Beachville Area Air Quality Assessment

Final Report

In partnership with Public Health Ontario April 26, 2016

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Acknowledgements:

Thank you to the Beachville area community for your support, cooperation and participation throughout the Beachville Area Air Quality Assessment.

Thank you to Amy Faulkner (Shared Library Services Partnership Librarian), Public Health Ontario, the Ministry of Environment and Climate and Change, the University of Guelph, and industry stakeholders.

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Executive Summary

The purpose of this report is to share the findings and actions that have risen from the Beachville Area Air Quality Assessment (BAAQA). The BAAQA consisted of the following: a communication strategy that emphasized a commitment to inform and engage the Beachville area community and relevant stakeholders about activities supporting the assessment; a comprehensive scoping literature review to obtain an overall view on the potential human health effects of community exposure to dust generated from aggregate operations; and local air sampling comprising of the collection, analysis and interpretation of new local air quality data within selected locations in the Beachville area.

Findings from the Beachville area air sampling, captured by Oxford County Public Health (OCPH) and Public Health Ontario (PHO) between May and August 2015 and October and November 2015, exhibited that 24-hour averages of $PM_{2.5}$ and PM_{10} were lower than the Canadian Ambient Air Quality Standards (CAAQS) of 28 µg/m³ and the interim PM10 Ambient Air Quality Criteria (AAQC) of 50 µg/m³. A single day at one of the sites exceeded the CAAQS guideline for $PM_{2.5}$. The CAAQS and AAQC were used as a benchmark for comparison in the absence of guidelines for 2-week or 24-hour sampling. These results align with findings of the Ministry of the Environment and Climate Change (MOECC) air monitoring program (August 2013 to January 2014). Further, the air monitoring conducted by OCPH and PHO provided evidence of episodic short-term (less than one hour) peaks of larger Particulate Matter (PM). Larger PM could relate to quarry activity and other dust events.

Findings from the scoping literature review identified one article from Fumane, Italy as being directly relevant to the Beachville area. The study findings showed that even though annual concentrations of PM_{10} were below the EU limits during the study period, a statistically significant 2.5% increase in school absenteeism was detected 2 days after the spike with each 10 ug/m^3 increase in PM_{10} (or spike in PM_{10} (Marcon et al., 2014). Investigations are ongoing in Fumane to evaluate how specific emissions may impact the local air quality.

In conclusion, OCPH will:Conduct further air monitoring for the next twelve (12) months on a random basis to generate an enhanced understanding of the frequency and duration of ‘dust events’ occurring in the community of Beachville.

i. Collaborate with the Community and Strategic Planning Department, to explore the feasibility of incorporating air quality studies for new quarry applications.
ii. Keep the community and stakeholders informed of the practices and activities that support air quality improvement efforts within Beachville.
iii. Pilot a new telephone surveillance system in the fall of 2016 titled the Oxford Health Matters Survey, to capture data on key public health indicators related to air quality in Oxford County.

Abbreviations

AAQC	Ambient Air Quality Criteria
BAAQA	Beachville Area Air Quality Assessment
CAAQS	Canadian Ambient Air Quality Standards
CWS	Canada Wide Standards
EIPH	Evidence informed public health
EOH	Environmental and Occupational Health
EU	European Union
IAP2	International Association for Public Participation
MOECC	Ministry of Environment and Climate Change
OCPH	Oxford County Public Health
PHI	Public Health Inspector(s)
PHO	Public Health Ontario
PM	Particulate matter
$PM_{2.5}$	Fine particulate matter
PM_{10}	Coarse particulate matter
ppb	Parts per billion
SLSP	Shared library services partnership librarian
UoG	the University of Guelph
$\mu g/m^3$	Micrograms per cubic metre

1. Introduction

1.1 Background

Oxford County is characterized by significant reserves of mineral aggregates. Extensive thick deposits of high calcium limestone in the Zorra and South-West townships are of primary importance because they contain the most uniform and the purest limestone found in Ontario. Situated near the Beachville area are three industrial quarrying operations. A fourth site operates a separate aggregate operation within one of the three existing sites.

From these sites, cement and lime are manufactured using high quality limestone. Extraction and manufacturing activities include drilling, blasting, excavation, loading, hauling, crushing, screening, material handling, processing, stockpiling and storing. These processes contribute to aerosolizing particles made up of limestone, dust, and organic matter. Airborne particles include minute dust, as well as organic and inorganic materials that combine to produce what is known as particulate matter (PM). Structurally, particulate is composed of a solid core, frequently with a liquid covering, and its composition varies with place, season, and weather conditions.

In 2003, the Ministry of Environment and Climate Change (MOECC) released a report titled, "A Summary of Air Monitoring in the Beachville Area." The components of the Action Plan were implemented with varying degrees of success. For example, the Best Management Practices and inspections components were carried out as expected, but the MOECC acknowledged concerns about the air monitoring data collected and possible issues with the reliability of the data collected through the Industry-led Source Emissions Monitoring Program between 2003 and 2013. Based on these concerns, OCPH staff determined that further monitoring and improvement efforts were warranted.

The Beachville Area Air Quality Assessment (BAAQA) Work Plan was initially approved at the June 25, 2014 County Council meeting in Report No. CAO 2014-08 and refreshed at the January 28, 2015 meeting, as outlined in Report No. PHES 2015-01. The purpose of the assessment was to provide information on which to base risk management decisions about air quality in the Beachville area. The assessment aimed to:

i. Assess particulate information that reflects current environmental conditions across Beachville area;

ii. Compare observed particulate matter levels to Ministry standards, Ambient Air Quality Criteria (AAQC), interim guidelines, and the Canadian Ambient Air Quality Standards;

iii. Identify possible short-term trends in local particulate matter concentrations;

iv. Review evidence concerning the potential human health impacts of nearby community exposure to particulate matter generated by aggregate operations; and

v. Increase public engagement in practices and activities that support air quality improvement efforts in the Beachville area.

The implementation of the work plan involved extensive collaboration with Public Health Ontario (PHO). Additional academic and research expertise was provided through a partnership with the Department of Population Medicine at University of Guelph (UofG) and Shared Library Services Partnership Librarian (SLSP) of Simcoe-Muskoka District Health Unit for Oxford. The assessment was further enriched through engagement and consultation with members of the community, representatives of the aggregate industries, and the MOECC.

1.2 Common Air Pollutants & Health Risks Associated with Aggregate Operations

Particulate matter (PM) is characterized according to size because of the different health and environmental effects associated with particles of different diameters (Cheng et al. 2014, Dockery et al. 1993, Grantz et al. 2003, Jones et al. 2014, Miller et al. 1979, Samet et al. 2000, Toren et al. 2007). Particles with a diameter greater than 10 µm have a relatively small suspension half-life and are largely filtered out by the nose and upper airway.

Researchers define a diameter between 2.5 µm and 10 µm as “coarse,” and less than 2.5 µm as “fine.” Fine particulate matter ($PM_{2.5}$), also known as respirable particles, can penetrate the respiratory system further than larger particles (Miller et al. 1979). Numerous studies have linked exposure to PM to aggravated cardiac and respiratory diseases such as asthma, bronchitis, emphysema, and cardiovascular disease; increased hospitalizations; and premature mortality (Cheng et al. 2014, Dockery et al. 1993, Miller et al. 1979, Ruckerl et al. 2006, Samet et al. 2000, Toren et al. 2007, Yorifuli et al. 2014).

People with asthma, cardiovascular or lung disease, as well as children and elderly people, are considered to be the most sensitive to the effects of fine PM. Visibility deterioration, and regional haze can also be attributed to PM (Grantz et al. 2003, Jones et al. 2014).

2. Community, Stakeholder Engagement & Relations Campaign

2.1 Inform & Engage Strategy

In 2013, Oxford County adopted a strategic plan that emphasized a commitment to better inform and engage its communities. In keeping with this strategy, OCPH was committed to partnering with members of the community throughout the entirety of the BAAQA to fulfill the goals of the review. Specifically, OCPH drew upon aspects of the International Association for Public Participation (IAP2) spectrum of community engagement to ensure members of the Beachville area and relevant stakeholders were:

- **Informed** about the air quality in the Beachville area and informed about the health impacts associated with particulate matter;
- **Consulted** with regard to their perceptions about the air quality in the Beachville area and the preparation of the BAAQA work plan;
- **Involved** to verify the their concerns were understood and considered;
- **Collaborated** with in all facets of the assessment including the decision making processes; and
- **Empowered** to participate in the development and delivery of the BAAQA work plan.

Examples of how this theoretical framework was applied are stated in the following section.

2.2 Community & Stakeholder Involvement

Over the course of the assessment, OCPH carried out an extensive communication and engagement campaign to keep the community and interested stakeholders informed about OCPH's ongoing activities related to the BAAQA work plan. Activities that were part of the awareness building phase included:

- **Online "hub."** A dedicated section on Speak Up, Oxford!, the County's "online town hall," was established to keep people up to date on activities related to the assessment, link to resources, and a conduit to submit comments or questions.
- **Public meeting.** A Public Information Session held on July 23, 2014 at the Colombo Club in Beachville was part of a first step in gathering feedback and information from the community. A second Public Information Session was held on February 11, 2015 to present the BAAQA work plan. A third Public Information Session was held on September 1, 2015 to present the preliminary findings of the BAAQA.
- **Media relations, social media and advertising.** The assessment was launched through a news release to the community, with social media serving to keep people updated at key milestones. Advertising in local media was undertaken as part of the public meetings.
- **Community presentations.** Presentations open to the public were made at Oxford County Council and Township of Zorra Council.

- **Air monitor hosting by residents.** OCPH sought local residents who were able to host temporary air monitoring equipment on their properties in the Beachville area. The monitors collected information about local exposure to particulate matter in the air and represented an opportunity to directly involve affected residents in the assessment. Interested residents were asked to contact OCPH.
- **Community consultations.** Discussions were held with members of the Beachville area community to obtain feedback on the work plan, and to share results of the various stages of the BAAQA.
- **Industry consultations.** Discussions were held with industry stakeholders to better understand operations and best management practices, while results were shared throughout the various stages of the BAAQA.
- **Ministry consultations.** Discussions were held with the MOECC to obtain technical support throughout the BAAQA.

Action

OCPH will keep the community and stakeholders informed of the practices and activities that support air quality improvement efforts within Beachville

Moving forward, OCPH will continue to utilize the Inform and Engage strategy as a way to keep the community and area stakeholders informed about the outcomes of the action items expressed in this report.

3. Literature Review

3.1 Methodology

Evidence-Informed Public Health (EIPH) is a process of distilling and disseminating the best available evidence from research, context and experience, and using that evidence to inform and improve public health practice and policy (National Collaborating Centre for Methods and Tools, 2012). The EIPH process was used to guide the literature review component of the BAAQA because it is an effective means of organizing work and leads towards evidence that is locally relevant to the Beachville area community.

In partnership with PHO, the SLSP and the UoG, OCPH completed a detailed scoping literature review to answer the following research question:

> "What are the potential health effects of nearby community exposure to dust generated from aggregate operations, including coarse and fine particulate matter (i.e. PM_{10} and $PM_{2.5}$) in a community like Beachville area?"

To obtain an overall view on the potential human health effects of community exposure to dust generated from aggregate operations, a comprehensive literature review was performed by searching the following electronic bibliographic databases: EMBASE, MedLine, Environment Complete, Cumulative Index to Nursing and Allied Health Literature (CINAHL), SCOPUS, Academic Search Premier, and PubMed. The computer-based search included primary studies published in English, but no time restriction was utilized. The search terms used were a combination of major concepts with specific key words relevant to the subject matter. The overall list of search terms was generated based on health outcomes with a well-established link to exposure to PM and reviewed for accuracy by the Environmental and Occupational Health (EOH) Team at PHO.

3.2 Results

Oxford County Public Health worked with the Beachville community members, PHO, and the SLSP Librarian to define the research question and develop the associated search strategy. Furthermore, local mining practices, community concerns, and environmental factors were incorporated in the search strategy.

The initial execution of the search resulted in 5333 citations and abstracts to be reviewed. These citations and abstracts were jointly screened by OCPH and the UoG. Two hundred articles were then determined to be of interest and reviewed for inclusion, of which, 29 were considered suitable in terms of findings. Subsequently these articles were appraised by the UoG, and synthesized into one document for use by OCPH.

Oxford County Public Health worked with area stakeholders to highlight how the synthesized evidence could be adapted to the Beachville area community. The following characteristics were considered relevant:

- Kilns operated in the study area were fueled by coal, natural gas, or petroleum coke;
- No other industrial sources of air pollution located in the study area; and
- Ambient air quality standards were comparable to those in Ontario, Canada.

Thus, after reviewing the synthesized evidence and taking into account the aforementioned characteristics, five articles/studies were considered to be locally relevant.

The five articles demonstrated that communities located near cement plants or quarries were significantly more likely to report the following non-specific health outcomes when compared to other communities: hospital admissions for respiratory or cardiovascular causes, bronchitis, nasal allergies, nasal congestion, nausea, vomiting, and mortality from respiratory diseases (Bertoldi et al., 2012; Calo et al., 2009; Giordano et al., 2012; Marcon et al., 2014; Roberts et al., 2013). However, four studies shared the same fundamental limitation: no air monitoring took place while the health outcomes were measured (Bertoldi et al., 2012; Calo et al., 2009; Giordano et al., 2012; Roberts et al., 2013). As a result of this limitation, it was difficult to determine if poor air quality contributed to the health outcomes observed.

One article, therefore, was considered directly relevant to the Beachville area because the measurement of health outcomes (school absenteeism) and air monitoring occurred simultaneously. This study took place in a small Northern Italian municipality named Fumane, where the cement plant was located 1.2 km from an elementary school. The plant kiln was fueled by petroleum coke, and no other industrial activity was present in the area. Of note, the ambient air quality standards for this region followed the European Union (EU) guidelines ($PM_{2.5}$ = 25 µg/m^3; PM_{10} = 50 µg/m^3 24-hour period), and findings from this study showed the annual concentrations of PM_{10} in Fumane during the study period were below the EU limits. At the same time, however, with each 10 ug/m^3 increase in PM_{10} (or spike in PM_{10}), a statistically significant 2.5% increase in school absenteeism was detected 2 days after the spike (Marcon et al., 2014). This suggests that a spike in coarse PM could have contributed to acute health effects in Fumane, even though annual concentrations of coarse PM were lower than legal EU limits. Currently, investigations are ongoing in Fumane to evaluate how specific emissions may impact the local air quality.

3.3 Discussion

How do we implement the adapted evidence?

Oxford County Public Health & Emergency Services intends to pilot a surveillance system in 2016 entitled the Oxford Health Matters Survey: a telephone survey developed by OCPH and administered by the Institute of Social Research at York University. The aim of the survey will be to gather data on key public health indicators and to assess the feasibility of its use for this purpose throughout Oxford County. It will also be used to monitor residents' sentiments on public health issues and to collect information on new matters of public health importance. Using random phone number dialing, approximately 300 adults ages 18 years and older will be interviewed throughout Oxford County. Results will be summarized to determine the value of this survey as an ongoing data collection system for health behaviours, risk factors and important new public health issues in Oxford County.

Additionally, as mentioned in the previous section, further investigations are underway by Marcon et al. in Fumane, Italy. These investigations are considered relevant to Oxford County, given that the Beachville area and Fumane share characteristics that have been locally determined to be applicable. In the meantime, OCPH has contacted the research team in Fumane to obtain guidance in how to move forward with the results from the BAAQA. This, in turn, has established a new collaborative relationship between OCPH and the University of Verona, where the research in Fumane has taken place. It is hoped that with guidance from Marcon et al., OCPH can make use of existing resources to see if similar trends exist in Oxford County, establish new resources that can accomplish the same, and develop a system of regular data collection that can be used to provide information on which to base risk management decisions about air quality in the Beachville and the larger Oxford County community.

Action

OCPH will pilot a surveillance system in the fall of 2016 titled the Oxford Health Matters Survey, to capture data on key public health indicators related to air quality in Oxford County

Oxford County Public Health looks forward to working with new and established partners to develop and implement the action items identified in this report. This work demonstrates the County's commitment to thinking ahead and wisely shaping the future.

4. Air Monitoring

In response to local residents' concern over exposure to particulate matter from various land use activities, and the MOECC questions about the reliability of the air monitoring data collected by industry (as part of the Industry-led Self-Monitoring Program) between 2003 and 2013, OCPH called on the Environmental and Occupational Health (EOH) team at PHO to assist in the collection, analysis and interpretation of new local air quality data within selected locations the Beachville Area. Data was used, in conjunction with data from MOECC particulate sampling to assess particulate levels of current environmental conditions across the Beachville Area and to identify possible short-term trends in local particulate matter concentrations. The following sections outline observations by OCPH and the MOECC.

4.1 Sampling Conducted by the Ministry of Environment & Climate Change (MOECC)

Although the MOECC was collecting their own particulate data and auditing the industry sampling between 2003 and 2013, the MOECC revised their sampling regime in August 2013 to collect particulate and metals background data by the standard method established by the US Environmental Protection Agency (US EPA). The MOECC provided OCPH with results of the first six months (August 2013 to January 2014) of the MOECC revised sampling program. Below is an excerpt of the MOECC's memorandum to OCPH "Re: Ministry particulate sampling results, Beachville Airshed, August 2013 to August 2014"

> 1. Average suspended particulate concentrations for the three ministry air monitoring stations placed within the local airshed suggest that levels are well below ministry Ambient Air Quality Criterion (AAQC) and that levels have declined since the implementation of the ministry's 2003 Action Plan.
>
> 2. Two single samples, from the same sampling location, revealed exceedances of the ministry's 24-hour Ambient Air Quality Criterion (AAQC) of 120 µg/m^3. Those two results were from Station #17006 with data exhibiting suspended particulate levels of 210 µg/m^3 and 146 µg/m^3 on December 12, 2013, and January 29, 2014 (respectively). These exceedances equate to approximately 1.3% of the 149 particulate results received from the ministry sampling.
>
> 3. The ministry has established an annual AAQC of 60 µg/m^3 for suspended particulate based on the geometric mean of the particle concentration. All three ministry sampling stations reported geometric means well below this value. It is expected that the MOECC will provide further reports of their air monitoring program to members of the Beachville area community.

4.2 Sampling Conducted by Oxford County Public Health (OCPH) & Public Health Ontario (PHO)

Through the summer and fall of 2015, PHO assisted OCPH in conducting air monitoring for 2-week periods at 8 properties located in the Beachville area. Monitoring was performed to measure concentrations of PM of different sizes at homes of local residents who volunteered to participate.

4.2.1 Sampling Instruments

For this assessment, DustTrak 8533 Desktop monitors were used for assessment of particulate matter fractions of $PM_{2.5}$ and PM_{10}. Wind direction, speed, temperature and relative humidity were measured at the same time as $PM_{2.5}$ and PM_{10} assessments with the Kestrel 4500 Weather Meter.

DusTrak Instrument

For this assessment, DustTrak 8533 Desktop monitors were used for assessment of particulate matter fractions of $PM_{2.5}$ and PM_{10}. TSI DustTrak monitors are used by PHO for PM assessments because of their ability to provide reliable data on PM concentration with portability and relative ease in operation and maintenance compared to other measurement methods. An important advantage of this instrument is the continuous, direct reading capabilities which allows for the determination of short-term (e.g., 5 minute) changes in PM concentrations.

Gravimetric monitors are larger and retain a sample of the dust collected for later chemical analysis if required. They are more precise than the Dust Trak and are approved for verifying compliance with air quality standards. However, they do not give minute by minute readings and it is difficult to set them up at multiple sites close to each other to check for differences in PM within small areas such as neighbourhoods.

In Southern Ontario, previous studies have documented that readings from a DustTrak tend to be 2-3 times higher than particulate levels sampled with gravimetric methods, which are considered superior (Wallace et al., 2010). This number is referred to as a correction factor. A correction factor of 2.4 for $PM_{2.5}$ has been previously established for the Toronto Area by members of the Southern Ontario Centre for Atmospheric Aerosol Research (SOCAAR) research group at the University of Toronto (G. Evans & K. Sabaliauskas, personal communication, 2014). No correction factor is documented for the Oxford County Area, and no comparable measurement could be used to establish a correction factor due to equipment limitations. For this report, a conservative correction factor of 2 was used in reporting. This number is conservative because it is the lower end of the range of reported corrections necessary for measurements taken in the Southern Ontario airshed (Wallace et al., 2010; see Appendix 1).

Kestrel 4500 Weather Meter

The Kestrel 4500 Weather Meters are used by Public Health Ontario for measuring weather information because of their accuracy and portability. Relevant parameters gathered include wind direction, wind speed, temperature and relative humidity.

4.2.2 Sampling Method for Beachville

The field portion of this study involved Public Health Inspectors (PHI) collaborating with the EOH Team to determine the best locations to set up the DustTrak and Kestrel equipment. The EOH Team took the lead in determining the schedule of sites to sample to obtain data which could show spatial comparison of different areas of Beachville in relation to surrounding industry.

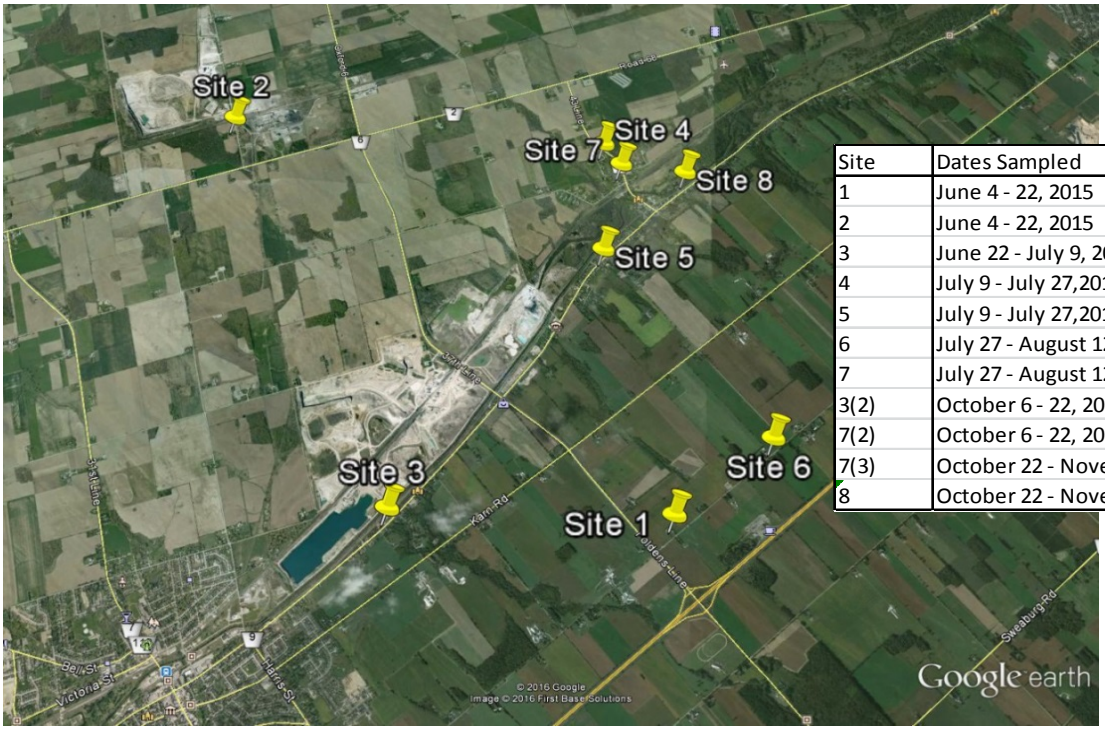
The location of the equipment on each of the volunteer sites were determined by both the EOH Team and the PHIs, and took into consideration distance from outdoor electrical outlets, tree cover, buildings, and available space where the DustTrak could remain undisturbed for the two-week sampling period. The members of the public who volunteered their sites were very accommodating and allowed for the use of their electrical outlets to power the DustTrak.

It was requested that homeowners notify PHIs when grass was cut on the property during a sampling period. Later in the study, a homeowner notes page was created and given out at the beginning of each two-week period so that homeowners could record any events that stood out in addition to grass cutting (e.g. farmer's equipment spraying/harvesting, wood fires, nearby trains passing, etc.). This information was sent to PHO for consideration in the analysis of the data.

Data was collected twice a week from the Kestrel unit, and once every fourteen days from the DustTrak. PHIs and PHO coordinated to find dates that worked for the takedown and set-up of the DustTrak and Kestrel units on new sites approximately every two weeks. Homeowners who had volunteered and had been identified as good comparison locations by the EOH Team were contacted shortly before the two-week period that their property had been selected for. Data was e-mailed to the EOH team for analysis at the end of each two-week period.

Eight Sites were ultimately sampled out of the fourteen that volunteered. One of the selected sites completed two different sampling periods, and a second site completed three sampling periods. These sites were placed in locations which were helpful in obtaining a broad snapshot of the air quality in the area in comparison to the site they were paired with. The site which completed two different periods was sampled on its own for the first sampling period that it hosted. There was an equipment malfunction at the partner site which resulted in the need to postpone data collection on that site until the issue was corrected. The sites are depicted in Figure 1.

Figure 1 – Sites sampled in Oxford County in the summer and fall of 2015



Site	Dates Sampled
1	June 4 - 22, 2015
2	June 4 - 22, 2015
3	June 22 - July 9, 2015
4	July 9 - July 27,2015
5	July 9 - July 27,2016
6	July 27 - August 12, 2015
7	July 27 - August 12, 2016
3(2)	October 6 - 22, 2015
7(2)	October 6 - 22, 2015
7(3)	October 22 - November 6, 2015
8	October 22 - November 6, 2015

4.2.3 Data Collection

The DustTrak measured levels of PM in select locations in the Beachville area. Based on information reviewed about quarry operations, PM_{10} and $PM_{2.5}$ were the fractions of interest in this study. The DustTraks were capable of simultaneously capturing both of these fraction measurements.

Dust data was paired with wind direction and wind speed data gathered on the Kestrel Weather Meter. The goal of this paired assessment was to better characterize dust levels and the source directions as they were experienced in the Beachville area on a day-to-day basis. For the 2015 Sampling period, both DustTrak units were housed in outdoor environmental enclosures on the volunteer sites, with the Kestrels set adjacent to the enclosures. The DustTraks logged data every 5minutes and were auto-zeroed (a type of calibration) hourly. AC power for the DustTrak was provided by the volunteer sites.

Approximately two weeks' worth of data was collected from two partner sites during each sampling period. Near the end of each two-week period, the next two sites' owners were contacted. The approximate sampling order was determined in conjunction with the EHO team prior to the start of the 2015 sampling period, and only varied slightly due to circumstances beyond our control.

The two sampling periods were conducted between May and August 2015, and October and November 2015.

4.2.4 Reference Guidelines

Guidelines used for comparison in this assessment were outlined in documents produced by the World Health Organization (WHO, 2006) and the Standards Development Branch of the MOECC (Ministry of Environment [MOE], 2012). The Canadian Ambient Air Quality Standards (CAAQS; formerly the Canada Wide Standards) for $PM_{2.5}$ (28 µg/m^3) is slightly higher than the WHO guideline (25 µg/m^3). Standards for recommended peak values are not used by either organization; the MOECC document clearly states that no conversion can be made from this standard to shorter time periods (MOE, 2012). For the purpose of this assessment, results were compared to the CAAQS for $PM_{2.5}$ (28 µg/m^3) and the interim Ambient Air Quality Criteria (AAQC) guideline value for PM_{10} (50 µg/m^3) using both 24-hour averages and peak events. These levels were used as a benchmark for comparison in the absence of short term guidelines. For this report, it is important to note that peak events above these values and single days above the CAAQS for $PM_{2.5}$ would not necessarily constitute an exceedance of the CAAQS. Table 1 displays a comparison of the various air quality guidelines for PM.

Table 1 –24-Hour Air Quality Guidelines for Particulate Matter

Pollutants	CAAQS (2015)	AAQC	WHO
$PM_{2.5}$ 24-hour	28 µg /m^3	30 µg /m^3	25 µg /m^3
PM_{10} 24-hour	-	50 µg /m^3	50 µg /m^3

According to the WHO, the health effects resulting from PM exposure are broad, but are predominantly in the respiratory and cardiovascular systems (WHO, 2006). For smaller particulate sizes ($PM_{2.5}$ and PM_{10}), these health effects are the rationale for the guideline values. In larger fractions, visibility is more important than health outcomes because these particles are too large to enter the respiratory system (WHO, 2006). It is also stated that it is unlikely that any standard or guideline will lead to complete protection in every individual against all possible adverse health effects, and that the standards setting process needs to aim to set the lowest concentrations possible in the context of local constraints, capabilities and public health priorities (WHO, 2006).

4.2.5 Results

The results below highlight comparisons of sampled data to applicable 24-hour standards and an analysis of peak events. Of note, PHOs Beachville Air Sampling final report includes additional information with regards to wind direction, wind speed, and other aspects of the air monitoring assessment.

Guideline Comparisons

Averages captured from each 2-week sampling period are presented in Figure 2. To illustrate the spread of concentrations, the maximum sampled 24-hour reading at each site is included alongside the 2-week averages for PM_{10} and $PM_{2.5}$. The highest 24-hour reading was at Site 3, with maximum value of 29.59 µg/m³ over 24 hours. This trend in $PM_{2.5}$ was similar to a period of elevated readings captured at an air quality monitoring station operating in London, Ontario, which suggests that the elevation was at least partly due to regional elevation rather than local PM sources (MOECC, 2015). The levels of PM_{10} at all sites closely followed $PM_{2.5}$, and none of the days approached or exceeded the 50 µg/m³ AAQC guideline value for PM_{10}.

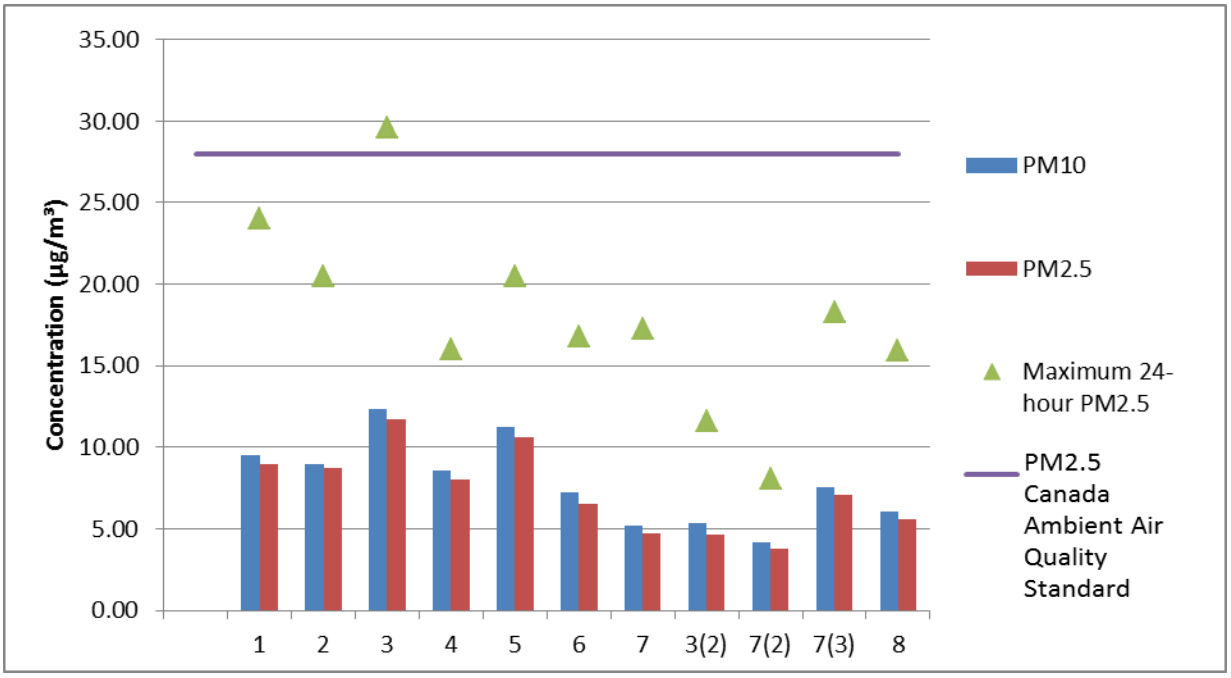


Figure 2 - Mean PM_{10} and $PM_{2.5}$ concentrations for summer and fall 2015 sites
Concentrations presented are the average reading for each site over the periods sampled. Also presented are the maximum 24-hour readings captured at each site. This figure includes both the measurements taken in the summer (Sites 1-7) and the fall (Sites 3(2), 7(2), 7(3) and 8). The concentrations are very similar for both PM_{10} and $PM_{2.5}$, indicating PM was mainly made up of fine PM ($PM_{2.5}$).

Analysis of Peak Events

To further identify peak events that may be a concern to local residents, a peak event analysis was conducted on the two-week samples taken at each site, using percentiles. A percentile of the data represents a cut-off, where a certain percentage of the readings fall. To illustrate this concept, in a list of numbers from one to a hundred, the 95th percentile would be 95. Potentially confusingly, this means that the 95th percentile is actually a lower cut-off for the highest five percent of data.

Because it represents a cut-off for higher values, the percentile is a useful tool for investigating peak dust events. This method has been identified in a previous study that investigated resident complaints about industry dust (Orkin et al., 2013). In the context of our measurements, a percentile can be interpreted as a period of time. For example, in a 2-week assessment, a reading of 47 µg/m³ of 99.9th percentile means that 99.9 per cent of the time the levels were below 47 µg/m³, while 0.1 percent of the time (meaning for about 20 minutes) the levels were above 47 µg/m³. Other examples are provided in Table 2. An increase in concentrations towards the 99.9 percentile indicates the presence of infrequent, local short-term dust events, especially when occurring in larger fractions of PM.

Table 2 - Approximate amount of time represented by a percentile for a two-week interval

Percentile	Amount of time levels sampled were at or above the level indicated (approximate)
95 %	16 hours and 38 minutes
99%	3 hours and 22 minutes
99.9 %	20 minutes

Figure 3 presents the percentiles of dust by fraction for each site sampled. On the x-axis of these graphs are increasing percentiles. These can be interpreted as PM levels of increasing rarity, with the 70th percentile occurring 30 percent of time, and the 99.9th percentile occurring only 0.1 percent of the time. Sites 3, 4, 6 and 7 all demonstrated evidence of peak events occurring in the summer assessment. In the fall assessment, site 3 demonstrated evidence of peak events, while site 7 also showed evidence of peak events in the first (but not the second) round of sampling. Because of the short time interval represented by the 99.9th percentile, the increase at sites 3 and 6 during the summer were likely due to single dust events.

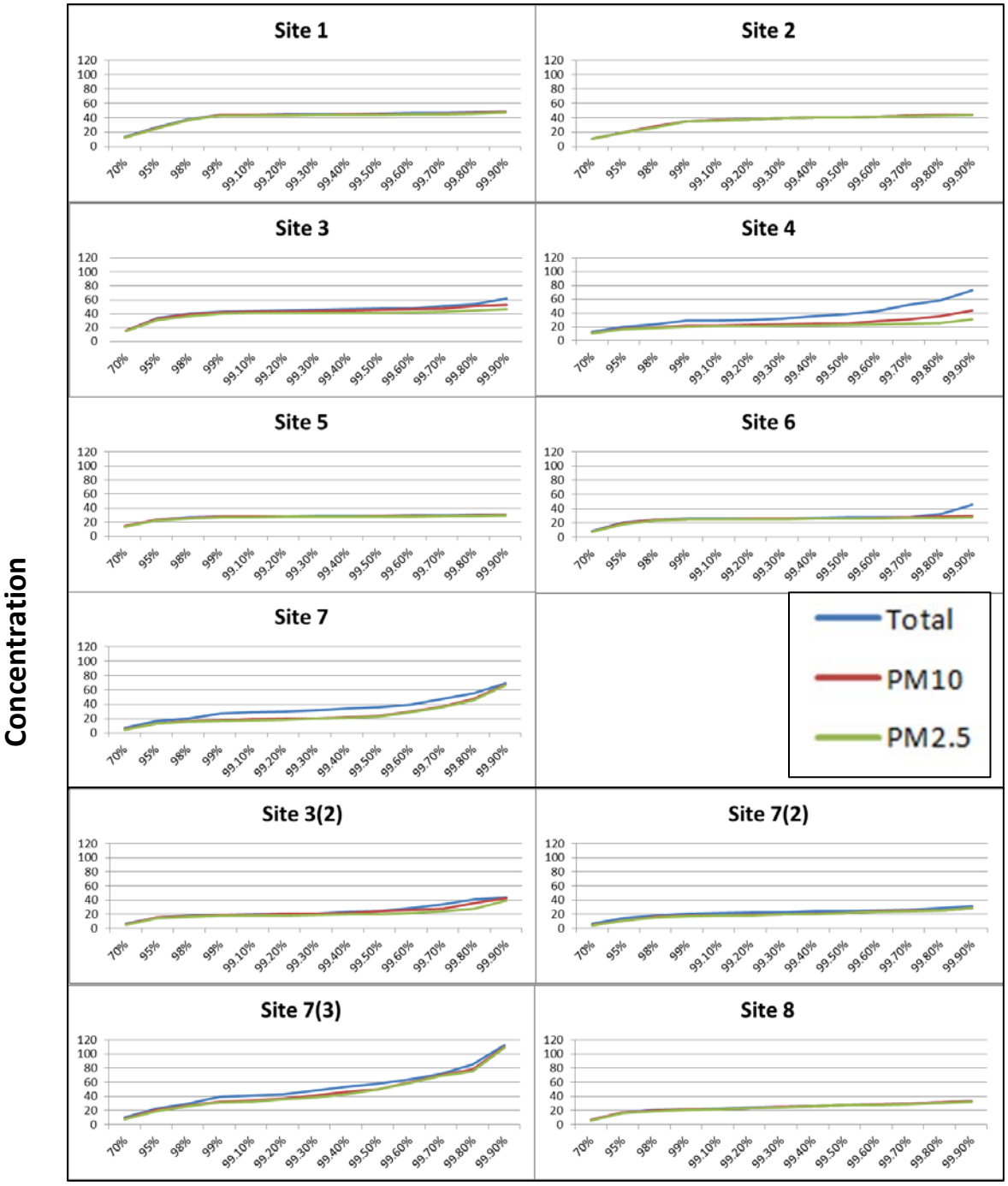


Figure 3 - 70th, 95th, 98th and 99.0th-99.9th percentiles for each site, in the Total, PM10 and PM2.5 fractions

A steep increase from the 99th to the 99.9th percentile indicates the presence of sporadic dust events. This was observed at sites 3, 4, 6 and 7 in the summer, and sites 3(2) and 7(3) in the second round of fall sampling.

4.2.6 Discussion

This assessment was not a compliance test. Instead, guidelines were used as a benchmark for comparison to see examples of how residents of Beachville experience particulate matter. Larger PM (PM larger than $PM_{2.5}$) is more likely to come from local sources and tends to deposit closer to where it is produced. For this reason, Total Suspended Particulate and PM_{10} are useful information to capture near a quarry operation. Initial descriptive assessments of $PM_{2.5}$ data suggested that for $PM_{2.5}$, trends captured over 2 week periods in Beachville paired well between sites and with $PM_{2.5}$ data captured by the MOECC in London for their Air Quality Hazard Index readings (MOECC, 2015). This finding could be further investigated when the MOECC releases validated data for the 2015 year.

Action

OCPH will conduct further air monitoring for the next twelve (12) months on a random basis to generate an enhanced understanding of the frequency and duration of 'dust events' occurring in the community of Beachville

It was recognized in this assessment that a primary concern of the community was visible dust events rather than compliance with applicable standards. The advantage of using a DustTrak over a compliance-based gravimetric test was the ability of the DustTrak to characterize concentrations over a short period of time, and by the size of PM, allowing for the characterization of peak events. Of the sites sampled simultaneously in the summer, sites 1 and 2 showed similar trends, Site 4 was dustier than Site 5, and Site 7 was dustier than Site 6. It has been noted in a previous analysis that levels of particulate can vary significantly by season and by month (Orkin et al., 2013). Resampling of site 7 demonstrated this finding. As shown in Figure 2, Site 7 displayed the presence of dust events in two out of the three times it was sampled, but peak events were absent for the first resampling period in the fall (site 7(2)). This finding highlights the usefulness of ongoing monitoring as an investigation tool for PM.

5. Policy Implications

5.1 Results to Support Oxford County Land Use Policy & Guideline Development

It is recognized that progressive and effective land use planning can contribute to the well-being and protection of a community. Section 3.4 of the Oxford County Official Plan includes policies on assessing the impact upon land uses in the surrounding areas in terms of the potential adverse effects on air quality through dust and particulate emissions, noise and vibration levels. It is less clear on the criteria that are used to facilitate these assessments. The relationship of air quality and land use compatibility has also been explored by the Halton Region Health Department (Halton Region Health Department, 2009). The document asks many questions related to the criteria of site specific assessment, including the recording of background concentrations for new developments, establishing baseline air quality data, and calculating the cumulative air impacts of several operations within the same area. To investigate this further OCPH will collaborate with the Community and Strategic Planning Department to explore the feasibility of incorporating air quality studies for new quarry applications.

Action

OCPH will collaborate with the Community and Strategic Planning Department to explore the feasibility of incorporating air quality studies for new quarry applications

6. Conclusion and Next Steps

Particulate concentrations for the MOECC air monitoring stations and monitoring stations used by OCPH suggest that levels are well below The Canadian Ambient Air Quality Standards and that levels have declined since the implementation of the MOECC 2003 Action Plan. For both sampling periods, air monitoring conducted by OCPH and PHO provided evidence of episodic short-term (less than one hour) peaks of larger PM. Larger PM could relate to quarry activity and other "dust events." Generating an enhanced understanding of the frequency and duration of these "dust events" through additional air monitoring may inform ongoing development of best management practices by the Industry. This, in conjunction with exploring the feasibility of incorporating air quality studies for new quarry applications and conducting the Oxford Health Matters Survey, will position OCPH to further develop air quality assessment strategies and policy tools. Considering the findings of the Beachville Area Air Quality Assessment, OCPH will:

iv. Conduct further air monitoring for the next twelve (12) months on a random basis to generate an enhanced understanding of the frequency and duration of 'dust events' occurring in the community of Beachville.
v. Collaborate with the Community and Strategic Planning Department, to explore the feasibility of incorporating air quality studies for new quarry applications.
vi. Keep the community and stakeholders informed of the practices and activities that support air quality improvement efforts within Beachville.
vii. Pilot a new telephone surveillance system in the fall of 2016 titled the Oxford Health Matters Survey, to capture data on key public health indicators related to air quality in Oxford County.

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Appendices

Appendix 1: Corrected Values for $PM_{2.5}$ and PM_{10}

Following a review of relevant literature, a correction factor of 2 was applied to the $PM_{2.5}$ readings, and to the $PM_{2.5}$ fraction of the PM_{10} readings. Though a correction factor did not exist for PM_{10} data, the values needed to be altered since $PM_{2.5}$ constitutes a portion of the PM_{10} fraction. Keeping this in mind, the following formulas were used to alter the $PM_{2.5}$ and PM_{10} data:

Corrected Values for $PM_{2.5}$

$$PM_{2.5}(\text{corrected}) = \frac{\text{PM}_{2.5}(\text{uncorrected})}{2}$$

Corrected Values for PM_{10}

First, the coarse fraction was established with the uncorrected readings:

$$PM_{10-2.5} = \text{PM}_{10}(\text{uncorrected}) - \text{PM}_{2.5}(\text{uncorrected})$$

Then the coarse fraction was added to the corrected $PM_{2.5}$ readings:

$$PM_{10}(corrected) = PM_{10-2.5} + PM_{2.5}(\text{corrected})$$