April 24, 2012
Project No. DFW12009

MODERN GEOSCIENCES
Trusted Environmental Advisors

Air Sampling Results
Near Titan Padsite
7504 Pleasant Run
Colleyville, Texas

Data Review Memorandum

BACKGROUND:

Titan Operating, LLC (Titan) performed hydraulic fracturing between January 30th and February 3rd and flowback activities between February 5th and February 16th, 2012. All padsite activities were performed between 7 am and 7 pm. Modern Geosciences, LLC (Modern) was engaged by the City of Colleyville (City) to perform air monitoring during these events.

The monitoring was summarized in a Padsite Monitoring Report dated February 22, 2012. Chemical of Concern (COC) concentrations observed during fracturing included the following:

- *Nitric Oxide (up to 2.297 ppmv);*
- *Ethylbenzene (up to 0.195 ppmv);*
- *o-Xylene (up to 0.139 ppmv); and*
- *Toluene (up to 0.137 ppmv).*

COC concentrations observed during flowback included the following:

- *Nitric Oxide (up to 0.196 ppmv);*
- *Ethylbenzene (up to 0.510 ppmv);*
- *o-Xylene (up to 0.737 ppmv);*
- *m-Xylene (up to 0.089 ppmv);*
- *p-Xylene (up to 0.033 ppmv);*
- *Benzene (up to 0.085 ppmv);*
- *Ammonia (up to 0.030 ppmv); and*
- *Toluene (up to 0.025 ppmv).*

Based on the above information, the City will require additional emission reduction efforts be employed during future hydraulic fracturing, flowback, or production at the padsite. It should also be noted that the monitoring results were communicated to the TCEQ during the event and that none of the above values exceeded applicable regulatory criteria.

Additionally, since the hydraulic fracturing event in February 2012, the U.S. Environmental Protection Agency issued final amendments to air regulations concerning Oil and Gas activities related to hydraulic fracturing, flowback, and production (April 17, 2012). These rules follow initiatives led by north Texas communities like Colleyville, Grand Prairie and Southlake and would place additional restrictions on flowback activities like those performed by Titan.

SUMMARY OF DATA PROVIDED TO THE CITY:

Modern was asked to provide technical support concerning recent sampling results presented to the City. The City was provided three laboratory data sets for air samples collected on February 1, 2012 (No Time Information) by Jay L., February 2, 2012 (9:35am to 9:35pm) by Chris M., and February 9, 2012 (7:15am to 9:15am) by Mike DeNicola. All samples were received by the laboratory (GD Air Testing, Inc. of Richardson, Texas) on February 22, 2012 and analyzed by EPA Method TO-14 five days later on February 27, 2012. The laboratory reports were issued to Leslie Guest of Southlake, Texas.

Based on the correspondence accompanying the data, the sampling was coordinated by Ms. Wilma Surba who provided reference to TCEQ Effect Screening Levels (ESLs) rather than AMCVs which are applicable to the data presented. No information concerning the sample collection methodology, sampling container preparation or cleaning methodology, sampling height, chain of custody documentation or explanation for the up to 20-day storage of the samples following sample collection was provided.

The accompanying map notes sampling on February 1, February 2, and February 9 to have been approximately 1,100 feet west, 1,700 feet north-northeast, and 1,500 feet northeast, respectively. Predominant wind direction in area of the Titan Padsite was to the southeast and northwest on February 1 and February 9, 2012, respectively.

A summary of the provided data is tabulated below.

Table 1 – Provided Data Summary

COC	During Fracturing 2.1.2012 (No Time Listed)	During Fracturing 2.2.2012 (0935 – 2135)	During Flowback 2.9.2012 (0715 – 0915)	Highest Observed at Titan Padsite	AMCV[2]
Benzene	0.00117	0.0128	0.00042	0.085	0.18
Methyl Chloride	0.00066	0.00114	0.0064	NE	0.5
Dichlorodifluoromethane	0.00058	0.00065	0.0059	NE	10
Ethylbenzene	<0.00034	0.00096	<0.0004	0.51	20
Styrene	<0.00034	0.00129	<0.0004	<0.006	5.1
Toluene	0.00152	0.0134	0.00196	0.137	4.0
1,2,4 Trimethylbenzene	<0.00034	0.00324	<0.0004	NE	0.250
m- & p- Xylenes	0.00099	0.00816	0.00209	0.122*	1.7
o- Xylene	<0.00034	0.00303	0.00108	0.737	1.7
Naphthalene[1]	0.00233	0.076	0.00142	<0.002	500
Carbon Disulfide[1]	0.013	0.0197	0.00081	<0.133	NE
Acetone[1]	0.00908	0.0154	0.00719	NE	2.5

All concentrations presented as parts per million by volume (ppmv) * Represents a combined value
NE = Not Evaluated/Not Established

1- Laboratory is not accredited for analysis of this compound by TCEQ and these are not target analytes within EPA Method TO-14. Alternate method is preferable to provide viable data for comparison.
2- Texas Commission on Environmental Quality (TCEQ) Short-term Air Monitoring Comparison Value (Updated March 2012)

COMMENTS:

To help appreciate the provided data, Modern has prepared the following comments.

Data Collection and Analysis

With the exception of tentatively identified compounds and analytes not included in the standard laboratory method selected, the laboratory data appears viable for evaluation of ambient air quality. However, it is unclear from the provided material if interference from motor vehicles, cooking/heating equipment or lawn equipment could have occurred as no screening for VOC sources was reported at each sample point.

The results appear to include a consistent set of compounds with several being commonly known for laboratory interference (i.e. acetone, methyl chloride). Consistent COC occurrences can often point to common issues with sample preparation, laboratory analysis or a common occurrence within the air. To help determine if a suspected impact is occurring it is prudent to design a sampling program that includes samples both close to and farther, or up and down wind, from a suspected source. In this case we have three static samples with little information on the sampling event (i.e., field conditions) or sampling design.

Additionally, based on the recorded meteorological data from the padsite monitoring event, it does not appear the dominant wind direction during the February 1st or February 9th sampling events would have been toward these sample points. Further, two of the three samples collected correspond with the significant diesel engine emissions (hydraulic fracturing) at the padsite rather than actual emissions from the well or flowback fluids.

Appropriate Comparison Criteria - AMCVs vs ESLs

In March 2010, the TCEQ published Air Monitoring Comparison Values (AMCVs) to provide additional clarity to the regulated public concerning appropriate screening criteria for air monitoring and sampling data.

Historically, the TCEQ utilized multiple criteria to evaluate air quality results. This included use of short and long-term Effect Screening Levels (ESLs) for both air permitting and air monitoring and, when available, Reference Values (ReVs) to determine if potentially unsafe conditions were present based on the air monitoring data. As noted by the TCEQ, "Like ESLs, ReVs are safe concentrations of chemicals in the air. ReVs are used to evaluate chemical levels found in outdoor air samples collected by TCEQ around facilities that release chemicals into the air." The ReV can be used for air monitoring whereas the health-based ESL, which is typically 70% lower than the ReV, is used in air permitting.

Since there are significant differences between performing health effect reviews for proposed air permits and the various forms of ambient air monitoring data now being collected, the TCEQ has developed AMCVs rather than ReVs to simplify evaluations of air monitoring and sampling data. Similar to ESLs, AMCVs are chemical-specific air concentrations set to protect human health and welfare.

The data collected represents a short-term event (non-continuous) that was monitored using short-term methods (non-continuous; <24 hours) and should utilize short-term AMCVs for comparison. Table 1, above, provides the current AMCVs. No exceedances were noted in the provided data.

Carbon Disulfide

There is no current AMCV for Carbon Disulfide. There are ESLs available for use in emission modeling, but the current TCEQ values are currently in review based on renewed interest in this compound. According to the TCEQ, "recent significant health concerns expressed outside of the agency regarding these reported carbon disulfide levels appear unwarranted and may distract focus and resources from other chemicals which likely represent more of a potential health concern based on reported data and available scientific literature (e.g., benzene)." (TCEQ Memo, February 8, 2010)

More importantly, there has been much confusion concerning this compound due to poor sampling and laboratory method selection. However, because of the common identification in early air sampling related to Oil and Gas concerns, and more accurately "estimation of occurrence" as part of broad VOC analyses, a good amount of regional data is available to help better understand the identification of this compound during this event. For example, this compound was noted in the 2009 TCEQ Barnett Shale Monitoring Effort, 2010 Southlake Limited Air Quality Evaluation, and March 2010 Flower Mound Limited Ambient Air Evaluation with concentrations estimated to exceed 60 ppbv. In each case, the carbon disulfide was "estimated" (as in this case) in the absence of an actual standard needed to verify both presence and quantity through a method that is poorly suited to identify reduced sulfur compounds.

In response to this early indication that carbon disulfide could be a concern, the TCEQ remobilized equipment as part of their 2009 evaluation to allow real-time evaluation in the field at multiple points at 15 operating Oil and Gas padsites and was unable to reproduce any occurrence of carbon disulfide (TCEQ 2010). The secondary efforts utilized a method tailored to verifiably identify reduced sulfur compounds. In Flower Mound, a targeted assessment of the locations originally producing the "estimated" carbon disulfide was performed. The subsequent sampling in Flower Mound during March and May 2011 did not detect reduced sulfur compounds (including Carbon Disulfide) through the use of appropriate sampling and laboratory methods.

If future evaluation of Carbon Disulfide is desired, it should utilize methodology not prone to sample interference and a method designed for verifiable detection of reduced sulfur compounds.

While the open path method utilized by Modern for this event offers higher detection limits than laboratory methods for shorter monitoring paths, it allows verification through analysis of the resulting spectra data and can be placed at the suspected source and produces real-time data.

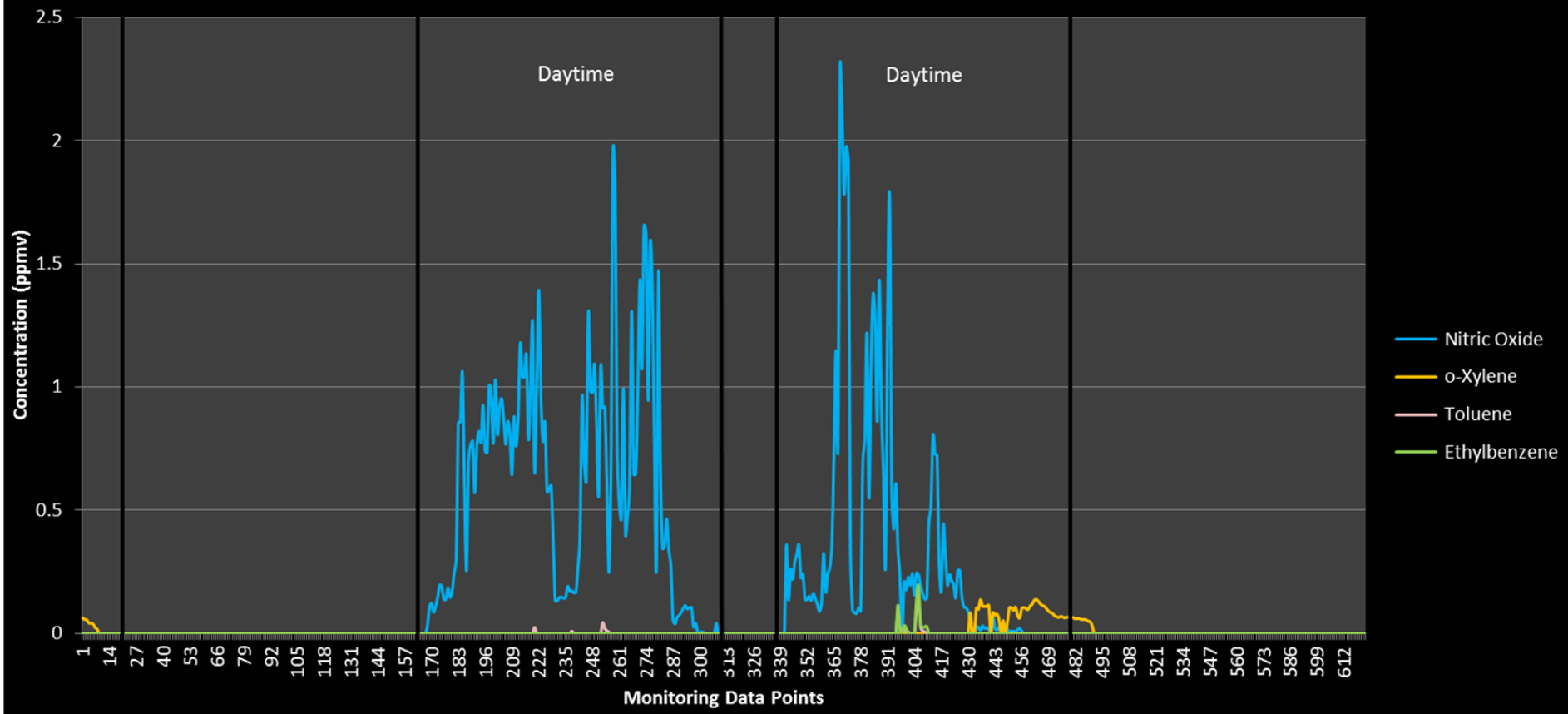
CLOSING:

It is recommended that the City coordinate any future sampling to allow use within the larger understanding of possible emission sources. This would improve the viability of results and allow informed decisions concerning sample point selection and methodology. While the intention of the sampling event performed is laudable, the unfortunate result of poorly collected information is often further confusion among the community at large.

If we can assist with the performance of sampling, monitoring or development of a sampling design to address concerns communicated to the City during future events, please do not hesitate to contact us.

Reference TCEQ 2010 – Interoffice Memorandum, Health Effects Review of Barnett Shale Formation Are Monitoring Projects, from Shannon Ethridge, TCEQ Toxicology Division, Chief Engineer's Office, dated January 27, 2010. Also see TCEQ Document No. BS0912-FR.

Figure 4: Air Quality Monitoring (Hydraulic Fracturing)



January 30th to February 2nd, 2012, Trinity Padsite, Colleyville, Texas

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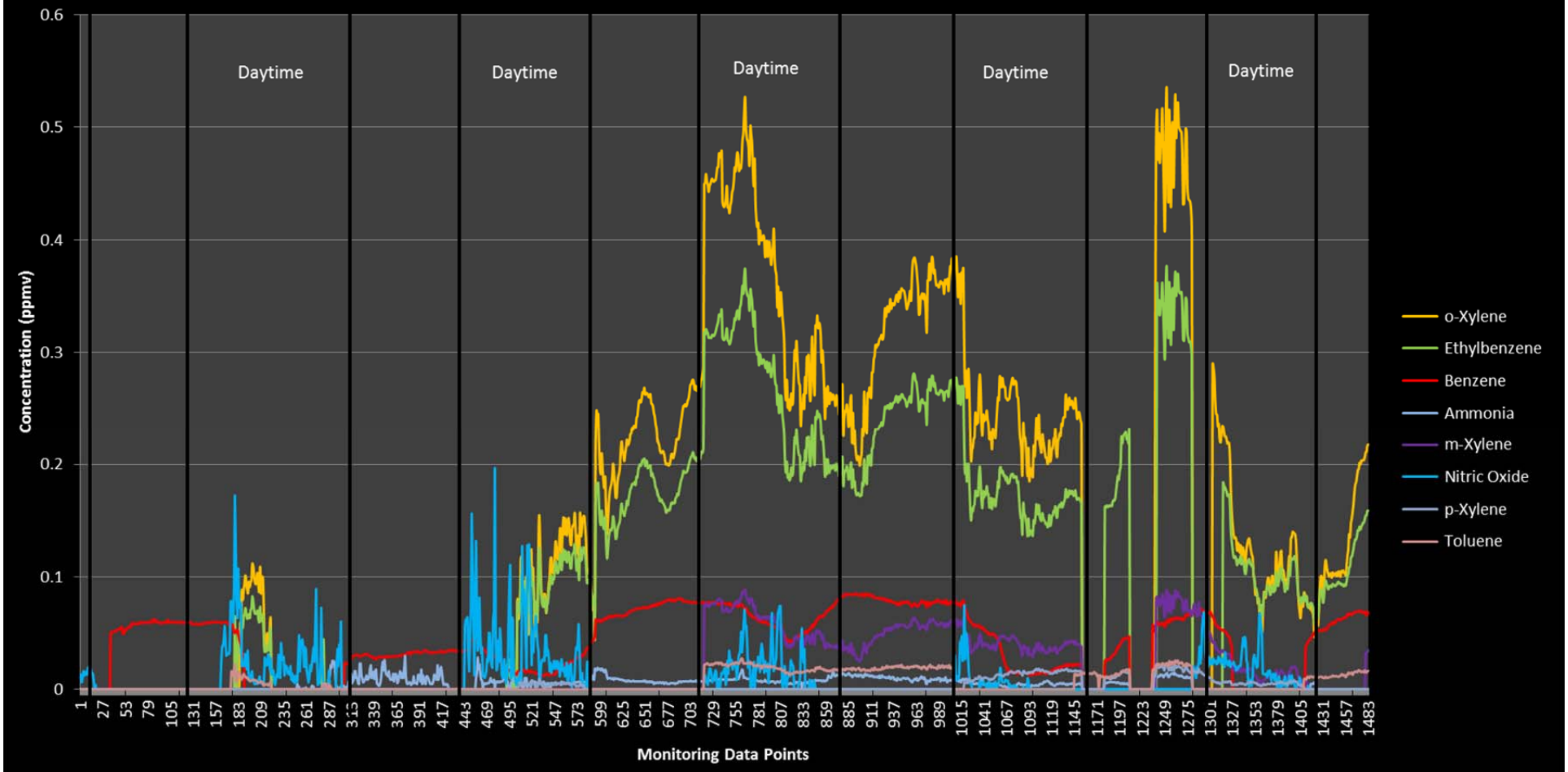
Figure 5-1: Air Quality Monitoring (Flowback)



February 5th to February 11th, 2012, Trinity Padsite, Colleyville, Texas

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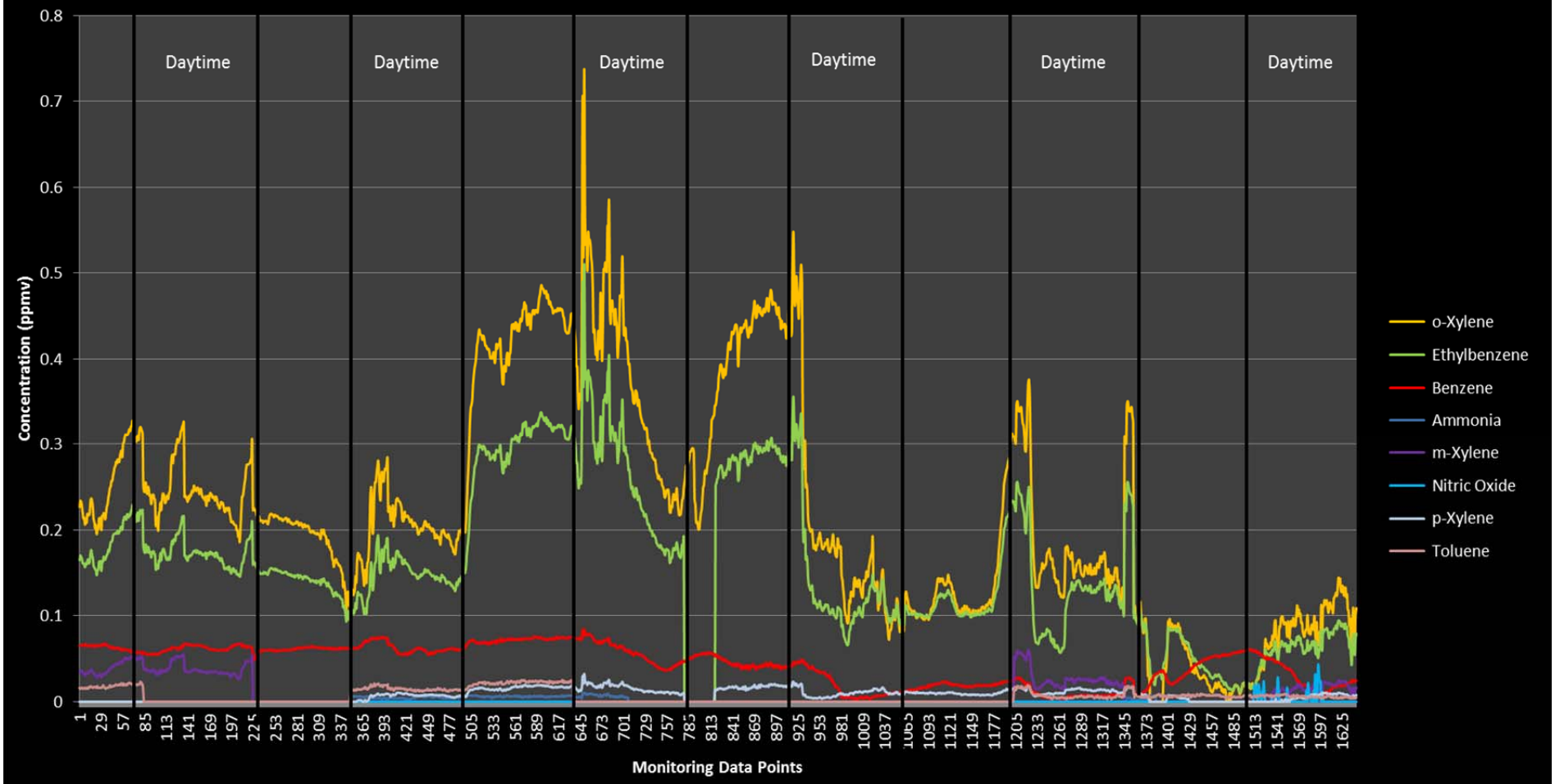
Figure 5-2: Air Quality Monitoring (Flowback)



February 11th to February 16th, 2012, Trinity Padsite, Colleyville, Texas

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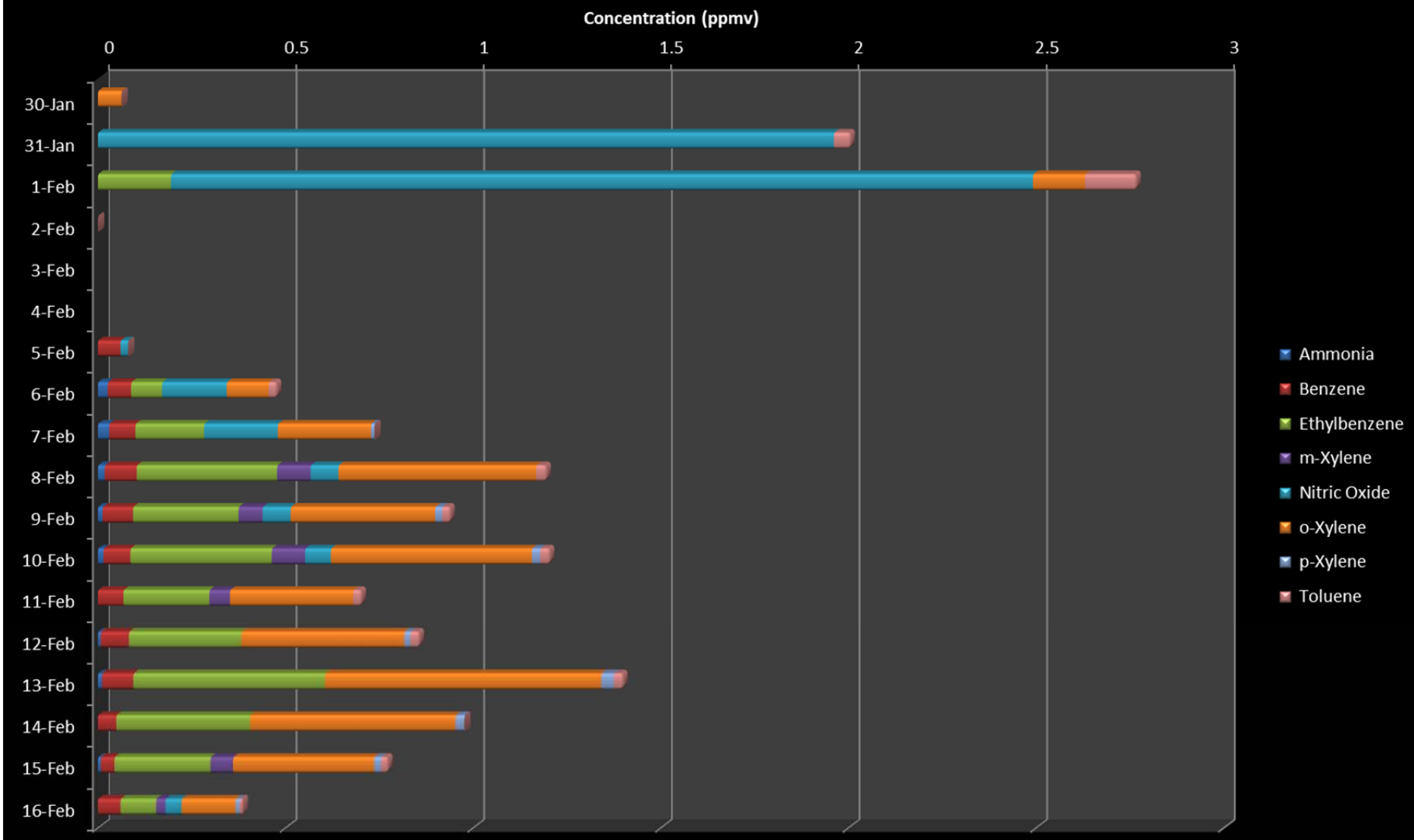
Figure 6: Air Quality Monitoring (Daily Maximum)



Trinity Padsite, Colleyville, Texas

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