National Toxicology Program

Headquartered at the
National Institute of Environmental
Health Sciences NIH-HHS

# West Virginia Chemical Spill: NTP Research Response and Findings

The National Toxicology Program (NTP) has completed a yearlong series of research studies on the toxicity of chemicals spilled into the Elk River in Charleston, West Virginia, in January 2014.

The peer-reviewed, collected findings from the studies supported the adequacy of the drinking water screening levels established at the time of the spill, and found very little reason for concern about long-term health effects. NTP findings and supporting materials are available at http://ntp.niehs.nih.gov/go/wvspill.

## Background

In January 2014, approximately 10,000 gallons of chemicals used to process coal spilled from a storage tank into the Elk River in West Virginia. The Elk River is a municipal water source that serves about 300,000 people in the Charleston area.

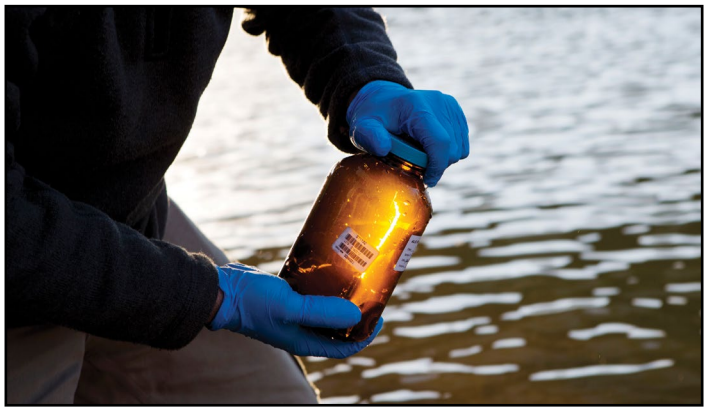
The spilled liquid was primarily 4-methylcyclohexanemethanol (MCHM). Other chemicals, including dipropylene glycol phenyl ether (DiPPH) and propylene glycol phenyl ether (PPH), were also present in lower amounts in the storage tank. Residents in the nine counties that receive their water from this municipal water system were advised not to use the water for drinking, bathing, cooking, or washing.

A team of local, state, and federal public health officials reviewed the limited toxicology information that was available, and developed short-term drinking water levels. They recommended a screening level of 1 part per million (ppm) for MCHM and 1.2 ppm for PPH. These levels were judged not likely to be associated with any adverse health effects.

In July 2014, NTP received a nomination from the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry to conduct additional toxicity studies on the main chemicals known to be involved in the spill. In response, a partnership was formed to conduct additional research to reduce uncertainty about the screening levels that were being established for the drinking water.

## Determining potential long-term health effects

NTP wanted to use the best model systems available to produce usable data relatively quickly. To accomplish this,



NTP designed and performed studies using a variety of toxicological models in assays of relatively short duration, which represented a wide spectrum of biology.

The studies included predictions of health effects based on computer models of chemical structure and toxicity; studies of gene mutations in bacteria; growth, development and behavior in roundworms; developmental studies in zebrafish embryos; toxicity to human cells in culture; and toxicity studies in rodents.

## Prenatal developmental toxicity studies

Because of public concern for the safety of pregnant women who may have been exposed to the chemicals, a high priority for NTP was to conduct studies that looked at potential developmental outcomes in animals. These prenatal developmental toxicity studies allowed researchers to determine if pregnant rats, exposed to the chemical MCHM, gave birth to offspring that had birth defects or other adverse health outcomes.

NTP found that MCHM caused lower birth weights in the fetuses of rats, only at doses that are about 2,000 to 4,000 times higher than estimated human exposure from consuming drinking water at one part per million, the recommended screening level for MCHM.

## Skin irritation and sensitization studies

NTP evaluated MCHM for its ability to irritate the skin or cause skin sensitization. NTP found MCHM is a skin irritant, however, it did not cause hypersensitivity, meaning it did not cause an allergic response in the skin.

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NTP also tested a commercial mixture containing MCHM that was believed to be nearly identical to that present in the leaking tank. The mixture caused skin sensitization and, in one study, was also found to be a mild skin irritant. The concentrations that produced either irritation or sensitization were well above the highest levels found in the tap water.

### Studies in lower animal species

NTP used lower animal species, including Danio rerio (zebrafish) and C. elegans (roundworms), to look at effects of MCHM and some of the other chemicals over the lifespan of the organisms. These studies can be conducted more efficiently than studies in rats and mice, allowing more chemicals to be tested in a shorter period of time.

None of the chemicals tested in C. elegans affected growth, development, feeding, or reproduction. MCHM and crude MCHM were also not found to be toxic to developing zebrafish. One minor component of the spill, dimethyl 1,4-cyclohexanedicarboxylate, did cause toxicity in the developing zebrafish. However, existing studies in rodents indicate there is limited concern for developmental effects in humans at the concentrations people may have been exposed to during the spill.

### Evaluating cell-based, high throughput screening assay studies

NTP evaluated the data available for four of the chemicals that were tested using cell-based, high throughput screening (HTS) assays. HTS assays are useful for rapidly evaluating large numbers of chemicals and providing insight into their potential health effects. NTP found the chemicals were not active in all of the assays for which data were available.

### Toxicogenomic studies

NTP also looked for more subtle biological changes that may occur during short-term exposures. In particular, NTP scientists examined changes in the expression of genes in the liver and kidney of rats. These types of toxicogenomic studies were conducted on MCHM, the MCHM mixture, and PPH.

These short-term studies, coupled with powerful molecular analysis, help determine what biological systems were affected, and at what dose levels below which no effects were seen. For MCHM, the lowest biological effect level was a dose that is considerably higher than estimated potential human exposures.

### Bacterial mutagenicity studies

NTP tested spill chemicals for their ability to cause mutations, or permanent changes in DNA sequence, using the bacterial mutagenicity or Ames test. The Ames test assesses the ability of a chemical to bring about mutations in any of several different strains of bacteria. A positive test in any strain indicates the chemical is mutagenic and has the potential to cause cancer.

NTP found that the main components of the spill, MCHM and the crude MCHM mixture, did not cause mutations in any of the bacterial strains that were used in the studies. However, a minor component, dimethyl 1,4- cyclohexanedicarboxylate, when tested at much higher levels than those found in the crude mixture, was found to be weakly mutagenic. Considering that potential exposure to this chemical during the spill was found to be very low, there is limited concern for this finding.

### Modeling efforts

NTP also used computational models to help predict potential toxicities of MCHM and other chemicals. The results were helpful for determining the types of toxicology studies that would be most appropriate for NTP to perform.

### Overall conclusions from NTP studies

Collectively, the NTP studies support the adequacy of the drinking water screening levels established at the time of the chemical spill.

For more detailed information about the NTP studies, visit http://ntp.niehs.nih.gov/go/wvspill.

The Centers for Disease Control and Prevention also has information about federal efforts after the spill at http://emergency.cdc.gov/chemical/MCHM/westvirginia2014.

National Toxicology Program
U.S. Department of Health and Human Services

The National Toxicology Program is an interagency program headquartered at the **National Institute of Environmental Health Sciences** that tests and evaluates chemicals in our environment.

For more information on NTP, go to **http://ntp.niehs.nih.gov**.