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EXPERT OPINION ON THE PROPOSED EXPANSION OF THE BRAESIDE QUARRY AND PERMANENT ASPHALT PLANT

Prepared for
The Friends Addressing Concerns Together in McNab/Braeside

By Henry S. Cole, Ph.D.

February, 2013

1.0 Summary: At the request of Friends Addressing Concerns Together in McNab/Braeside (FACT-MB), I have prepared this expert opinion on the adequacy of the air quality assessment as a basis for the McNab/Braeside Township's decision on the zoning revision request by Miller Paving Limited. The Zoning request would enable Miller to install and operate a permanent hot mix asphalt plant.

This report provides my expert evaluation of the applicant's Air Quality Assessment. My principal findings are:

- The applicant's air modeling assessment (Church and Trought, March 2010) is deficient in its documentation to the point that critical details needed to evaluate the validity of the modeling are absent. I have reviewed numerous modeling reports; in my judgment this is one of the most poorly documented.

- Certain of the methods used are likely to result in calculated concentrations that underestimate actual concentrations to which residents are exposed.

This report also recommends two alternative approaches that would enable the Township Council to ensure that its decision protects the health and well being of residents living in close proximity to the proposed asphalt plant.

Alternative 1: Deny the Official Plan amendment allowing a permanent asphalt plant. This decision provides greater assurance by preventing potentially harmful and odorous asphalt plant emissions. This decision may be based on the applicant's record at the site, the deficiencies in its Air Quality Assessment (as discussed in Sections 3 and 4), the emissions of pollutants with a known potential to cause adverse health effects and odor, and on the proximity of the facility's location to residential neighborhoods.

Alternative 2: Establish a process that would allow the Council to obtain clear and comprehensive information regarding the potential impact of the proposed expansion. This process would be designed to promote dialog between opposing experts and to give the Council access to the expertise and additional evidence needed to make an informed decision (as discussed in Section 2). However, this alternative may not afford the greater degree of protection provided by an outright denial (Alternative 1).

Limitations: Based on my review, I have many questions about the methods, modeling options, assumptions and inputs used by the applicants. In order to provide a more detailed review, I would require an opportunity to receive additional information and an opportunity to meet with those whom conducted the modeling and peer reviews.

1.1 Expertise: My qualifications are summarized below and further described in Attachment 1. I received a Ph.D. in meteorology at the University of Wisconsin-Madison in 1969. From 1969-1977, I was an associate professor of environmental earth sciences at the University of Wisconsin-Parkside. During this period I conducted EPA-funded research on the air pollution meteorology of the Chicago-Milwaukee lake shore corridor and was co-author of several often-cited journal articles on the impacts of Lake Michigan on transport and dispersion of air pollutants. I also served for several years as a member of the Wisconsin State Air Pollution Control Advisory Board.

During the late 1970's and early 1980's I served as senior scientist and section chief with U.S. EPA's Office of Air Quality Planning and Standards (OAQPS). My charge was the application and refinement of a variety of air quality models including single source models, urban scale (multiple source) models, and regional models.

As an environmental consultant for the past 20 years, I have provided scientific support to a variety of clients on issues related to the impact of various sources (landfills, incinerators, industrial facilities, and power plants) on community exposures to toxic pollutants and odors. I have been retained as an expert witness for several cases in Ontario involving MOE permitting and the ESDM process.[1]

[1] These include Ontario Waterkeepers opposition to a permit for the Lafarge cement kiln to burn alternative fuel (various wastes) and litigation by Ecojustice in opposition to an MOE permit allowing Suncor to increase throughput and emissions at its Sarnia refinery.

1.2 Basis: My findings are based on my expertise and on my review of the following:

- Multiple versions of applicant's Air Quality Assessment (AQA) obtained from the McNab/Braeside Township website (http://www.mcnabbraeside.com/municipal-information/planning/notices/information/

- Correspondence from the RWDI peer reviewers also from the McNab/Braeside website from 2008 to 2010.

- Church and Trought responses to RWDI peer review comments.

- Renfrew County Senior Planners Report: Review of Church and Trought, Inc. Air Quality Assessment Report and RWDI Peer Review Comments, Braeside Quarry Expansion. By Bruce Howarth, April 13, 2010

- U.S. EPA, *AP-42 Emission Factors for Hot Mix Asphalt Plants*, 2004.

- U.S. EPA, AP-42, *Emission Factors*, Volume 1, Introduction

- Judgment of R. Sauriol, Deputy Judge, Ontario Superior Court of Justice, Small Claims Court, Renfrew in the case of Moore et al., (Plaintiffs) and Smith Construction Co. (Division of Miller Group, Inc.), November 3, 2011.

- Expert testimony of Dr. Elaine MacDonald, in the above mentioned case of Moore et al. vs. Smith Construction Co. (Division of Miller Group, Inc.), ruling November 3, 2011.

2.0: Alternative decisions: This section describes two approaches that the Township Council could make with regard to a decision on Miller Group's application for a

2.1 Denial: The Township has a mandate to protect the public health and well being of its citizens. The most effective way to carry out this mandate is to deny the applicant its proposed Official Plan amendment allowing a permanent hot mix asphalt plant at the site.

The Council in making this decision should consider the applicant's record at the site—a history that includes a November 2011 court ruling that held the company liable for its failure to extend the HMA stack from 2 meters above grade to 12.1 meters above grade as required in MOE's Certificate of Approval. Only after numerous and repeated complaints were made by residents did the company carry out its permit obligations.

Note that C&T's 2010 Air Quality Assessment no-adverse effect finding is conditional and will require continued surveillance and actions by an applicant to ensure that particulates do not exceed standards.

> Based on the AERMOD model assessment of particulate matter and nitrogen oxides emission sources on the site, in our opinion the impact on air quality from the site operations would not constitute an adverse effect, provided that the Dust Management Plan is followed.
>
> (Underscore added for emphasis)

Please note that the applicant's Dust Management Plan relies heavily on water sprays to suppress particulate emissions. In my experience, relying on water sprays is often ineffective when conditions are dry and windy. Water evaporates quickly under such circumstances and it would be necessary for operators to cover many areas repeatedly to prevent releases of dust.

In addition RWDI peer reviewers in their final review (March 16, 2010) note that addressing air quality concerns will require the applicant to limit hourly production and shipping rates to those specified in the air quality report.

Moreover, C&T acknowledges (p. 4) that having a Certificate of Approval, i.e. following modeling guidance, does not prevent the air emissions from the site from causing an adverse effect and a company can still be found in violation if MOE shows an adverse impact. The problem with this approach is that the enforcement and corrective actions (which are not ensured) will occur only after residents have already been subject to adverse impacts.

2.2 Expert process: *I would strongly recommend against the Council's further consideration of the applicant's requested Official Plan amendment without an additional process involving stakeholder experts, officials and the public.*

Conducting an assessment of the facility, with numerous sources located in and adjacent to a quarry is inherently complex. C&T claims that its modeling is consistent with MOE regulations on modeling. However, air quality modeling, even if consistent with regulatory guidance, is not an exact science but is subject to numerous choices by modelers including choice of model(s), meteorological data, methods to estimate emission rates, and other factors. The choices individually and collectively affect concentration estimates and the evaluation of impacts and risks of pollutants with potentially adverse impacts on the health of those exposed. Section 3 includes a number of significant concerns that I have with regard to the applicant's air quality and odor assessments conducted to date.

The expert-based process describe below would involve a diverse group of experts including Miller's air quality consultants, the RWDI peer review team, Township staff or consultants, health experts and those representing FACT-MB, etc. I recommend a process that would enable participants to:

- Obtain a common, clear and complete understanding of modeling methods, inputs and results of the applicant's final air quality assessment (2010).
- Clearly identify areas of agreement and disagreement.

- Make recommendations for additional modeling, monitoring, and/or research needed to provide further resolution where there are significant disagreements, uncertainties and data gaps. This step should be taken prior to any additional modeling by the applicant's consultant.

- Examine alternative proposals designed at preventing pollution and reducing exposures to air pollutants.
- Provide answers to questions posed by FACT-MB to RWDI peer reviewers via the Township Council and additional questions raised by members of the public.

At the conclusion of the expert process, members of the Council, other officials and the public should have ample opportunity to interact with the experts involved in the process prior to a final public meeting and decision by the Council.

One might argue that RWDI's peer review sponsored by the Township fills this need for an expert process. However, I would emphasize that the peer review process focused narrowly on whether the Air Quality Assessment reports met regulatory requirements for modeling. However, the peer review is not a scientific assessment and fails to examine how well the emissions and dispersion treatments replicate the actual processes that affect offsite pollutant concentrations.

Nor is the analysis an adequate basis for making judgments on potential adverse health effects. For example, neither the AQA nor the peer review discusses the risks associated with the proposed emissions including the carcinogenic risks associated with emissions from hot mix asphalts. As both EPA emission factors and the applicant's reports indicate, hot mix asphalt plants emit significant quantities of benzene and formaldehyde, known human carcinogens (documentation) and lesser quantities of benzo-(a)-pyrene. Attachment 2 provides an excerpt from the expert testimony of Dr. Elaine MacDonald in the November 2011 court case[2] which provides information on carcinogenicity designations of PAHs, most of which are <u>not</u> included in the applicant's AQA (2010) Table 1 emissions used in its Regulation 346 modeling.

Standard guidance for cancer risk assessments requires: (a) estimates of long-term exposures to carcinogens and (b) the additive risks associated with exposures to mixtures of carcinogens such as those emitted from hot mix asphalt plants. The applicant's AQA provides no long-term monitoring or modeling data needed to estimate cancer risk to residents who would be exposed to carcinogens for years if the applicant is permitted to install a permanent hot mix asphalt plant. Similarly, the applicant neglects to assess the potential health effects known to be associated with long-term exposure to particulates and SOx.

[2] Judgment of R. Sauriol, Deputy Judge, Ontario Superior Court of Justice, Small Claims Court, Renfrew in the case of Moore et al., (Plaintiffs) and Smith Construction Co. (Division of Miller Group, Inc.), November 3, 2011.

In addition, the AQA doesn't address the issue of particle size distribution, but lumps all particulates into a single category, despite abundant evidence that the finest particulates, e.g. those associated with the combustion process have the greatest potential to be deposited in the lungs and to cause and/or aggravate respiratory and cardiovascular problems.

Finally, the applicant has failed to provide modeling or monitoring that would enable one to estimate the risks of cancer or other diseases known to be associated with chronic exposure to asphalt plant emissions and pollutants including NOx, particulates, and SOx.

3.0 Deficiencies in the applicant's Air Quality Assessment: In my professional judgment, the applicant's Air Quality Assessment Report (March 2010) fails to provide complete and detailed information necessary for one to evaluate the adequacy and reliability of the modeling analysis. Moreover, certain model treatments rather than being conservative are likely to result in underestimations of actual pollutant concentrations to which nearby residents are exposed.

3.1 Inadequate documentation: The Assessment Report fails to provide sufficient detail on the methods, assumptions, and inputs to allow the Township, the public or outside experts to evaluate the validity of the applicant's assessment and the accuracy of its findings. I have reviewed numerous modeling reports; in my judgment this is the most poorly documented.

To exacerbate the problem, none of applicant's Air Quality Assessment (original or revisions) includes a single map or diagram showing the actual locations of sources, configurations, and source release heights relative to the floor and upper rim of the quarry. Nor are there any map displays showing the distribution of contaminant concentrations in offsite areas which is standard output. I find this failure to meet standard practices astounding.

The Air Quality Assessment Report (March 2010) states that U.S. EPA's AP-42 emission factors were used to calculate pollutant emission rates. However, the Agency's AP-42 document for hot mix asphalt plants[3] shows that emissions factors vary according to design and the type of control used. Unfortunately, the Air Quality Assessment doesn't provide sufficient documentation to know which options were used in calculating emissions. Furthermore, with regard to organic hazardous air pollutants including PAHs the emission factor ratings are E's and D's indicating that EPA has minimal confidence in the veracity of the emission factors. This is shown in the following table from EPA's AP-42 document for hot mix asphalt plants. Adherence to scientific standards requires that such uncertainties should be clearly stated; however Church and Trought's reports fail to do so.

[3] U.S. EPA, AP-42, Vol. 1, Section 11.1, Hot Mix Asphalt Plants, 2004
http://www.epa.gov/ttnchie1/ap42/ch11/final/c11s01.pdf

Table 11.1-9. EMISSION FACTORS FOR ORGANIC POLLUTANT EMISSIONS FROM BATCH MIX HOT MIX ASPHALT PLANTS[a]

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. Nos.
	CASRN	Name			
Natural gas- or No. 2 fuel oil-fired dryer, hot screens, and mixer with fabric filter (SCC 3-05-002-45,-46)	Non-PAH Hazardous Air Pollutants[b]				
	75-07-0	Acetaldehyde	0.00032	E	24,34
	71-43-2	Benzene	0.00028	D	24,34,46, 382
	100-41-4	Ethylbenzene	0.0022	D	24,46,47,49
	50-00-0	Formaldehyde	0.00074	D	24,34,46,47,49,226,382
	106-51-4	Quinone	0.00027	E	24
	108-88-3	Toluene	0.0010	D	24,34,46,47
	1330-20-7	Xylene	0.0027	D	24,46,47,49
		Total non-PAH HAPs	0.0075		
	PAH HAPs				
	91-57-6	2-Methylnaphthalene[c]	7.1×10^{-5}	D	24,47,49
	83-32-9	Acenaphthene[c]	9.0×10^{-7}	D	34,46,226
	208-96-8	Acenaphthylene[c]	5.8×10^{-7}	D	34,46,226
	120-12-7	Anthracene[c]	2.1×10^{-7}	D	34,46,226
	56-55-3	Benzo(a)anthracene[c]	4.6×10^{-9}	E	46,226
	50-32-8	Benzo(a)pyrene[c]	3.1×10^{-10}	E	226
	205-99-2	Benzo(b)fluoranthene[c]	9.4×10^{-9}	D	34,46,226
	191-24-2	Benzo(g,h,i)perylene[c]	5.0×10^{-10}	E	226
	207-08-9	Benzo(k)fluoranthene[c]	1.3×10^{-8}	E	34,226
	218-01-9	Chrysene[c]	3.8×10^{-9}	E	46,226
	53-70-3	Dibenz(a,h)anthracene[c]	9.5×10^{-11}	E	226
	206-44-0	Fluoranthene[c]	1.6×10^{-7}	D	34,46,47,226
	86-73-7	Fluorene[c]	1.6×10^{-6}	D	34,46,47,226
	193-39-5	Indeno(1,2,3-cd)pyrene[c]	3.0×10^{-10}	E	226
	91-20-3	Naphthalene	3.6×10^{-5}	D	34,46,47,49,226
	85-01-8	Phenanthrene[c]	2.6×10^{-6}	D	34,46,47,226
	129-00-0	Pyrene[c]	6.2×10^{-8}	D	34,46,226
		Total PAH HAPs	0.00011		
	Total HAPs		0.0076		
	Non-HAP organic compounds				
	100-52-7	Benzaldehyde	0.00013	E	24
	78-84-2	Butyraldehyde/ isobutyraldehyde	3.0×10^{-5}	E	24
	4170-30-3	Crotonaldehyde	2.9×10^{-5}	E	24
	66-25-1	Hexanal	2.4×10^{-5}	E	24
		Total non-HAPs	0.00019		

Source: U.S. EPA, AP-42, Vol. 1, Section 11.1, Hot Mix Asphalt Plants, 2004, Table 11.1-9
http://www.epa.gov/ttnchie1/ap42/ch11/final/c11s01.pdf

3.2 AERMOD pit application: *The peer review process* conducted by RWDI did help to clarify the methods and inputs used, however, many questions remain. RWDI reports also point to several problems with C&T's modeling approach. In particular, RWDI's July 2008 review describes a serious deficiency; C&T's modeling scheme assumes that all of the quarry sources are spread into the total area of the pit with a virtual source at a central location as shown in Figure 1 below *copied from RWDI's July 2008 report.*

The peer reviewer states that this approach

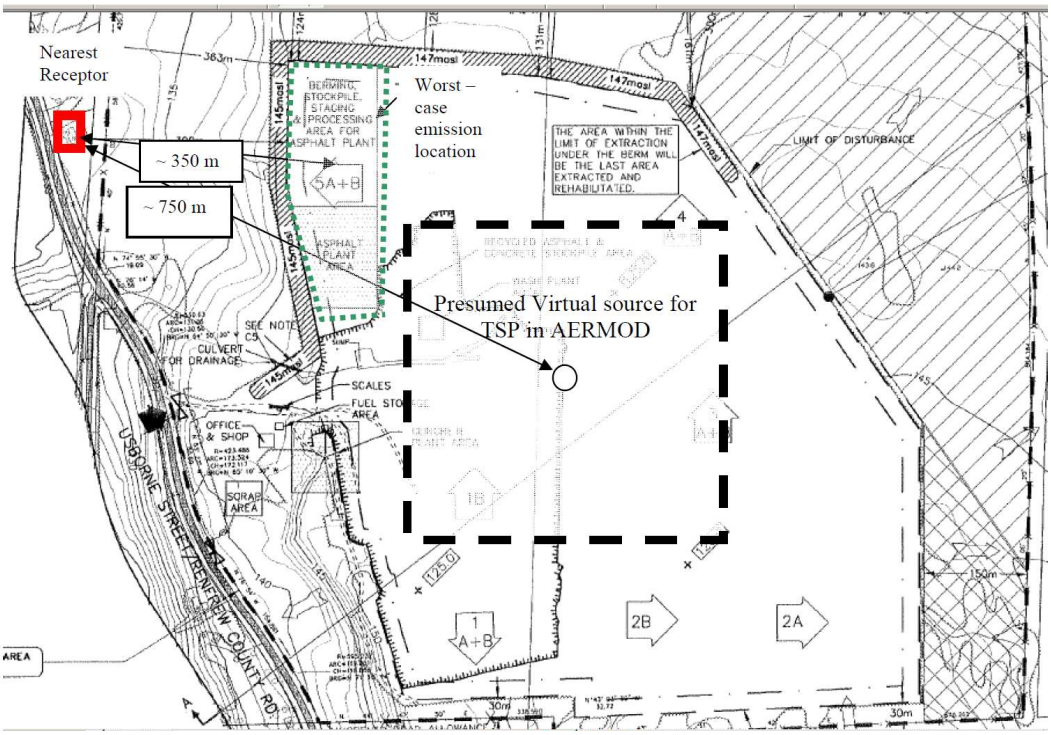
> "*appears to be a very coarse estimation of the emission sources. It also may result in AERMOD under-predicting concentrations, since most of the sources are expected to be at or near the active face. For example, the most southerly residence is approximately 350 metres from the Asphalt Plant Processing area but more than 750 metres from the center of the pit expansion. It is recommended modeled sources be located as realistically as possible to worst-case locations."* This apparent discrepancy is shown in Figure 1.

C&T's response of November 12, 2008 is as follows:

> *Section 1.3 claims that the AERMOD model lumped all sources into a single source. This is not correct. All surface sources were individually modeled including detailed road segments. The sources within the Pit were modeled as a PIT source in AERMOD, which requires that all emissions of particulate within the pit be summed into a single value for use in specifying the PIT sources emission rate.*

However several problems remain: (a) it is not at all clear from the documentation which sources, e.g. as the asphalt plant and crushing areas are included in the pit modeling area and (b) the pit averaging method fails to account for the proximity of specific emission points to residential receptors as shown in Figure 1 below.

Figure 1: Comparison of presumed virtual source location in AERMOD to actual worst case emission location.



The second point was also raised by MOE inspector Robert Bloxam at a meeting with RWDI peer reviewer Colin Welburn. According to Welburn's memorandum[4] Mr. Bloxam said that MOE would be likely to request additional information on the distribution of sources throughout the pit and revised modeling to reflect the actual location of sources, especially if there were a significant emission source in close proximity to areas of maximum concentration. It is not clear from the record, whether MOE required these measures. Nor is there any indication that the C&T revised its modeling to provide a more realistic location of sources within the pit.

3.2 Meteorological data: Church and Trought (C&T) used meteorological data from the Ottawa airport and consider this data set to be representative. They state that airport is 20 km from the Braeside Quarry. However, I measured the distance using the Google Earth ruler tool and found that the Ottawa Airport from which the weather data is obtained is actually about 63-65 km from the Braeside Quarry. Secondly the period used is stated as 1996-2000; C&T provide no explanation as to why the most current five year meteorological data was not used.[5] In my judgment, the weather data from Ottawa is not likely to be representative of conditions at the site. Ottawa's urban area will have a strong impact on wind directions and

[4] Memorandum, to Dr. Trought of C&T, from Colin Welburn, October 8/2009, Re: Meeting Minutes to Resolve Braeside Quarry Assessment Review

[5] According to Lakes Environmental the five year period Nov. 1, 2007 to Oct. 31, 2012 is currently available in AERMOD usable format from Lakes Environmental, Inc. an internationally recognized leader in the field of air quality modeling (Personal communication, January 30, 2012).

atmospheric stability (vertical temperature profiles). Secondly, climate is currently undergoing rapid change and current conditions may be different from those in the late 1990's.

Recommendation: Based on these considerations I would strongly recommend that the Township Council require applicant to install and operate an onsite meteorological station for at least a year as part of the process recommended in Section 2.2.

3.3 Two models: The applicant's air quality assessment is based on two different models: (a) AERMOD, a refined, state of the art model, for particulates and NOx emissions and (b) (Regulation 346 Model) for VOCs and poly-aromatic hydrocarbons (PAHs) and for particulates, SOx and NOx as well. It is not clear why the C&T used the Reg. 346 model a screening technique that MOE is phasing out and replacing with AERMOD and other more refined models. Conversely, AERMOD is a well established, internationally recognized model which uses far more realistic methods for simulating atmospheric dispersion based on a multilayer approach and site specific surface characteristics affecting wind profiles, stability and turbulence.

Recommendation: I would recommend that the Township Council require the applicant to conduct additional modeling using AERMOD and incorporating all sources and emissions in each run (i.e. for each pollutant). This approach would ensure that the cumulative impact of all sources would be captured in the modeling. The expert panel described in Section 2 should be involved in the development of protocol for additional modeling.

3.4 No monitoring data: The applicant's assessment fails to include any emissions testing that could be used to evaluate the accuracy of emission rate inputs or ambient air monitoring that could be used to evaluate how accurately the modeling replicates actual concentrations.

Recommendation To fill this need, I recommend that Township Council require both emissions and ambient air monitoring. Again the expert panel should be involved in protocol development if the Council decides to consider the applicant's proposed quarry expansion and installation of a permanent hot mix asphalt plant.

* * *

Attachments 1 and 2 follow.

Attachment 1

Henry S. Cole, Ph.D.
Summary of Professional Experience

February 2013

Henry S. Cole, Ph.D., the President of Henry S. Cole & Associates, Inc. (founded 1993), is an environmental and atmospheric scientist with more than 35 years of experience in academics, government, environmental organizations and business. He has provided scientific and strategic support to numerous legal, environmental and community organizations in the U.S., Canada and Europe. Areas of expertise include:

- Air pollution and odorous emissions from a variety of sources including landfills, incinerators, power plants, cement kilns, and industrial plants.
- Air pollution meteorology, air quality modeling, and exposure assessments.
- Environmental impacts of solid waste landfills
- Hazardous waste site cleanup

Major Award: Dr. Cole was awarded EPA's Presidential Green Chemistry Challenge Award (2002) for his scientific support for environmentally safe, arsenic-free wood preservatives treatment alternatives.

Education: Cole obtained his Ph.D. in meteorology at the University of Wisconsin in 1969. He earned a BS with high honors at Rutgers University (1965) with majors in soil science and meteorology.

Faculty research and teaching: As an associate professor at the University of Wisconsin-Parkside (1969-1977) Cole conducted EPA-sponsored research air pollution affecting the Chicago-Milwaukee L, Michigan shoreline corridor. He co-authored numerous articles and reports including some of the earliest and most referenced journal articles on the air quality impact shoreline sources (e.g. power plants, urban emissions). Cole served as a member of the Wisconsin State Air Pollution Control Council during the 1970's. Cole teaching included courses in meteorology, geology, environmental science, and air pollution meteorology.

U.S. EPA Senior Scientist: During the period 1977-1983, Dr. Cole served as a senior scientist at U.S. EPA's Office of Air Quality Planning and Standards. Cole directed a section dealing with the application of point/stationary source, urban, and regional modeling to develop emission limits and ambient air strategies as part of the regulatory process.

Clean Water Action: From 1983-1993, Cole served as Science Director of Clean Water Fund a national environmental organization. Cole authored studies on EPA's Superfund program, the impacts of municipal waste incinerators and mercury emissions and frequently testified before Congressional committees on issues pertaining to Superfund cleanups, mercury emissions, solid waste management policies, and pollution prevention (e.g. alternatives to PCE-based dry cleaning).

Professional Associations: American Meteorological Association, the American Chemical Society and the American Association for the Advancement of Science.

Attachment 2:

Testimony of Dr. Elaine MacDonald, EcoJustice, in the a case of Moore et al. vs. Smith Construction Co. (Division of Miller Group, Inc.), ruling by Judgment of R. Sauriol, Deputy Judge, Ontario Superior Court of Justice, Small Claims Court, Renfrew, November 3, 2011.

Polycyclic Aromatic Hydrocarbons (PAHs)

Within an HMA plant both the heated asphalt cement and the combustion of fuels releases PAHs. A report prepared on the HMA sector for Environment Canada available through Environment Canada explains that PAHs are present in the combustion gas and can be released from dryers and drum mixers, HMA silos and load out, and from the displaced saturated vapour when asphalt cement storage tanks are filled.[6]

PAHs are listed on the toxic substance list under the *Canadian Environmental Protection Act* (CEPA). The assessment of PAHs under CEPA made the following conclusion:

> Therefore, based on available data, polycyclic aromatic hydrocarbons are entering the environment in a quantity or concentration or under conditions that are having or may have a harmful effect on the environment. They are not considered to be entering the environment in a quantity or concentration or under conditions that constitute or that may constitute a danger to the environment on which human life depends. The polycyclic aromatic hydrocarbons benzo[*a*]pyrene, benzo[*b*]fluoranthene, benzo[*j*]fluoranthene, benzo[*k*]fluoranthene, and indeno[*1,2,3-cd*]pyrene are considered to be entering the environment in a quantity or concentration or under conditions that may constitute a danger to human life or health**.**[7]

The International Agency for Research on Cancer (IARC) has determined the following with respect to the carcinogenicity of PAHs: benz[a]anthracene and benzo[a]pyrene are probably carcinogenic to humans; benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-c,d]pyrene are possibly carcinogenic to humans; and anthracene, benzo[g,h,i]perylene, benzo[e]pyrene, chrysene, fluoranthene, fluorene, phenanthrene, and pyrene are not classifiable as to their carcinogenicity to humans. [8]

The United States Environmental Protection Agency (US EPA) has determined that benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene are probable human carcinogens and that acenaphthylene, anthracene, benzo[g,h,i]perylene, fluoranthene, fluorene, phenanthrene, and pyrene are not classifiable as to human carcinogenicity.[9]

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[6] Canadian Ortech Environmental Inc. and John Emery Geotechnical Engineering Limited prepared for Environment Canada and the Canadian Council of Ministers of the Environment. September 2002, Multi-pollutant emission reduction analysis foundation (MERAF) for the hot-mix asphalt sector. p. 22

[7] Environment Canada and Health Canada, 1994.CEPA Priority Substances List Assessment: Polycyclic Aromatic Hydrocarbons, p. 42

[8] Agency for Toxic Substance and Disease Registry, Pubic Heath Statement for Polycyclic Aromatic Hydrocarbons (Available at http://www.atsdr.cdc.gov/toxprofiles/phs69.html)

[9] Ibid.