicate that certain plastics are penetrated more rapidly by organic chemicals than others. Biofilms, pipes, and hot water heaters are all potential in-home sources of crude MCHM components or any breakdown products that were formed.

4.2.3 Reevaluation of Decontamination Measures. The US EPA defines decontamination as *“the inactivation or reduction of contaminants by physical, chemical or other methods to meet a cleanup goal. Decontamination is a key component of the remediation phase in a contamination incident. During a water incident, once contamination and characterization are confirmed, decontamination is performed before returning a system to service.”* In accordance with the decontamination cleanup goals established by the State of West Virginia, affected infrastructure and plumbing systems had been decontaminated to a level below the 10 ppb screening level. Despite attainment of this goal, the presence of 4-MCHM at resident taps was objectionable to residents and negatively impacted public perception about their drinking water and their water utility. Those factors should be considered in a reassessment of the clean-up goals for this spill.

5.0 CONCLUSION

The purpose of this work was to conduct a focused residential drinking water field study that included a resident survey and tap water testing. Ten homes affected by the Crude MCHM Elk River chemical spill were surveyed and sampled in eight of the nine counties affected (Boone, Cabell, Clay, Kanawha, Lincoln, Logan, Putnam, and Roane counties). Upon arrival, tap water was characterized for pH, free and total chlorine concentration, turbidity, and odor at the kitchen sink and bathroom tub faucets. Cold water quality was examined first followed by hot water analysis. Water samples were then collected and shipped to two commercial laboratories for determination of TOC, 4-MCHM, and PPH concentrations. MRL and MDLs for their respective methods differed for the two laboratories.

The only parameters that were tested that appear to contribute any useful information for spill characterization and response are MCHM concentration, odor, temperature, and chlorine concentration. The contaminant 4-MCHM was detected in all 10 homes by Eurofins Analytical Laboratory, but not detected by ALS Environmental Laboratory in replicate water samples. This finding is significant and underscores the importance of selecting laboratories that can detect and quantify low concentrations of contaminants during a chemical contamination incident. The reason for this difference is likely due to 4-MCHM method MDL differences. Eurofins Analytical Laboratory’s MDL and

MRL for 4-MHCM were nearly 0.5 ppb and 1.0 ppb while ALS Environmental Laboratory's MRL and MDL values were greater at 2.7 ppb and 5.0 ppb. Ninety percent of the 4-MCHM concentrations reported by Eurofins Analytical Laboratory were less than 2.4 ppb. Thus, ALS Environmental Laboratory's method could not detect the low levels of 4-MCHM present in tap water at a 4-MCHM concentration equal to or less than 2.4 ppb. Home #8 had the greatest average 4-MCHM concentration of 4.4 ± 1.4 ppb, and the maximum observed concentration of 6.1 ppb. No 4-MCHM concentration detected in any home exceeded the 10 ppb State of West Virginia screening level.

6.0 ACKNOWLEDGEMENT

Special thanks are extended to the residents who permitted the WV TAP team to enter their homes and test their tap water. These individuals, who will remain anonymous, have done a great service to thousands of West Virginians who were also affected by the spill. Appreciation is also extended to ALS Environmental Laboratory and Eurofins Laboratories for their participation.

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