

# SENES Consultants Limited

## MEMORANDUM

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TO: Kathllen Johnnie, Snuneymuxw First Nation 38094  
cc. Tony Pearse, Tim Howard

FROM: Dan Hrebenyk 11 February 2003

SUBJ: Uncertainty in Harmac Mill PM<sub>10</sub> and PM<sub>2.5</sub> Emission Rates

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In my initial report of the review of the air quality impact assessment conducted by Levelton Engineering Ltd. for the VIGP permit application, I raised the issue of uncertainty in the estimated emission of PM<sub>10</sub> and PM<sub>2.5</sub> emissions from sources at the Harmac Mill. The significance of this issue was re-iterated in the meeting on November 29<sup>th</sup>, and is also addressed in the accompanying memorandum dated February 11, 2003 that addresses differences between modelled and observed PM<sub>10</sub> levels at the Cedar Woodbank monitoring site. The following memorandum addresses issues related to Levelton's use of average PM<sub>10</sub> and PM<sub>2.5</sub> emission rates for the power boilers and recovery boilers at the Harmac mill in the CALPUFF modelling analysis.

To re-state the issue that I raised in my initial report dated October 14, 2002, "*...the PM<sub>10</sub> and PM<sub>2.5</sub> emission rates from the Harmac mill modelled for the VIGP cumulative impact assessment are estimated from average stack sampling results for total suspended particulate matter (TSP), prorated to the PM<sub>10</sub> and PM<sub>2.5</sub> size fractions using factors from the USEPA's AP-42 document rather than actual measured PM<sub>10</sub> and PM<sub>2.5</sub> emissions at the mill*" ..... "There appears to be no requirement for the Harmac mill to monitor PM<sub>10</sub> and PM<sub>2.5</sub> emission rates. Consequently, the emission rates modelled in the VIGP permit application were derived from the USEPA's emission factors. The problem with relying on emission factors is that the use of emission factors introduces a level of uncertainty into the impact assessment which is unacceptable given that the assessment predicts exceedance of ambient air quality objectives." ..... "Therefore, although it may be appropriate to use the emission factors provided in AP-42 for evaluating the potential emissions from the Harmac mill for the purposes of a screening-level air quality impact assessment or for calculating permit fees, the results should not be viewed as definitive estimates of either predicted emissions or ambient concentrations from this particular plant. Actual emissions and impacts may be higher, or lower, than those presented in the VIGP permit application." (B. Hrebenyk, October 14, 2002, pages 46-47).

The USEPA emission factors used by Levelton to estimate PM<sub>10</sub> and PM<sub>2.5</sub> emission rates from the Harmac mill are generalized values for sources having similar characteristics, but they do not reflect actual emission rates from any particular source. On December 30, 2002, Levelton provided SENES

with electronic copies of spreadsheet calculations used to estimate the PM<sub>10</sub> and PM<sub>2.5</sub> emissions from the Harmac mill. Because the power boilers and recovery boilers are the largest sources of PM<sub>10</sub> and PM<sub>2.5</sub> emissions at the Harmac mill, the following discussion will focus primarily on these sources.

Table 1 below provides a summary of the measured total particulate emissions from stack tests conducted 4 times a year, as well as the estimated PM<sub>10</sub> and PM<sub>2.5</sub> emission rates used by Levelton in the CALPUFF dispersion modelling analysis.

**Table 1**  
**Summary Data for Particulate Emissions**  
**From Boilers at the Harmac Mill**

Stack Test (month)	Mill Production Rate (BADt/month)	Measured Total Particulate Emission Rates (g/s)		
		Power Boilers	Recovery Boilers #4 & #5	Recovery Boiler #6
January 2001	33,897	3.53	9.88	2.37
April 2001	28,550	5.05	9.86	2.93
June 2001	35,897	1.49	7.97	5.14
October 2001	35,218	2.19	10.13	4.21
Average		3.06	9.46	3.66
Standard deviation		1.57	1.00	1.25
Particulate Fraction		Estimated PM <sub>10</sub> & PM <sub>2.5</sub> Emission Rates Used in CALPUFF Modelling		
Average	PM <sub>10</sub>	2.25	7.06	2.74
Standard deviation	PM <sub>10</sub>	1.15	0.75	0.94
Average	PM <sub>2.5</sub>	1.94	6.08	2.37
Standard deviation	PM <sub>2.5</sub>	0.99	0.65	0.81

For the power boilers, Levelton assumed that the PM<sub>10</sub> size fraction comprised 73% of the total particulate matter (PM) emissions, while the PM<sub>2.5</sub> size fraction comprised 63% of total PM emissions. Similarly, for the recovery boilers Levelton estimated that 75% of the total PM was comprised of PM<sub>10</sub> and 65% of the total PM was comprised of PM<sub>2.5</sub> emissions. There are two issues related to these figures:

1. Since no actual stack testing for PM<sub>10</sub> and PM<sub>2.5</sub> has been conducted for any of the sources

at the Harmac mill, the estimated fractions for PM<sub>10</sub> and PM<sub>2.5</sub> are purely conjectural, based on calculations using emission factors. The emission of PM<sub>10</sub> and PM<sub>2.5</sub> size fractions are highly dependent on the control efficiencies of the electrostatic precipitators (ESPs) at the Harmac mill, but Levelton has stated that the control efficiencies of the ESPs at Harmac are unknown (e-mail message from R. Humphries, February 7, 2003). Consequently, Levelton used the general values for ESP control efficiency provided in the USEPA AP-42 compilation of emission factors.

2. Regardless of the control efficiency of the ESPs, the use of an average total PM emission rate from quarterly stack test data as the basis for estimating the PM<sub>10</sub> and PM<sub>2.5</sub> emission rates does not address the uncertainty in emission rates due to variability in measured emissions. The standard deviation of the total PM measured in the quarterly stack tests is on the order of  $\pm 50\%$  for the power boilers,  $\pm 10\%$  for recovery boilers #4 and #5, and  $\pm 35\%$  for recovery boiler #6. This variability in measured total PM emission rates translates into uncertainty in estimated PM<sub>10</sub> and PM<sub>2.5</sub> emission rates used in the dispersion modelling analysis, regardless of what ratios to total PM are used to estimate PM<sub>10</sub> and PM<sub>2.5</sub> emissions.

The differences between estimated PM<sub>10</sub> and PM<sub>2.5</sub> based on quarterly stack tests and modelled PM<sub>10</sub> and PM<sub>2.5</sub> in the VIGP permit application are illustrated in Figures 1-3, below. For all three figures, the assumed size fractions used to calculate PM<sub>10</sub> and PM<sub>2.5</sub> emission rates were the same as those used by Levelton.

The figures show that the modelled average PM<sub>10</sub> and PM<sub>2.5</sub> emission rates would tend to underestimate emissions based on some stack test results, and overestimate emissions based on results conducted at other times in the year. This is particularly true for stack tests conducted in April and June 2001 for both the power boilers and recovery boiler #6. The use of average PM<sub>10</sub> and PM<sub>2.5</sub> emission rates does not account for uncertainty in actual emission rates from the Harmac mill for short time periods which may be critical in capturing the impact of these emissions on predicted ambient 24-hour averaged PM<sub>10</sub> and PM<sub>2.5</sub> concentrations. Actual impacts of the Harmac mill on ambient fine particle concentrations may have been underestimated in some instances in the VIGP permit application because the analysis did not account for the variability in emission rates over short time periods. Additional repeat stack testing of actual PM<sub>10</sub> and PM<sub>2.5</sub> emission rates are required to resolve this issue.

Figure 1: Estimated PM<sub>10</sub> and PM<sub>2.5</sub> Emissions From Harmac Mill Power Boilers

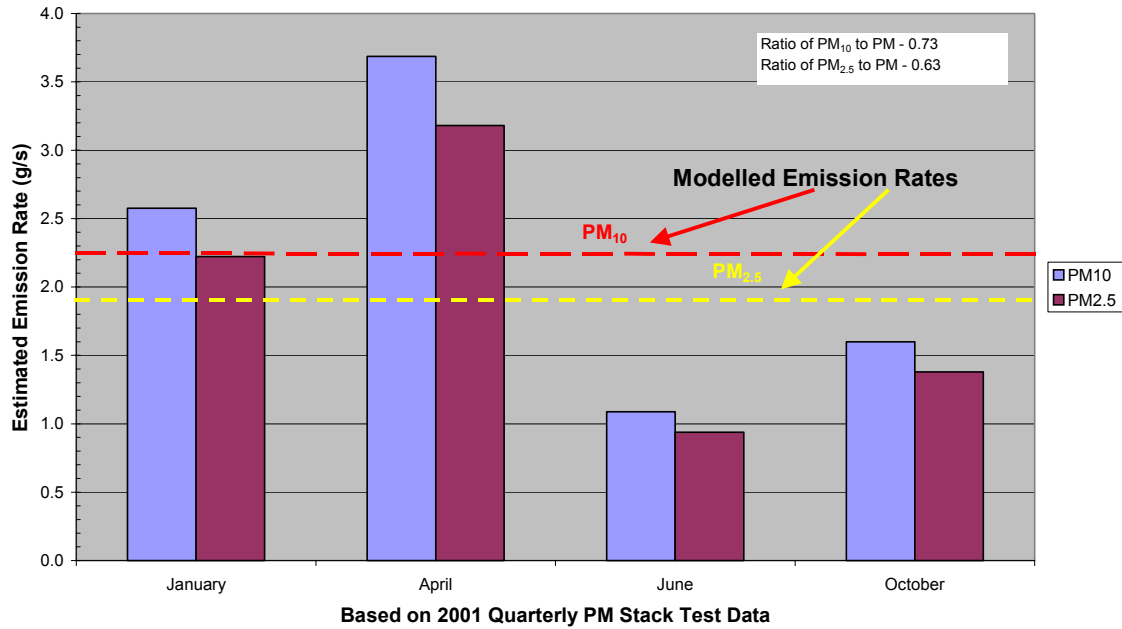


Figure 2: Estimated PM<sub>10</sub> and PM<sub>2.5</sub> Emissions From Harmac Mill Recovery Boilers #4 and #5

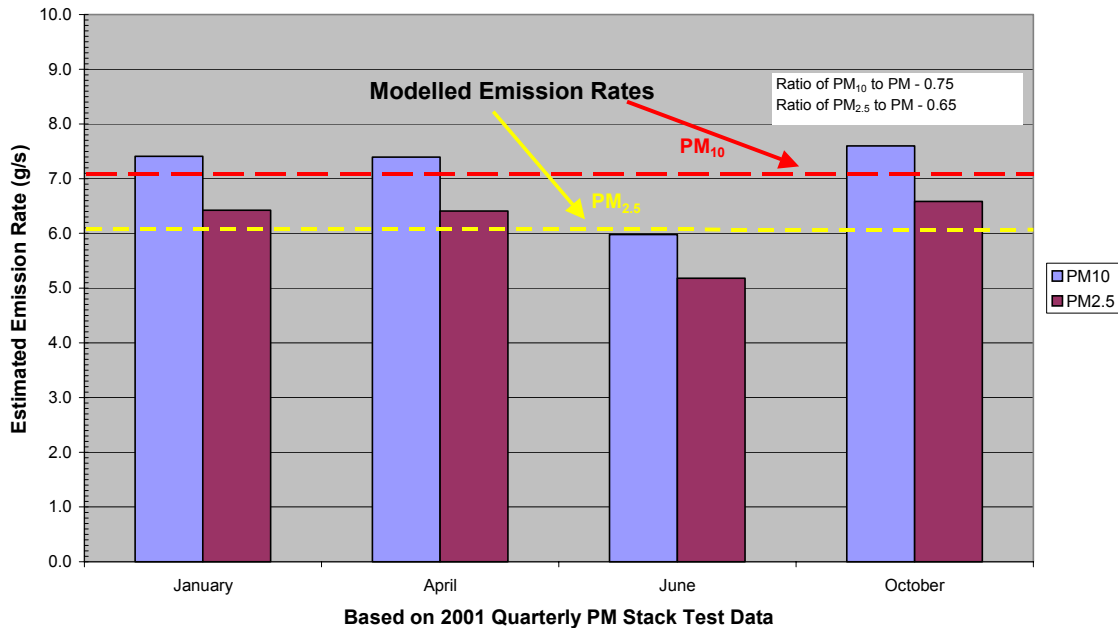
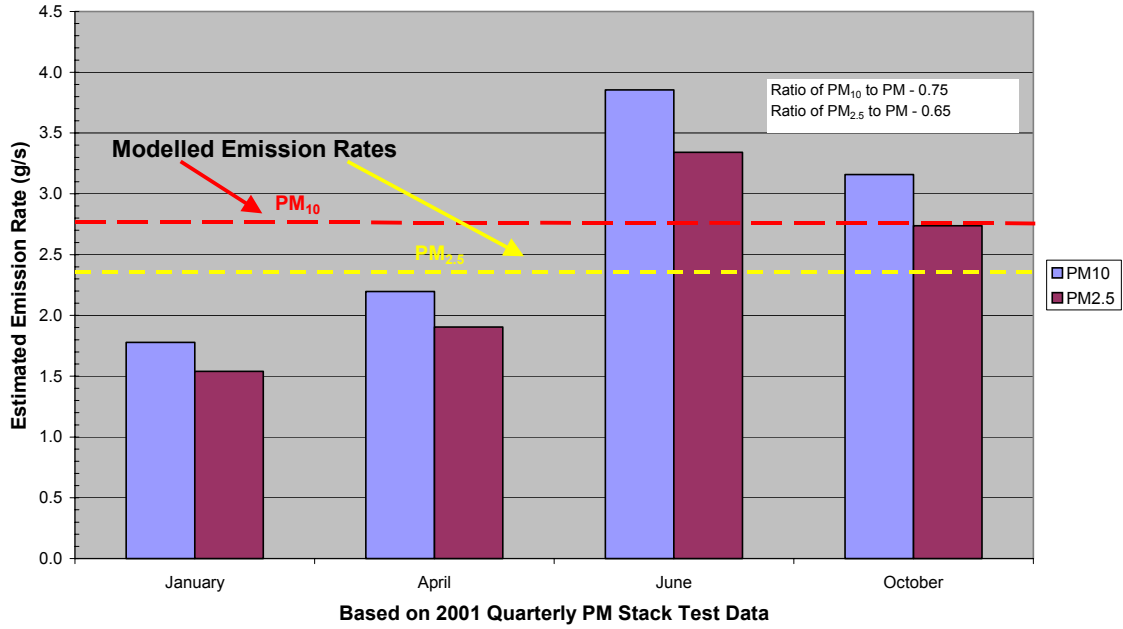


Figure 3: Estimated PM<sub>10</sub> and PM<sub>2.5</sub> Emissions  
From Harmac Mill Recovery Boiler #6



# SENES Consultants Limited

## MEMORANDUM

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TO: Kathleen Johnnie, Snuneymuxw First Nation 38094  
cc. Tony Pearse, Tim Howard

FROM: Dan Hrebenyk 11 February 2003

SUBJ: Contribution of Harmac Mill Emissions to PM<sub>10</sub> Levels  
at the Cedar Woodbank Monitoring Station

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Due to remaining concerns about the uncertainty in the estimated emissions of PM<sub>10</sub> and PM<sub>2.5</sub> from the Harmac mill, I have tried to estimate the relative magnitude of contributions from the mill against measured PM<sub>10</sub> levels at the Cedar Woodbank PM<sub>10</sub> and H<sub>2</sub>S monitoring station.

Based on the CALPUFF modelling conducted by Levelton, the maximum predicted 24-hour average PM<sub>10</sub> concentration in the vicinity of the Cedar Woodbank monitoring station was estimated to be about 5 µg/m<sup>3</sup>. By comparison, the modelling conducted by SENES estimated the maximum contribution from Harmac at about 5-10 µg/m<sup>3</sup>. In an attempt to verify these levels, I have used the H<sub>2</sub>S and PM<sub>10</sub> monitoring data from this site for the period 2000-2001, coupled with meteorological monitoring of wind speed and direction at the Harmac mill. The wind direction measurements were used to determine periods when the monitoring station was downwind of the mill, while the H<sub>2</sub>S measurements were used as an additional marker compound to identify periods when pollutant emissions from the mill would be contributing to pollutant concentrations in the vicinity of the monitoring station.

The results of the analysis suggest that PM<sub>10</sub> concentrations during periods when the winds are blowing from the direction of the Harmac mill are as high as 11-21 µg/m<sup>3</sup> at the Cedar Woodbank monitoring site, or approximately 2-4 times higher than the predicted impact derived from the CALPUFF modelling conducted by Levelton for the Harmac mill emissions, and at least twice as high as the estimated impacts based on the SENES modelling results. The possible implications of these results are:

- 1) the emission inventory used for the dispersion modelling analysis underestimates actual PM<sub>10</sub> emissions from the Harmac mill;
- 2) the differences between predicted and observed contributions are a reflection of the inherent uncertainty in the dispersion modelling analysis; or,

- 3) there are significant sources of Pm10 emission upwind of the Harmac mill that account for the differences between maximum predicted impacts from Harmac and observed PM<sub>10</sub> levels downwind of the Harmac mill.

The first point relates to the lack of any actual stack sampling data for PM<sub>10</sub> emissions from the Harmac mill. The emission inventory for the mill developed by Levelton is based on measured total PM emissions from stack testing data conducted 4 times per year, averaged for the year 2001. The PM<sub>10</sub> emissions were then estimated as a fraction of the total average PM emission rate using emission factors from the U.S. Environmental Protection Agency's (USEPA) AP-42 compilation of factors. These factors are generalized values for sources in particular industry sectors, and do not reflect actual emission rates from any particular source. Therefore, their use does not necessarily represent an accurate estimate of actual PM<sub>10</sub> emission from the Harmac mill. I will have more to say about this issue in a separate report that will follow. The point here is that there is uncertainty about the actual PM<sub>10</sub> (and PM<sub>2.5</sub>) emission from the Harmac mill, and the differences between maximum predicted and maximum observed PM<sub>10</sub> concentrations at the Cedar Woodbank monitoring station during periods when the station is downwind of the Harmac mill may be a reflection of that uncertainty.

Alternatively, the differences between predicted and observed PM<sub>10</sub> concentrations at the monitoring station may simply be a reflection of the inherent uncertainty in the modelling analysis. Gaussian dispersion models are considered to have an inherent uncertainty on the order of a factor 2-4 for maximum predicted concentrations. That is to say, the predicted values are expected to be within a factor of 2 most of the time, but may differ from actual observed concentrations by as much as a factor of 4. The observed differences between measured and predicted PM<sub>10</sub> concentrations at the Cedar Woodbank monitoring station fall within that range of inherent modelling uncertainty. Consequently, even if the estimate of PM<sub>10</sub> emissions from the Harmac mill are considered accurate, the CALPUFF model may still be underestimating the impact of the mill's emissions on PM<sub>10</sub> concentrations in the vicinity of the monitoring station. Furthermore, the inherent modelling uncertainty would not be restricted to PM<sub>10</sub> alone, but would also apply to the modelling of all other pollutants emitted by both the Harmac mill and proposed VIGP plant.

The third possibility is that there are significant sources of PM<sub>10</sub> north of the Harmac mill which account for a significant portion of the observed PM<sub>10</sub> concentrations during periods when winds blow from the north towards the Cedar Woodbank monitoring site. As there are no monitoring stations located directly north of the Harmac mill (i.e., over the Northumberland Channel), there is

no way to verify what level of 'background' PM<sub>10</sub> exists upwind of the Harmac mill during periods of northerly winds.

In order to estimate the potential contribution of the Harmac mill's PM<sub>10</sub> emissions on observed levels of PM<sub>10</sub> at the monitoring site, the data record for hourly observed H<sub>2</sub>S and PM<sub>10</sub> levels was examined in the following manner:

- 1) All days on which the observed daily PM<sub>10</sub> level was greater than 20 µg/m<sup>3</sup> were extracted from the 2 year record, yielding a total of 21 days.
- 2) Wind direction data from the monitoring station at the Harmac mill were then examined to identify those periods of each day during which the monitoring site would have been downwind of the mill. The mill is located at approximately 350<sup>0</sup> north of the monitoring station. Winds within a n arc of  $\pm 22.5^0$  (i.e., from 327<sup>0</sup> to 12.5<sup>0</sup>) were considered to be indicative of transport from the mill to the monitoring site.
- 3) The wind direction data were supplemented by observed H<sub>2</sub>S concentrations as an indicator that pollutant emissions from the mill were being carried to the monitoring site.

Figures 1-4 provide examples of days on which the observed PM<sub>10</sub> concentrations during periods when the winds were blowing from the direction of the Harmac mill appear to substantially exceed the level of 5 µg/m<sup>3</sup> estimated by Levelton through CALPUFF modelling. It should be noted, however, that not all instances of elevated PM<sub>10</sub> concentrations at the Cedar Woodbank monitoring site are necessarily the result of emissions from the Harmac mill. Figure 5 provides an example of a day on which PM<sub>10</sub> concentrations exceeded 20 µg/m<sup>3</sup>, little or none of which could be attributable to the Harmac mill based on recorded wind directions. Each figure is described in detail below.

### **Figure 1: April 11, 2000**

On this date, the daily average PM<sub>10</sub> level recorded at the Cedar Woodbank monitoring station was 23 µg/m<sup>3</sup>. The monitoring station was downwind of the Harmac mill from 8:00 am to 6:00 pm. The hourly PM<sub>10</sub> concentrations recorded during this time ranged from 16 µg/m<sup>3</sup> to 50 µg/m<sup>3</sup>, resulting in a total 24-hour average PM<sub>10</sub> concentration of 13.5 µg/m<sup>3</sup>. Thus, more than half of the daily average PM<sub>10</sub> concentration at this location occurred while the monitoring station was downwind of the Harmac mill. This is supported by the fact that hourly H<sub>2</sub>S concentrations were elevated throughout this period, ranging from a low of 4.3 µg/m<sup>3</sup>, and peaking at 9.9 µg/m<sup>3</sup> on three occasions.

In fact, H<sub>2</sub>S concentrations remained at measurable levels after 6:00 pm until midnight, even though the monitoring station was no longer directly downwind of the Harmac mill, as indicated by measured wind direction. Wind speeds during this period (i.e., after 6:00 pm) were very low, ranging from 0.4 to 1.5 m/s. At such low wind speeds, the measured wind direction is no longer a good indicator of direct transport of pollutants because pollutants tend to be transported in a meandering path. The fact that measurable levels of H<sub>2</sub>S continued to be recorded during this period is a further indication that PM<sub>10</sub> emissions from the Harmac mill would have also contributed to the observed PM<sub>10</sub> concentrations to some degree. The 24-hour average PM<sub>10</sub> concentration for levels recorded between 8:00 am and midnight on this date was 18.5 µg/m<sup>3</sup>, most of which (13.5 µg/m<sup>3</sup>) was recorded between 8:00 am and 6:00 pm.

Figure 1: Trend in Hourly PM<sub>10</sub> and H<sub>2</sub>S Concentrations  
Cedar Woodbank Monitoring Station  
April 11, 2000

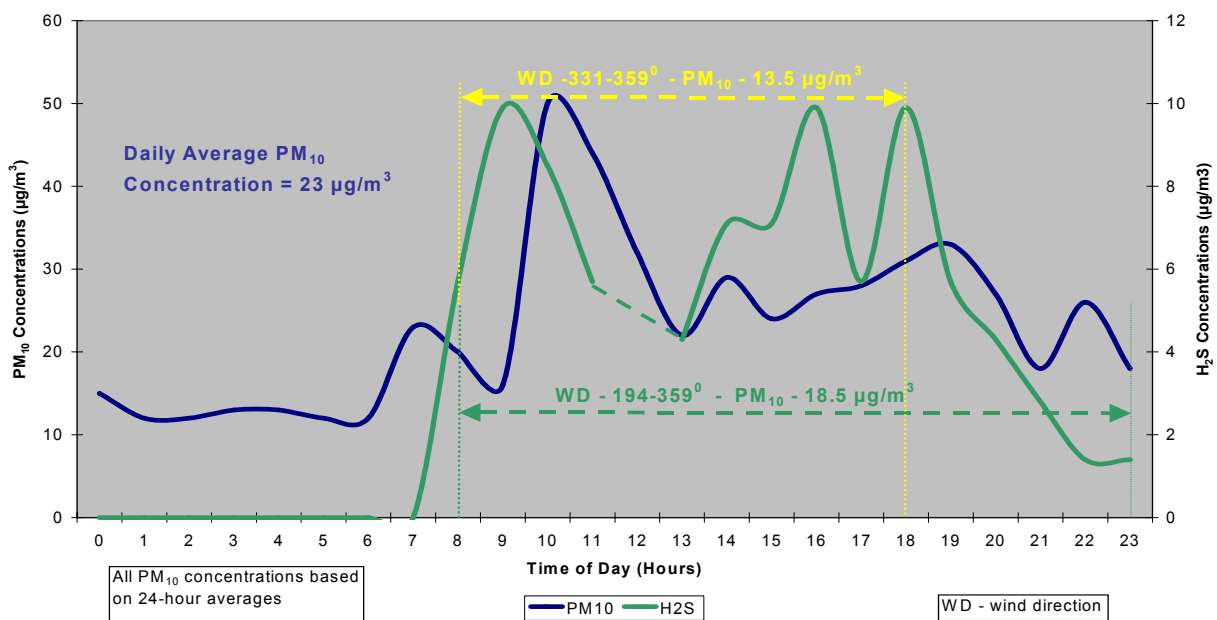


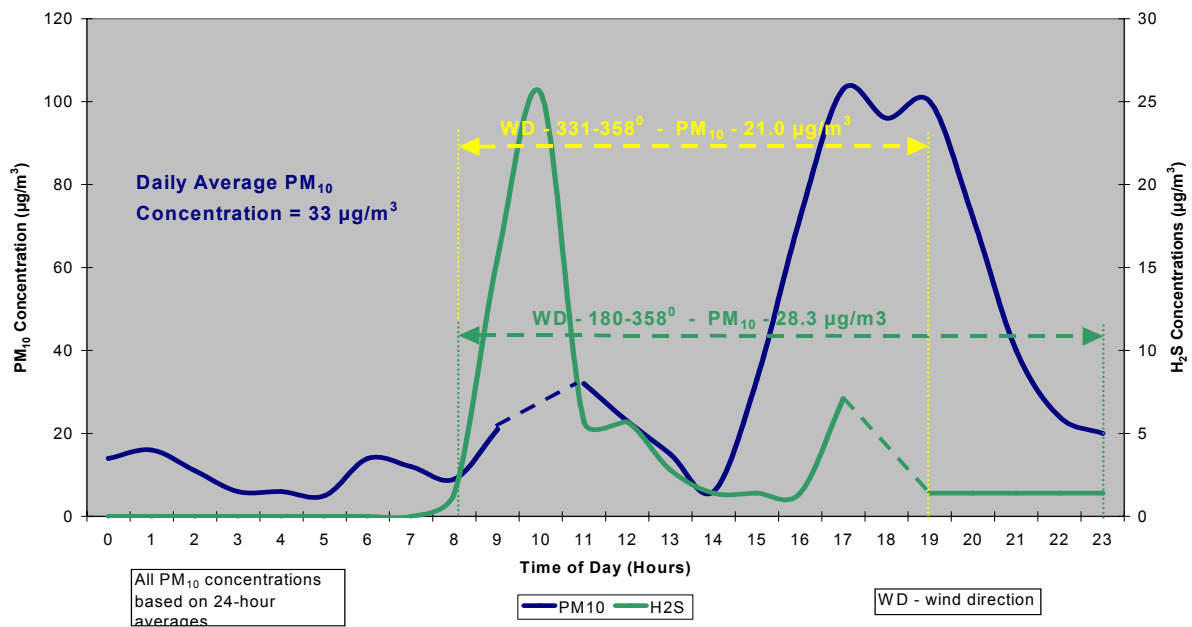
Figure 2: April 17, 2000

The daily average PM<sub>10</sub> concentration recorded at the Cedar Woodbank monitoring station on this date was 33 µg/m<sup>3</sup>. Measured wind directions place the monitoring station downwind of the Harmac mill for the period from 8:00 am to 7:00 pm, with only one exception at 2:00 pm when the wind direction was outside the  $\pm 22.5^\circ$  arc at  $311^\circ$ . The measured H<sub>2</sub>S levels peaked at over 25 µg/m<sup>3</sup> at 10:00 am, but the data record for the PM<sub>10</sub> monitor shows no data for that hour. Consequently, the

actual PM<sub>10</sub> levels for the period 8:00 am to 7:00 pm are underestimated. Nevertheless, excluding the hour of missing PM<sub>10</sub> data at 10:00 am as well as the PM<sub>10</sub> level at 2:00 pm, the 24-hour average PM<sub>10</sub> concentration during the period 8:00 am to 7:00 pm was 21 µg/m<sup>3</sup>. Thus, almost two-thirds of the daily average PM<sub>10</sub> level was attributable to transport of PM<sub>10</sub> emissions from the direction of the Harmac mill.

Lower levels of H<sub>2</sub>S continued to be recorded at the Cedar Woodbank monitoring station after 7:00 pm until midnight. Wind speeds were less than 1 m/s from 8:00 to 10:00 pm, rising to 2 m/s until midnight. For the period of measurable H<sub>2</sub>S levels from 8:00 am to midnight, the 24-hour average PM<sub>10</sub> concentration is 28.3 µg/m<sup>3</sup>. While not all of the PM<sub>10</sub> levels recorded after 7:00 pm may be attributable to the Harmac mill, the greater part of the PM<sub>10</sub> recorded (21 µg/m<sup>3</sup>) occurred while the monitoring station was directly downwind of the mill.

Figure 2: Trend in Hourly PM<sub>10</sub> and H<sub>2</sub>S Concentrations  
Cedar Woodbank Monitoring Station  
April 17, 2000

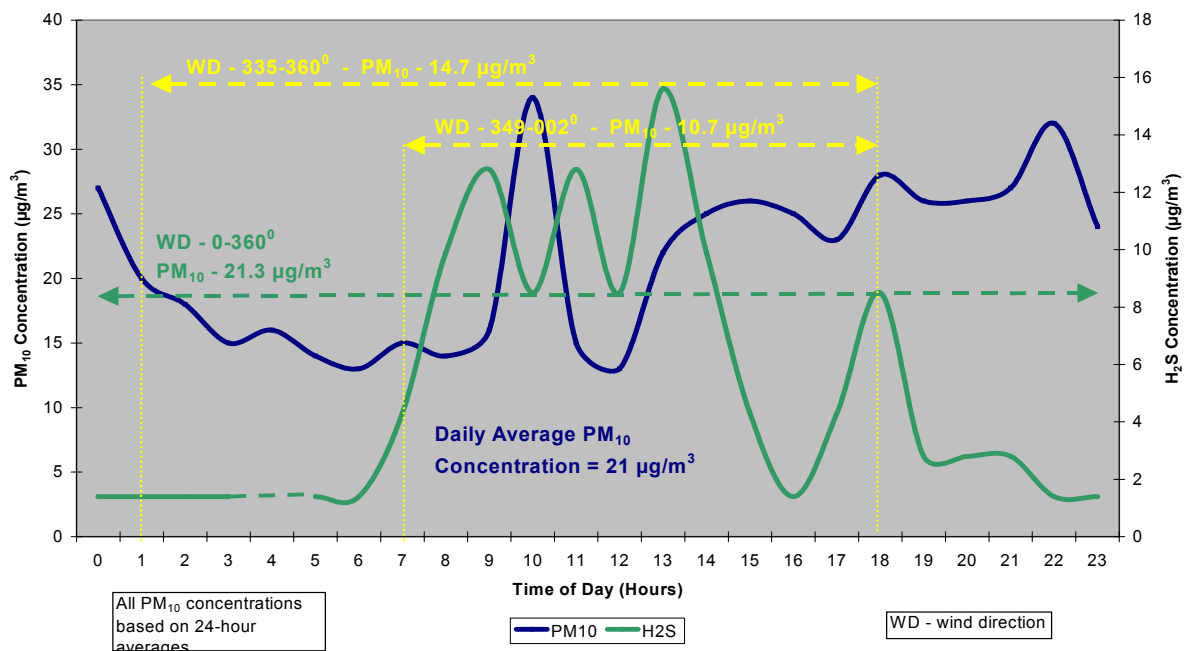


**Figure 3: August 11, 2001**

The daily average PM<sub>10</sub> concentration at the Cedar Woodbank monitoring station on August 11, 2001 was recorded as 21 µg/m<sup>3</sup>. On this date, the monitoring station was downwind of the Harmac mill from 1:00 am to 6:00 pm. Measurable H<sub>2</sub>S concentrations were recorded in all hours of the day, with the exception of missing data at 4:00 am. The period of elevated H<sub>2</sub>S concentrations extended from 7:00 am to 6:00 pm. During the period when the monitoring station was downwind of the Harmac mill (i.e., from 1:00 am to 6:00 pm), the PM<sub>10</sub> concentration, averaged over 24-hours, was 14.1 µg/m<sup>3</sup>, accounting for two-thirds of the observed daily average concentration.

Over the period of elevated H<sub>2</sub>S concentrations from 7:00 am to 6:00 pm, the 24-hour averaged PM<sub>10</sub> concentration was 10.7 µg/m<sup>3</sup>. During this shorter period, the recorded wind directions varied from 349° to 2°, placing the monitoring station almost directly downwind of the Harmac mill during the entire period.

**Figure 3: Trend in Hourly PM<sub>10</sub> and H<sub>2</sub>S Concentrations  
Cedar Woodbank Monitoring Station  
August 11, 2001**



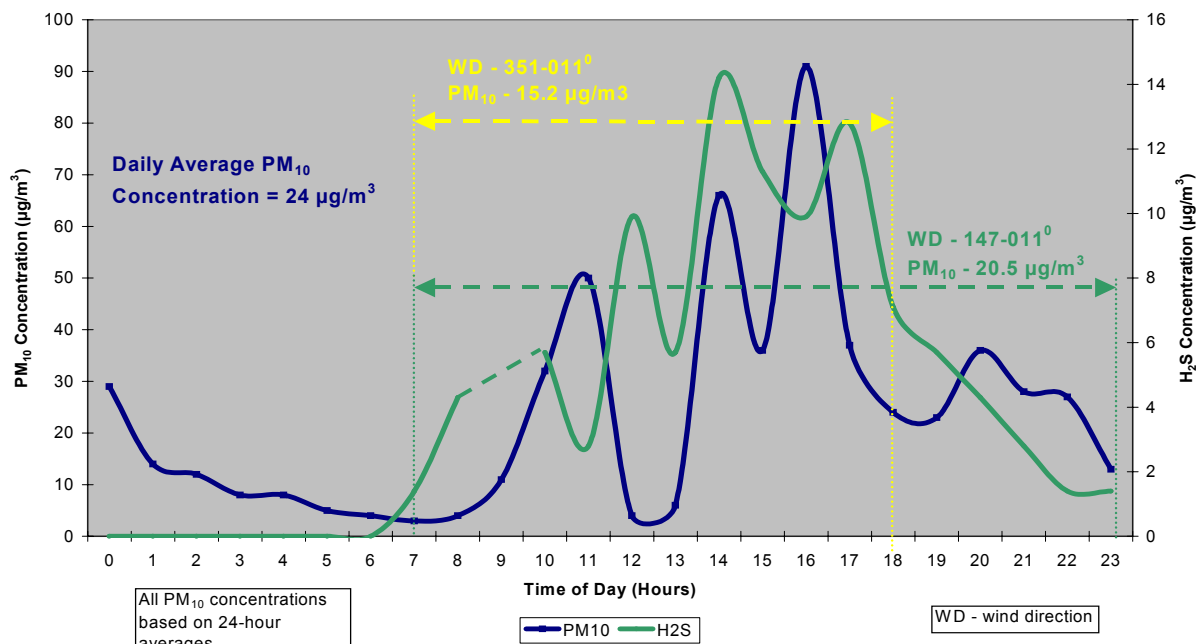
For those hours between 6:00 pm and midnight, wind speeds were around 1 m/s or less, making for poor dispersion conditions. During these periods, the wind direction measured at the Harmac mill

was not a good indicator of the direction of pollutant transport. Given that H<sub>2</sub>S was present during all hours of the day, it would be reasonable to assume that some portion of the PM<sub>10</sub> levels recorded during all hours of the day were also attributable to the Harmac mill, even when the recorded wind direction does not appear to place the monitoring site downwind of the mill.

#### Figure 4: September 10, 2001

The average daily PM<sub>10</sub> concentration on September 10, 2001 was 24 µg/m<sup>3</sup>. Based on wind direction data, the monitoring station at Cedar Woodbank was downwind of the Harmac mill at 1:00 am, 3:00 am, and continuously from 5:00 am to 6:00 pm. Measurable H<sub>2</sub>S concentrations began to be recorded at 7:00 am, and continued to be recorded for the remainder of the day, with the exception of missing data at 9:00 am. For the period beginning at 7:00 am when measurable H<sub>2</sub>S levels began to be observed, until 6:00 pm when the H<sub>2</sub>S levels began to drop, the monitoring station was consistently downwind of the Harmac mill. During this period, the measured PM<sub>10</sub> levels averaged 15.2 µg/m<sup>3</sup> on a 24-hour basis. Thus, almost two-thirds of the observed daily average PM<sub>10</sub> concentration was recorded during this period when the monitoring station was located downwind of the Harmac mill.

Figure 4: Trend in Hourly PM<sub>10</sub> and H<sub>2</sub>S Concentrations  
Cedar Woodbank Monitoring Station  
September 10, 2001

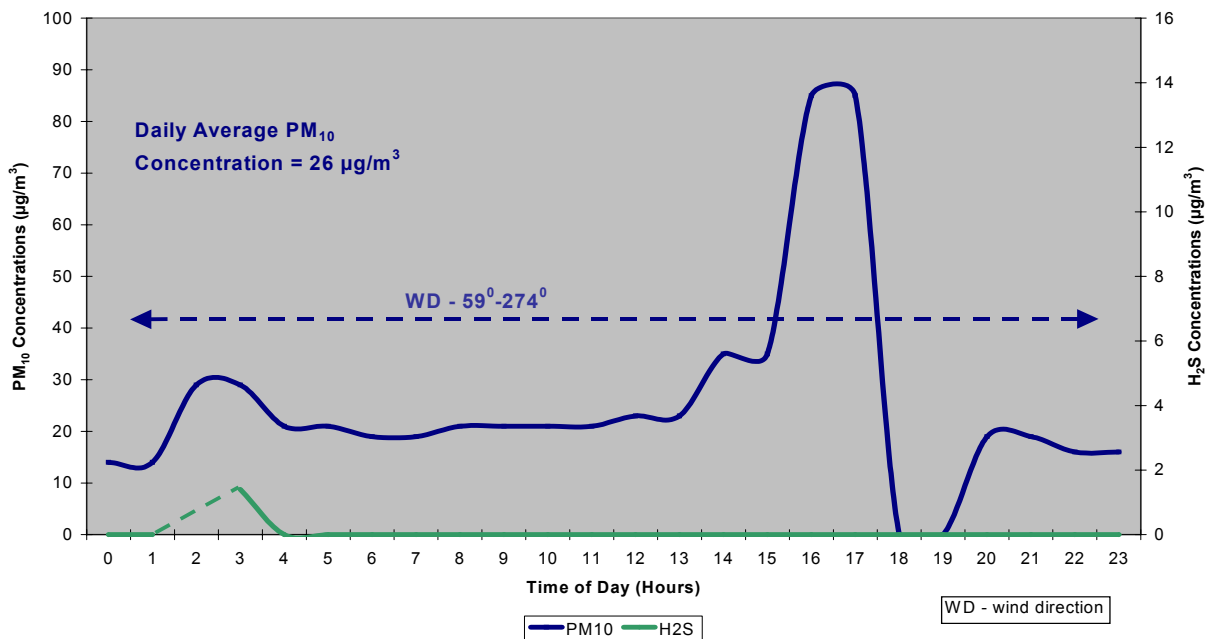


Since H<sub>2</sub>S concentrations continued to be recorded after 6:00 pm until midnight, some portion of the PM<sub>10</sub> levels recorded in the evening hours could also be attributed to the Harmac mill as well. During this period, wind speeds averaged from less than 1.5 m/s to less than 1 m/s.

**Figure 5: September 13, 2000**

Figure 5 provides an example of a day when PM<sub>10</sub> concentrations at the Cedar Woodbank monitoring site exceeded 20 µg/m<sup>3</sup>, little or none of which would likely have been attributable to the Harmac mill. Except for a low reading of H<sub>2</sub>S recorded at 3:00 am (the 2:00 am reading was missing), there were no measurable levels of H<sub>2</sub>S recorded during the remainder of the day. Wind directions throughout the day ranged from ENE (59°) to W (274°), ensuring that there was little chance for transport of pollutants from the Harmac mill to the monitoring site. Nevertheless, the observed daily average PM<sub>10</sub> concentration of 26 µg/m<sup>3</sup> indicates that there exist substantial sources of background PM<sub>10</sub> in the area, in addition to emissions from the Harmac mill.

**Figure 5: Trend in Hourly PM<sub>10</sub> and H<sub>2</sub>S Concentrations  
Cedar Woodbank Monitoring Station  
September 13, 2000**



## CONCLUSIONS

Close examination of the monitoring data from the Cedar Woodbank station suggests that the impact of PM<sub>10</sub> emissions from the Harmac mill may be substantially higher than was indicated by the CALPUFF modelling analysis presented by Levelton for the VIGP permit application. Specifically, whereas the modelling analysis concluded that the maximum impact of PM<sub>10</sub> emissions from the Harmac mill in the vicinity of the Cedar Woodbank monitoring station was only about 5 µg/m<sup>3</sup>, the observed PM<sub>10</sub> concentrations during 2000-2001 at the monitoring station were at times on the order of 2-4 times higher during periods when the station was downwind of the Harmac mill. Four examples have been presented which indicate that, for those periods when the monitoring station was downwind of the Harmac mill and there were elevated levels of H<sub>2</sub>S as a marker compound for emissions from the mill, 24-hour averaged PM<sub>10</sub> concentrations ranged from 10.7 µg/m<sup>3</sup> to 21 µg/m<sup>3</sup>.

The H<sub>2</sub>S measurements also provide an indication of the lingering effects of emissions from the Harmac mill during the evening hours when wind speeds drop to low levels, and wind direction is no longer an effective indicator of the source of the pollutants. For the four examples cited above, the 24-hour averaged PM<sub>10</sub> concentrations ranged from 18.5 µg/m<sup>3</sup> to 28.3 µg/m<sup>3</sup> during periods of measurable H<sub>2</sub>S levels. While the Harmac mill may not be responsible for all of the PM<sub>10</sub> measured during these periods, the lingering levels of H<sub>2</sub>S provide an indication that the contributions of PM<sub>10</sub> from the mill may continue to affect PM<sub>10</sub> levels even when the measured wind direction does not appear to coincide with direct pollutant transport from the mill.

The possible explanations for the differences between the observed PM<sub>10</sub> levels and model-predicted maximum impacts are these:

- 1) the emission inventory prepared by Levelton for the Harmac mill underestimates actual PM<sub>10</sub> emissions (and by extension PM<sub>2.5</sub> emissions) from the mill;
- 2) the differences between predicted and observed PM<sub>10</sub> levels are a reflection of inherent modelling uncertainty; or,
- 3) there are other significant sources of PM<sub>10</sub> emission north of the Harmac mill which account for the observed differences between modelled and measured PM<sub>10</sub> concentrations.

If the PM<sub>10</sub> emission inventory has underestimated PM<sub>10</sub> emissions from the Harmac mill, then the predicted impacts of the mill are higher than reported in the VIGP application. Since there are no

actual measurements of PM<sub>10</sub> emissions for the Harmac mill, there is no way to verify whether or not the emission inventory is accurate. The same conclusion would apply to the PM<sub>2.5</sub> concentrations, as the PM<sub>2.5</sub> emissions were determined using the same methodology. Only stack sampling of PM<sub>10</sub> and PM<sub>2.5</sub> emissions from the Harmac mill can resolve this issue.

On the other hand, if the differences between predicted and observed PM<sub>10</sub> concentrations are an indicator of modelling uncertainty, then that uncertainty must also apply to all predicted impacts, for all pollutants from both the VIGP plant as well as from the Harmac mill. There would be no way to resolve such uncertainty other than through additional ambient monitoring.

Lastly, there is the question of whether there are any sources located north of the Harmac mill which would be sufficiently large to account for the differences between modelled and observed PM<sub>10</sub> concentrations during periods of northerly winds. As there is no place where a monitoring station can be located in the Northumberland Channel, there appears to be no simple way to answer this question.