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Review of Ambient Air Monitoring Project and Related Communications Concerning Gas Well Emissions

Provided for
The City of Fort Worth –
Environmental Management Department

Attn: Michael Gange

Report Date: 8/24/2009

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Executive Summary

Over the period from August 19 – August 21, 2009, Industrial Hygiene and Safety Technology, Inc. (IHST) performed a review of a particular set of reports and associated communications provided by the City of Fort Worth - Environmental Management Department. This documentation concerned the potential impact of gas well exploration and drilling activities to Deborah's Farmstead, a farming operation located at 300 McNaughton Lane, in the city of Westworth Village, Texas.

IHST concludes the ambient air sampling performed by Wolf Eagle Environmental Engineers and Consultants at Deborah's Farm was rudimentary in scope and design. Results of the sampling appear to IHST to be inconclusive at best. Most compounds of interest detected were present as tentatively identified compounds (TICs), and the identity and determined concentration of these compounds are necessarily estimates, subject to non-quantifiable error. Possible problems in sample recovery for samples collected June 27, 2009, are not fully documented in the information provided to IHST. IHST believes these sample results must remain questionable until further information is available. This problem also raises questions regarding conclusions reached by various authors, based on comparison of sample data from different days.

Reasonably possible sources for the contaminants detected, other than gas well operations, appear to have been ignored. No samples were collected for hydrogen sulfide, sulfur dioxide, oxides of nitrogen or other inorganic compounds strongly associated with gas well operations, and primarily responsible for typically reported adverse effects. Discussions of chemical hazards in the documents reviewed were generally exaggerated and speculative, not representative of the hazards posed by the actual concentrations of compounds detected. Application and use of TCEQ Effects Screening Levels (ESL) were inappropriate.

In brief, IHST does not believe the documentation reviewed provides sufficient evidence to demonstrate adverse impact from gas well exploration and operations to the property at 300 McNaughton Lane, in Westworth Village, TX. The sampling data is too general and limited to make such determinations. Opinions based on the sample data should likewise be considered general or speculative, based on very limited data.

These opinions are limited to review of the provided documentation. IHST does not intend to suggest determination of the potential impact of gas well exploration and operation to the surrounding environment should not be seriously and thoroughly investigated. Such impacts may indeed be significant, especially as density of such operations increases. However, such evaluations should be properly designed, controlled and conducted, and reviewed objectively, considering all available data. IHST believes Texas state agencies or independent and objective third parties are best positioned to perform such evaluations. IHST simply does not believe the documentation reviewed in this report provided adequate project design, sufficient data, control or objectivity for such evaluation.

Purpose and Scope

Over the period from August 19 – August 21, 2009, Industrial Hygiene and Safety Technology, Inc. (IHST) performed a review of a particular set of reports and associated communications provided by the City of Fort Worth - Environmental Management Department. This documentation concerned the potential impact of gas well exploration and drilling activities to Deborah's Farmstead, a farming operation located at 300 McNaughton Lane, in the city of Westworth Village, Texas. The central piece of documentation was a report of two air sampling events conducted at this location by Wolf Eagle Environmental Engineers and Consultants. Also included were a number of letters expressing opinions from various third parties, including Deborah Rogers of Deborah's Farmstead, David A. Sterling, Ph.D., CIH, with UNT School of Public Health, E. Murl Bailey, Jr., D.V.M., Ph.D., Veterinary Toxicologist, and Al Armendariz, Ph.D., with the SMU Department of Environmental and Civil Engineering.

IHST was tasked by the City of Fort Worth to review these documents, and offer objective opinions regarding the technical methods and data detailed therein, and the related opinions and conclusions expressed. IHST's review was limited to review and evaluation of the documents provided by the City of Fort Worth. IHST conducted no additional sampling or onsite investigation in this preparation of this review.

IHST has no business nor professional relationship with any of the persons or businesses that are the subjects or authors of the documentation reviewed.

Overview of Information Reviewed

The documentation submitted for review by IHST consisted of a collection of reports and letters concerning the impact of air releases from nearby natural gas well drilling and exploration activities to Deborah's Farmstead, an all-natural farming operation. The document appears to be a collection of documentation compiled by HDLA, LLC, Deborah's Farmstead. It includes a set of bullet points discussing concerns over chemicals detected in the ambient air, a letter from Deborah Rogers to Tony Yeager, Mayor of Westworth Village, opinion letters from three health/environmental professionals, two air monitoring reports prepared by Wolf Eagle Environmental Engineers and Consultants, and an email and follow-up letter from Alisa Rich of Wolf Eagle.

The central technical documents in the collection are the reports prepared by Wolf Eagle Environmental Engineers and Consultants, dated May 26, 2009, with an additional report dated June 27, 2009, which describes ambient air sampling performed at or near the Deborah's Farmstead property at 300 McNaughton Lane in Westworth Village, Texas. Other documents include incomplete lab reports of air sample analyses, followup communications from Wolf Eagle to Deborah's Farm, letters presenting opinions of various professionals on the significance and meaning of the data in the Wolf Eagle reports, and communications from Deborah Rogers to the City of Westworth Village and DFW office of the TCEQ.

The Wolf Eagle reports describe two (2) similar ambient air sampling events conducted at the Deborah's Farmstead property in Westworth Village on May 25, 2009 and June 27, 2009, respectively. The sampling was apparently conducted due to concerns regarding the impact of nearby gas well drilling and exploration operations. During the first sampling event, Wolf Eagle reported gas flaring activity at the Shady Oaks 1H, 2H, and 3H well sites adjacent to Highway 183, operated by Chesapeake Operating, Inc. These well sites to be clustered slightly over 4150 feet southwest of the

farm.[1] Other well sites marked on a site map included in the Wolf Eagle report include Westworth Village 1H,2H (~950 ft northwest of site), Doug A 1H-4H (~3782 ft east of site), Multipad Site (~7552 ft east-southeast of site) and Rivercrest 1H-12H (~ 8298 ft east-southeast of site). The Wolf Eagle reports reviewed by IHST provide no information on the operational status of any well sites other than Shady Oaks 1H-3H. The runway of the Joint Reserve Naval Air Station is also located approximately 4200 feet due west of the site, with fuel storage tanks and support building and roadways approximately 2400 feet northwest of the site. The Wolf Eagle reports do not discuss the airport or its proximity to the site.

The Wolf Eagle reports present sampling results which show the presence of low concentrations of various organic compounds, including chloroform. The report also highlights compounds which were tentatively identified, including carbon disulfide and a handful of other organic sulfur compounds. Some of the samples indicate airborne concentrations which Wolf Eagle concluded could exceed TCEQ Effects Screening Levels (ESL). The Wolf Eagle reports provide descriptions of the potential health effects of some of the compounds detected, highlighting carcinogenicity, irritation, asphyxiation, nausea and flammability issues, and strongly suggest the nearby gas wells as the source of these compounds.

Measured concentrations of contaminants were generally higher on May 26 than on June 27. In summarizing the June 27 results, the Wolf Eagle report concludes the lower airborne contaminant concentration obtained from sampling on June 27, 2009 are more representative of typical ambient air conditions in urban areas, except for the presence of disulfides. The report further concludes the presence of the disulfides are not typical in urban areas, but are consistent with gas exploration, compression and distribution. Wolf Eagle states the concentrations of disulfides are higher than would be expected in urban-residential areas, and highlights carcinogenicity concerns with 'many of these compounds'.

The documentation includes three (3) subsequent letters, one each from D. Sterling (UNT), M. Baily (Baily & Associates) and A. Armendariz (SMU). These letters are all apparent responses to requests from Deborah Rogers to review and comment on the Wolf Eagle reports. The tone and content of each of the letters is very similar, highlighting the potential hazards of the chemical compounds detected, and expressing the opinion that additional sampling should be performed, and appropriate controls implemented. The letters from D. Sterling and M. Baily are somewhat general responses, while that of A. Armendariz is longer, and includes more supporting references and specific information.

The Wolf Eagle reports reference appendices which were not included in the documentation provided to IHST. These appendices apparently provided GPS coordinates for each sample location. Also, the laboratory report included in the Wolf Eagle report for samples collected on June 27 refers to a case narrative, which was not included.

The remainder of this document will focus on specific comments and opinions regarding the technical and data interpretation aspects of the available documents. The review is limited to items which IHST believes are significant, and is not an exhaustive discussion of minutiae from the documentation.

The documentation provided for review by IHST is included as Appendix A of this report.

[1] The Wolf Eagle report references appendices which provide GPS coordinates for sample locations. However, this appendix was not included in the documentation submitted to IHST. Distances mentioned are best estimates of the distances from the 300 McNaughton Lane address to the referenced landmarks, based on review of a single site location map included in the provided documentation.

Opinions Regarding Sampling and Analysis Methods

Appropriateness of Selected Sampling/Analysis Method

The sampling and analysis method (analysis method EPA TO-14) used by Wolf Eagle in the ambient air monitoring projects reviewed was a routine, broad-spectrum test for certain volatile organic compounds. IHST believes the data derived from this sampling method was insufficient to adequately characterize or isolate potential emissions from gas well operations.

The Wolf Eagle report indicates samples were collected using evacuated SUMMA canisters, according to ASTM Method D31357, and submitted for analysis by EPA method TO-14 for volatile organic compounds. The reports state this method was chosen because it covered the widest range of volatile organic compounds.

While the TO-14 analysis method does cover a broad range of compounds, it is very heavily weighted towards detection of chlorinated hydrocarbon compounds. Only six (6) of the forty compounds validated for detection by TO-14 are non-chlorinated compounds (benzene, ethylbenzene, styrene, toluene, m-&p- xylene and o-xylene). Chlorinated compounds are neither strongly nor uniquely linked to gas well exploration and operation activities. The remaining non-chlorinated compounds may be associated with such operations, but are not unique to them, and can be produced from a number of sources.

The sampling methods employed by Wolf Eagle were not capable of detecting inorganic compounds such as hydrogen sulfide, sulfur dioxide, nitrogen dioxide, and nitric oxide. Hydrogen sulfide is a frequent contaminant of concern in gas well drilling and exploration operations, and is known to be present in petroleum and gas beds in the Barnett Shale. Sulfur dioxide is formed by combustion of hydrogen sulfide during flaring operations, and can combine with ambient moisture to reform hydrogen sulfide. Nitrogen dioxide and nitric oxide (NOx) can be formed during flaring operations, and are also produced by engine exhaust, such as that produced by engines for compressors and other equipment. While these inorganic contaminants are not unique to gas well exploration and operation, their direct correlation with such activities is much stronger than the organic compounds presented in the reviewed documents. In addition, these inorganic compounds are generally of primary concern with regards to pollution and public exposure.

Sample Collection Procedures

The Wolf Eagle reports do not indicate whether samples and site conditions were continually monitored, or for what portion of the sample period they were monitored. The report also does not describe the placement and protection of the sample collection apparatus. Due to the sensitivity of the analytical methods employed, placement and protection of samples are important. Placing samples too close to the ground may result in detection of emissions of volatile organic compounds (VOC) from vegetation and soils. People, animals and nearby equipment or operations can also generate VOC's which may be detected by the analysis.

The Wolf Eagle reports do not indicate that control or reference samples were collected. The basis of Wolf Eagle's conclusions that specific VOCs are elevated or unusual for the environment sampled is unclear.

Sample Analysis Methods

The TO-14 method has been validated for forty specific organic compounds. This means the test method is considered reliable and accurate for these compounds when properly performed. The TO-14 method can also identify organic compounds other than the forty validated compounds, but such identification is classified as tentative. Concentrations of tentatively identified compounds (TICs) are considered estimates only. The skill and experience of the analyst, as well as the reliability and

performance of analytical equipment can significantly influence the detection and quantification of tentatively identified compounds.

Of the chemical compounds highlighted and discussed in the Wolf Eagle reports, chloroform is the only validated compound detected. All other highlighted compounds (carbon disulfide, dimethyl sulfide, methyl ethyl disulfide, etc.) were tentatively, not positively, identified. Concentrations reported for these compounds must be considered semi-quantitative estimates.

Also, the lab report for samples collected on June 27, 2009, indicated a low surrogate recovery percentage from all the samples. Surrogates are known chemical compounds added by the laboratory to a sample, in order to verify the extent to which the analysis method can recover all of a known contaminant. In the May 26 samples, surrogate recovery rates were near 100% in all samples. However, for all the June 27 samples, surrogate recovery percentages ranged from 54.4% - 60.4%. Such low recovery is likely to bias the sample results lower than actual. The laboratory report refers to a case narrative addressing the low recovery rates, but this documentation was not included in the reports submitted to IHST for review.

The low recovery rates for samples collected on June 27, combined with the heavy reliance on TICs in all samples, makes comparison of samples collected on the two different days much less meaningful than might normally be the case.

Opinions Regarding Technical Data Presented in Reports

Application and Use of Effects Screening Levels

IHST believes the Wolf Eagle reports and related documents did not appropriately apply and use the TCEQ Effects Screening Levels (ESL). According to the Texas Commission on Environmental Quality (TCEQ), ESLs are described as follows:

> *Effects Screening Levels are used to evaluate the potential for effects to occur as a result of exposure to concentrations of constituents in the air. ESLs are based on data concerning health effects, the potential for odors to be a nuisance, effects on vegetation, and corrosive effects. They are not ambient air standards. If predicted or measured airborne levels of a constituent do not exceed the screening level, adverse health or welfare effects are not expected. If ambient levels of constituents in air exceed the screening levels, it does not necessarily indicate a problem but rather triggers a review in more depth.*[2]

The Wolf Eagle reports and other documents in the package use language that treat the ESL as ambient air standards, and imply that exceeding these values results in a hazardous condition, in contradiction of the TCEQ's clear definition.

The Wolf Eagle reports also inappropriately compare the sampling results to both Short-Term and Long-Term ESLs. The Short-term ESL is an hourly average concentration of the specified contaminant. The sampling method used by Wolf Eagle does produce data which may be compared with relative confidence to Short-Term ESLs. However, Long-term ESLs are annual averages. The data presented by Wolf Eagle is in no way sufficient to demonstrate exceedance of Long-term ESLs. IHST believes extrapolation of the two samples sets collected by Wolf Eagle to an annual average concentration involves a large number of gross assumptions, which are unsupportable in the provided data.

[2] http://www.tceq.state.tx.us/implementation/tox/esl/ESLMain.html

Descriptions of Chemical Effects

IHST believes the depictions of health effects of the detected compounds presented in Wolf Eagle reports and related documents are misleading. While the health effects described in these documents are associated with exposures to those chemicals, the specified effects and hazards are present only at concentrations far above those detected in the ambient air sampling. Wolf Eagle reports do not specifically state the detected concentrations will result in the stated effects, but by omission of any discussion of dose-response and the actual anticipated effects of chemicals at or near the concentrations detected, the reports create a strong suggestion the chemicals detected are hazardous at the concentrations detected.

As an example, the Wolf Eagle reports correctly state the ACGIH TLV for dimethyl disulfide is 0.5 ppm. The report then *incorrectly* states this value is "considerably lower than TCEQ limits." [3] In fact, the TLV is 100 times *higher* than the TCEQ ESL of *5 ppb*. The TLV is a standard intended to prevent adverse health effects in workers exposed to chemical compounds on a daily basis. IHST finds the implication that exposure to a concentration 100 times below that considered safe for daily exposure by workers will result in "irritation, nausea and overall weakness" to be preposterous and irresponsible. Likewise, the Wolf Eagle report states that "vapor or air mixtures" of dimethyl disulfide above 24 degrees C may be explosive. However, the reports neglect to mention the highest concentration of dimethyl disulfide detected in samples (50.3 ppb) is over 218,000 times less than the lowest concentration of dimethyl disulfide in air which can ignite (1.1 %, or 11,000,000 ppb)[4].

Interpretation of Sample Results

In general, IHST believes the Wolf Eagle reports and associated documents present the hazards of the chemicals detected in analyses in a manner that exaggerates the hazards posed at or near the measured concentrations. Comments and opinions contained in reports and letters tended to be speculative and general in nature, based on extrapolation of very limited data. In addition, IHST believes the sampling data does not support a conclusion that the compounds detected are the sole result of nearby gas well exploration and operation activities. IHST does not believe the sampling performed employed sufficient controls or generated sufficient data to link detected contaminants directly to gas well activities, nor to demonstrate a significant health hazard.

IHST raises the following key cautions regarding the conclusions stated or implied by Wolf Eagle and other authors:

- The tentatively identified compounds highlighted in discussions are not unique to gas well production.
    - For example, dimethyl disulfide is one of the compounds responsible for the offensive odor of fecal matter, certainly possible on a farm with goats, chickens or other livestock. It is also produced naturally from certain vegetation. All of the other organic sulfides detected can be produced by naturally occurring sources as well.
- Potential impact from exhaust emissions from airplane traffic at the nearby Joint Reserve Naval Air Station was apparently ignored by all commenters, in spite of the fact that many of the detected compounds can be produced by engine exhaust.
- Nearly all significant conclusions and statements appeared to be based on concentrations tentatively identified compounds (TIC), which are necessarily estimates, and must be viewed and used with caution.

[3] Wolf Eagle Amient air Monitoring Report, Tos/RogersAirEmissionReport-final0609, page 6

[4] MSDS for Methyl Disulfide, Acros Organics, N.V., 3/18/2003, https://fscimage.fishersci.com/msds/96874.htm. Conversions and calculations: (1.1% = 11,000,000 ppb; (11,000,00 ppb / 50.3 ppb) = 218,687.9)

- Application and interpretation of ESLs and the ACGIH TLV indicated misunderstanding and/or misapplication of these standards.
- Low surrogate recovery rates for samples collected on June 27, 2009, and the potential impact on sample results, were not addressed in the Wolf Eagle reports or other documents.
- Wind patterns were actually variable during the sample collection period, and no attempt was made in any of the documentation reviewed to address the potential impact of these variations.
- IHST does not believe the small variations in methane concentrations identified during sampling were significant. Variation was no greater than 1 ppm between all samples collected on all days.

Conclusions and Recommendations

IHST concludes the ambient air sampling performed by Wolf Eagle Environmental Engineers and Consultants at Deborah's Farm was rudimentary in scope and design, and of limited value in evaluating potential hazards produced by neighboring gas well activities. Results of the sampling appear to IHST to be inconclusive at best. Most compounds of interest detected were present as tentatively identified compounds (TICs), and the identity and determined concentration of these compounds are necessarily estimates, subject to non-quantifiable error. Possible problems in sample recovery for samples collected June 27, 2009, are not fully documented in the information provided to IHST. IHST believes these sample results must remain questionable until further information is available. This problem also raises questions regarding conclusions reached by various authors, based on comparison of sample data from different days.

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In brief, IHST does not believe the documentation reviewed provides sufficient evidence to demonstrate adverse impact from gas well exploration and operations to the property at 300 McNaughton Lane, in Westworth Village, TX. The sampling data is too general and limited to make such determinations. Opinions based on the sample data should likewise be considered general or speculative, based on very limited data.

These opinions are limited to review of the provided documentation. IHST does not intend to suggest determination of the potential impact of gas well exploration and operation to the surrounding environment should not be seriously and thoroughly investigated. Such impacts may indeed be significant, especially as density of such operations increases. However, such evaluations should be properly designed, controlled and conducted, and reviewed objectively, considering all available data. IHST believes Texas state agencies or independent and objective third parties are best positioned to perform such evaluations. IHST simply does not believe the documentation reviewed in this report provided adequate project design, sufficient data, control or objectivity for such evaluation.

Limitations

This document is the rendering of a professional service, the essence of which is the advice, judgment, opinion, or professional skill. In the event that additional information becomes available that could affect the conclusions reached in this investigation, IHST reserves the right to review and change if required, some or all of the opinions presented herein.

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Tracy K. Bramlett, CIH, CSP
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Appendix A. Documentation Provided for Review