May 31, 2013

Shawn Johnson
Assistant Attorney General
State of Arkansas
323 Center Street, Suite 200
Little Rock, AR 72201

SUBJECT: Evaluation of Air Sampling Data from Carlisle Consulting, Inc. (Second Set)

Mr. Johnson:

Pursuant to your request of May 17, 2013 to evaluate third-party air sampling data collected by an independent contractor hired by the Arkansas Attorney General’s office, the Arkansas Department of Health (ADH) Environmental Epidemiology Section has evaluated these second set of data for public health impact. ADH has completed this health consultation supported by funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services, although ATSDR has not evaluated this document. This evaluation of inhalation exposures is based on the third-party air sampling data provided to ADH by your office [1].

Background and Statement of Issues
As previously stated, on March 29, 2013, ExxonMobil Pipeline reported a release of Wabasca heavy crude oil from a 20-inch diameter pipeline in Mayflower, Faulkner County, AR to the National Response Center (1042466 and 1042476) [2]. Due to the amount of oil that was present on the ground and in the street, multiple homes were evacuated in the Northwoods Subdivision upon immediate release, and 22 homes still remain evacuated. The heavy crude oil released from the damaged pipeline flowed east down a residential street (North Starlite Road), into a bar ditch adjacent to a Union Pacific Railroad line, into an unnamed creek, and into a tributary to a cove of Lake Conway [2].

During the evacuation, clean-up, and recovery processes, air quality monitoring has been performed daily from the time of the initial release of the spill to the present time. Continuous air quality monitoring has been conducted by both the U.S. Environmental Protection Agency (EPA) and ExxonMobil. Real-time air
monitoring and analytical air sampling for constituents of crude oil have been performed in the neighborhood surrounding the spill site, as well as designated areas throughout the community of Mayflower. EPA and ExxonMobil [using the contractors Weston Solutions and Center for Toxicology and Environmental Health, LLC. (CTEH), respectively] also conducted indoor air monitoring in non-evacuated homes as requested by individual community members. The data have been made public and available on the Arkansas Department of Environmental Quality (ADEQ) website.

The Attorney General’s office hired Carlisle Consulting, Inc. (CCI) to perform independent air sampling inside residences potentially affected by the crude oil spill. Beginning April 25, 2013, initial results of 12 residences sampling events were presented to ADH. On May 7, 2013, a health consultation letter was sent to your office summarizing the air sampling results, which concluded: (1) that for all residences sampled, breathing the indoor air is not expected to harm people’s long-term health; (2) that for all residences sampled but one, breathing the indoor air is not expected to harm people’s short-term health, and (3) that breathing the indoor air at residence [redacted] is an indeterminate public health hazard. [Note: [redacted] is a currently evacuated residence and prior to re-entry, additional air sampling data would be collected per the Unified Command re-entry plan.]

A second set of data were presented to ADH (with a request for public health evaluation of these data) on May 17, 2013. This set included air sampling data for 10 residences total. See Appendix A for a figure of the location of each residence sampled in this evaluation. On May 28, 2013, a verbal response was sent to your office indicating that ADH had performed a preliminary review of these data and determined that no immediate public health threat exists. A copy of the laboratory quality assurance/quality control (QA/QC) records, the “Occupant Questionnaire,” and a copy of CCI hand-written field notes were also sent at the time of this request [3]. ADH was told that the CCI Revised Sampling Plan (dated April 14, 2013) remained the same [4]. This health consultation serves as an in-depth quantitative analysis of all data received on May 17, 2013, related to the CCI testing. This health consultation is intended as an interpretation of data as requested, and should not be used as the sole source of information for re-entry purposes in the case of currently evacuated residences. An independent re-entry protocol for evacuated residences has been established by the Mayflower Pipeline Incident Unified Command. Permanent re-entry of all remaining evacuated residences will be approved after indoor air sampling and indoor air monitoring has been performed by Unified Command and evaluated by ADH.

Discussion

During an ADH/ATSDR public health evaluation, exposure to a chemical, or contaminant of concern (COC), is determined by examining human exposure pathways. An exposure pathway has five parts:

1. A source of contamination (e.g., crude oil from pipeline spill),
2. An environmental medium such as air, water, or soil that can hold or move the contamination,
3. A point at which people come in contact with a contaminated medium (e.g., residential outdoor and/or indoor air),
4. An exposure route, such as breathing air, and
5. A population who could come in contact with the contaminants (e.g., Mayflower residents).
An exposure pathway is eliminated if at least one of the five parts is missing and will not occur in the future. For a completed pathway, all five parts must exist and exposure to a contaminant must have occurred, is occurring, or will occur. For the nine homes sampled that are currently occupied residences, a complete pathway has been identified for an infant, a child, and/or an adult, since all five exposure steps did exist and pertain to past, current, and future conditions in the residential area. In the one currently evacuated residence that was sampled the exposure pathway is identified as “potential”, although no one is occupying that home presently. Also, the spill is primarily remediated from the immediate area of the Northwoods Subdivision to further eliminate future exposures. However, a future potential exposure pathway was considered for this evaluation in order to conservatively calculate potential exposure once residents return home.

Based on field notes of all samples collected on May 6 and 7, 2013, eight residences were sampled inside only, and two residences were sampled both inside and outside. Of the 10 residences, nine were in non-evacuated (i.e., occupied) homes and one was part of the 22 evacuated (i.e., unoccupied) homes in the affected subdivision [3]. The evacuated home sampled was part of a revised zone division plan set-up by Unified Command (color-coded red, blue, or yellow). The purpose of the zones was to distinguish a re-entry time frame for each residence based on the degree of contamination and clean-up necessary. Residences in the red zone would be the first scheduled for permanent re-entry, followed by residences in the blue zone, and lastly, residences in the yellow zone. To date, Unified Command has indicated that none of these 22 residences have returned to re-occupy their homes. For the purpose of this evaluation, the residences tested by CCI will be categorized in the same zone schematics. Therefore, the residence is categorized in the red, Phase 1 “Proposed Move-in Timeline”. See Appendix B for a figure of these zones.

According to the previous CCI “Revised Air Sampling Plan,” air samples were collected during a one-time event at each residence with 6-liter sulfur summa canisters. A one-hour sampling period per canister was performed; each regulator had a 2-micron pre filter. The majority of the residential samples were collected from at least three locations inside the home (two residences had samples collected from four locations; two residences had an additional trip blank canister alongside the canisters collecting air samples). The height of the canister, the specific room location, and the temperature and humidity readings were recorded at the time of sampling [3, 4].

For laboratory analysis, EPA Method TO-15 was used to analyze for individual volatile organic compounds, naphthalene, and total volatile organics (i.e., volatile organic compounds, VOCs, plus tentatively identified compounds, TICs). American Society for Testing and Materials (ASTM) D5504 was used to analyze the samples for hydrogen sulfide. Laboratory analysis was performed by ALS Environmental, an American Industrial Hygiene Association (AIHA) accredited laboratory, in Salt Lake City, Utah [4].

All the data received were evaluated using available public health guidelines to screen each compound included in summa canister sampling (a total of 59 individual COCs plus a total VOC concentration, as stated above). The ADH preliminary screening process utilized ATSDR Health Comparison Values (CVs). CVs are chemical and media-specific concentrations in air, soil, and drinking water that are used by ATSDR to identify environmental contaminants that require further evaluation. CVs incorporate assumptions of daily
exposure to the chemical. CVs are conservative and non-site specific. CVs are based on health guidelines with uncertainty or safety factors applied to ensure that they are adequately protective of public health.

When screening these COCs, both the ATSDR Minimal Risk Level (MRL) and the Environmental Media Evaluation Guide (EMEG, derived from ATSDR MRLs) values were used. The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse, non-cancer health effects over a specified duration of exposure (usually less than one year). ATSDR MRLs are derived for continuous, 24-hour a day exposures.

Based on the CCI data, the COCs that warranted further public health evaluation of residential indoor inhalation risks were total VOCs in all residences and toluene in only one residence. Maximum concentrations of all COCs are shown in Table 1 (data for May 6, 2013) and Table 2 (data for May 7, 2013). The health impact of these chemicals as a ‘mixture exposure’ was considered for this health evaluation. However, after review of the toluene toxicological profile chemical interactions section, it was determined that this COC should be evaluated as an individual chemical-specific exposure [5].

To determine a daily exposure concentration for an infant, a child, and an adult, the maximum concentration for each COC that exceeded ATSDR CVs was determined. Refer to Table 1 and Table 2 for the COC concentrations and calculated results. All concentrations were calculated in units of micrograms per cubic meter (µg/m³). For all 10 residences sampled, total VOCs were used to calculate an exposure concentration and corresponding theoretical health risks [using benzene as the representative surrogate compound for an EPA reference concentration (RfC) and inhalation unit risk (IUR)]. Note that in the ALS analytical reports, all the total VOC laboratory values were marked with “J”, representing an estimated result. The “J” qualifier was defined by ALS as indicating the analyte value is between the method detection limit (MDL) and the reporting limit (RL). It is also used to indicate an estimated value for TICs in mass spectrometry where a 1:1 response is assumed [1].

The exposure concentration was calculated using site-specific exposure assumptions for each individual receptor (i.e., infant, child, and/or adult) and applying them to risk equations [6]. These equations provide the health assessor a means by which one can take site-specific concentration levels and exposure assumptions and estimate a theoretical excess risk expressed as the proportion of a population that may be affected by a compound during a specified time of exposure. In the residential inhalation (indoor breathing exposure) scenario, the maximum contaminant concentration, the exposure frequency (30 days per year), the exposure time (24 hours per day), the exposure duration (six months), and the time-weighted average of 10 years were all used to calculate the theoretical exposure concentrations for every person potentially exposed. Also, because benzene was used as the surrogate compound for an EPA RfC and IUR, a ‘worst-case-scenario’ is represented in order to be comprehensively protective of public health. See Appendix C for all equations used.

To put the calculated exposure concentrations into a meaningful context for non-cancer, acute effects [meaning a rapid onset of an illness, or an illness that happens in less than a year (short duration)] the Hazard Quotient (HQ) was calculated for each potentially exposed person. An HQ is the average daily intake
divided by a chemical specific RfC set by the EPA. If the HQ for a chemical is equal to or less than one, it is believed that there is no appreciable risk that non-cancer health effects will occur. If the HQ exceeds one, there is some possibility that non-cancer effects may occur, although an HQ above one does not indicate an effect will definitely occur. This is because of the margin of safety inherent in the derivation of all RfC values. The larger the HQ value, the more likely it is that an adverse effect may possibly occur. The calculated HQ for each potentially exposed person breathing the air using concentrations from the CCI data was at or below 1.0, with the exception of one residence. An HQ of 1.1 was calculated for  (an occupied residence.) CCI Field Notes indicate that contained cleaning products and cosmetic products that were recently used before the indoor air sampling was performed, as well as air fresheners present indoors, which may account for the elevated presence of total volatile organics. An HQ value of 1.1 does not indicate that any non-cancer health effects will definitely occur, since these products are used inside their residence on a regular basis and theoretical estimates were calculated using the benzene RfC. Due to the products documented in the residence, the use of a benzene surrogate ‘worst-case-scenario’ representation of estimated potential risks for conservative calculations, and the low HQ value, ADH does not anticipate short-term (non-cancer) health effects for  residents. See Table 1 and 2 for all calculation results.

To characterize potential cancer effects from inhalation of indoor air equivalent to the concentrations reported in all the CCI air samples, a theoretical Lifetime Excess Cancer Risk (LECR) value was calculated. The LECR is an estimated theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a specified time of exposure. (Again, benzene was used as the surrogate compound for an EPA IUR.) For this scenario, the specified chronic exposure time used was 10 years. Risk values greater than one in 1,000,000 (or 1.0E-06), that represent no risk of cancer (termed “insignificant”), but less than one in 10,000 (or 1.0E-04, termed “low”) are within the EPA’s target risk range and considered an adequate level of health safety. If the additional lifetime cancer risk is greater than one in 10,000 (or 1.0E-04), it is generally considered a “moderate” potential risk and an indicator that further evaluation would be warranted [6, 7]. The calculated estimated LECR for each person breathing the air using concentrations from the CCI data was within EPA’s target risk range and considered to be an unlikely source of cancer risk over a 10-year period. A LECR was not calculated for toluene because it is not classified as a carcinogen. See Table 1 and 2 for all calculation results.

Community Health Concerns

Some residents reported that strong odors associated with crude oil were adversely affecting their health and quality of life. Getting sick from a chemical exposure or a chemical odor will depend on what a person is exposed to; how much a person was exposed to (dose); how long a person was exposed (duration); how often a person was exposed (frequency); and how sensitive a person is to the odor. As the crude oil is remediated from the Mayflower subdivision and community, the chemical exposures and odors associated with the spill will also be reduced or eliminated.

In public health, there is a distinction between chemical exposure and chemical odors. While some chemical exposures may not pose a long-term health risk, the odors themselves may be unpleasant and produce discomfort and temporary health symptoms, such as headaches, nausea and dizziness. Odors can alert people
that something may be harmful, but generally a person can smell many chemicals before they are at levels that are harmful to their health. Following ATSDR’s mission to prevent harm to human health and diminished quality of life from exposure to hazardous substances found at waste sites, in unplanned releases, and in other sources of pollution present in the environment, ADH will continue to work with your office as well as Unified Command, EPA, ADEQ, other agencies, and the residents in Mayflower to adequately determine the public’s potential health risk exposures.

**Limitations**

Air samples provide a “snapshot” of conditions happening at a specific time. For this event, residential air samples were collected by using a one-hour sampling time; therefore, the results are indicative of the levels in each residence during that particular time only. The samples may or may not be representative of long-term conditions. Measuring indoor air contaminant concentrations, regardless of their source, is an important factor in assessing potential health effects from inhalation exposure to COCs. Estimating indoor air contaminant levels is challenging due to their fluctuating levels and the variability of vapor entry by the vapor intrusion pathway. Additionally, low level indoor air contamination measurement is particularly susceptible to background interference (such as household products and cleaners) and uncertainties introduced during sample collection and lab analysis. The most prudent approach to evaluating health effects is to choose a representative indoor air concentration and evaluate whether or not that value poses a health concern.

**Conclusions**

ADH has evaluated the results of the estimated risk calculations based on the reported concentrations of COCs documented in the CCI air sample reports.

1. It is determined that the short-term (acute) HQ values of these chemical concentrations do not exceed standard health values for infants, children, and/or adults based on calculations of the reported air samples for all residences. *For all residences sampled, based on HQ results found herein, ADH concludes that breathing the indoor air is not expected to harm people’s short-term health.*

2. Likewise, it is determined that the long-term (chronic) LECR values of these chemical concentrations do not exceed standard health values for infants, children, and/or adults based on calculations of the reported air samples for all residences. *For all residences sampled, based on LECR results found herein, ADH concludes that breathing the indoor air is not expected to harm people’s long-term health.*

**Recommendations**

ADH has no further recommendations at this time for the 10 residences evaluated utilizing these air sampling data results, with the exception of [redacted]. ADH recommends that [redacted], the one currently evacuated residence of these 10 residences, follow the permanent re-entry protocol previously established by Unified Command.
References

1. ALS Laboratory Analytical Reports. Received per Attorney General’s Office. May 17, 2013.
3. Carlisle Consulting, Inc. (CCI), Handwritten Field Notes for “Project: Mayflower Pipeline Oil Spill;” May 6 – 7, 2013. Received per Attorney General’s Office.

If there are any questions, I can be reached by phone at 501-280-4041, or by email at Ashley.Whitlow@arkansas.gov.

Sincerely,

Ashley Whitlow, M.S., CPM
Environmental Epidemiologist/ATSDR [Cooperative Agreement] Health Assessor

cc: William Mason, M.D., MPH, Preparedness & Emergency Response Branch Chief/Associate Director for Science, ADH
Shirley Louie, M.S., CIH, Applied Epidemiology Branch Chief/Deputy State Epidemiologist, ADH
Lori Simmons, M.S., Environmental Epidemiology Section Chief/ATSDR Program Coordinator, ADH
Carrie Poston, MPH, MCHES, Environmental Epidemiologist/ATSDR Health Outreach Coordinator, ADH
Quinyatta Mumford, MPH, CHES, Environmental Epidemiologist, ADH
Alex Hill, B.S., Environmental Epidemiologist, ADH
Rick Hogan, J.D., MPH, General Counsel, ADH
Table 1. Carlisle Consulting, Inc. (CCI) Data and Calculation Results of Exposure Concentrations and Estimated Health Risks for Contaminants of Concern Collected on May 6, 2013

<table>
<thead>
<tr>
<th>ALS Work Order Number</th>
<th>Sampling Location</th>
<th>Sampling Date</th>
<th>Report Date</th>
<th>Evacuated (Y/N)</th>
<th>Maximum VOC level* (µg/m³)</th>
<th>Sample ID/Location/Height (inches off floor)</th>
<th>Exposure Concentration (EC) (µg/m³)</th>
<th>Hazard Quotient (HQ)</th>
<th>Lifetime Excess Cancer Risk (LECR)</th>
<th>Other COCs (Max. Con. in µg/m³)</th>
<th>Other COCs EC/HQ/LECR</th>
<th>Comments from Field Notes</th>
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<td>5/6/13</td>
<td>5/17/13</td>
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<td>1000</td>
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<td>0.1</td>
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<td>N/A</td>
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<td>52</td>
<td>0072/Trip Blank</td>
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*All total volatile organics (VOCs) analyzed have a “J” qualifier attached. “J” qualifier defined as “Qualifier indicates that the analyte value is between the MDL and the RL. It is also used to indicate an estimated value for tentatively identified compounds in mass spectrometry where a 1:1 response is assumed.”; µg/m³ = microgram per cubic meter

Table Shading Key: Grey = non-evacuated residence; Red = residence evacuated in red zone (Phase 1); Blue = outdoor sample; White = laboratory trip blank
<table>
<thead>
<tr>
<th>ALS Work Order Number</th>
<th>Sampling Location</th>
<th>Sampling Date</th>
<th>Report Date</th>
<th>Evacuated (Y/N)</th>
<th>Maximum VOC level* (µg/m³)</th>
<th>Sample ID/Location/Height (inches off floor)</th>
<th>Exposure Concentration (EC) (µg/m³)</th>
<th>Hazard Quotient (HQ)</th>
<th>Lifetime Excess Cancer Risk (LECR)</th>
<th>Other COCs (Max. Con. in µg/m³)</th>
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</table>

*COC = contaminants of concern; VOC = total volatile organic compounds; all COCs listed represent the maximum concentration reported; µg/m³ = microgram per cubic meter; Table Shading Key: Grey = non-evacuated residence; Blue = outdoor sample; White = laboratory trip blank
Appendix A: Figure of Residence Air Sampling Locations Collected May 6 & 7, 2013 by Carlisle Consulting, Inc.
Appendix B: Figure of Residence Permanent Re-Entry Zones Identified by Unified Command
Appendix C: Variables Used in Exposure Concentrations and Theoretical Risk Calculation Scenarios for the ExxonMobil Pipeline Spill in Mayflower, AR

**Inhalation From Ambient Air Exposure Concentration Equation**

\[ EC = \frac{(CA \times ET \times EF \times ED)}{AT} \]

EC = Exposure Concentration (micrograms per cubic meter, \(\mu g/m^3\))  
CA = Contaminant Concentration in air (micrograms per cubic meter, \(\mu g/m^3\))  
ET = Exposure Time (hours per day, h/day) = 24  
EF = Exposure Frequency (days per year, d/yr) = 30  
ED = Exposure Duration (years) = 0.5  
AT = Averaging Time (10 years x 365 days/year x 24 hours/day)

**Hazard Quotient Equation for Estimating Short-Term Health Effects**

\[ HQ = \frac{EC}{(Toxicity Value \times 1000 \mu g/mg)} \]

HQ = Hazard Quotient (unitless)  
EC = Exposure Concentration (micrograms per cubic meter, \(\mu g/m^3\))  
Toxicity Value = Inhalation Toxicity Value  
(e.g. Reference Concentration, RfC in milligrams per cubic meter, mg/m\(^3\))

**Theoretical Cancer Risk Equations for Estimating Long-Term Health Effects**

\[ LECR = EC \times IUR \times \frac{(Exposure Duration Years)}{70} \]

LECR = Lifetime Excess Cancer Risk (unitless)  
EC = Exposure Concentration (micrograms per cubic meter, \(\mu g/m^3\))  
IUR = Inhalation Unit Rate \([\text{micrograms per cubic meter}^{-1}, (\mu g/m^3)^{-1}]\)  
Exposure Duration Years = 10 years was also used for this site scenario  
70 = Average number of years per one’s lifetime