2017 Toxics Report

By
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Introduction

The Division of Air Quality (DAQ) has been tasked with the mission of protecting Utah's public health and environment through the enforcement of federal and state air quality regulations. DAQ achieves this mission by regulating urban and industrial emission sources through its permit issuing activities, inspections, monitoring, active research, and recommending appropriate rules and regulation to the Utah Air Quality Board. Through these activities DAQ works to bring Utah's air quality into compliance with the federally established National Ambient Air Quality Standards (NAAQS).

A combination of Utah's unique topology, climate, and the complex photochemistry associated with pollutants such as ozone and $PM_{2.5}$ creates a particular challenge in controlling their presence in Utah's air. Utah has had success in reducing these pollutants by implementing a mandatory wood burning action program, carpool requirements for large businesses, and promoting a no-idling campaign. In addition, initiatives like the state's Clean Air Retrofit, Replacement, and Off-Road Technology program (CARROT) and the ban of several volatile organic compounds (VOC) used in consumer products show promise in improving air quality in areas that do not yet meet the requirements of the NAAQS.

There is another class of pollutants, not subject to the NAAQS requirements, known as Hazardous Air Pollutants (HAPs). Although most of these pollutants are detected at extremely low concentrations, some of them, like formaldehyde and benzene, can play an important role in photochemical formation of ozone and $PM_{2.5}$ in addition to the potential deleterious effects on public health. The potential health threats may include increased risk of certain types of cancer, tissue irritation, cellular damage, and birth defects through continuous long-term exposure. While no federally or state enforced regulations such as the NAAQS exist for HAPs, hazardous risk levels have been identified by the EPA. While EPA does not control hazardous emissions through the NAAQS, they have developed regulations that control industrial process emissions directly through standards known as control technology guidelines (CTG).

The Bountiful monitoring site has been a part of National Ambient Air Toxics Stations network (NAATS) since 2002 which provides DAQ with a rich data set to observe the most recent HAPs concentrations as well as their long-term trends. The initial interest in the contribution of HAPs to the ambient air pollution in Utah was first sparked in 2012, after the Bountiful data revealed sporadic, but uncharacteristically high concentrations of dichloromethane. Although no individual emissions source of dichloromethane was found, this finding prompted a closer investigation of the levels of other HAPs in Utah.[1]

In 2014 DAQ conducted a comparison study to estimate the impact that local industries might have on Utah's HAPs levels. The study examined eleven HAPs that exceeded the health-relevant thresholds in more than 5% of the yearly samples. To compare the concentrations observed at Bountiful with another city, Phoenix, AZ was selected for its similarity to Utah's climate and the lack of major mining and oil refining industries. Study results showed that the HAPs composition between the two cities was very similar. Oil refining and mining industries appeared to have little impact on the differences in the

[1] Abnormally High Concentrations of Dichloromethane and Acetonitrile, DAQP-025-13, Roman Kuprov, 2012

number of detected HAPs and their concentrations. However, trace levels of lead and cadmium indicated a possible impact from current and historic mining and smelting in the Salt Lake Valley.[2] This study left two critical questions unanswered. First, is the Bountiful site representative of the Salt Lake and Utah Valleys and, if so, what is the distribution of HAPs between the two? Second, what are the long-term trends of the relevant HAPs?

DAQ addressed these questions by conducting the 2015 Special Toxics Study. The study deployed two additional monitors; one at Lindon and the other in West Valley City to match the suite of VOCs and metals collected at Bountiful. The study lasted throughout calendar year 2015. Sampling frequency at the three sites was doubled from the regular 1-in-6 day monitoring schedule to provide greater resolution. The results of the study revealed that Utah's most prominent HAP, formaldehyde, is an emerging phenomenon that began in 2013. The lack of similarly high concentrations of formaldehyde in Lindon and West Valley suggested that formaldehyde in Bountiful could be connected to a very localized emission source. The other two major findings were the prevalence of dichloromethane in Bountiful (also linked to an unidentified local source as identified previously) and slightly elevated lead concentrations in West Valley (compared to the other sites). It was impossible to determine, however, whether the lead in West Valley was connected with the current mining activities or with a former Superfund site that included a lead smelter.[3]

As a direct result of the 2015 findings, a new, ongoing saturation study is currently underway. The study utilizes 34 passive monitors strategically placed across Bountiful, North Salt Lake, and Woods Cross with the goal of identifying areas which might contain the emission source of formaldehyde and dichloromethane. It is expected to conclude in the summer of 2017 with the results available shortly thereafter.

This report aims to identify where Bountiful fits among other metropolitan areas across the continental United States with respect to HAPs' concentration and trends. To accomplish that, four other metropolitan areas with diverse levels of industrialization, population, geography, and climate were used for comparison. A crucial requirement in selection was for each area to have identical monitoring equipment and analytical methods.

The intent of this report is to evaluate whether Bountiful differs significantly from other urban areas in the number of HAPs as well as their concentrations. Although, this comparison was made with Phoenix, AZ, the data used in this report covers twice the length of time used in the previous study and includes the most recent years available. The additional urban areas provide a more reliable basis for comparing HAPs trends. The extra points of comparison will help the reader to understand whether the unusually high concentrations of formaldehyde and dichloromethane are particular to Utah or also observed in other places.

[2] Utah Toxics Report 2014, Roman Kuprov, 2014
[3] 2015 Special Toxics Report, Roman Kuprov, 2016

Method

The main goal of this study was to compare the levels of HAPs, especially formaldehyde and dichloromethane, at Bountiful to the other urban areas across the continental United States and to determine long-term trends for each of the pollutants. A number of urban areas across the United States were selected: Phoenix, AZ (PHX); Detroit, MI (DMI); Rubidoux, CA (RBD); St. Louis, MO (SMO).

The main criteria for the selection were compatibility and continuity of the monitoring data and that each of the selected sites observed the same suite of VOC HAPs using identical measurement methodology over the same length of time. Another consideration was that there is sufficient dissimilarity between the sites in terms of population, levels of industrialization and urbanization, vegetation, and climate. This allowed for observation of the differences or, maybe more importantly, similarities in the make-up, levels, and trends of ambient HAPs between these urban areas.

The data for analysis were acquired from the Air Quality System (AQS), the EPA's centralized database for ambient monitoring data. The time period for the study spanned the decade from 2005 through 2015. This range was advantageous in two ways. First, it included the most recent available years of HAPs data (2012-2015) to identify the current, short-term trends in HAPs emissions. Second, having the older set of data (2005-2010) allowed us to observe the long-term changes in HAPs levels over the past decade. The long-term changes were tracked by way of comparing annual means of the pollutants before and after an inflection point in the data. If the inflection point wasn't obvious or didn't exist the first half of the data, 2005 through 2010, was compared to the second half, 2010-2015. The two-sample t-test was used as a method for comparing long-term means of the pollutant data.

As with the previous study, only the pollutants mentioned in the Special Toxics Study 2014, those exceeding health-relevant thresholds in more than 5% of their annual samples in Bountiful, were considered.[2] These pollutants were used in a one-way comparison between Bountiful and the other urban areas as a two-way comparison would be less relevant to Utah's air quality considerations. Table 1 shows the list of the HAPs analyzed in this report.

Table 1. The list of HAPs of interest for Bountiful

1,4-Dichlorobenzene	Acrylonitrile	Carbon Tetrachloride	Dichloromethane
Ethylene Dichloride	Tetrachloroethylene	Benzene	Ethylbenzene
Formaldehyde	Acetaldehyde	2,3-Butadiene	

The findings and discussion in this report are similar in form and content to the previous findings by the DAQ. Therefore, the main body of this report will be dedicated to the information that was new relative to the previous findings. Specifically, formaldehyde, acetaldehyde, and dichloromethane are discussed in detail in the main body of this report. Other pollutants listed in Table 1 either presented no substantial changes from previous findings or had insignificant impact on the local air quality. The discussion and figures associated with them can be found in the appendix for this report.

Formaldehyde and Acetaldehyde

The Bountiful NAATS site has the highest ambient annual formaldehyde concentrations in the EPA National Toxics Report for 2012. The formaldehyde measurements at Bountiful over the subsequent years have also been higher than the other urban areas in the nation. As of 2015, ambient formaldehyde is the HAP that contributes the most to cancer risk by means of lifetime exposure in Utah. However, formaldehyde's more prominent contribution to Utah's air quality is the role it plays in photochemical formation of secondary ozone and $PM_{2.5}$. As such, understanding the sources and nature of formaldehyde observations in Bountiful could be a key to measurable improvements in Utah's air quality not only with respect to the long-term cancer risk but also to criteria pollutant levels.

The 2015 Special Toxics Study showed that Bountiful had higher ambient concentrations of formaldehyde than observations made at Lindon in Utah County and West Valley, south and west of the Salt Lake City limits. However, the seasonal analysis revealed that the elevated values were primarily driven by the unusually high concentrations during wintertime. This is an unusual behavior for formaldehyde as its ambient concentrations tend to decrease at lower temperatures when the photochemical activity is inhibited. Meanwhile, summer formaldehyde levels were uniform across the two valleys and the three monitoring sites. This discovery suggested that the formaldehyde observations at Bountiful could be highly localized and not indicative of the rest of the Wasatch Front.

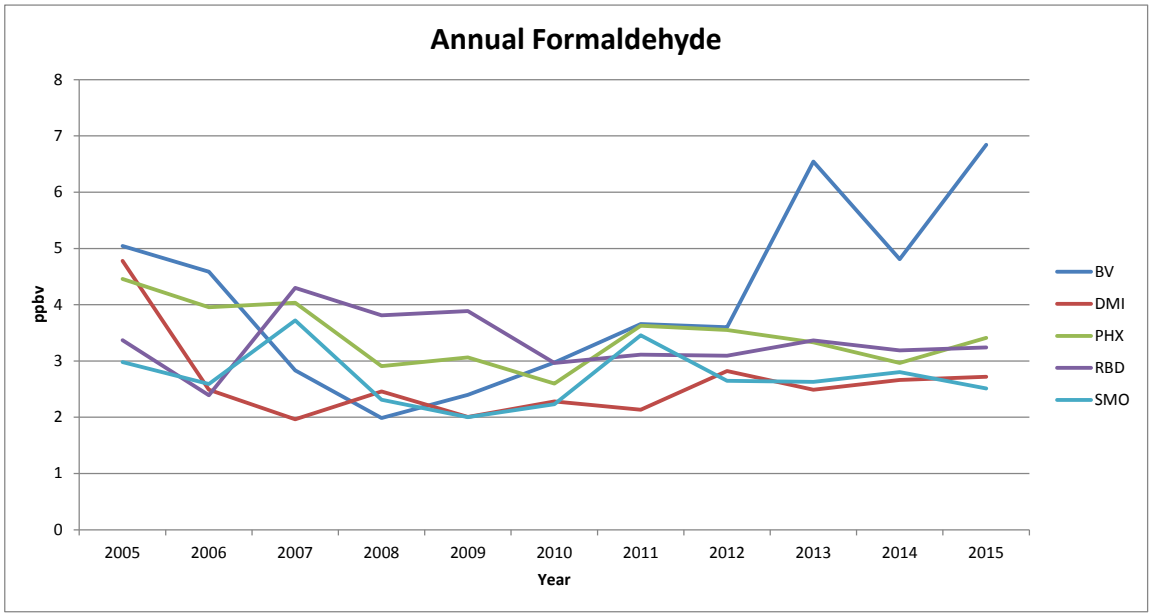
The long-term trend presented in Figure 1 shows that formaldehyde was in line with, or below, most of the other urban areas for the greater part of the last decade. The high formaldehyde observations first occurred in 2012, as noted by the EPA, and continued to be significantly above the rest of the sites in this report. Consistent with the 2015 Special Toxics Study, the high annual means at Bountiful are primarily driven by the unusually high wintertime concentrations.

From 2005 to 2012 formaldehyde concentrations in the five cities sustained a slight downward trend that leveled out in 2012 and remained flat between 2.5 ppb and 3.5 ppb. Bountiful, following the trend, reached the minimum of 2.0 ppb in 2008 after which it began experiencing steady gains in annual formaldehyde. From 2013 through 2015 Bountiful experienced a sharp increase in annual formaldehyde reaching between 5.0 and 7.0 ppb, well above the rest of the urban areas in the country. As mentioned before, this jump in annual concentrations was characterized by the high concentrations during winter.

Ambient acetaldehyde measurements were found to be highly correlated with those of formaldehyde at Bountiful as well as the other urban sites with the exception of Saint Louis. The high correlation between the two pollutants is expected for two reasons: they share sources and have similar chemical decomposition pathways. As such, their ratio (formaldehyde/acetaldehyde) and correlation determinant (R^2) tended to remain in a fairly constant range in urban areas; between 2 and 3, and 0.75-0.9, respectively. The ten-year coefficient of determination for formaldehyde and acetaldehyde was between 0.87 and 0.79, with the exception of Saint Louis where it was 0.41. However, the coefficient of

determination value for St. Louis fell in line with the rest of the sites after 2011. The annual acetaldehyde concentrations are displayed in Figure 2.

Figure 1. Mean annual formaldehyde across the five urban monitoring sites between 2005 and 2015.



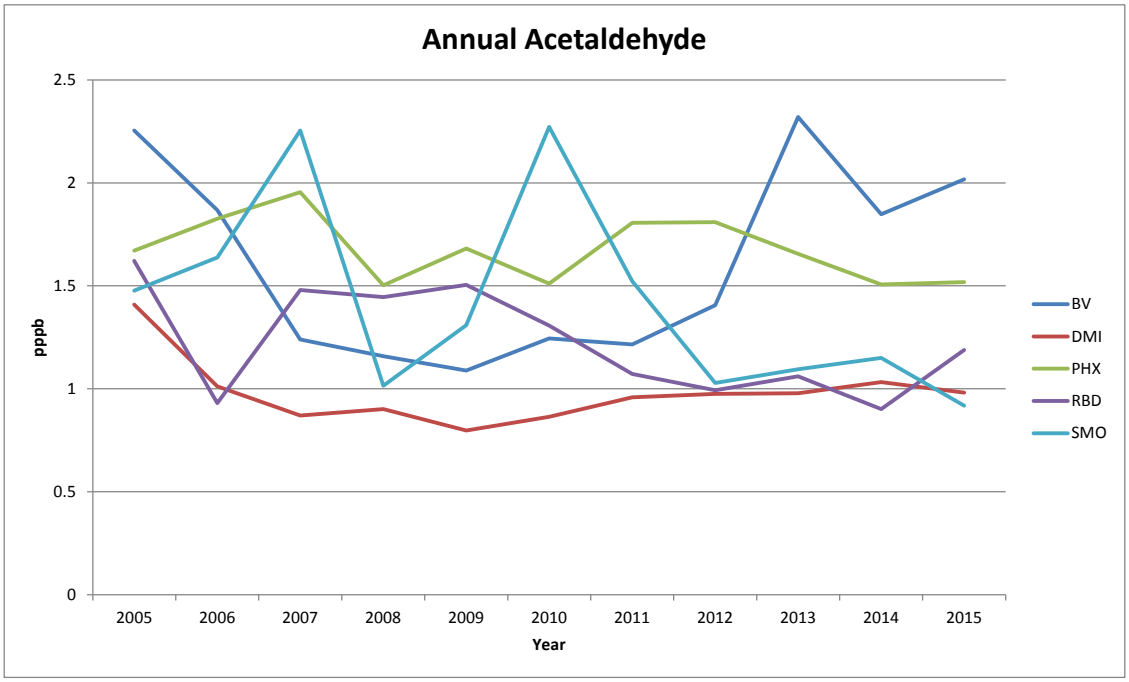
The long-term acetaldehyde trend remained relatively flat for most of the urban areas in this study. Beginning in 2012, Bountiful experienced a significant increase in ambient acetaldehyde concentrations that moved in lock-step with formaldehyde. As with formaldehyde, the increase was caused by the uncharacteristic increases in acetaldehyde concentrations in the winter.

The main source of acetaldehyde in the environment is respiration of vegetation, but it can also form as a byproduct of various combustion processes.[4] Therefore, higher levels of acetaldehyde are expected to be observed during the warm months of the year due to the increase in biogenic emissions. For these reasons, the correlation determinant and the formaldehyde-acetaldehyde ratio are similar for most of the cities. The formaldehyde-acetaldehyde ratio remained between 2 and 3 while the correlation determination was between 0.75 and 0.9 between 2005 and 2016 for four of the five urban areas in this study. SMO (St. Louis) experienced unusually high (relative to formaldehyde) acetaldehyde concentrations in 2006 and 2010, ranging between 1.0 and 1.6, which, considering the major sources of the pollutant, were probably impacted by the local plant life.

[4] U.S. Environmental Protection Agency. Health Assessment Document for Acetaldehyde. EPA/600/8-86- 015A. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Research Triangle Park, NC. 1987.

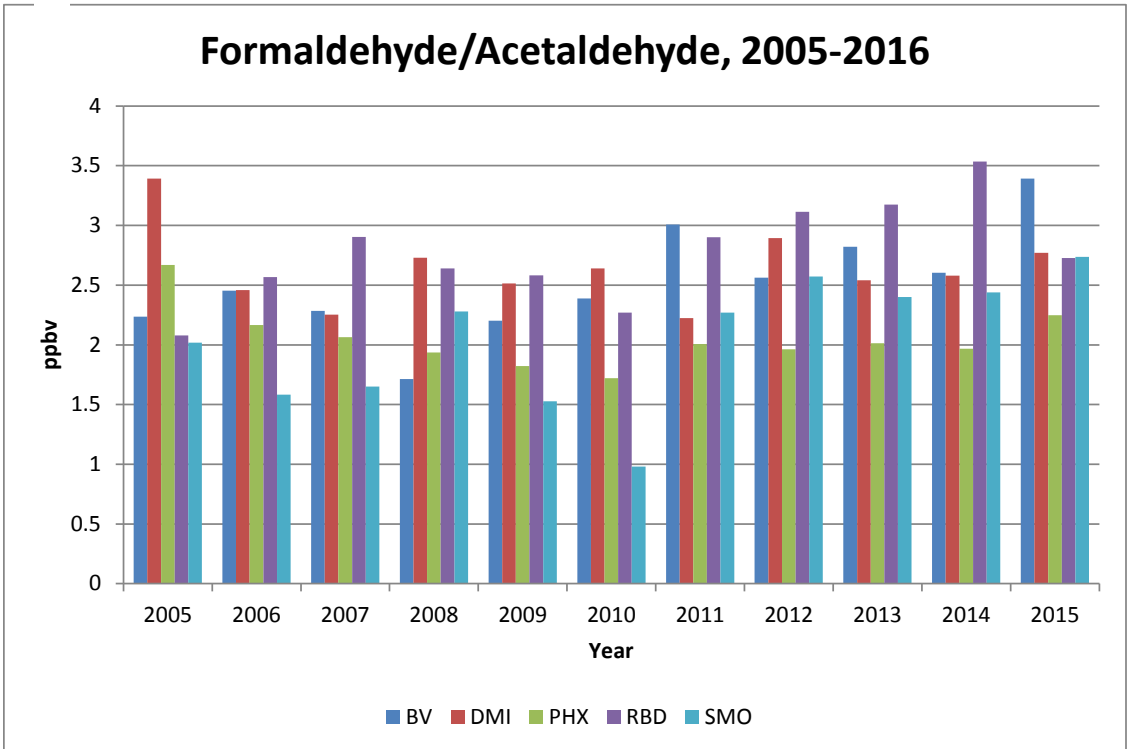
The formaldehyde-acetaldehyde ratio for Bountiful was between 2.25 and 1.5 through 2010, after which it increased above 2.5 for the duration of the data set. Incidentally, the marked increase in formaldehyde occurred and continued after 2012. Rubidoux showed a similarly high ratio for the same years, however, the absolute concentrations for both pollutants in that area were significantly lower than in Bountiful. Figure 3 shows the formaldehyde-acetaldehyde ratios for the urban areas between 2005 and 2015.

Figure 2. Mean annual acetaldehyde concentrations between 2005 and 2015.



Overall, formaldehyde and acetaldehyde behaved fairly consistently for all of the urban areas in the study. The high correlation determinant for formaldehyde and acetaldehyde indicates that both pollutants share a common source. Although, the main emission source for both of these pollutants is secondary chemistry followed by biogenic emissions, automobile emissions are the major primary source that may account for nearly 20% of formaldehyde and acetaldehyde in the environment during summer. It is unlikely, therefore, that the automobile emissions alone could be directly responsible for the sharp increase in wintertime concentrations of these compounds that were observed at the Bountiful monitor. Even accounting for a shallower mixing height during wintertime inversions, the vehicular formaldehyde emissions would need to be at least doubled over the summertime values to account for the wintertime levels. Ongoing research efforts should shed light on the issue.

Figure 3. Formaldehyde-acetaldehyde ratios between 2005 and 2015.



Methylene Chloride (Dichloromethane)

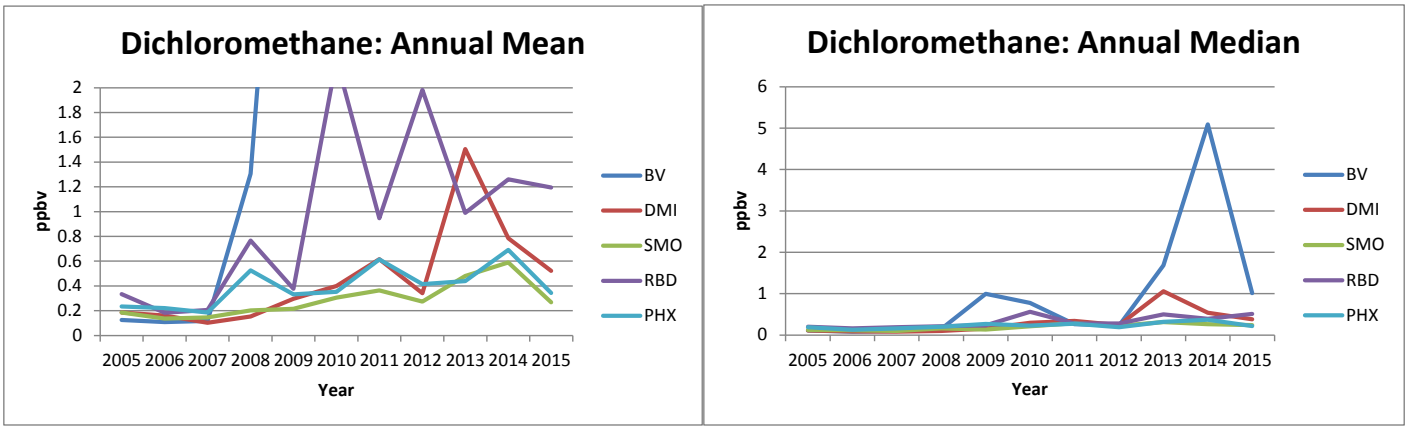
Methylene chloride was one of the HAPs that caused DAQ's initial interest in taking a closer look at the levels of toxics along the Wasatch Front. Although classified as a probable human carcinogen, no epidemiological study detected a statistically significant cancer risk in humans. Methylene chloride is commonly used in a number of industrial processes, but especially in adhesives, paints, paint removal, and aerosols. It can also be emitted from landfills.

The irregular but unusually high measurements of this pollutant (100 to 500 times the cancer screening level) could not be explained by interstate transport and the likely explanation was poor control mechanisms at one of the possible emission sources. Having no biogenic sources, the anthropogenic nature of methylene dichloride emissions is all but certain.

The current study of the long-term data confirmed that the drastic increase in methylene chloride concentrations began in the fall of 2008. The exceedingly high and sporadic measurements of the pollutant were absent in 2011 and 2012, after which they resumed through 2015. The Bountiful site remained at the top of the urban areas included in this report for the mean annual methylene chloride concentrations from 2008 through 2015. Figure 4 shows the annual mean and median concentrations of the HAP for this study. The vertical scale in Figure 4.a was reduced, cutting off the maximum values for Bountiful, to allow the features of other cities be distinguishable.

Figure 4. Annual mean and median concentrations of dichloromethane in 2005-2015.

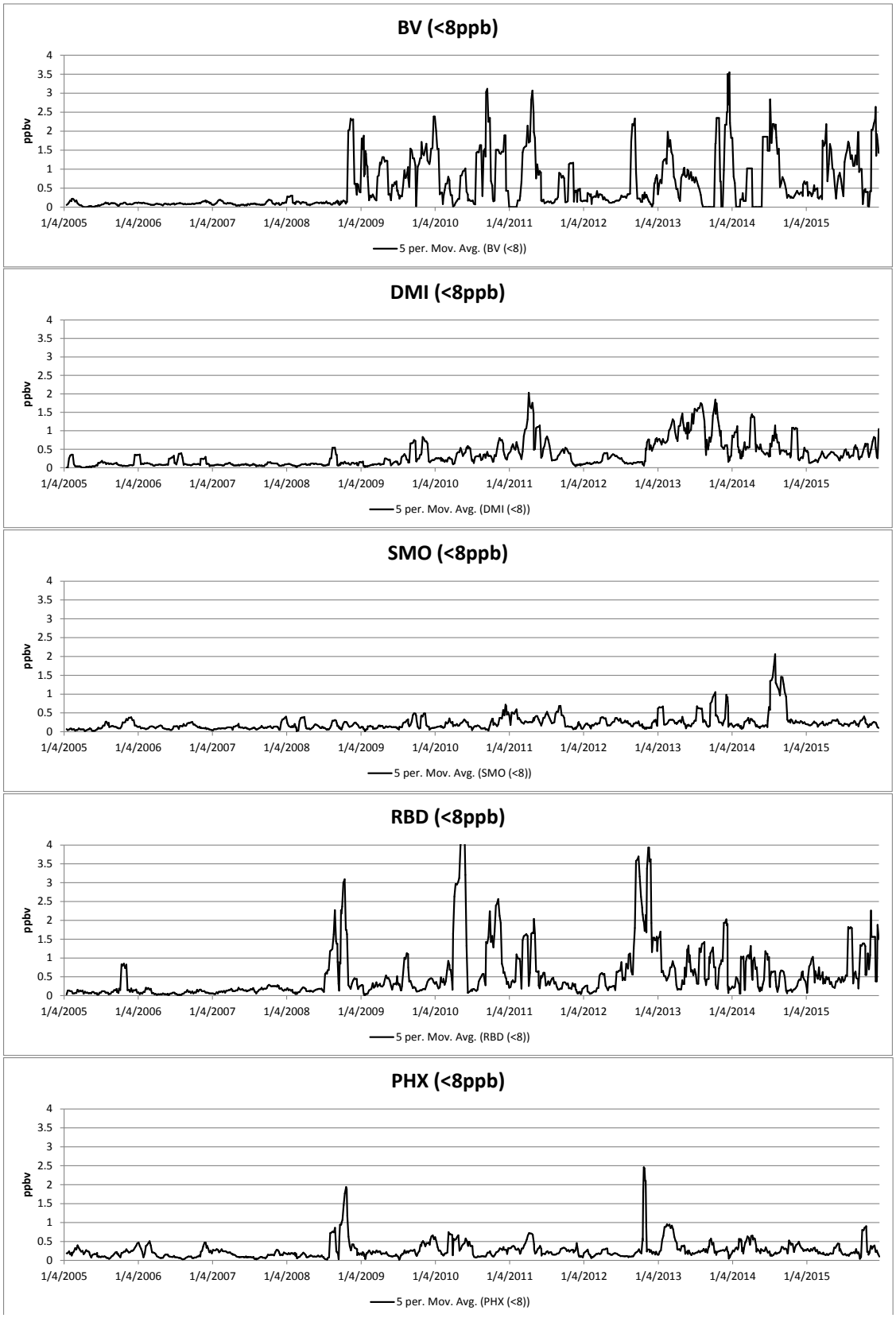
a) **b)**



The sharp increase in methylene chloride concentrations in Bountiful was not unique to Utah except in magnitude. Rubidoux experienced a significant increase in methylene chloride levels beginning in 2008, while Detroit and Saint Louis observed a slight increase in 2010 and on. Figure 5 shows the mid-range concentrations (below 8ppb) for all five metropolitan areas as a monthly running average. The removal of the values over 8ppb resulted in 76 and 14 measurements eliminated from the Bountiful and Rubidoux datasets, while the rest of the cities lost between zero and two data points. The monthly

average method was deemed necessary to smooth out some of the variation in data and make the graph more meaningful.

Figure 5. The truncated (<8ppb) monthly running average values of methylene chloride.

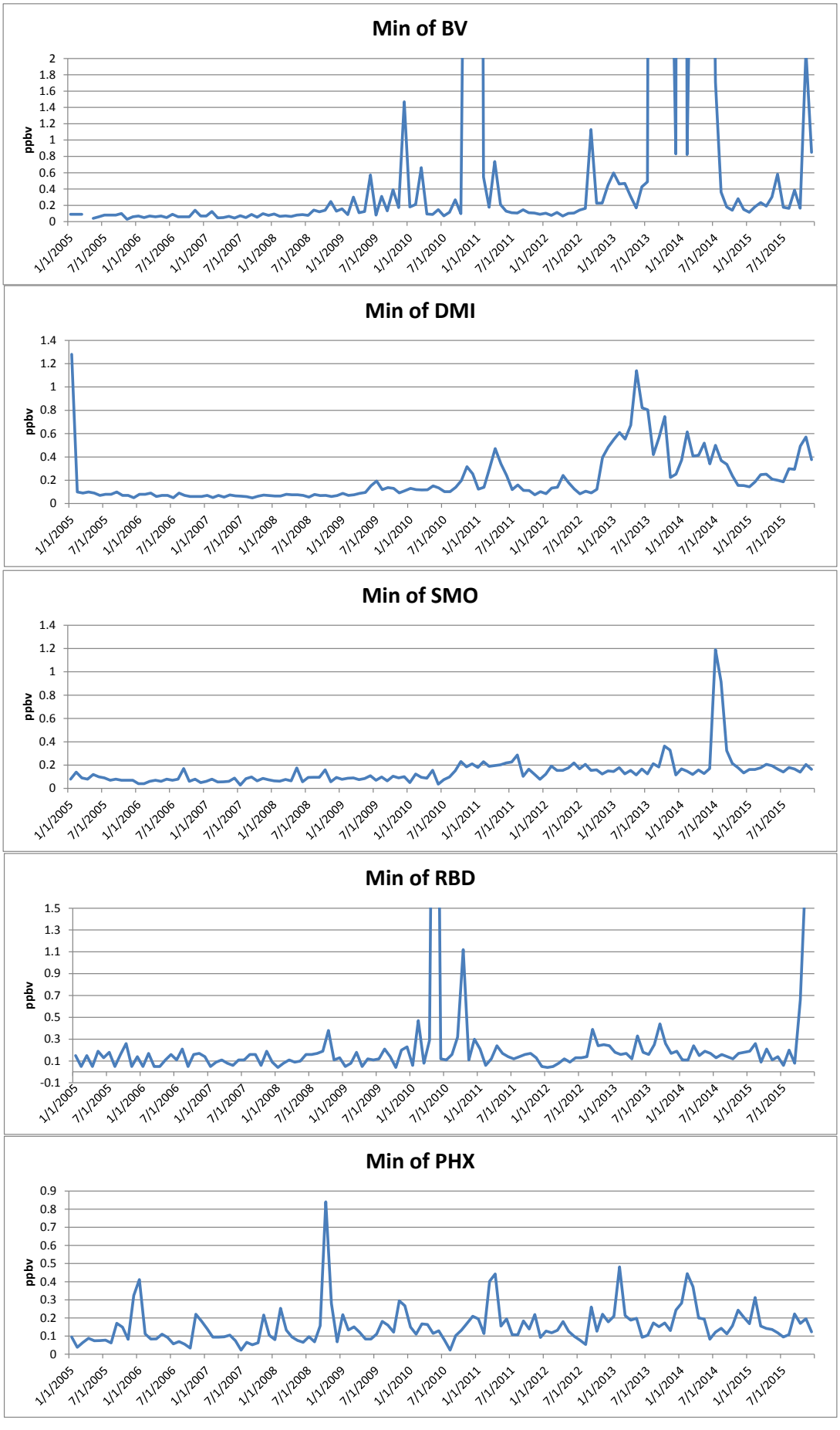


The onset of elevated ambient methylene chloride concentrations in three out of five areas is difficult to link to a reliable source. It is possible that a new type of technology, industrial process practice, or regulation came in effect around just before 2008 that caused this observed elevation in ambient methylene chloride.

The 2-sample t-test of monthly minima showed a slight but universal increase in baseline methylene chloride in all five cities at 95% confidence interval. The approximate dates for the increases in baseline concentrations of the pollutant were similar to those mentioned earlier. Bountiful and Rubidoux saw the elevation of methylene chloride minima around 2009, while Detroit and Saint Louis experienced it around 2010. It is important to point out that the minimum dichloromethane values observed in Bountiful experience the largest amount of variation between 2008 and 2015. That is, despite the dramatic increase in maximum observed concentrations and annual median, methylene chloride in Bountiful can disperse rather quickly and thoroughly. The degree to which methylene chloride disperses and the speed with which it does indicates that its source is located very close to the monitor. Figure 6 displays the minimum monthly concentrations for each of the urban areas.

It is unlikely that the sampling methodology or laboratory procedures changed to bring upon these increases in methylene chloride. As mentioned before, it is likely that a new regulation or technology had affected the urban emissions of methylene chloride. The exact nature of what caused the increase in these emissions is unclear at this time.

Figure 6. Monthly minima of methylene chloride between from 2005 to 2015.



Conclusion

As was identified in the previous study, methylene chloride levels in Utah rose in 2008 after which they remained consistently above the cancer screening level, interjected with occasional extremely high concentration samples. The lack of seasonal pattern and the extremely high spikes in concentrations that tended to dissipate rather quickly indicates that the likely source of methylene chloride is located near the monitor and has low impact on anything but the neighborhood scale.

The mean annual concentrations of methylene chloride in Bountiful remained significantly above those observed in the other cities considered in the study. Two urban areas: Rubidoux and Detroit, experienced elevation of methylene chloride roughly around the same time (spring of 2008 for Rubidoux, and summer 2010 for Detroit). This may indicate a particular technology or regulation that was implemented in the three areas that could be responsible for this elevation.

As was noted in the EPA's report, the Bountiful monitor observed the highest annual average concentration of formaldehyde and acetaldehyde in the country. That was confirmed by the data used in this report. Additionally, the most recent (2014-2015) formaldehyde and acetaldehyde annual levels were observed significantly above those recorded in 2012. The unusually high annual levels of formaldehyde (and acetaldehyde) were confirmed to be primarily driven by the uncharacteristic increase in their wintertime concentrations. Summertime concentrations for both pollutants were relatively similar to those observed in the rest of the state and the urban areas in this report. The lack of elevated formaldehyde concentrations outside of Bountiful indicates that the emission of this pollutant is highly localized and is likely on neighborhood scale. The high correlation determination value between formaldehyde and acetaldehyde points to a possibility of a common source for both of these compounds. Considering that the local biogenic sources of formaldehyde and acetaldehyde (vegetation) are largely inactive during winter, it is likely that the wintertime formaldehyde and acetaldehyde emissions are due to some anthropogenic activity.

Although the exact sources of methylene chloride and formaldehyde are yet unidentified rigorous research is underway to locate the emission sources of these pollutants.

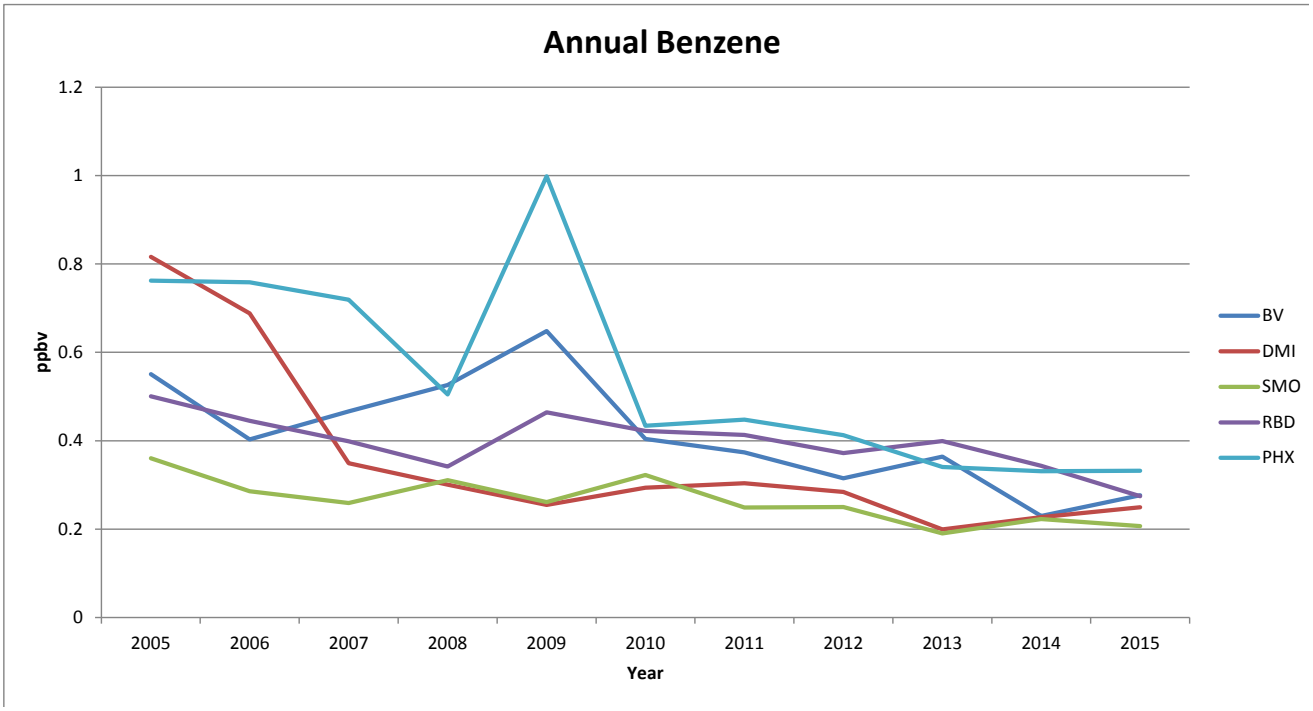
Appendix

Benzene & Ethylbenzene

Benzene and ethylbenzene share a primary emission source: combustion engine exhaust. The improvements in gasoline engines' efficiency and fuel quality over the past two decades resulted in a significant decrease of ambient benzene and ethylbenzene concentrations across the nation. A nearly 50% decrease in annual benzene and ethylbenzene was observed for all study monitoring sites between 2005 and 2015. As with most volatile organic compounds, seasonal concentrations of these pollutants spike in the wintertime due to more stable atmospheric conditions and a diminished removal rate though photochemistry.

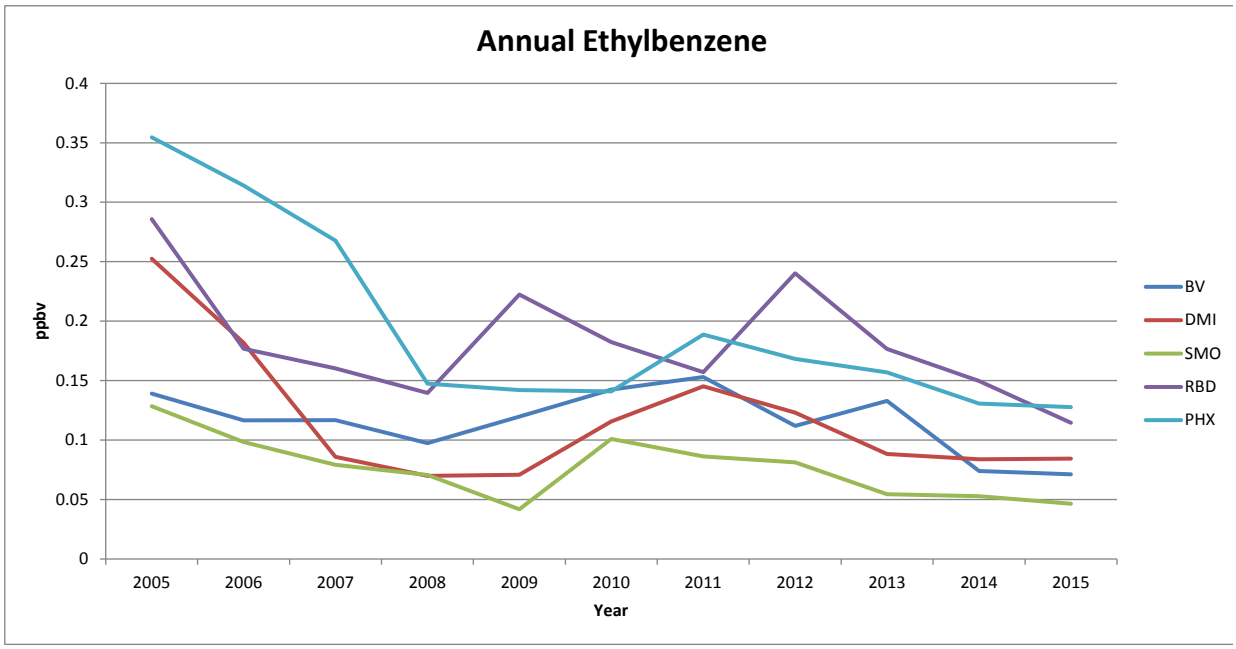
Mean annual ambient concentrations of benzene are presented in Figure 7. A steady downward trend, seldom interrupted by occasional spikes, is seen for all five cities.

Figure 7. Annual ambient benzene concentrations between 2005-2015.



Annual ambient ethylbenzene follows a similar downward trend. In terms of benzene-ethylbenzene ratio, Bountiful resembles St. Louis more than the other study sites. The average benzene-ethylbenzene ratio for the period between 2005-2015 was 3.64 and 3.72 for Bountiful and St. Louis, respectively. The rest of the cities' ratio varied between 3.1 and 2.2. Aside from natural variance and differences in ambient emissions of these compounds, it is possible that both Bountiful and St. Louis have additional benzene sources. Annual ethylbenzene values are displayed in Figure 8.

Figure 8. Annual ambient ethylbenzene values, 2005-2015.



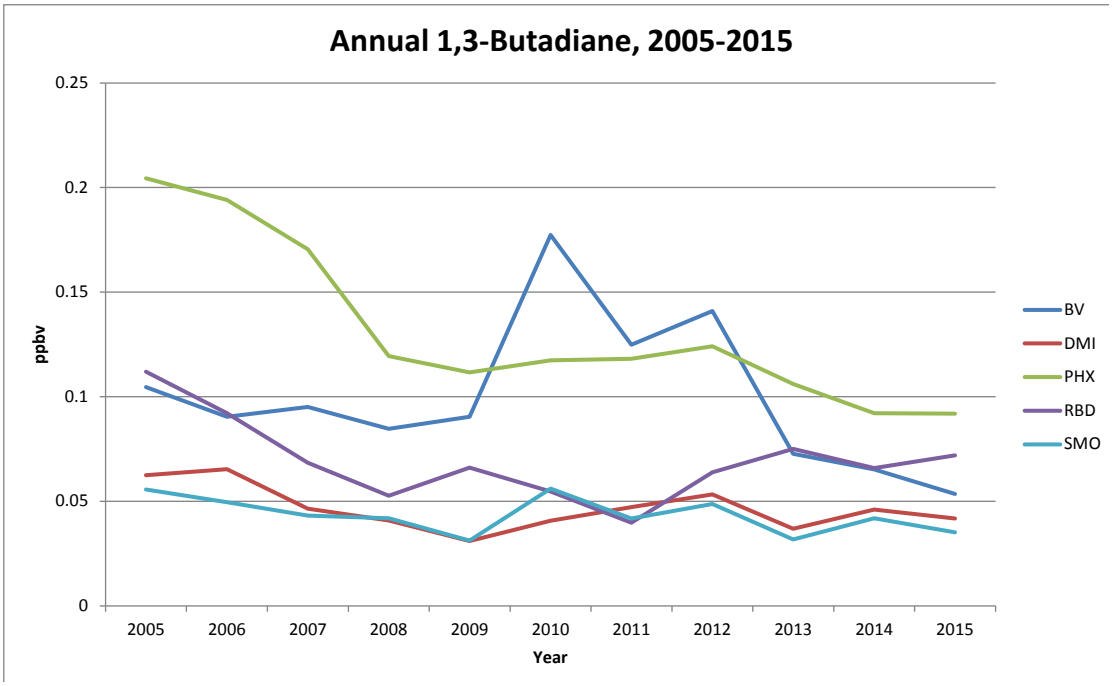
As mentioned above, both pollutants show a marked decrease in ambient concentration between 2005 and 2015. However, it appears that the current annual averages will remain in the same range in the near future.

1,3-Butadiene

1,3-Butadiene is a strong human carcinogen that is common with the major emission sources in urban areas related to gasoline and diesel combustion. Smoking can be a major source of individual exposure to butadiene, but that source is insignificant on any level of exposure other than at the individual scale. Some industrial processes involve creation and production of 1,3-butadiene, but those sources are generally insignificant.

As with benzene and ethylbenzene, ambient concentrations of 1,3-butadiene have been steadily declining between 2005 and 2015. The decline in emissions of this pollutant is likely the supplanting of old gasoline and diesel vehicles with newer, more efficient ones. The general downward trend is displayed in Figure 9.

Figure 9. Mean annual 1,3-butadiene concentrations for the cities of interest between 2005 and 2016.



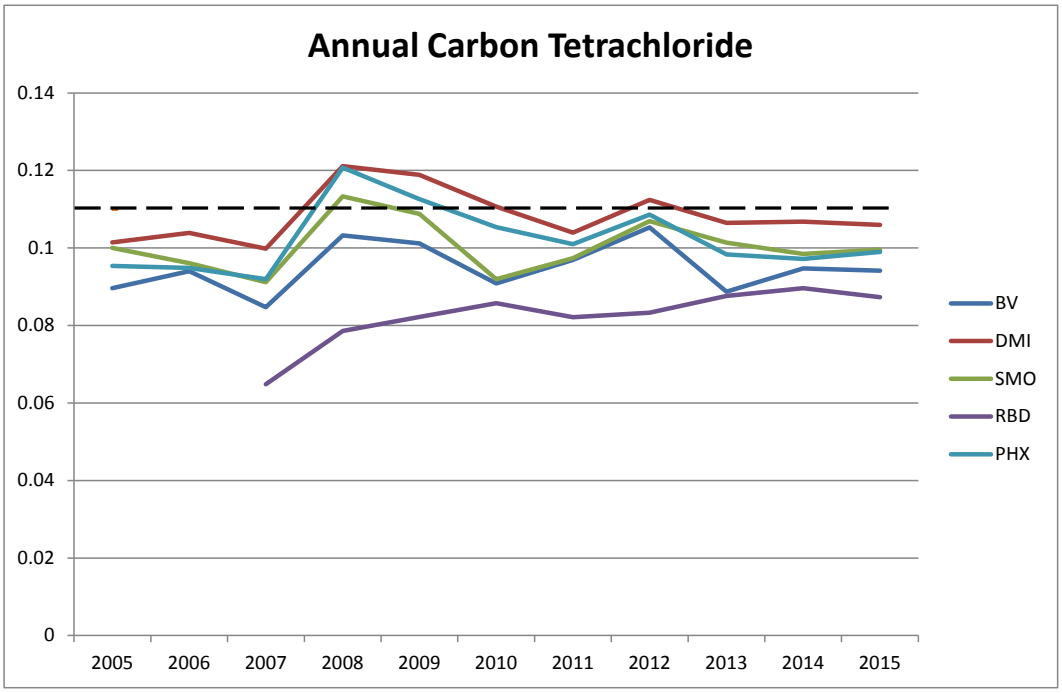
There was a spike in 1,3-butadiene concentrations at Bountiful between 2010 and 2012, the source of which is unknown. The 2010 surge is largely associated with an unusually high concentration detected on April 20, when the value of 1,3-butadiene was nearly five times above its annual maximum. The next two years had no abnormal concentrations, except for the slightly elevated wintertime concentrations likely associated with local inversion episodes.

Carbon Tetrachloride

Carbon tetrachloride is one of the chlorofluorocarbons banned in the 1990 amendment to Title VI of the Clean Air Act. As such, its use in domestic products and most industrial processes has been largely phased out. Because carbon tetrachloride is exceptionally resistant to photochemical decomposition (half-life of nearly 80 years) its concentrations are more dependent on meteorological conditions, atmospheric transport and dispersion as well as the rate of emissions than any other factor.

The ambient concentration of carbon tetrachloride remained fairly even between 2005 and 2015. The annual values of carbon tetrachloride are displayed in Figure 10.

Figure 10. Annual mean carbon tetrachloride concentrations between 2005 and 2015.



*The black dashed line indicates the 1-in-1,000,000 cancer risk threshold for carbon tetrachloride.

As it can be seen from the figure, annual concentrations of carbon tetrachloride rarely exceeded the one-in-one-million cancer risk threshold. Because of the exceptional photochemical stability of the compound no seasonal trends were observed. However, the mean annual values for carbon tetrachloride showed a strong correlation for all monitoring sites with the exception of Rubidoux. This pattern suggests that the inner-continental monitors are exposed to roughly the same concentrations of the pollutant as it is emitted and transported across regions. The lower correlation and absolute values detected at the Rubidoux site is most likely due to its proximity to the oceanic coastline.

In 2005 and 2006, when the Rubidoux monitor was not operational, Bountiful was the site with the lowest annual carbon tetrachloride among the four active monitors. When the Rubidoux monitor came online in 2007 it displaced Bountiful making it consistently the second lowest ranked among the five monitors involved in the study. The data from the study suggests that there are no major sources of carbon tetrachloride emissions in the State of Utah and most of the observed concentrations are likely due to interstate transport.

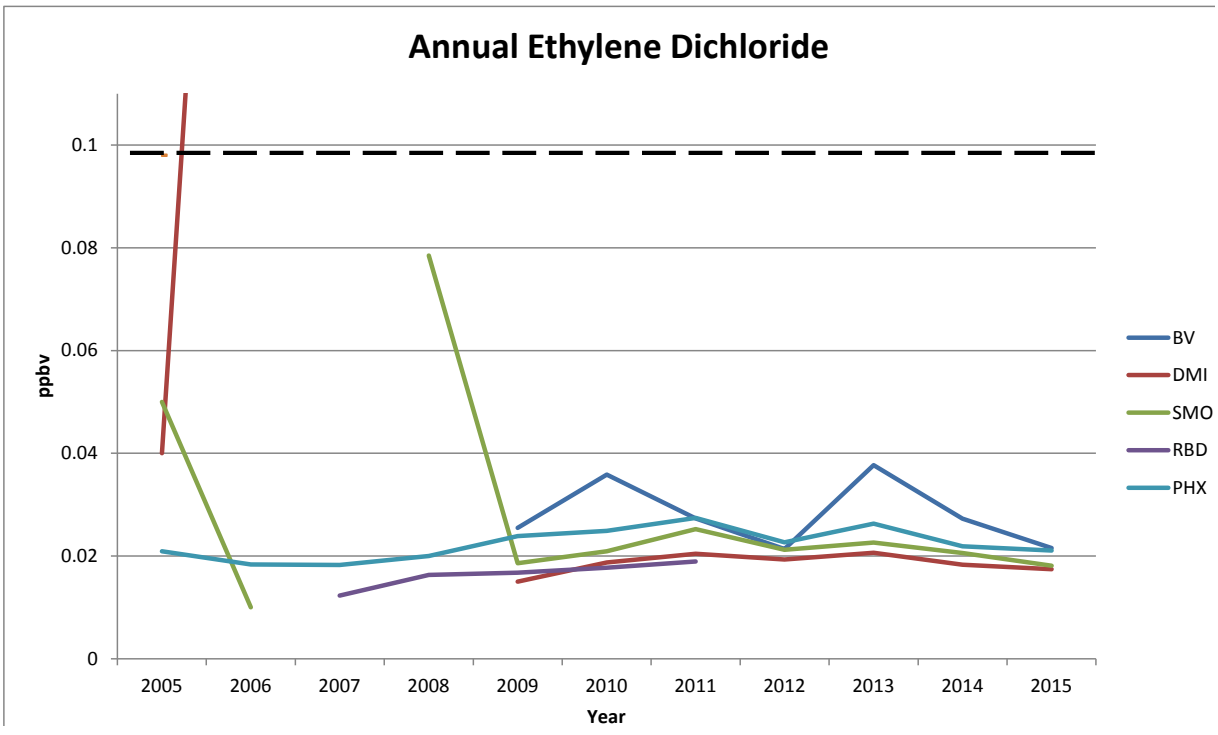
Ethylene Dichloride

Ethylene dichloride also known as 1,2-dichloroethane is a compound mostly used as a dispersant in plastic and rubber. Although other industrial uses of this compound are limited, it is used in the synthesis of other chlorinated compounds. Until 2009, there were no reliable measurements of ethylene dichloride in Utah. As ethylene dichloride is not produced naturally in the environment, all of its sources are strictly anthropogenic. Mean annual ethylene chloride measurements are presented in Figure 11.

With the exception of three data points, the data collected at the Bountiful site contained only zeroes starting in 2005 through 2009. In 2010, only seven out of sixty possible valid measurements were obtained, followed by 15 in 2011. From 2012 on, the annual data collection efficiency (the ratio of valid measurements to the total expected measurements for the year) for ethylene dichloride improved dramatically, reaching 80%-90%.

The data suggests two possible explanations for this occurrence. First, the laboratory protocols, instrumentation, sampling media could have dramatically improved in the period between 2005 and 2010. Because NAATS program is funded and run by the EPA, UDAQ would have no influence on which lab or instrumentation is used to analyze the samples. Second, a new source (or sources) of ethylene dichloride emerged in the proximity of the Bountiful site.

Figure 11. Mean annual ethylene chloride between 2005 and 2015.



It is difficult to attribute the cause for this pattern in data to either of the alternatives. However, Table 2 shows that the similar pattern was observed in Detroit and St. Louis. Conversely, the number of detections was relatively constant and high at Rubidoux and Phoenix during the low/no-detection years at the other three sites. So, the validity of non-detects between 2005 and 2010 may very well be sound, which would attribute the increase in positive detects to an emerging industrial source.

Table 2. Number of detects (non-zero measurements) of ethylene chloride in the five cities between 2005 and 2015.

Year	BV	DMI	SMO	RBD	PHX
2005	-	1	1	-	14
2006	-	3	2	-	46
2007	1	-	-	26	29
2008	-	-	2	27	1
2009	2	4	5	49	7
2010	7	12	10	48	9
2011	15	11	18	37	12
2012	47	53	56	-	47
2013	37	57	58	-	38
2014	54	55	58	-	53
2015	47	58	60	-	54

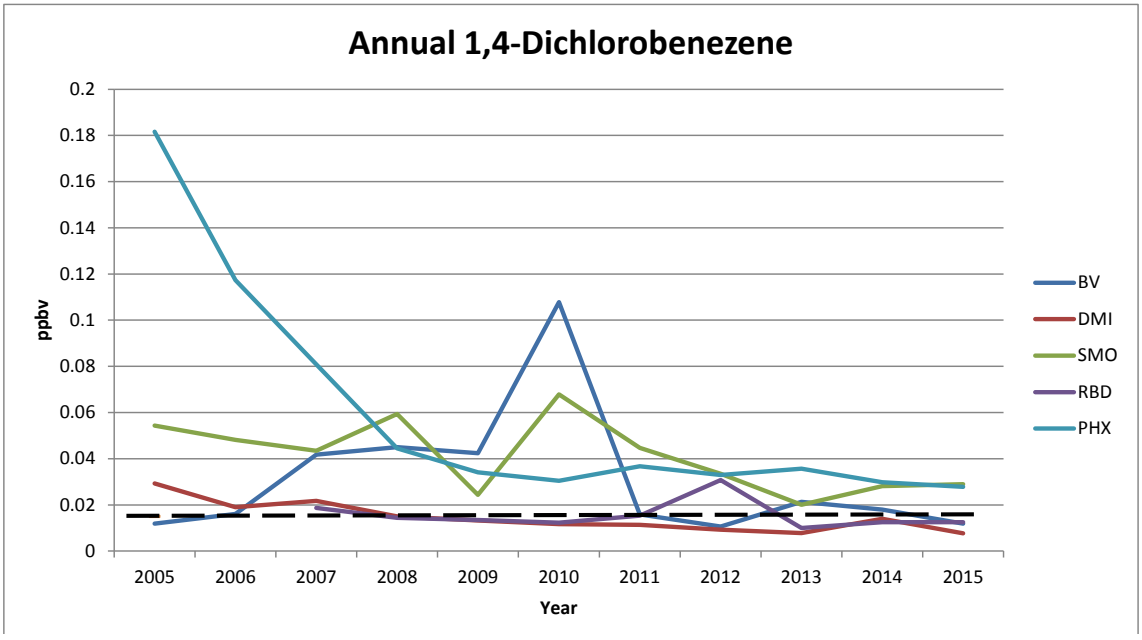
It is important to point out that the long-term trend for ethylene dichloride in Bountiful, as well as the rest of the study sites, is largely flat and well below the one-in-one-million cancer risk threshold.

1,4-Dichlorobenzene

Primary exposure to 1,4-dichlorobenzene occurs indoors through the use of various fumigants and odor suppressants (mothballs, toilet deodorants, mildew and mold fumigants, etc.). Additional exposure and release could occur at production facilities that manufacture products containing 1,4-dichlorobenzene.

The long term trend for 1,4-dichlorobenzene presents a generally steady decline from 2005 to 2015. Although, between 2007 and 2012 (the periods of previous HAPs analyses) 1,4-dichlorobenzene exceeded the one-in-one-million chancer risk threshold regularly, these occurrences were much less frequent in 2014 and 2015. The long term trends for the pollutant is shown in Figure 12.

Figure 12. Annual mean 1,4-dichlorobenzene between 2005 and 2015. One-in-one-million cancer risk is shown by the black dashed line.



Bountiful ranking for 1,4-dichlorobenzene was on the lower end (3rd, 4th) of the five cities during the last five years of the analysis range.

Tetrachloroethylene and Acrylonitrile

Tetrachloroethylene is a compound widely used in dry cleaning. Measurements of this compound decreased slightly between 2005 and 2015, remaining 10-20 times below the one-in-one-million cancer risk threshold for this compound. As such, this HAP plays an insignificant role in public health and because of its stability it doesn't actively participate in tropospheric photochemical processes.

Acrylonitrile is a chemical used in the production of resins, fibers, and is used as a chemical intermediate. It is also commonly detected around waste disposal, storage, and transportation facilities. Acrylonitrile measurements were infrequent throughout the study duration with no more than a handful of detections during most years. Although acrylonitrile one-in-one-million cancer risk level is exceedingly low, the infrequency of detections makes it of little importance with respect to local environmental impact. The scarcity of acrylonitrile detections across the years is demonstrated in Table 3.

Table 3. Counts of acrylonitrile detections at Bountiful between 2005 and 2015.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
BV	2	1	3	4	20	6	7	8	17	8	2

With the exception of 2009 and 2013, acrylonitrile appeared in, at most, 13% of the total measurements for the year. This low, irregular number of detections, even though above the screening level, makes it impossible to derive any meaningful information.