September 19, 2018

Ms. Siobhan Burland Ross
A/Director
Environmental Approvals
Manitoba Sustainable Development
1007 Century Street
Winnipeg, MB
R3H 0W4

Dear Ms. Burland Ross,

As per clause 23 (a), and Schedule 1 of Environment Act Licence 2954 RR, please accept this request to discontinue monitoring for acrolein and benzene from our ambient air monitoring program..

The attached reports from SLR Consulting provide in-depth statistical analysis of measured results collected from 2011 through March 2018, which clearly demonstrate that measured values of acrolein and benzene are not attributed to mill activities. To summarize, the results of the statistical analysis testing indicated:

- No significant upward trend in the measured acrolein or benzene concentrations in the vicinity of the mill;
- Populations of data were similar from days on which the facility is operating versus days when the mill is shutdown; and
- The differences in concentrations between days when the mill was operating versus when the mill was shut down could not be distinguished from random variability with statistical confidence.

Clause 23 provides the Director with the authority to amend the ambient air monitoring program after a five year monitoring period from the date of issuance of the licence in March 24, 2011, hence the request for the discontinuation of monitoring for these parameters. The ambient air monitoring program will continue collecting data on ambient MDI and formaldehyde concentrations with the intention of assessing the benefit of continuing the air monitoring program for these two parameters in the future.

I look forward to your favorable response to our request. Please do not hesitate to contact Al Hambley at (204) 525-2479 x.2114 if you have any questions or comments.

Sincerely,

Kevin Betcher
Plant Manager

Cc: Al Hambley

September 26, 2018

Mr. Al Hambley
Louisiana-Pacific Canada Ltd.
Swan Valley Siding Mill
Highway #10, 5 Km East
Minitonas, MB   R0L 1G0

SLR Project No.: 208.04436.00015

Dear Mr. Hambley,

RE: LOUISIANA-PACIFIC CANADA LTD. SWAN VALLEY SIDING MILL AMBIENT AIR BENZENE CONCENTRATIONS STATISTICAL ANALYSES

1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (SLR) was retained by Louisiana-Pacific Canada Ltd. (LPC) to perform a statistical analysis of concentrations of benzene measured in ambient air samples collected in the vicinity of the LPC Swan Valley mill located near Minitonas, MB. Ambient air samples were collected from three air stations surrounding the mill, with samples generally collected every sixth day. Ambient air samples were collected in Summa® passivated canisters using US Environmental Protection Agency method TO-15. Previous analysis conducted by SLR examined the period of 2011 through 2015. In this work, SLR has extended the period of analysis by including 2016, 2017, and January-March 2018 data. The statistical methods employed are similar to those previously used.

The location of the mill and the air sampling stations are shown in Figure 1.

2.0 QUALITATIVE DISTRIBUTION OF DATA

Figure 2, Figure 3, and Figure 4 present the distributions of samples collected at each of the three sites since 2011. For each of the three histograms, a bin width of 0.5 microgram per cubic metre (µg/m^3) was chosen. The histograms reveal that the distribution of measurements at each of the three points does not follow the normal distribution. At each of the three sites most observations are between 0 and 0.5 µg/m^3, with a smaller number of higher measurements. The addition of 2016, 2017, and early 2018 data has not changed the distribution, as most results from those two-plus years are placed in the 0 to 0.5 µg/m^3 bin similar to the 2011-2015 data.

In these three figures, non-detects have been placed in the 0 to 0.5 µg/m^3 bin. It is worthwhile to note that in the spring of 2012, the detection limit changed from 0.64 µg/m^3 to 0.064 µg/m^3. Prior to the spring of 2012, most samples taken were below the detection limit at the time of 0.64 µg/m^3.

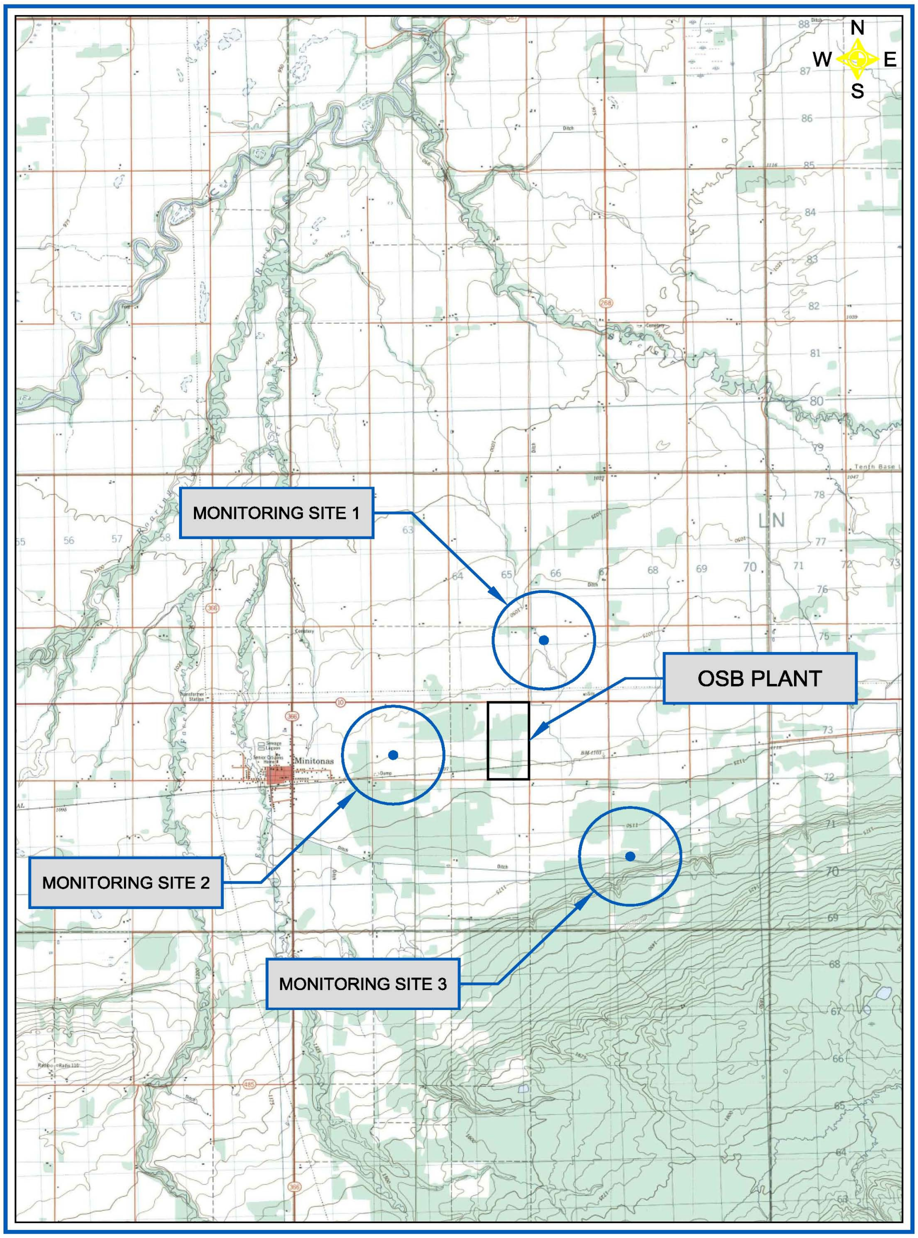

Figure 1: Site location map

While at each site the majority of measurements belong to the range with the lowest concentrations, at each site there are also a small number of outlying measurements at high concentrations. For example, at Site 3 there are single observations in the 9.5-10.0, 7.0-7.5, 6.5-7.0, and 6.0-6.5 μg/m^3 categories. The outlying measurements at Site 1 and Site 2 are not as high, but a single measurement may be noted in the 5.0-5.5 μg/m^3 category at Site 2 and two measurements in the 4.5-5.0 μg/m^3 category at Site 1. Laboratory quality control checks associated with these samples were within tolerance limits, and there are no other indications as to why these samples should be treated as invalid. Therefore they are treated as valid samples and included in the analysis.

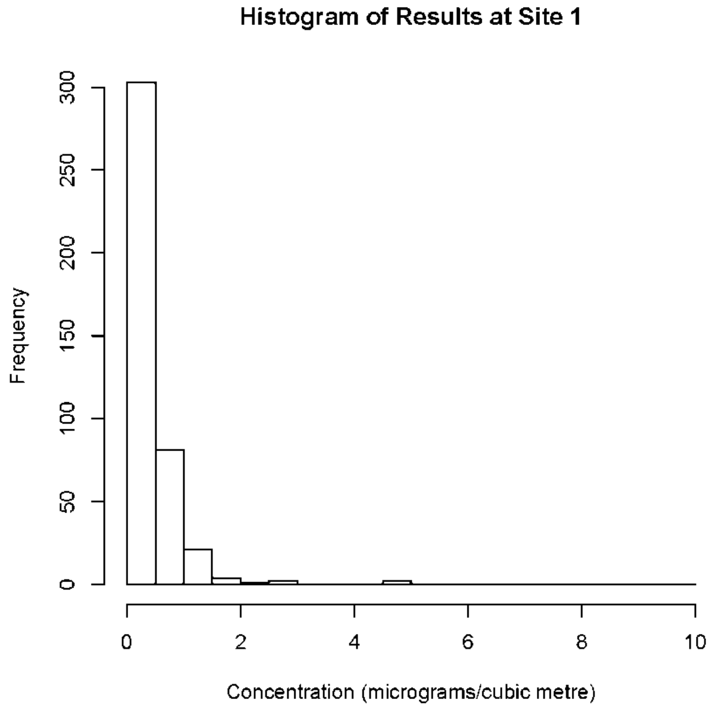

Figure 2: Histogram of Benzene Concentrations at Site 1 (2011-March 2018)

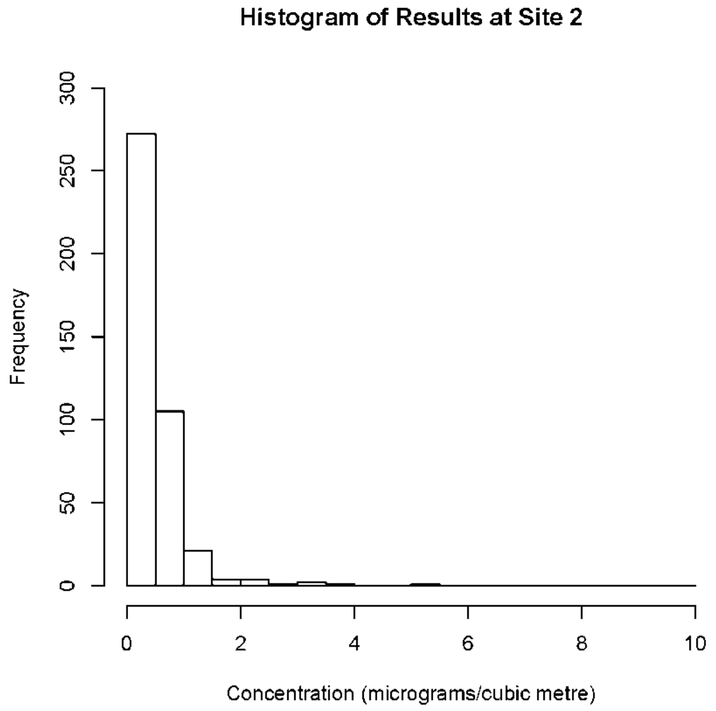

Figure 3: Histogram of Benzene Concentrations at Site 2 (2011-March 2018)

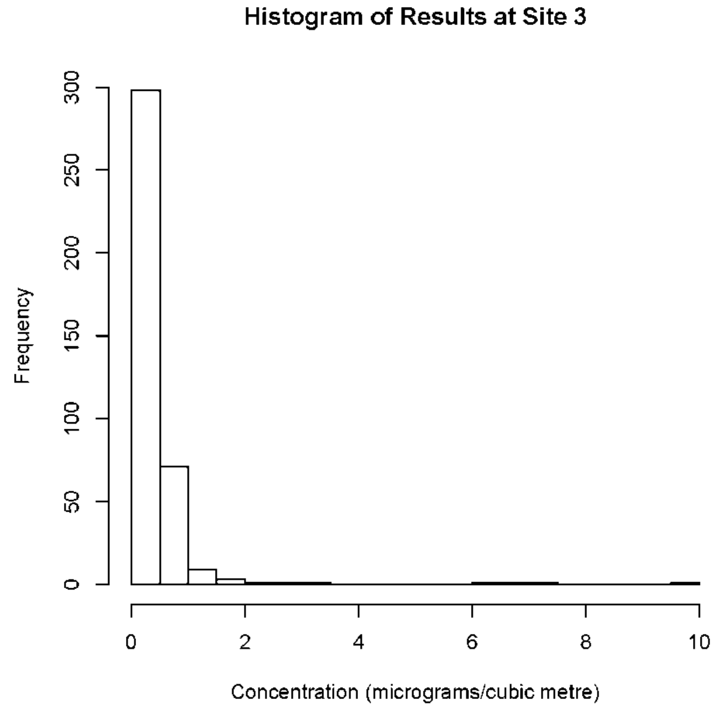

Figure 4: Histogram of Benzene Concentrations at Site 3 (2011-March 2018)

A summary of the mean and median for each of the three sites is shown in Table 1. The presence of a number of samples returning concentrations below the detection limit, and the two differing detection limits used over the course of the seven years in this analysis, present complications in determining the mean and median of the datasets. In order to do so, Kaplan-Meier estimation is used to treat the non-detects.

Kaplan-Meier estimation is a nonparametric technique for calculating the cumulative density function for datasets with “censored” data, such as the non-detect data here. Having obtained a cumulative density function through this technique, the mean may then be found through analysis of the cumulative density function.

The cumulative density functions for the benzene data are shown for each of the sites in Figures 5 through 7. In each figure, the black lines indicate the calculations for the 2011-2018 data, the red lines are for the 2011-2015 data, and the blue lines are for the 2016-2018 data. Solid lines indicate the central estimate of cumulative probability, while the dashed lines indicate the 95 percent confidence intervals. The left panels show the central estimates and 95 percent confidence intervals of the 2011-2018 data, as well as the central estimates for 2011-2015 and 2016-2018 data. The right panels show the central estimates and 95 percent confidence intervals for the 2011-2015 and 2016-2018 data.

At each site, the cumulative probability of measurements for the 2011-2018, 2011-2015, and 2016-2018 periods are similar at the lowest concentrations and concentrations exceeding about 1 microgram/cubic metre. At concentrations around 0.3-0.7 micrograms/cubic metre, there is a tendency for cumulative probability to be higher in the more recent data. This indicates a greater number of measurements for the 2016-2018 data in the 0.3-0.7 microgram/cubic metre range relative to values at about 0.7-1.0 microgram/cubic metre as compared to the older data. Data trends will be analyzed further in the next section.

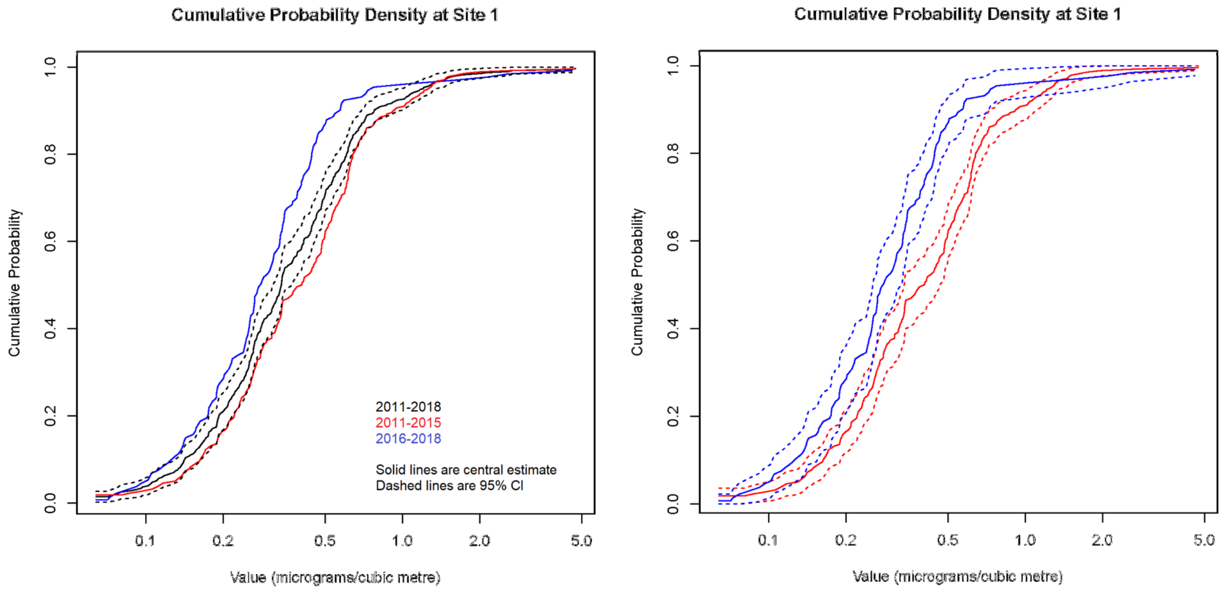

Figure 5. Cumulative density functions of measurements at Site 1.

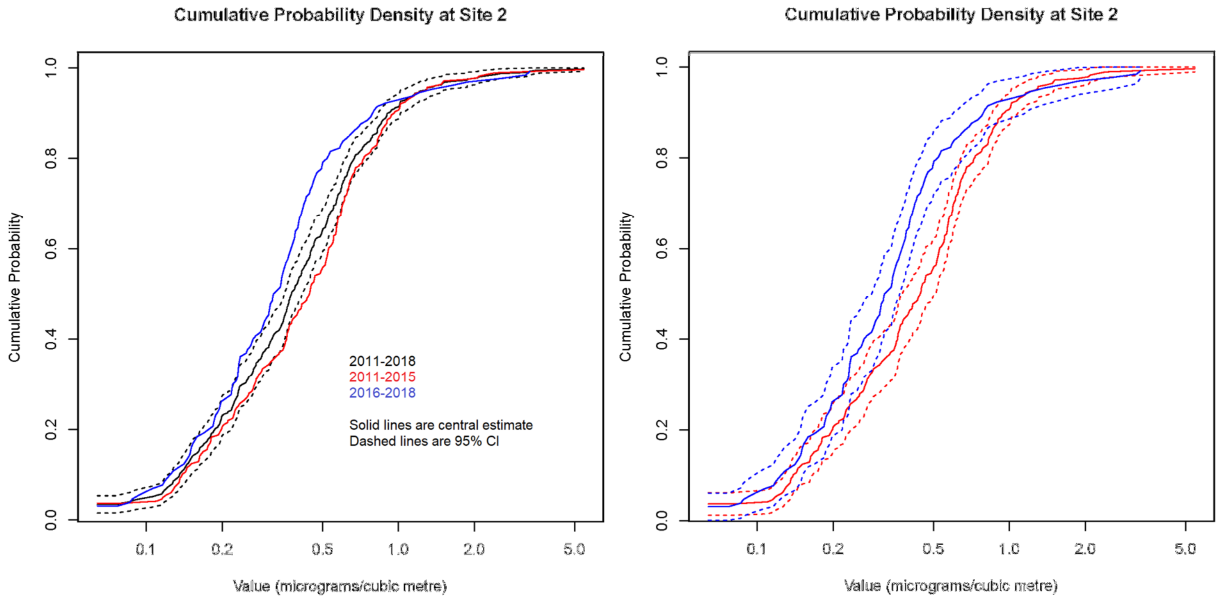

Figure 6. Cumulative density functions of measurements at Site 2.

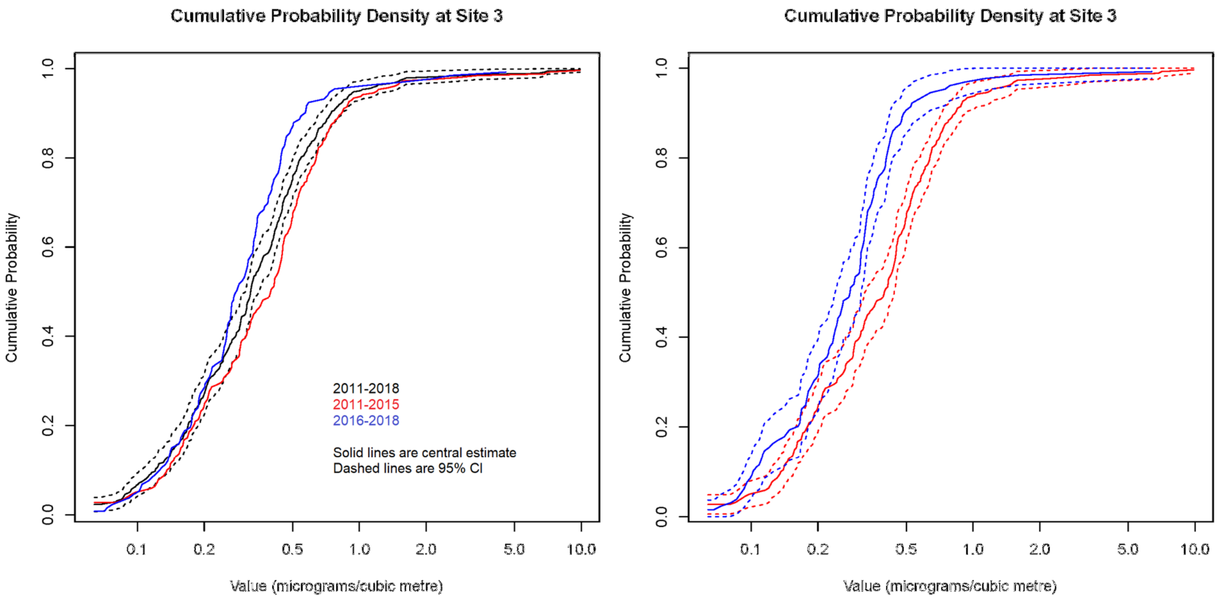

Figure 7. Cumulative density functions of measurements at Site 3.

The U.S. EPA has developed a software program, ProUCL, which automatically determines statistics using the Kaplan-Meier method for an input of data values and information regarding whether the sample was above or below the detection limit. This program is used here to determine the mean and median of each dataset.

Table 1: Mean and Median of Benzene Concentrations Measured at Each Site Using Kaplan-Meier Estimation

Location	Mean (µg/m^3)			Median (µg/m^3)		
	2011-2018[1] Data	2016-2018[1] Data	2011-2015 Data	2011-2018[1] Data	2016-2018[1] Data	2011-2015 Data
Site 1	0.44	0.38	0.47	0.32	0.28	0.33
Site 2	0.49	0.44	0.51	0.40	0.34	0.56
Site 3	0.47	0.35	0.53	0.33	0.28	0.45

[1] 2018 data includes samples collected through March 31, 2018.

During the observational period, there are some days when the mill is not operating. The distribution of concentrations at each sampling site may be examined for days on which the mill is operating versus days on which the mill is shut down. These results are presented in Figure 8, Figure 9, and Figure 10. As before non-detects are assigned to the lowest range.

Figure 8: Frequency of samples from Site 1 falling in the indicated 0.5 $\mu g/m^3$ width concentration categories for days when the mill is operating (left) and shut down (right)

Figure 9: Frequency of samples from Site 2 falling in the indicated 0.5 $\mu g/m^3$ width concentration categories for days when the mill is operating (left) and shut down (right)

Figure 10: Frequency of samples from Site 3 falling in the indicated 0.5 µg/m^3 width concentration categories for days when the mill is operating (left) and shut down (right)

Results for this analysis are similar to those conducted for the 2011-2015 data. At all sites, the bulk of observations occur in the 0-0.5 µg/m^3 ranges, while the next most common observations are in the 0.5-1.0 µg/m^3 ranges. At all three sites, these two ranges account for 90 percent or more of the observations. Most outlying observations (beyond 4 µg/m^3) are observed on days when the mill is shut down, but these measurements are few in number.

3.0 TREND ANALYSIS OF DATA

For each of the three monitoring sites, trend analysis was performed to determine if statistically significant trends exist in the data.

In Tables 2 through 4, the median concentration by site and season is shown. The data are also illustrated in Figures 11 to 14. There are seasonal differences in the measured concentrations, with the highest median concentration over the course of the seven years occurring in meteorological winter[1] at all three sites, and the lowest median concentration occurring in summer. It is possible that increased benzene concentrations during the winter season may be due to increased logging truck traffic as logging activities in the area are conducted disproportionately during the winter months.

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[1] - Meteorological seasons are defined slightly differently than astronomical seasons. For example, meteorological summer is usually defined as lasting from 1 June to 31 August, whereas astronomical summer excludes most of June but includes most of September. Meteorological summer is so defined because, for most locations in the Northern Hemisphere, the mean temperature in June is higher than the mean temperature in September. A review of the data from the Swan River meteorological station indicates this to be the case here. The four meteorological seasons, then, are “JJA”, “SON”, “DJF”, and “MAM”. Each season contains three calendar months, and the initials of the season correspond to the months included.

For some sites and seasons, over half of the samples retuned values below the detection limits. In the tables below the detection limits are reported in these cases; the entries are bolded and italicized where this occurs. The detection limits are used where needed in Figures 11 through 14.

In the following section, non-linear trend analyses are performed on data from each of the three sites, examining each season separately due to the differences in concentrations among the seasons.

Table 2: Seasonal Medians of Benzene Concentrations at Site 1 (μg/m^3)

Year	MAM Median	JJA Median	SON Median	DJF Median[2]
2011	***0.64***	***0.64***	***0.64***	***0.64***
2012	***0.64***	0.21	0.33	0.60
2013	0.28	0.22	0.52	0.54
2014	0.47	0.50	0.31	0.64
2015	0.44	0.32	0.31	0.47
2016	0.34	0.17	0.25	0.34
2017	0.19	0.16	0.25	0.40
2018[3]	0.35	--	--	--
All	0.42	0.26	0.32	0.54

Notes:
MAM – March, April, May
JJA – June, July, August
SON – September, October, November
DJF – December, January, February

Table 3: Seasonal Medians of Benzene Concentrations at Site 2 (μg/m^3)

Year	MAM Median	JJA Median	SON Median	DJF Median[2]
2011	***0.64***	***0.64***	***0.64***	***0.64***
2012	***0.64***	0.21	0.31	0.57
2013	0.36	0.31	0.55	0.62
2014	0.46	0.29	0.43	0.68
2015	0.40	0.59	0.28	0.42
2016	0.38	0.19	0.24	0.39
2017	0.22	0.12	0.23	0.39
2018[3]	0.34	--	--	--
All	0.41	0.32	0.36	0.57

Notes:
MAM – March, April, May
JJA – June, July, August
SON – September, October, November
DJF – December, January, February

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[2] - Includes December of the indicated year and January to February of the next calendar year.

[3] - Includes results from March 1 – March 31, 2018.

Table 4: Seasonal Medians of Benzene Concentrations at Site 3 (µg/m^3)

Year	MAM Median	JJA Median	SON Median	DJF Median[2]
2011	--	--	***0.64***	***0.64***
2012	***0.64***	0.17	0.31	0.52
2013	0.29	0.27	0.34	0.62
2014	0.45	0.29	0.34	0.56
2015	0.45	0.42	0.21	0.37
2016	0.33	0.18	0.20	0.34
2017	0.20	0.11	0.23	0.36
2018[3]	0.29	--	--	--
All	0.33	0.20	0.27	0.51

Notes:
MAM – March, April, May
JJA – June, July, August
SON – September, October, November
DJF – December, January, February

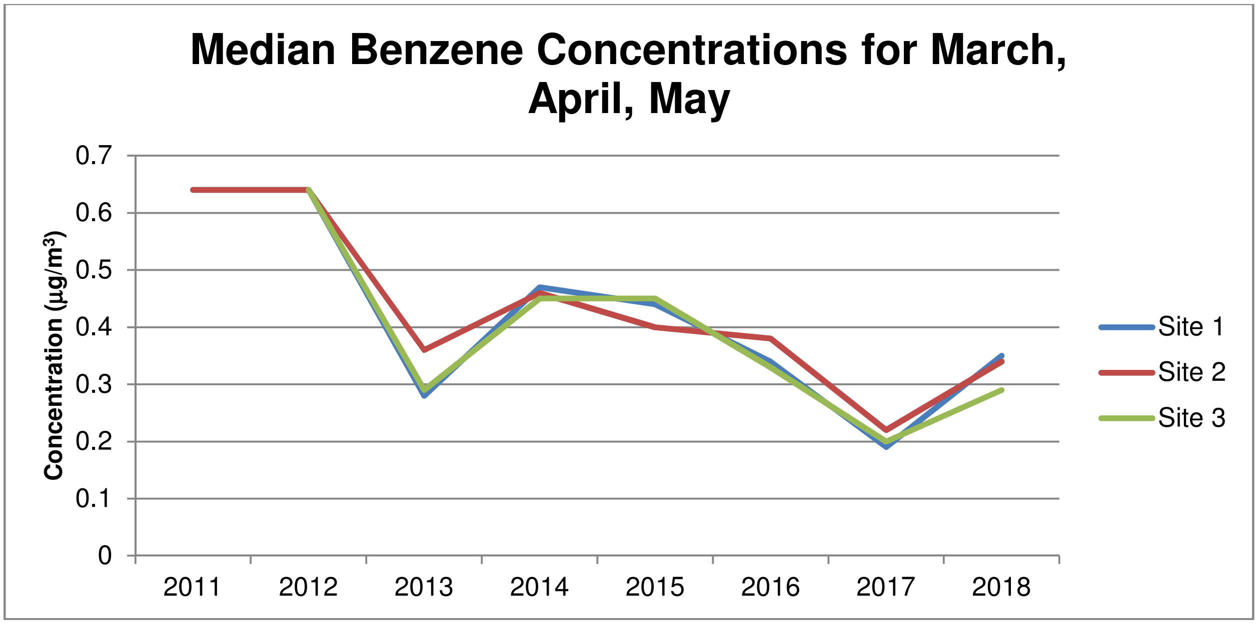

Figure 11. Median benzene concentrations by year and site for meteorological spring.[4]

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[4] 2018 average values based on results from March 1 – March 31, 2018.

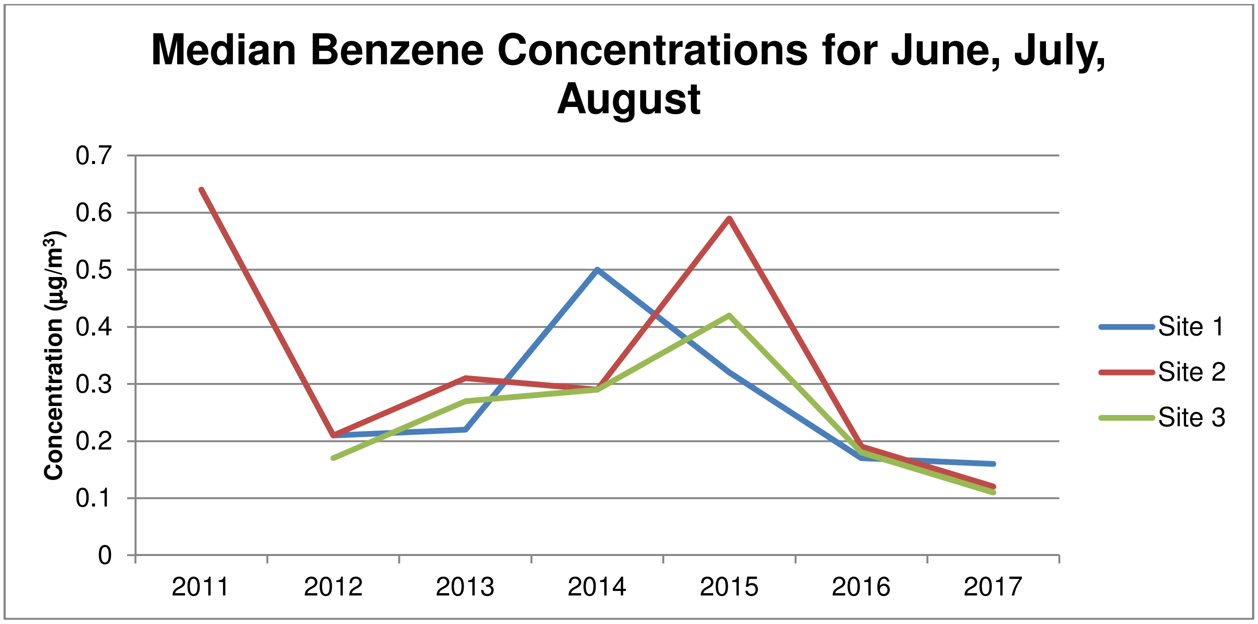

Figure 12. Median benzene concentrations by year and site for meteorological summer.

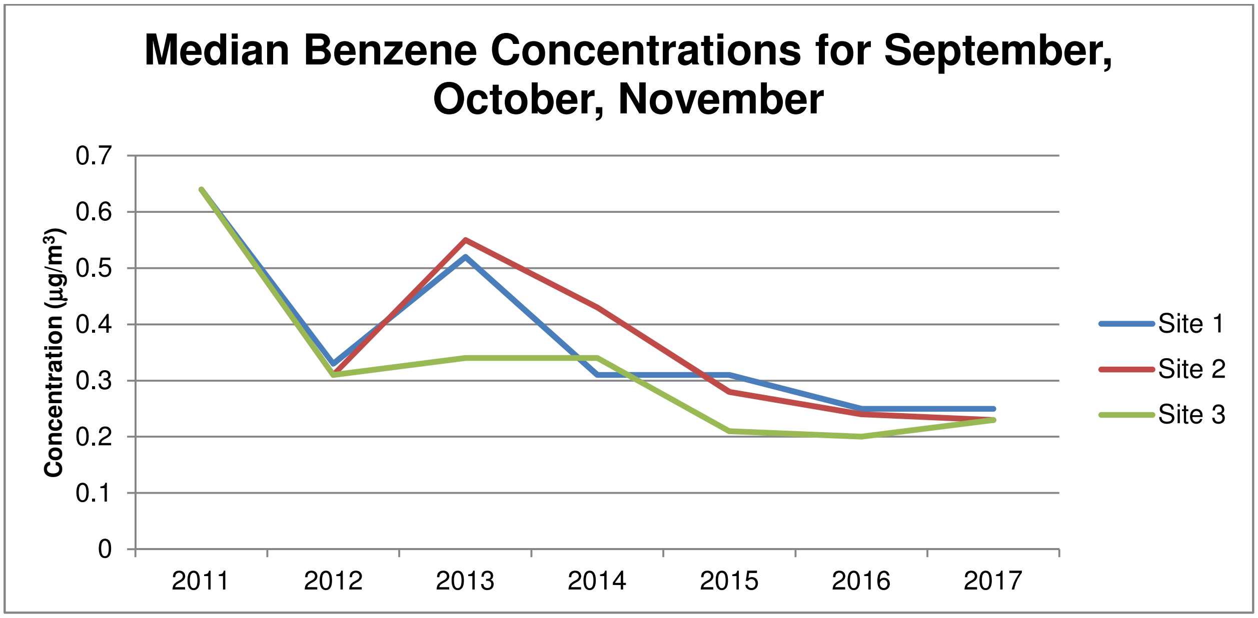

Figure 13. Median benzene concentrations by year and site for meteorological autumn.

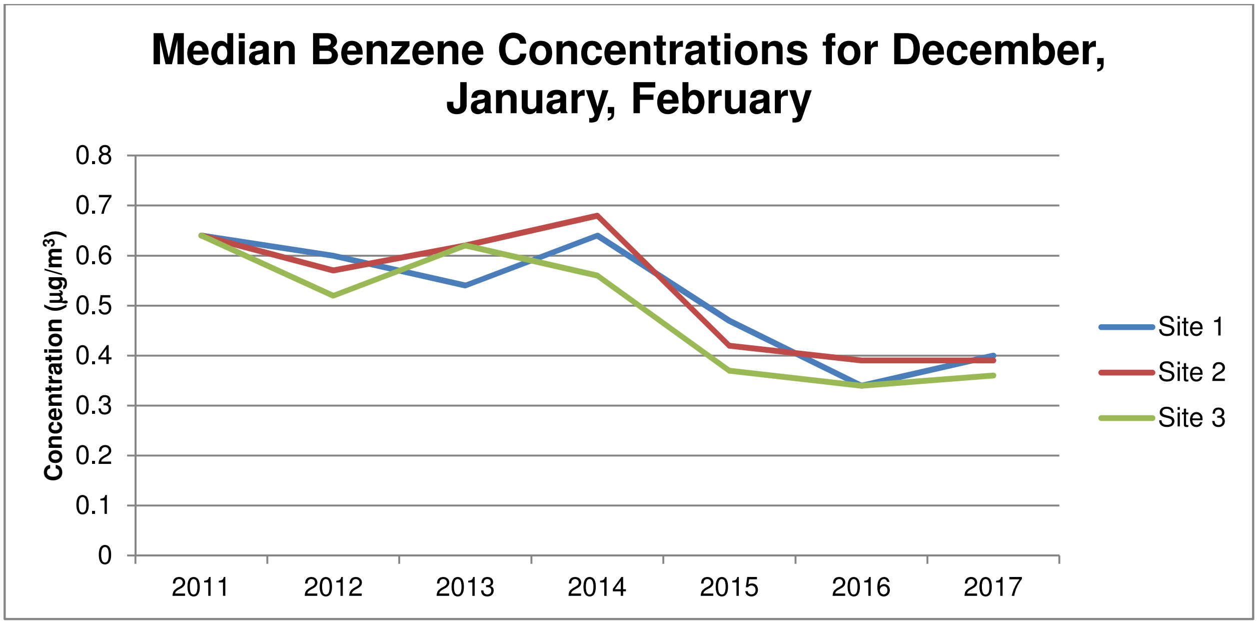

Figure 14. Median benzene concentrations by year and site for meteorological winter.

The most common trend analysis technique is linear regression. However, linear regression requires certain assumptions of the data, including that the underlying trend be linear, that variance in the data be approximately constant, and the residuals from the fitted line be normally distributed.

To complete a trend analysis of the benzene data set, an alternate trend analysis method was chosen, the Mann-Kendall test, which does not impose these restrictions on the data. In addition, the Mann-Kendall test does not require any underlying distribution of data nor a particular form of trend tested. The Mann-Kendall test assumes that when no trend exists, the data are independent and identically distributed (that is, no bias toward either higher or lower values occurring earlier or later in time). Therefore, it ultimately may be used to assess whether an observation later in time is more likely to be higher than an observation from a preceding time period.

Formally, the test computes a test statistic. The value of the test statistic may then be assessed for statistically significant differences from zero (the no-trend value).

There are additional complications beyond the linearity of the data that need to be addressed before the test is performed on the benzene data. The first is the change in detection level in May of 2012. Since the Mann-Kendall test depends on the magnitude of an observation relative to future and past observations, and the detection factor changed by a factor of 10, the analysis will be sensitive to this artifact. Review of the median values in Tables 2 through 4 indicates that, with the exception of the 2014 DJF season, the highest median values are the substituted non-detects at the beginning of the period. Therefore, calculations are only performed for 2013-2018 for the MAM data and 2012-2017 data for the other seasons. This eliminates the higher, 0.64 microgram/cubic metre substituted non-detect values from the analysis.

A second complication is the seasonality of the data, shown in Tables 2 through 4 above. Since the tests will include six years of data, the results may be sensitive to the ordering of data and specifically the start of the data set in April. This start date results in front-weighting the sample set with relatively low measurements as compared to winter. In contrast, if a winter date were chosen instead, the sample set would be front-weighted with relatively high data. To eliminate the problem of seasonality, the trend analysis will be performed for each of the four meteorological seasons.

The median benzene concentrations at each of the three sites were subjected to a Mann-Kendall test for each of the four meteorological seasons. The data are separated into MAM, JJA, SON, and DJF sub-sets at each site.

The “null hypothesis” for this test states that the future samples are equally likely to be higher or lower than the past samples (or, mathematically, that the value of the test statistic is not significantly different from zero). The null hypothesis presumes that there is no trend. A probability statistic (the p-value) is calculated for each case, and the confidence in the statistical significance of the trend assessed. In principle, any confidence level may be chosen, but it is typical to choose the 95 percent confidence level, which was chosen for this analysis.

If the value of the probability statistic meets a certain criteria (which, for the 95 percent confidence test, is p-value <0.05), then the null hypothesis is rejected, and the trend is found to be statistically significant at the indicated confidence level. If the probability statistic does not meet the criteria, then the null hypothesis cannot be rejected, and the trend cannot be determined to be significantly different from zero. As such, for a statistically significant upward trend to be found, two conditions must be met: the test statistic must be greater than zero, and p must be less than 0.05.

Results for each site, and each season, are shown in the Tables 5 through 8.

Table 5: Mann-Kendall Analysis for Benzene Concentrations at Each Site — Spring Observations

Location	2013-2018 Data		
	Test Statistic	p-Value	Is Trend Significant?
Site 1	-3	0.36	No
Site 2	-7	0.14	No
Site 3	-5	0.24	No

Table 6: Mann-Kendall Analysis for Benzene Concentrations at Each Site — Summer Observations

Location	2012-2017 Data		
	Test Statistic	p-Value	Is Trend Significant?
Site 1	-5	0.24	No
Site 2	-5	0.24	No
Site 3	-1	0.50	No

Table 7: Mann-Kendall Analysis for Benzene Concentrations at Each Site — Autumn Observations

Location	**2012-2017 Data**		
	Test Statistic	**p-Value**	**Is Trend Significant?**
Site 1	**-11**	**0.03**	**Yes**
Site 2	**-11**	**0.03**	**Yes**
Site 3	-6	0.14	Yes

Table 8: Mann-Kendall Analysis for Benzene Concentrations at Each Site — Winter Observations

Location	**2012-2017 Data**		
	Test Statistic	**p-Value**	**Is Trend Significant?**
Site 1	-9	0.07	No
Site 2	-8	0.07	No
Site 3	-9	0.07	No

For most seasons and sites, the Mann-Kendall tests find no significant trend (p value greater than 0.05). The Mann-Kendall tests find significant downward trends (negative test statistic and p value less than 0.05) at Sites 1 and 2 in autumn. At no site and season is a significant upward trend found (positive test statistic and p value less than 0.05)

However, this analysis does not discriminate between days on which the mill is operating and days on which it is shut down. Discussion of similarities and differences in the data between operating and shutdown days appears in Section 5.

4.0 ANALYSIS OF CONCENTRATIONS VERSUS DOMINANT WIND

The above calculations considered only the trends in the observed data and not the potential causes. In the following sections the concentrations will be analyzed versus the dominant wind and dates of mill operation versus shut down, in order to learn more about whether the mill is contributing to elevated benzene concentrations.

For each day on which samples were collected, the wind direction from the meteorological monitoring station is analyzed. Winds were determined to be predominant for the day if winds were from a particular direction or two adjacent directions for 13 or more hours each day. If the wind direction did not meet these criteria, no dominant wind direction was found.

Scatter plots of benzene concentrations versus dominant wind direction are examined for each of the sites. If the benzene concentration was below the detection level, or no dominant wind direction was found on a particular day, then the point was excluded from this analysis. Hence, only those points with a detectable concentration and a dominant wind direction are included for analysis in this sub-section.

At the air station, the dominant wind readings exist in two directional bands. The first is from north-northeast to southeast (ranging from about 10 to 130 degrees). The second is from southwest to west-northwest (ranging from about 230 to 310 degrees).[5] There are few days with a detected sample and a dominant wind direction from southeast to southwest, or from west-northwest to north.

The scatter plots of benzene concentrations versus wind direction for each of the three sites are shown in Figures 15 through 17. For each case, data points are shown in both black and red: red data points were measured on days for which the mill was operating, while black data points were measured on days the mill was not operating. The values on the y-axis represent the compass direction from which the predominant wind was blowing, with 0 degrees being true north, 90 degrees east, 180 degrees south, and 270 degrees west.

The addition of the 2016 through 2018 data does not alter the results and conclusions from the previous analysis. At each site, the values recorded for benzene concentrations are similar in each of the two dominant wind bands, although two outlying high concentrations occurred at Site 3 during predominantly westerly winds. The typical concentrations observed at the mill site were similar regardless of whether the mill was operating or shut down. Of the two outlying concentrations at Site 3, one occurred on an operation day and one on a shutdown day. The most extreme value observed occurred on a day that the mill was not operating.

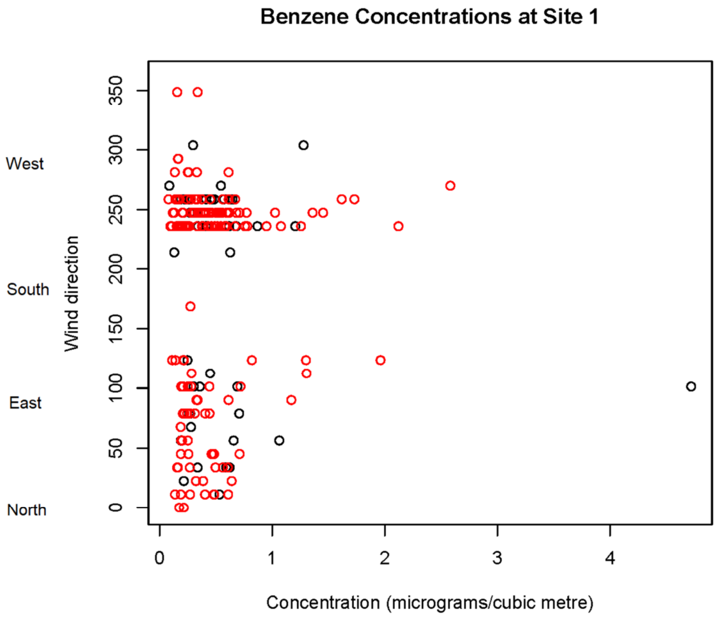

Figure 15: Scatter Plot of Benzene Concentrations versus Dominant Wind Direction at Site 1

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[5] - Following meteorological convention, wind is described in the direction it blows from. For example, a northeast wind blows from the northeast and toward the southwest.

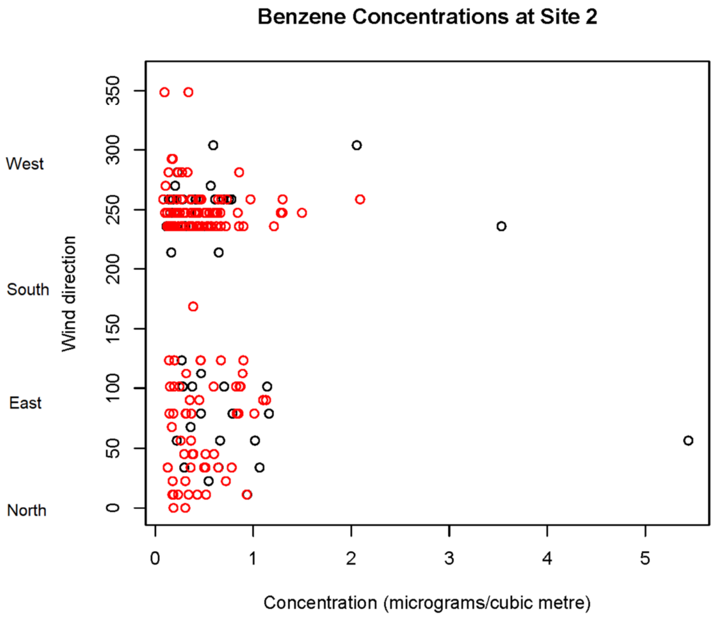

Figure 16: Scatter Plot of Benzene Concentrations versus Dominant Wind Direction at Site 2

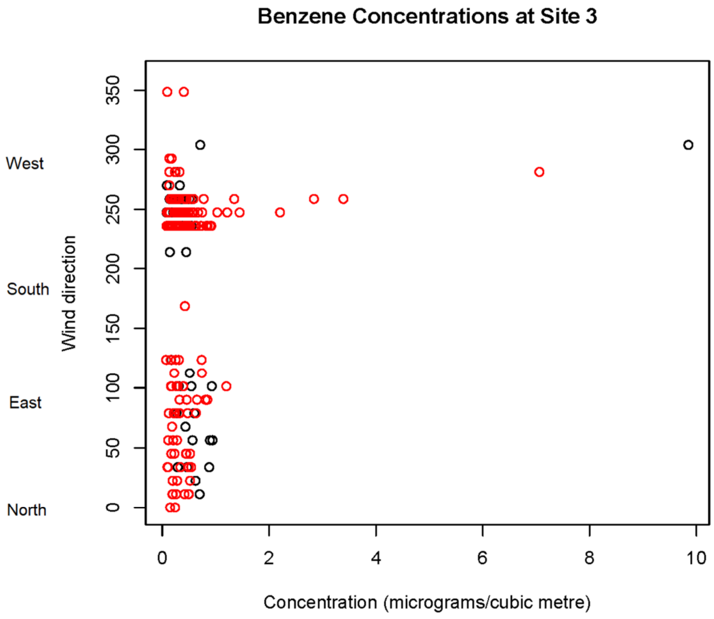

Figure 17: Scatter Plot of Benzene Concentrations versus Dominant Wind Direction at Site 3

5.0 ANALYSIS OF CONCENTRATIONS ON DAYS OF MILL OPERATION VERSUS SHUT DOWN

A comparison test may be performed to assess whether the measured concentrations are statistically distinct on days for which the mill was operating versus days for which the mill was shut down.

A commonly chosen parametric test to assess the similarity of data sets is the Student's t-test, which, formally, compares the means of the two datasets. However, the t-test assumes that the distribution of underlying data is normal. As illustrated by the histograms earlier in the report, the distribution of sampled data here is non-normal. Therefore, an alternate test is chosen to assess the similarity of the datasets. Kruskal-Wallis tests are performed to assess the statistical similarity of subpopulations for each sampling site when the mill is operating versus when the mill is not operating. Formally, the Kruskal-Wallis test assesses the probability that a random observation from one group is equally likely to be above or below a random observation from the second group. As such, it is more related to the differences between the medians of two groups, rather than the mean. The null hypothesis for the Kruskal-Wallis test is that the random observation is equally likely to be above or below the second random observation, and consequently, that the populations of observations in the two groups are similar. A p-value of <0.05 allows the user to reject the null hypothesis at the 95 percent confidence level; that is to say, to conclude that the populations of data are from statistically distinct sub-sets. Unlike the Student's t-test, the Kruskal-Wallis test assumes no particular distribution on the underlying data.

The change in detection limit occurring in 2012, discussed in previous sections, must also be considered here. In principle, it is possible to perform Kruskal-Wallis tests on data sets with non-detect samples. However, as noted in the ProUCL version 5 user guide, the Kruskal-Wallis test will consider all non-detects as equally-ranked observations irrespective of reporting limits. In the case here, this will cause complications because the post-2012 data contains many detected values which are lower than the detection limit of 0.64 µg/m^3 used for samples analyzed in 2011 and early 2012. Since the presence of multiple detection limits and a number of detected samples with values interspersed between those limits are present in the data here, the data collected before the change in the detection limit in 2012 will not be analyzed. Therefore, the analysis will be performed on data from May of 2012 through 2018. In order to assess whether more recent changes have occurred, the analysis will also be repeated for 2016 through 2018 only.

The Kruskal-Wallis tests all return values >0.05 for each site, for both the 2012-2018 analysis and for 2016-2018 only. This indicates the hypothesis that the statistical behavior of the two sub-populations (days when the mill is operating versus days when it is shut down) is similar and cannot be rejected with 95 percent confidence. The results are summarized in Table 9.

Table 9: Results of Kruskal-Wallis Tests for Subpopulations of Data on Days of Mill Operation Versus Shut Down

Location	Period	Avg. Conc. When Operating (µg/m^3)	Avg. Conc. When Shut Down (µg/m^3)	p-Value	Populations Statistically Distinct?
Site 1	2012-2018	0.44	0.47	0.13	No
Site 1	2016-2018	0.39	0.31	0.76	No
Site 2	2012-2018	0.47	0.52	0.21	No
Site 2	2016-2018	0.45	0.37	0.87	No
Site 3	2012-2018	0.40	0.64	0.12	No
Site 3	2016-2018	0.30	0.56	0.88	No

The results in Table 9 consider results over the entire year(s). In order to check whether there are any differences in seasonal behavior, the Kruskal-Wallis tests are performed again at each site for each of the four meteorological seasons. As the data pools are smaller upon division into seasons, the analysis is only performed on the 2012-2018 aggregate and not 2016-2018 alone. The results for each site and meteorological season are shown in Table 10. P-Values meeting the 95 percent confidence test are highlighted in bold.

Table 10: Results of Kruskal-Wallis Tests for Mill Operation/Shutdown by Season

	Site 1			Site 2			Site 3		
Season	Oper. Avg. Conc.	Shut Avg. Conc.	p-Value	Oper. Avg. Conc.	Shut Avg. Conc.	p-Value	Oper. Avg. Conc.	Shut Avg. Conc.	p-Value
MAM	0.47	0.40	0.55	0.48	0.47	0.65	0.38	0.46	0.16
JJA	**0.38**	**0.40**	**0.02**	**0.41**	**0.49**	**0.04**	**0.42**	**0.98**	**0.01**
SON	0.41	0.53	0.79	0.45	0.52	0.83	0.36	0.64	0.81
DJF	0.54	0.52	0.68	0.55	0.68	0.36	0.49	0.52	0.85

Notes:
MAM – March, April, May
JJA – June, July, August
SON – September, October, November
DJF – December, January, February

Of the 12 possible season-site combinations, only the three combinations in meteorological summer (JJA) have p-values that indicate a statistically significant difference between concentrations on operational versus shutdown days at the 95 percent confidence level. For each of these three cases the concentrations are higher when the mill is shut down, meaning these values indicate that there is a statistically significant tendency for concentrations to be lower on mill operation days than for mill shutdown days at each site during the summer.

It is important to stress that, while the statistical tests demonstrate whether a relationship exists, they do not identify the cause of that relation. If a secondary factor also exists that would affect the data that is not accounted for by the statistical test, then an apparently significant result can be found when the cause of the difference in concentrations is, in fact, external to the conditions being considered. In the cases considered here, other regional sources or transport of benzene from distant sources could account for the statistically significant concentration differences in summer.

6.0 SUMMARY

SLR completed a statistical analysis of benzene concentrations in air samples collected in the vicinity of the LPC Swan Valley mill near Minitonas, MB. The analysis presented in this report is an extension of earlier work done for the 2011-2015 period. With this update, data from 2016, 2017, and January-March 2018 are also included in the analysis.

A Kruskal-Wallis test was performed to examine the similarity of data samples gathered on days when the mill was operating versus when it was shut down. As the Kruskal-Wallis test is non-parameteric, it does not rely on underlying assumptions of the distribution of sample data (as would, for example, a t-test). Results indicate the populations of data between operation and shutdown days are similar except for the summer months. In those cases summer concentrations were higher on mill shutdown days than mill operation days with statistical significance. Mann-Kendall statistical tests indicated that either no significant trend exists in measured concentrations, or a significant downward trend exists, for all periods and seasons considered.

The results of the Kruskal-Wallis test showed that the populations of data are similar from days on which the facility is operating versus days when it is shut down, except for the summer cases where concentrations are higher on shutdown days. This is true for each of the three sites, and for both the 2012 to 2018 data period, and for the 2016-2018 data alone. The differences in concentrations between days when the mill is operating versus when the mill is shut for other seasons and sites cannot be distinguished from random variability with statistical confidence. Mann-Kendall tests revealed no significant upward trends in concentration for any season.

Yours sincerely,
SLR Consulting (Canada) Ltd.

Michael J Ring

Tracey Forbister

Mike Ring, Ph.D.
Project Scientist

Tracey Forbister, B.Sc., CET
Principal Scientist

September 26, 2018

Mr. Al Hambley
Louisiana-Pacific Canada Ltd.
Swan Valley Siding Mill
Highway #10, 5 Km East
Minitonas, MB   R0L 1G0

SLR Project No.: 208.04436.00015

Dear Mr. Hambley,

***RE: LOUISIANA-PACIFIC CANADA LTD. SWAN VALLEY SIDING MILL
AMBIENT AIR ACROLEIN CONCENTRATIONS
STATISTICAL ANALYSES***

1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (SLR) was retained by Louisiana-Pacific Canada Ltd. (LPC) to perform a statistical analysis of concentrations of acrolein measured in ambient air samples collected in the vicinity of the LPC Swan Valley siding mill located near Minitonas, MB.

Ambient air samples were collected from three air stations surrounding the mill, with samples generally collected every sixth day. Ambient air samples were collected in Summa® passivated canisters using US Environmental Protection Agency method TO-15. Previous analysis conducted by SLR examined the period of 2011 through 2015. In this work, SLR has extended the period of analysis by including 2016, 2017, and January-March 2018 data.

The location of the mill and the air sampling stations are shown in Figure 1.

2.0 QUALITATIVE DISTRIBUTION OF DATA

Figure 2, Figure 3, and Figure 4 present the distributions of samples collected at each of the three sites since the beginning of the acrolein sampling program in 2011. For each of the three histograms, a bin width of 1 microgram per cubic metre (µg/m^3) was chosen. The histograms reveal that the distribution of measurements at each of the three points does not follow the normal distribution. At each of the three sites most observations are between 0 µg/m^3 and 1 µg/m^3, with a smaller number of higher measurements. The addition of 2016, 2017, and early 2018 data has not changed the distribution, as most results from those two-plus years are clustered into the 0-1 µg/m^3 bin similar to the 2011-2015 data.

In these three figures, non-detects have been plotted at the detection limit, and therefore placed in the 0-1 µg/m^3 bin as the detection limits in use are lower than 1 µg/m^3. It is worthwhile to note that in June 2013, the detection limit changed from 0.46 µg/m^3 to 0.23 µg/m^3.

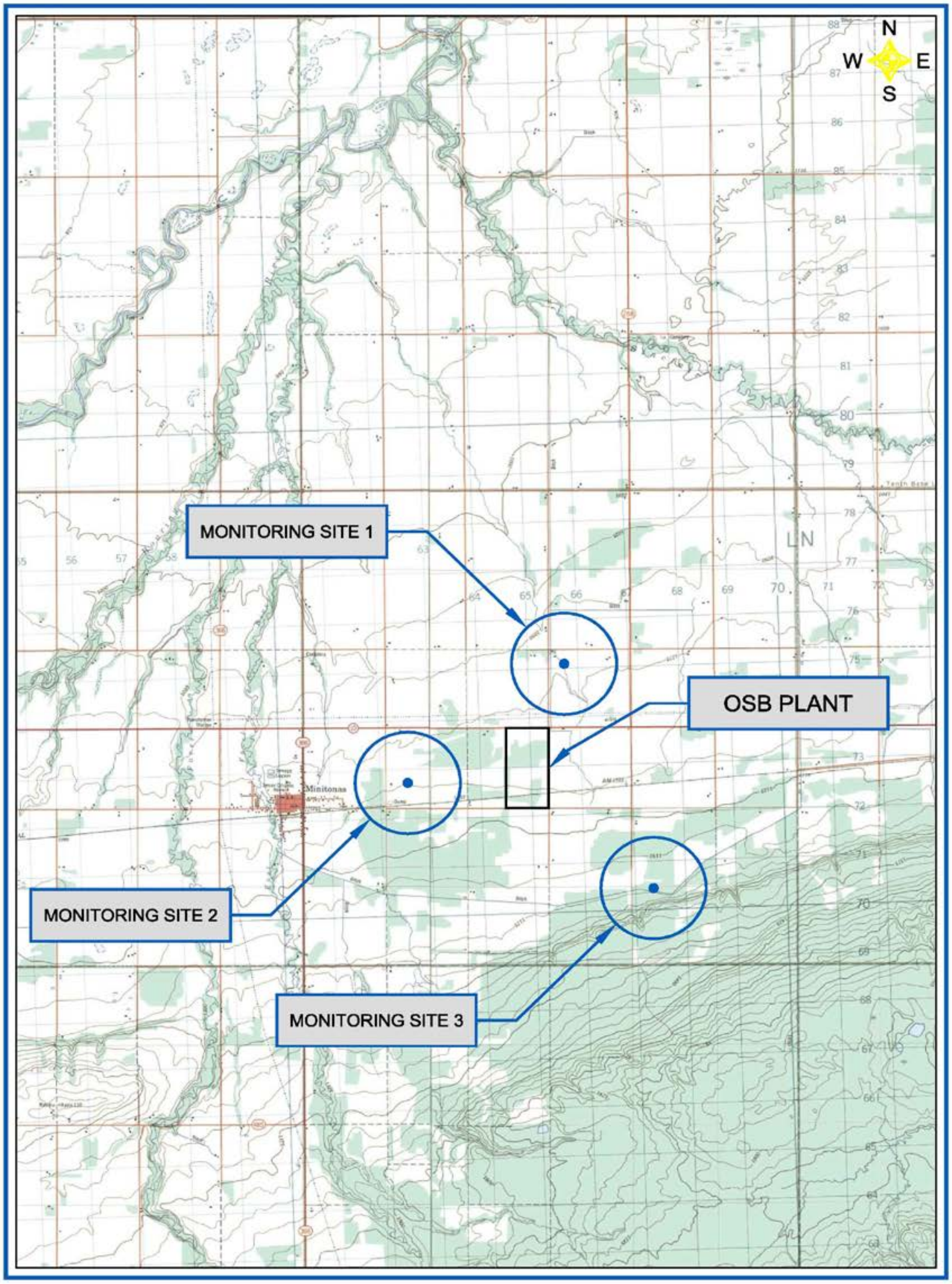

Figure 1: Site location map

Particularly notable in the histograms are outlying measurements at high concentrations of acrolein, for example, at Site 1 there is a single measurement between 17 μg/m^3 to 18 μg/m^3 and another single measurement between 12 μg/m^3 to 13 μg/m^3. Site 3 features a single measurement between 19 μg/m^3 to 20 μg/m^3. At each site, the three individual measurements occurring on January 6, 12, and 18, 2015 were among the four highest measurements at each site to date. Laboratory quality control checks associated with these samples were within tolerance limits, and there are no other indications as to why these samples should be treated as invalid. Therefore they are treated as valid samples and included in the analysis.

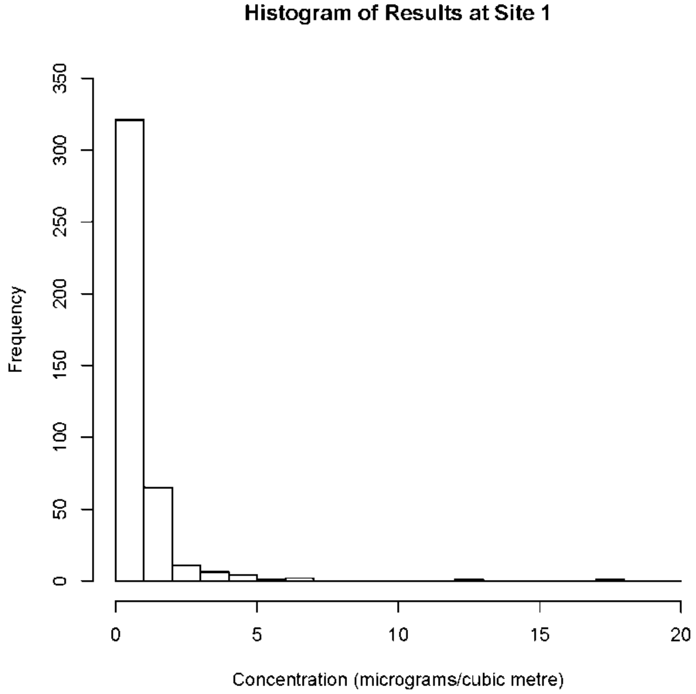

Figure 2: Histogram of Acrolein Concentrations at Site 1 (2011-March 2018)

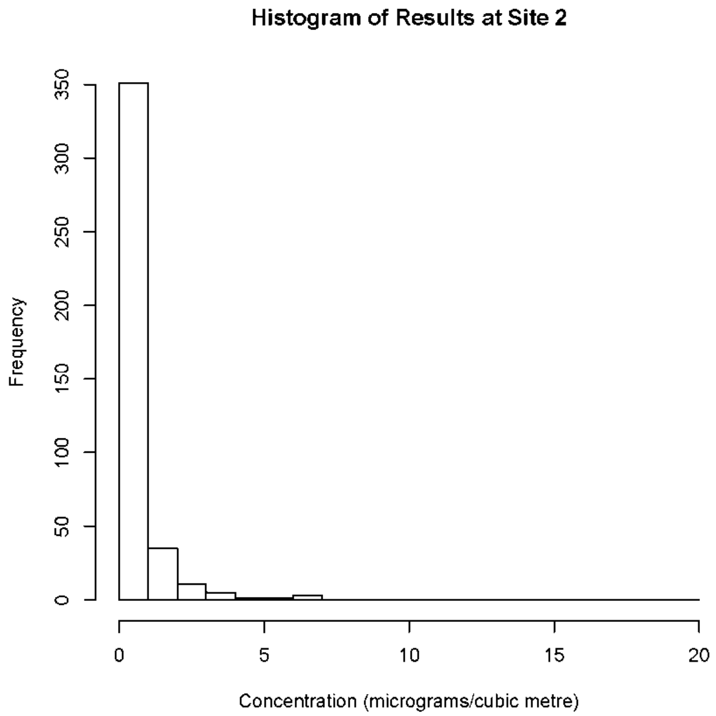

Figure 3: Histogram of Acrolein Concentrations at Site 2 (2011-March 2018)

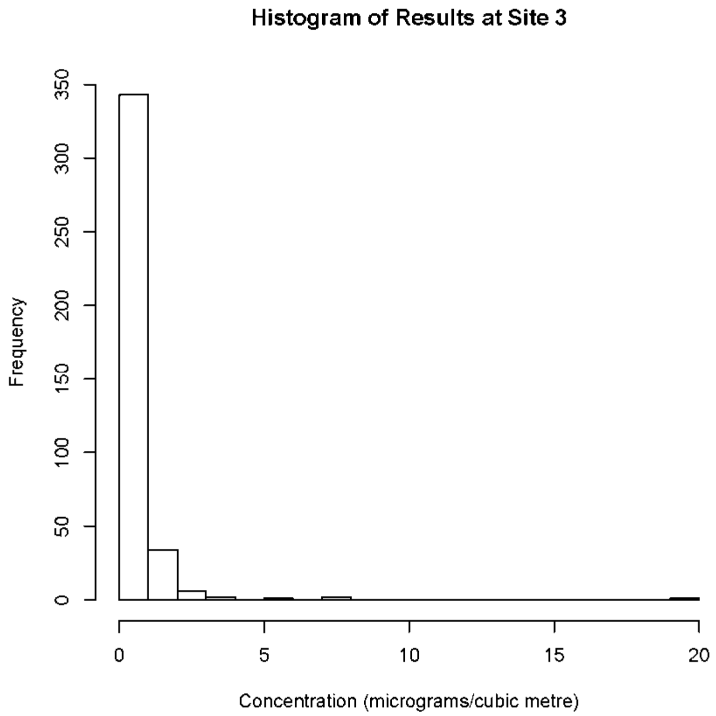

Figure 4: Histogram of Acrolein Concentrations at Site 3 (2011-March 2018)

A summary of the mean and median for each of the three sites is shown in Table 1. The presence of a number of samples returning concentrations below the detection limit, and the two differing detection limits used over the course of the seven years in this analysis, present complications in determining the mean and median of the datasets. In order to do so, Kaplan-Meier estimation is used to treat the non-detects.

Kaplan-Meier estimation is a nonparametric technique for calculating the cumulative density function for datasets with “censored” data, such as the non-detect data here. Having obtained a cumulative density function through this technique, the mean and median may then be found through analysis of the cumulative density function.

The cumulative density functions for the acrolein data are shown for each of the sites in Figures 5 through 7. In each figure, the black lines indicate the calculations for the 2011-2018 data, the red lines are for the 2011-2015 data, and the blue lines are for the 2016-2018 data. Solid lines indicate the central estimate of cumulative probability, while the dashed lines indicate the 95 percent confidence intervals. The left panels show the central estimates and 95 percent confidence intervals of the 2011-2018 data, as well as the central estimates for 2011-2015 and 2016-2018 data. The right panels show the central estimates and 95 percent confidence intervals for the 2011-2015 and 2016-2018 data.

At each site, the cumulative probability of measurements is greater for the 2016-2018 data than for the 2011-2015 data, suggesting a tendency for the more recent measurements to record lower concentrations. At each site the cumulative probability for the 2011-2015 data is above the 95 percent confidence interval for the total length of data (2011-2018) when the values exceed about 0.5 micrograms/cubic metre. The central estimate from the earlier period of data (2011-2015) is roughly in line with the lower 95 percent confidence estimate of the total length of data. Data trends will be analyzed further in the next section.

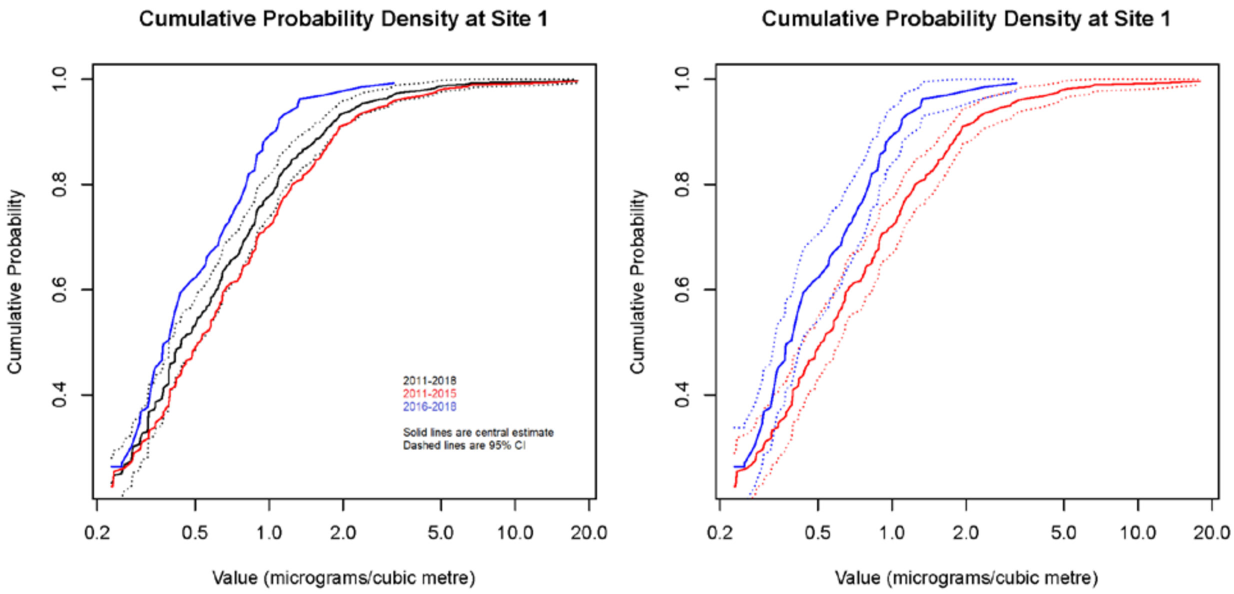

Figure 5. Cumulative density functions of measurements at Site 1.

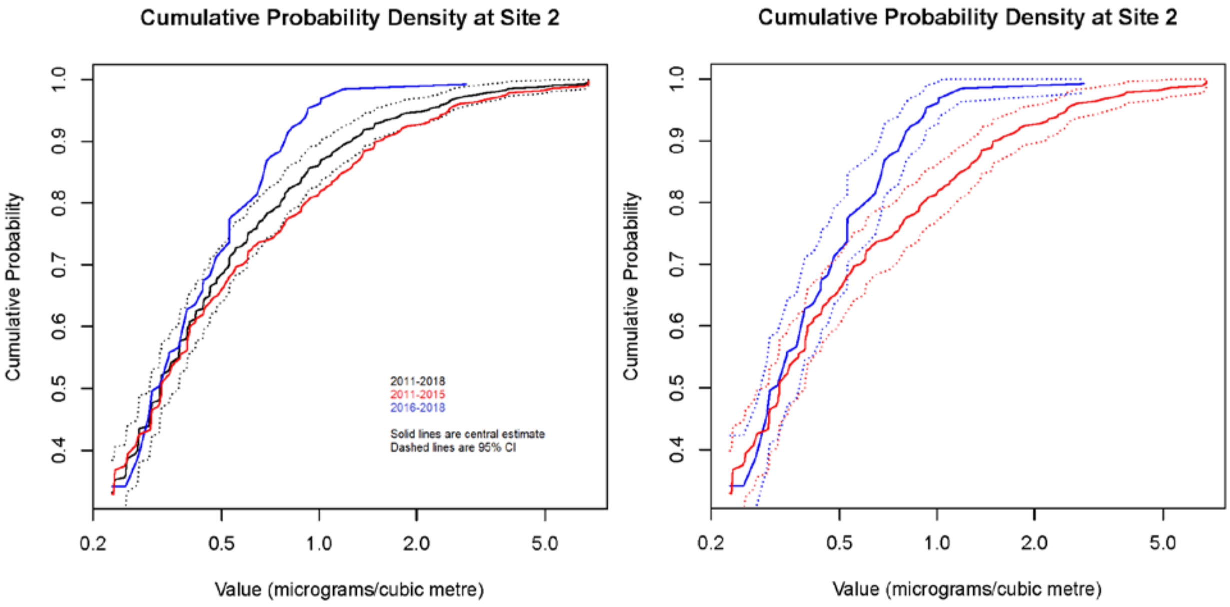

Figure 6. Cumulative density functions of measurements at Site 2.

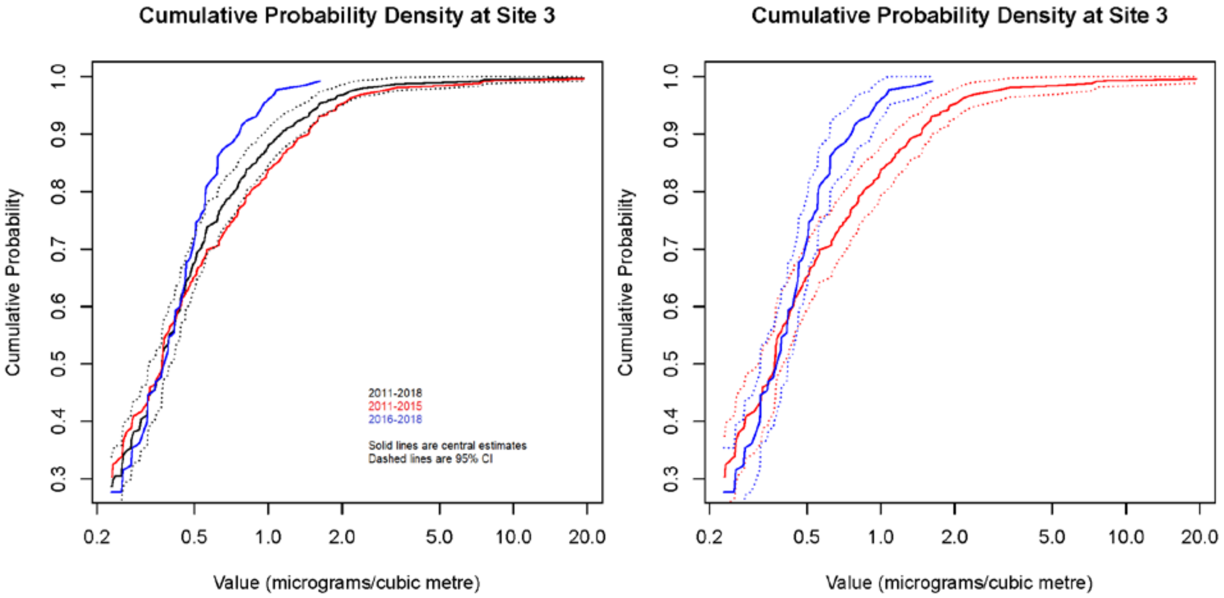

Figure 7. Cumulative density functions of measurements at Site 3.

The U.S. EPA has developed a software program, ProUCL, which automatically determines statistics using the Kaplan-Meier method for an input of data values and information regarding whether the sample was above or below the detection limit. This program is used here to determine the mean and median of each dataset.

Table 1: Mean and Median of Acrolein Concentrations Measured at Each Site Using Kaplan-Meier Estimation

Location	Mean ($\mu g/m^3$)			Median ($\mu g/m^3$)		
	2011-2018[1] Data	2016-2018[1] Data	2011-2015 Data	2011-2018[1] Data	2016-2018[1] Data	2011-2015 Data
Site 1	0.83	0.54	0.96	0.71	0.46	0.85
Site 2	0.62	0.42	0.70	0.53	0.34	0.63
Site 3	0.62	0.43	0.71	0.51	0.25	0.65

[1] 2018 data includes samples taken through March 31.

During the observational period, there are some days when the mill is not operating. The distribution of concentrations at each sampling site may be examined for days on which the mill is operating versus days on which the mill is shut down. These results are presented in Figure 8, Figure 9, and Figure 10. As before non-detects are assigned to the lowest range.

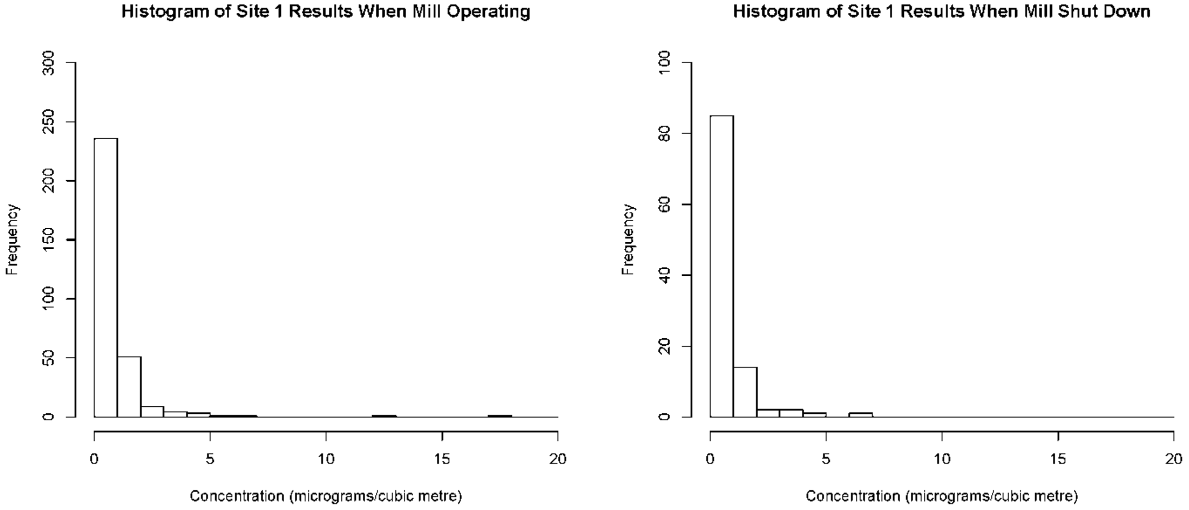

Figure 8: Frequency of samples from Site 1 falling in the indicated 1 $\mu g/m^3$ width concentration bins for days when the mill is operating (left) and shut down (right)

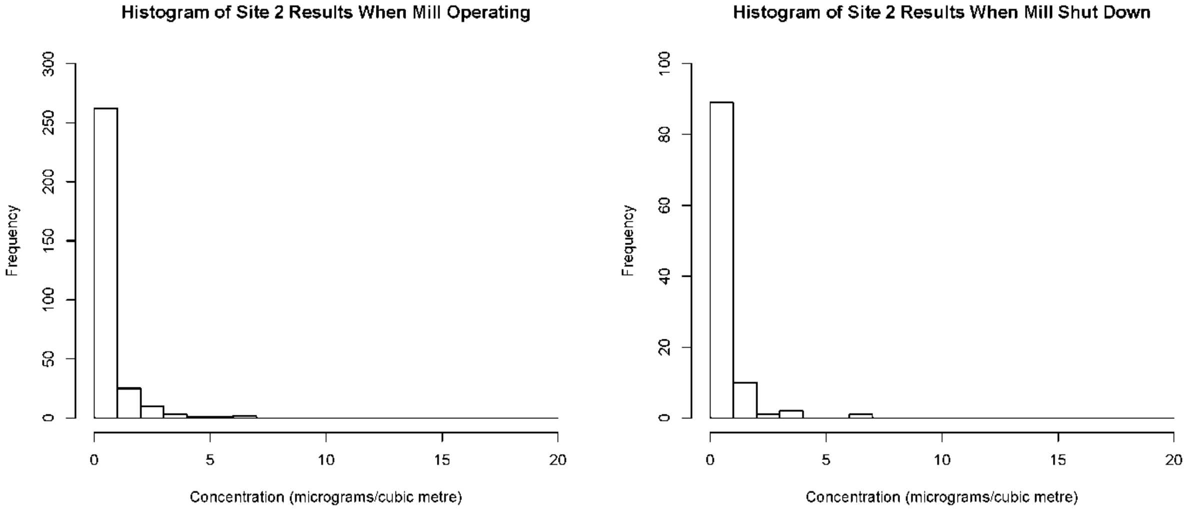

Figure 9: Frequency of samples from Site 2 falling in the indicated 1 µg/m^3 width concentration bins for days when the mill is operating (left) and shut down (right)

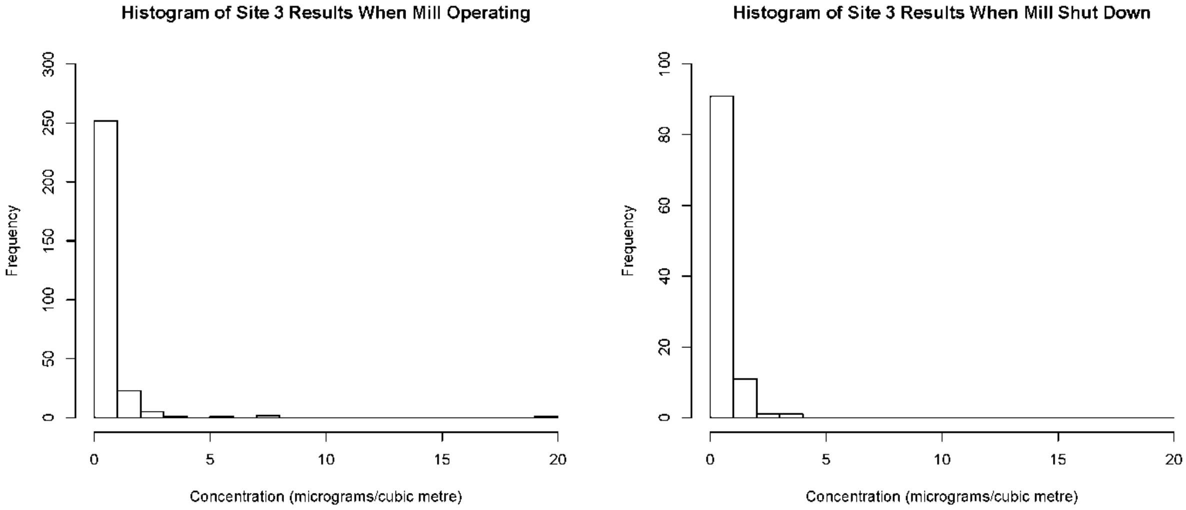

Figure 10: Frequency of samples from Site 3 falling in the indicated 1 µg/m^3 width concentration bins for days when the mill is operating (left) and shut down (right)

At all three sites, the bulk of observations occur in the 0-1 µg/m^3 bins, while the next most common observations are in the 1-2 µg/m^3 bins. At all three sites, these two bins account for 90 percent or more of the observations. At Sites 1 and 3, outlying observations (beyond 7 µg/m^3) are observed on days when the mill is operating, but they are very few.

3.0 TREND ANALYSIS OF DATA

For each of the three monitoring sites, trend analysis was performed to determine if statistically significant trends exist in the data.

In Tables 2 through 4, the median concentration by site and season is shown. The data are also illustrated in Figures 11 to 14. There are seasonal differences in the measured concentrations, with the highest median concentration over the course of the seven years occurring in meteorological summer[1] at each of the three sites.

For some sites and seasons, over half of the samples retuned values below the detection limits. In the tables below the detection limits are reported in these cases; the entries are bolded and italicized where this occurs. The detection limits are used where needed in Figures 11 through 14.

In the following section, non-linear trend analyses are performed on the median data from each of the three sites, examining each season separately due to the differences in concentrations among the seasons.

Table 2: Seasonal Medians of Acrolein Concentrations at Site 1 ($\mu g/m^3$)

Year	MAM Median	JJA Median	SON Median	DJF Median[2]
2011	0.88	1.21	0.62	***0.46***
2012	***0.46***	1.17	***0.46***	***0.46***
2013	***0.46***	1.54	0.44	***0.23***
2014	0.37	1.60	0.47	0.46
2015	0.30	0.95	0.59	***0.23***
2016	0.50	0.70	0.39	0.28
2017	0.41	0.78	0.39	***0.23***
2018[3]	0.37	--	--	--
All	0.37	1.08	0.47	0.25

Notes:
MAM – March, April, May
JJA – June, July, August
SON – September, October, November
DJF – December, January, February

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[1] - Meteorological seasons are defined slightly differently than astronomical seasons. For example, meteorological summer is usually defined as lasting from 1 June to 31 August, whereas astronomical summer excludes most of June but includes most of September. Meteorological summer is so defined because, for most locations in the Northern Hemisphere, the mean temperature in June is higher than the mean temperature in September. A review of the data from the Swan River meteorological station indicates this to be the case here. The four meteorological seasons, then, are “JJA”, “SON”, “DJF”, and “MAM”. Each season contains three calendar months, and the initials of the season correspond to the months included.

[2] - Includes December of the indicated year and January to February of the next calendar year.

[3] - Includes results from March 1 – March 31, 2018.

Table 3: Seasonal Medians of Acrolein Concentrations at Site 2 (μg/m^3)

Year	MAM Median	JJA Median	SON Median	DJF Median[2]
2011	0.49	0.88	0.51	***0.46***
2012	***0.46***	0.72	0.46	***0.46***
2013	***0.46***	0.63	0.28	***0.23***
2014	0.40	0.81	0.33	0.33
2015	***0.23***	0.23	0.23	***0.23***
2016	***0.23***	0.39	0.32	0.28
2017	0.53	0.48	0.25	0.32
2018[3]	0.46	--	--	--
All	0.30	0.60	0.32	0.25

Notes:
MAM – March, April, May
JJA – June, July, August
SON – September, October, November
DJF – December, January, February

Table 4: Seasonal Medians of Acrolein Concentrations at Site 3 (μg/m^3)

Year	MAM Median	JJA Median	SON Median	DJF Median[2]
2011	--	--	0.47	***0.46***
2012	0.56	0.51	***0.46***	***0.46***
2013	***0.46***	1.00	0.28	***0.23***
2014	0.54	1.51	0.40	0.26
2015	***0.23***	***0.46***	0.28	***0.23***
2016	0.28	0.56	0.32	0.41
2017	0.44	0.41	0.48	0.32
2018[3]	0.48	--	--	--
All	0.37	0.56	0.34	0.25

Notes:
MAM – March, April, May
JJA – June, July, August
SON – September, October, November
DJF – December, January, February

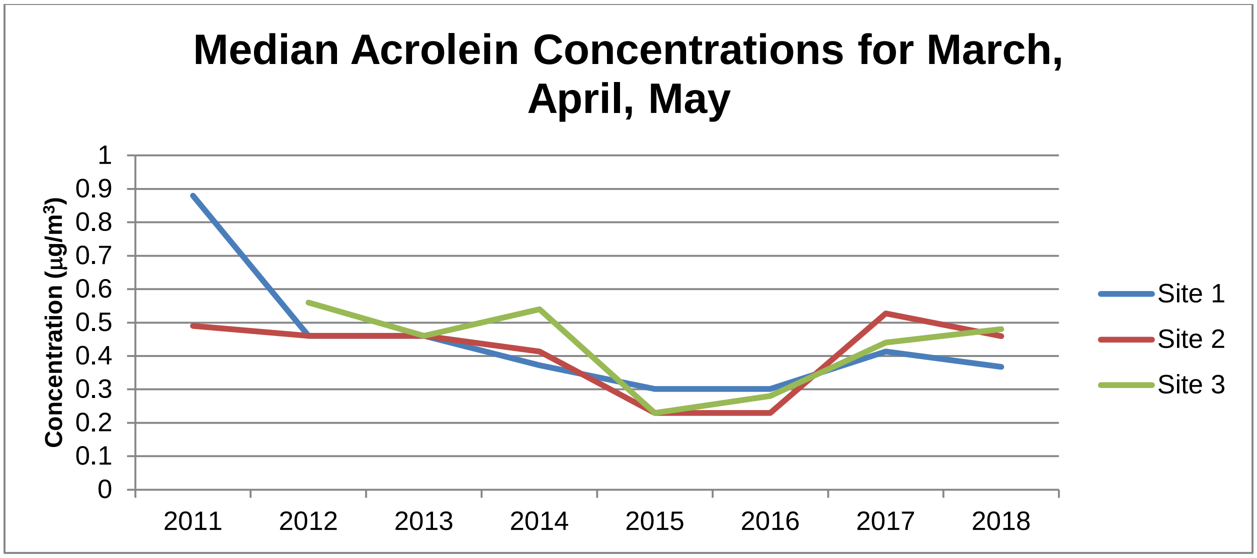

Figure 11. Median acrolein concentrations by year and site for meteorological spring.[4]

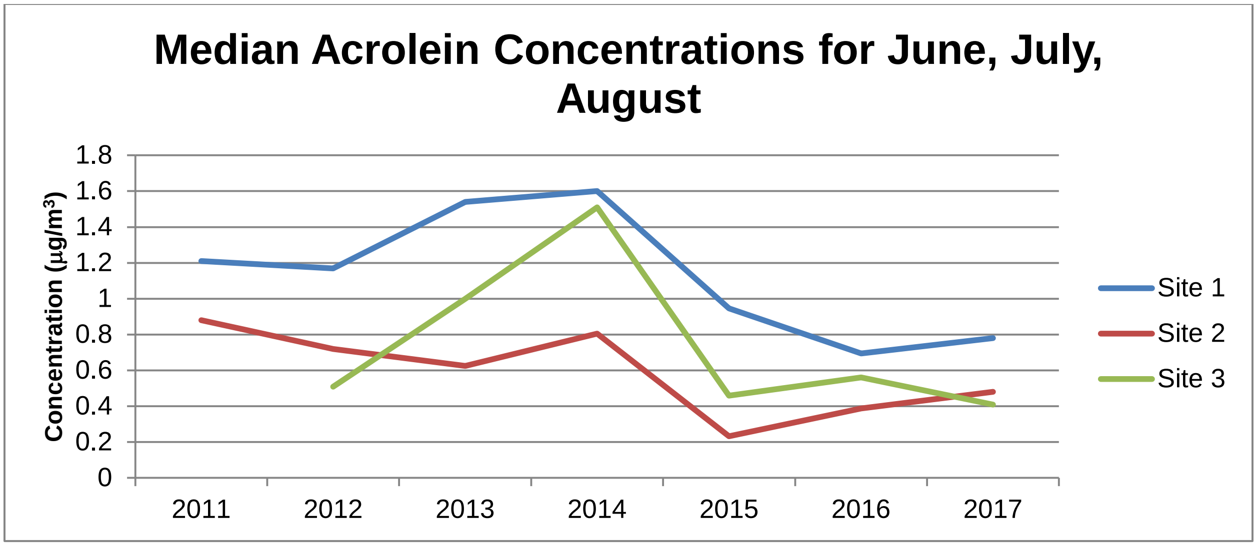

Figure 12. Median acrolein concentrations by year and site for meteorological summer.

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[4] 2018 median values based on results from March 1 – March 31, 2018.

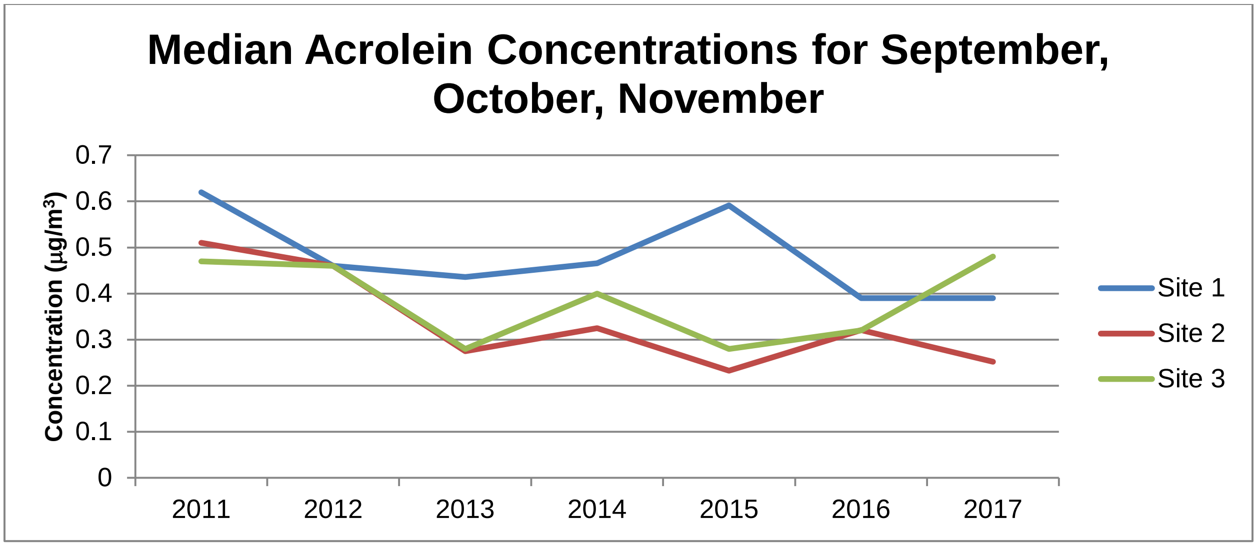

Figure 13. Median acrolein concentrations by year and site for meteorological autumn.

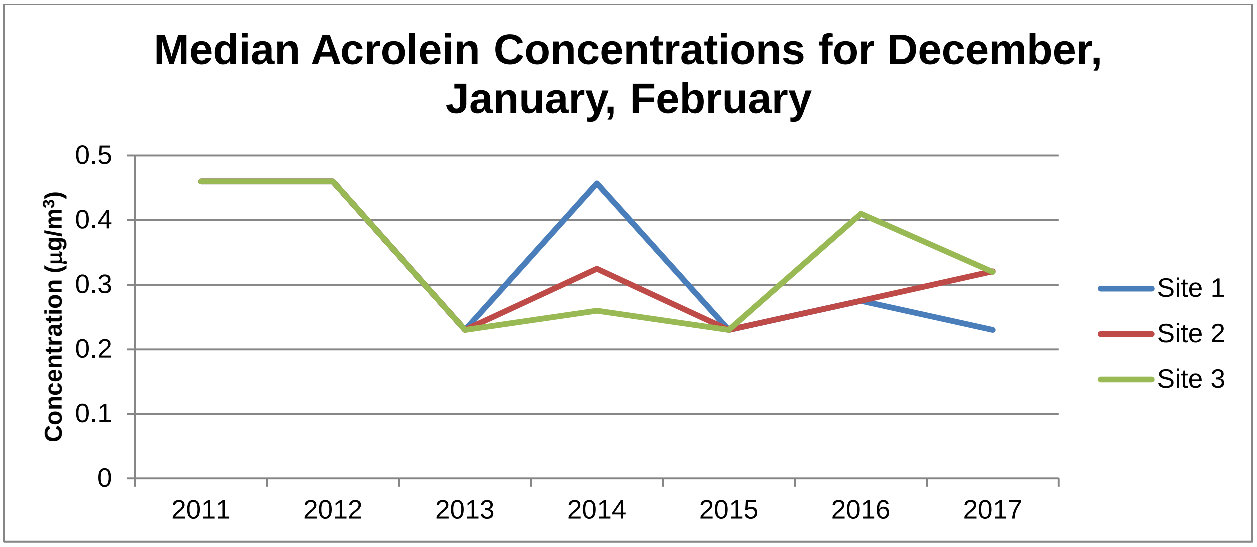

Figure 14. Median acrolein concentrations by year and site for meteorological winter.

The most common trend analysis technique is linear regression. However, linear regression requires certain assumptions of the data, including that the underlying trend be linear, that variance in the data be approximately constant, and the residuals from the fitted line be normally distributed.

To complete a trend analysis of the acrolein data set, an alternate trend analysis method was chosen, the Mann-Kendall test, which does not impose these restrictions on the data. In addition, the Mann-Kendall test does not require any underlying distribution of data nor a particular form of trend tested. The Mann-Kendall test assumes that when no trend exists, the data are independent and identically distributed (that is, no bias toward either higher or lower values occurring earlier or later in time). Therefore, it ultimately may be used to assess whether an observation later in time is more likely to be higher than an observation from a preceding time period.

Formally, the test computes a test statistic. The value of the test statistic may then be assessed for statistically significant differences from zero (the no-trend value).

There are additional complications beyond the linearity of the data that need to be addressed before the test is performed on the acrolein data. The first is the change in detection level in June of 2013. With non-detects being a priori more likely in the beginning of the period, when the detection limit is higher, the analysis may be sensitive to their presence. Therefore, calculations performed two different ways are presented: calculations for the trend analysis from 2011-2018; and trends for data collected since the change in laboratory detection limit in 2013.

A second complication in this analysis is the seasonality of the data. As shown in Tables 2-4 above, the median values of the acrolein concentration vary from season to season. Since the tests will include only about five or seven years of data, depending on the time span chosen, the results may be sensitive to the ordering of data. Starting the analysis during a season where concentrations tend to be high would front-load the data set with relatively high measurements, while starting the analysis during a season where concentrations tend to be low would do the opposite. To eliminate the problem of seasonality, the trend analysis will be performed separately for each of the four meteorological seasons.

The median acrolein concentrations at each of the three sites were subjected to a Mann-Kendall test for each of the four meteorological seasons. The data are separated into MAM, JJA, SON, and DJF sub-sets at each site.

The “null hypothesis” for this test states that the future samples are equally likely to be higher or lower than the past samples (or, mathematically, that the value of the test statistic is not significantly different from zero). The null hypothesis presumes that there is no trend. A probability statistic (the p-value) is calculated for each case, and the confidence in the statistical significance of the trend assessed. In principle, any confidence level may be chosen, but it is typical to choose the 95 percent confidence level, which was chosen for this analysis.

If the value of the probability statistic meets a certain criteria (which, for the 95 percent confidence test, is p-value <0.05), then the null hypothesis is rejected, and the trend is found to be statistically significant at the indicated confidence level. If the probability statistic does not meet the criteria, then the null hypothesis cannot be rejected, and the trend cannot be determined to be significantly different from zero. As such, for a statistically significant upward trend to be found, two conditions must be met: the test statistic must be greater than zero, and p must be less than 0.05.

Results for each site, and each season, are shown in the next four tables.

Table 5: Mann-Kendall Analysis for Acrolein Concentrations at Each Site — Spring Observations

Location	2011- March 2018 Data			June 2013 - March 2018 Data		
	Test Statistic	p-Value	Is Trend Significant?	Test Statistic	p-Value	Is Trend Significant?
Site 1	**-16**	**0.03**	**Yes**	1	0.59	No
Site 2	-8	0.12	No	3	0.41	No
Site 3	-5	0.29	No	2	0.41	No

Table 6: Mann-Kendall Analysis for Acrolein Concentrations at Each Site — Summer Observations

Location	2011- March 2018 Data			June 2013 - March 2018 Data		
	Test Statistic	p-Value	Is Trend Significant?	Test Statistic	p-Value	Is Trend Significant?
Site 1	-9	0.12	No	-6	0.12	No
Site 2	-11	0.07	No	-2	0.41	No
Site 3	-5	0.24	No	-6	0.12	No

Table 7: Mann-Kendall Analysis for Acrolein Concentrations at Each Site — Autumn Observations

Location	2011- March 2018 Data			June 2013 - March 2018 Data		
	Test Statistic	p-Value	Is Trend Significant?	Test Statistic	p-Value	Is Trend Significant?
Site 1	-10	0.07	No	-3	0.41	No
Site 2	**-13**	**0.04**	**Yes**	-2	0.41	No
Site 3	-2	0.39	No	5	0.24	No

Table 8: Mann-Kendall Analysis for Acrolein Concentrations at Each Site — Winter Observations

Location	2011- March 2018 Data			June 2013 - March 2018 Data		
	Test Statistic	p-Value	Is Trend Significant?	Test Statistic	p-Value	Is Trend Significant?
Site 1	-11	0.07	No	-1	0.59	No
Site 2	-7	0.20	No	3	0.41	No
Site 3	-5	0.28	No	5	0.24	No

For all cases in the 2013-2018 data, and all but two cases in the 2011-2018 data, the Mann-Kendall tests find no statistically significant trends in the median values (p value greater than 0.05). For two cases in the 2011-2018 analyses, Site 1 in spring and Site 2 in autumn, a significant downward trend is found in the median values (negative test statistic and p value less than 0.05). In no case is a significant upward trend found in the data in the median values (positive test statistic and p value less than 0.05).

This analysis does not discriminate between days on which the mill is operating and days on which it is shut down. Discussion of similarities and differences in the data between operating and shutdown days appears in Section 5.

4.0 ANALYSIS OF CONCENTRATIONS VERSUS DOMINANT WIND

The above calculations considered only the trends in the observed data and not the potential causes. In the following sections, acrolein concentrations versus the predominant wind direction and dates of mill operation versus shut down, are analyzed in order to learn more about whether the mill is contributing to elevated acrolein concentrations.

For each day on which samples were collected, the wind direction from the meteorological monitoring station is analyzed. Winds were determined to be predominant for the day if winds were from a particular direction or two adjacent directions for 13 or more hours each day. If the wind direction did not meet these criteria, no dominant wind direction was found.

Scatter plots of acrolein concentrations versus dominant wind direction are examined for each of the sites. If the acrolein concentration was below the detection level, the detection level is substituted. If no predominant wind direction was found on a particular day, then the point was excluded from this analysis.

At the air station, the predominant wind readings exist in two directional bands. The first is from north-northeast to southeast (about 10 to 130 degrees). The second is from southwest to west-northwest (about 230 to 310 degrees).[5] There are few days with a detected sample and a dominant wind direction from southeast to southwest, or from west-northwest to north.

The scatter plots of acrolein concentrations versus wind direction for each of the three sites are shown in Figures 15 through 17. For each case, data points are shown in both black and red: red data points were measured on days for which the mill was operating, while black data points were measured on days the mill was not operating. The values on the y-axis represent the compass direction from which the predominant wind was blowing, with 0 degrees being true north, 90 degrees east, 180 degrees south, and 270 degrees west.

At each site, the values recorded for acrolein concentrations are similar in each of the two dominant wind bands, except for the outlying days in January 2015 where winds were westerly. In addition, the distribution of acrolein concentrations for days when the mill was operating versus shut down is also similar except for the outlying days in January 2015. This reinforces the conclusion that the acrolein concentrations measured during January 2015 were outliers and not representative of typical conditions observed in the vicinity of the mill site. Additionally, at Site 2 an outlier was observed on a mill shutdown day at the same concentration as the highest recorded concentration on a mill operation day for that site. The addition of the 2016 through 2018 data does not alter the results and conclusions from the previous analysis.

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[5] - Following meteorological convention, wind is described in the direction it blows from. For example, a northeast wind blows from the northeast and toward the southwest.

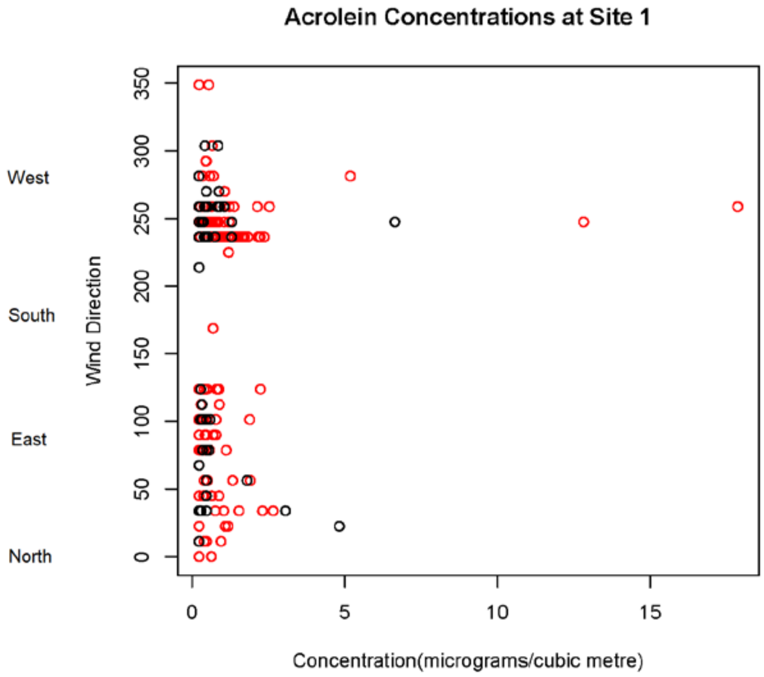

Figure 15: Scatter Plot of Acrolein Concentrations versus Dominant Wind Direction at Site 1

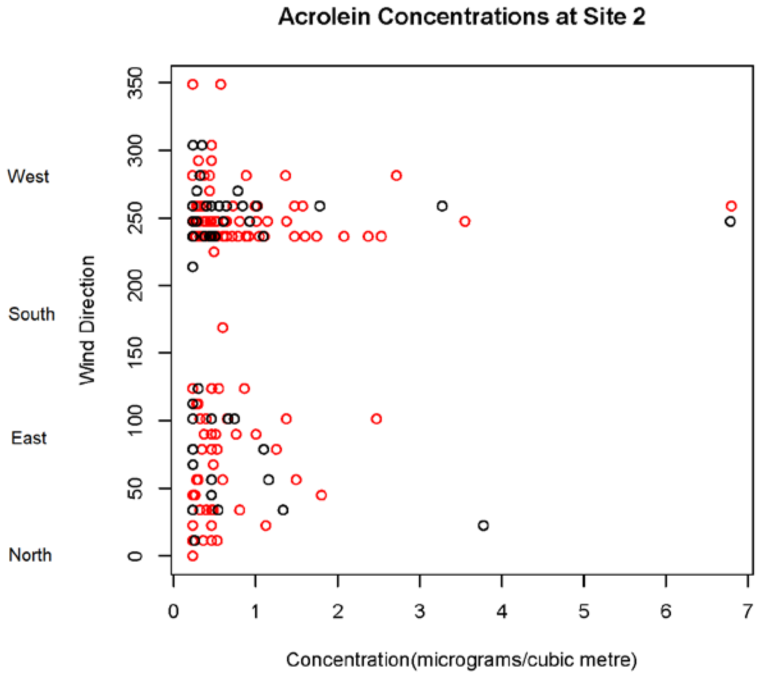

Figure 16: Scatter Plot of Acrolein Concentrations versus Dominant Wind Direction at Site 2

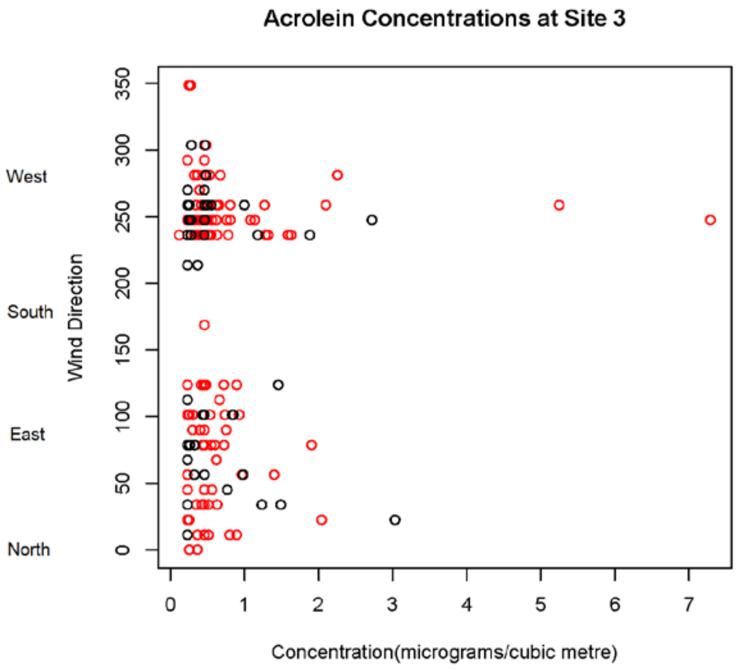

Figure 17: Scatter Plot of Acrolein Concentrations versus Dominant Wind Direction at Site 3

5.0 ANALYSIS OF CONCENTRATIONS ON DAYS OF MILL OPERATION VERSUS SHUT DOWN

A comparison test may be performed to assess whether the measured concentrations are statistically distinct on days for which the mill was operating versus days for which the mill was shut down.

A commonly chosen parametric test to assess the similarity of data sets is the Student’s t-test, which, formally, compares the means of the two datasets. However, the t-test assumes that the distribution of underlying data is normal. As illustrated by the histograms earlier in the report, the distribution of sampled data here is non-normal. Therefore, an alternate test is chosen to assess the similarity of the datasets. Kruskal-Wallis tests are performed to assess the statistical similarity of subpopulations for each sampling site when the mill is operating versus when the mill is not operating. Formally, the Kruskal-Wallis test assesses the probability that a random observation from one group is equally likely to be above or below a random observation from the second group. As such, it is more related to the differences between the medians of two groups, rather than the mean. The null hypothesis for the Kruskal-Wallis test is that the random observation is equally likely to be above or below the second random observation, and consequently, that the populations of observations in the two groups are similar. A p-value of <0.05 allows the user to reject the null hypothesis at the 95 percent confidence level; that is to say, to conclude that the populations of data are from statistically distinct sub-sets. Unlike the Student’s t-test, the Kruskal-Wallis test assumes no particular distribution on the underlying data.

The change in detection limits occurring in 2013, discussed in previous sections, must also be considered here. In principle, it is possible to perform Kruskal-Wallis tests on data sets with non-detect samples. However, as noted in the ProUCL version 5 user guide, the Kruskal-Wallis test will consider all non-detects as equally-ranked observations irrespective of reporting limits. In the case here, this will cause complications because the post-2013 data contains many detected values which are lower than the detection limit of 0.46 µg/m^3 used for samples analyzed in 2011, 2012, and early 2013. Since the presence of multiple detection limits and a number of detected samples with values interspersed between those limits are present in the data here, the data collected before the change in the detection limit in 2013 will not be analyzed. Therefore, the analysis will be performed on data from June of 2013 through 2018. In order to assess whether more recent changes have occurred, the analysis will also be repeated for 2016 through 2018 only.

The Kruskal-Wallis tests all return values >0.05 for each site, for both the 2013-2018 analysis and for 2016-2018 only. This indicates the hypothesis that the statistical behavior of the two sub-populations (days when the mill is operating versus days when it is shut down) is similar and the null hypothesis cannot be rejected with 95 percent confidence. The results are summarized in Table 9.

Table 9: Results of Kruskal-Wallis Tests for Subpopulations of Data on Days of Mill Operation Versus Shut Down

Location	Period	Avg. Conc. When Operating (µg/m^3)	Avg. Conc. When Shut Down (µg/m^3)	p-Value	Populations Statistically Distinct?
Site 1	2013-2018	0.91	0.79	0.58	No
Site 1	2016-2018	0.53	0.59	0.89	No
Site 2	2013-2018	0.52	0.62	0.55	No
Site 2	2016-2018	0.35	0.40	0.19	No
Site 3	2013-2018	0.69	0.53	0.31	No
Site 3	2016-2018	0.36	0.41	0.24	No

The results in Table 9 consider results over the entire year(s). In order to check whether there are any differences in seasonal behavior, the Kruskal-Wallis tests are performed again at each site for each of the four meteorological seasons. As the data pools are smaller upon division into seasons, the analysis is only performed on the 2013-2018 aggregate and not 2016-2018 alone. The results for each site and meteorological season are shown in Table 10.

Table 10: Results of Kruskal-Wallis Tests for Mill Operation/Shutdown by Season

	Site 1			Site 2			Site 3		
Season	Oper. Avg. Conc.	Shut Avg. Conc.	p-Value	Oper. Avg. Conc.	Shut Avg. Conc.	p-Value	Oper. Avg. Conc.	Shut Avg. Conc.	p-Value
MAM	0.47	0.43	0.84	0.48	0.41	0.57	0.46	0.45	0.57
JJA	1.43	0.95	0.08	0.73	0.75	0.73	0.85	0.73	0.65
SON	1.00	0.33	0.18	0.55	0.30	0.73	0.90	0.32	0.29
DJF	0.47	0.43	0.51	0.48	0.41	0.50	0.46	0.45	0.21

Notes:
MAM – March, April, May
JJA – June, July, August

SON – September, October, November
DJF – December, January, February

Of the 12 possible season-site combinations, there are no p-values that indicate a statistically significant difference between concentrations on operational versus shutdown days at the 95 percent confidence level.

6.0 SUMMARY

SLR completed a statistical analysis of acrolein concentrations in air samples collected in the vicinity of the LPC Swan Valley Siding mill near Minitonas, MB. The analyses focused on the period of the entire data record from 2011 through 2018, and for the 2016-2018 data only.

A Kruskal-Wallis test was performed to examine the similarity of data samples gathered on days when the mill was operating versus when it was shut down. As the Kruskal-Wallis test is non-parameteric, it does not rely on underlying assumptions of the distribution of sample data (as would, for example, a t-test). Results indicate the populations of data between operation and shutdown days are similar. Mann-Kendall statistical tests indicated no significant upward trend is found in the measured acrolein concentrations around the mill.

The results of the Kruskal-Wallis test showed that the populations of data are similar from days on which the facility is operating versus days when it is shut down. This is true for each of the three sites, and for both the 2013 to 2018 data period, and for the 2016-2018 data alone. The differences in concentrations between days when the mill is operating versus when the mill is shut cannot be distinguished from random variability with statistical confidence.

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