



The Economic Benefits of Improving Visual Air Quality in British Columbia's Lower Fraser Valley

*A Discussion Paper by the
British Columbia Visibility
Coordinating Committee*

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INTRODUCTION

British Columbia is known for its spectacular vistas. BC residents value the natural environment as an important aspect of our quality of life. In addition, BC's beautiful vistas benefit tourism, property values, and business investment, making BC an attractive place to work, live and visit. However, air pollution can threaten the clarity of our beautiful BC vistas.

"Visibility" is a measure of how clearly we can see objects in the distance. Poor visibility occurs when air pollutants absorb or scatter sunlight, making objects and vistas appear less vivid. In general, the more pollutants in the air, the more visibility can be obscured. Weather conditions such as temperature, wind speed, and humidity can also affect visibility. This document focuses on the impacts that air pollution can have on visibility, hereon referred to as "visual air quality".

The BC Visibility Coordinating Committee (BCVCC)

With the primary objective of human health protection, air quality management has been a priority in Canada and the United States for over 40 years. The US Environmental Protection Agency has established regulations to protect visual air quality in US National Parks. Although visibility protection is required under the 1991 US-Canada Air Quality Agreement, visual air quality improvement in Canada has typically been thought of as a co-benefit of health-based air pollution reduction efforts. Starting in 2007, a multi-agency group called the British Columbia Visibility Coordinating Committee (BCVCC) has been developing a visual air quality management framework for BC. The BCVCC includes representatives from the BC Ministry of Environment, Environment Canada, Health Canada, Metro Vancouver, Fraser Valley Regional District, and the City of Kelowna. The BCVCC is currently implementing a visual air quality improvement pilot project within the Lower Fraser Valley (Metro Vancouver and the Fraser Valley Regional District).

Managing Visual Air Quality

Current evidence suggests that visual air quality improvements can be achieved by reducing the levels of microscopic particles (referred to as PM_{2.5}) in our atmosphere. PM_{2.5} originates in two ways. Firstly, it can be emitted directly by a variety of sources including dust, soot from fires, industrial activities, automobiles and ships. PM_{2.5} created in this way is called "primary PM_{2.5}". Secondly, PM_{2.5} can be formed in the atmosphere when nitrogen oxides, sulphur oxides and ammonia react together. PM_{2.5} created in this way is referred to as "secondary PM_{2.5}". Efforts to reduce PM_{2.5} levels must address both primary and secondary PM_{2.5}.

Environment Canada recently concluded that noticeable improvements in visual air quality will not be achieved with the implementation of the existing air quality management programs in the Lower Fraser Valley.¹ As such, the BCVCC is conducting visual air quality monitoring and modelling studies to understand and ultimately manage visual air quality. The BCVCC plans to establish a visual air quality improvement goal and an index, as well as communicating current efforts underway via www.clearairbc.ca.

¹ So, R., Vingarzan, R., Jones, K., and Pitchford, M., 2015. *Modelling of Time-Resolved Light Extinction and Its Applications to Visibility Management in the Lower Fraser Valley of British Columbia, Canada*. Journal of the Air & Waste Management Association, 65:6, 707-720.

ECONOMIC BENEFITS

Although visual air quality has no market value (i.e., it can't be bought or sold), this discussion paper attempts to quantify the benefits that visual air quality improvements may have on key economic sectors in the Lower Fraser Valley. This paper provides a summary of existing studies and analyses that have placed a value on visual air quality. ***It is not intended to be a conventional cost-benefit analysis, whereby benefits are summed and compared to implementation costs.*** Firstly, it is not appropriate to sum the benefits for each sector, since they may not be equivalent. For example, one valuation places a dollar figure on benefits due to a percentage improvement in visual range and another focuses on benefits from a percentage reduction in PM_{2.5} levels, while others assess benefits from general improvements in visual air quality. Secondly, summing the valuations may result in double counting, particularly in the case of resident willingness to pay and property values. Finally, the BCVCC has not yet determined the actions necessary to achieve visual air quality improvements in the Lower Fraser Valley, so it is not possible to determine the costs of implementation at this time.

The following sections assess economic benefits of improving visual air quality in the Lower Fraser Valley for:

- Residents
- Real estate industry
- Tourism industry
- Film industry
- Agriculture
- Health
- First Nations

Resident Willingness to Pay

By its very nature visual air quality is human perception-based, so the most common method of estimating the value of visual air quality is by determining the viewer's "willingness to pay" for clearer vistas. Haider *et al* (2002) presented 221 residents of BC's Lower Mainland with photographs of summer views with differing visual air quality and potential cost of abatement to the household. To avoid confounding responses with health benefits, Haider asked residents to evaluate their willingness to pay for improvements in both local visual air quality and health conditions separately, but within the context of each other. This survey determined that residents were willing to pay CAD \$34.17 per household per year for a 10% improvement in visual range², aside from the associated health benefits. Accounting for inflation³, this value equates to \$40.68 in 2011 dollars. With a total of 908,030 households⁴ in Metro Vancouver and the Fraser Valley Regional District, it can be concluded that residents regarded **\$37 million per year** (2011 dollars) as an acceptable cost of improving visual range by 10%, without

² Haider, W., Moore, J., Knowler, D., and D. Anderson, 2002. *Estimating Visual air quality Aesthetic Damages for the Air Quality Valuation Model*. Report prepared for Environmental Economics Branch, Environment Canada.

³ Historical Inflation Rates for Canada. See www.rateinflation.com/inflation-rate/canada-historical-inflation-rate.php

⁴ Census of Canada data, 2006.

considering the spin-off health benefits. Considering a discount rate of 5% over the span of the next 20 years, the present value (or publically acceptable cost) for a visual air quality improvement program would total about \$480 million. Surveys in the US, Korea and New Zealand have drawn comparable conclusions about resident willingness-to-pay for visual air quality improvements.

Real Estate Industry

The real estate and housing industries also stand to benefit from good visual air quality. A study in Los Angeles estimated that the impact that visual air quality has on housing prices ranged from 3 to 8% of the total house price.⁵ In Greater Vancouver 54,410 homes changed ownership in 2009 generating \$29.5 billion in sales, while 13,123 homes changed hands in the Fraser Valley, generating \$4.57 billion in sales⁶. If haze-free views are worth 3% of the total house price in this region, and 20% of the homes in Metro Vancouver have a view, “view sales” in the Lower Mainland could be worth $0.03 \times 0.20 \times (\$29.5 \text{ billion} + \$4.57 \text{ billion}) = \$208 \text{ million per year in 2011 dollars}$.

Real estate is an asset value and therefore not a direct contributor to the overall economy per se. Nonetheless, home sales generate local economic spin-off benefits for the economy. Spin-off economic benefits (such as lawyers, real estate agents, appraisers, financial institutions, home improvements and taxes) in BC accounted for approximately 11.5% of the value of all property sales.⁷ Therefore the spin-off benefits of clear views for the real estate industry and related businesses could be $0.115 \times \$208 \text{ million} = \underline{\$25 \text{ million per year}}$ (2011 dollars). It should be noted, however, that this valuation may result in double counting when compared to Haider *et al*'s willingness to pay valuation, since the non-market benefit of a clear view is also captured in the market transaction of house sales.

Good visual air quality can also result in a higher perceived quality of life for established residents. Conversely, poor visual air quality reduces the attractiveness of the region for new residents, workers, and businesses, which may impact the real estate market.

Tourism Industry

Tourism is a major economic sector in BC, directly employing more than 129,000 people and generating over \$12.7 billion in revenue in 2009. Visitor surveys demonstrate that tourists, when confronted with poor visual air quality at their destination, tend to shorten their stay, go elsewhere or not return in the future. Based on tourist surveys in 1999, McNeill and Roberge⁸ concluded that one poor visual air quality event could result in revenue losses of up to \$9 million (\$7.45 million for the Vancouver area and \$1.32 million for the Fraser Valley area). Accounting for projected losses from three distinct poor visual air quality events in 2010, future tourism losses are estimated at up to \$27 million. As BC tourism

⁵ Beron, K., Murdoch, J., and M. Thayer, 2001. *The Benefits of Visual air quality Improvement: New Evidence from the Los Angeles Metropolitan Area*. Journal of Real Estate Finance and Economics, 22:2/3, 319-337.

⁶ Landcor Data Corporation, 2010. *British Columbia 2009 Residential Sales Summary*. See <http://storage.ubertor.com/tinamak2.ourubertor.com/content/document/4496.pdf>

⁷ Calculated using economic spin-off data from Altus Group, 2009. *Economic Impacts of MLS® Home Sales and Purchases in Canada and the Provinces 2006 – 2008*. See www.ledevoir.com/documents/pdf/economic_impact.pdf

⁸ McNeill, R. and A. Roberge, 2000. *The Impact of Visual Air Quality on Tourism Revenues in Greater Vancouver and the Lower Fraser Valley*. See www.clearairbc.ca/visibility/Documents/VisibilityTourism-McNeill.pdf

revenues doubled between 1999 and 2009,⁹ it is estimated that approximate future revenue losses could reach up to **\$55 million per year** (2011 dollars). Using the BC Input-Output model¹⁰, this value translates into 1,403 direct and indirect accommodation and food service jobs lost due to decreased activity in the tourism industry.

Further, during the June 2007 workshop of the BCVCC, a representative from Tourism Vancouver commented that any deterioration in visual air quality would deteriorate BC's brand, reputation and the visitor experience. They also suggested that there could be a tipping point at which poor visual air quality will erode BC's competitiveness as a destination.

Film Industry

BC is the third-largest film and television service production centre in North America, after Los Angeles and New York. A total of 239 productions were filmed in BC in 2009 contributing \$1.3 billion to the province's economy and providing an estimated 20,000 direct and 15,000 indirect jobs.¹¹ Film production companies find a broad appeal for filming in BC due to the variety of location resources (e.g. urban, wilderness, waterfront, etc.) and the diversity of the province's biogeoclimatic zones within close proximity of one another. In Metro Vancouver and the Lower Fraser Valley, these factors have made the region popular as a stand-in for other cities and locations around the world. When asked whether visual air quality is important for the film industry in BC, a few film industry stakeholders were sceptical. Firstly, it is not common to film distant landscapes/viewsapes because Vancouver's identity is often disguised to represent an alternate city or location. Secondly, delays associated with filming are commonly attributed to weather (rain or fog) as opposed to visual air quality.¹² Finally, much of Vancouver's feature film industries' clientele is from Los Angeles and the perception is that Metro Vancouver and the Lower Fraser Valley have excellent visual air quality.¹³ However, a thorough assessment of the potential impacts of poor visual air quality on the film industry has not been undertaken to date. The BCVCC has attempted to quantify these impacts.

In 2009, productions in BC included 56 features (worth an average BC-based budget of \$12 million each), 48 TV Series (\$9 million each), 26 Movies of the Week (\$2 million each), and 3 Mini Series (\$8.7 million each). If poor visual air quality had forced crews to delay filming until visual air quality improved, this delay could have resulted in significant losses. Assuming that 75% of the BC productions were filmed in the Lower Mainland, 5% of these productions had planned to shoot during three distinct poor visual air quality days, and the average production involves 60 days of shooting per year, delay-related losses could total **\$2 million per year** (2011 dollars). Using the BC Input-Output model¹⁴, this value translates into 59 potential direct and indirect jobs lost due to decreased activity in the film industry.

⁹ Tourism BC, 2011. The Value of Tourism in British Columbia – Trends from 1999 to 2009.

¹⁰ BC Input-Output Model. See www.bcstats.gov.bc.ca/StatisticsBySubject/Economy/BCInputOutputModel.aspx

¹¹ Government of British Columbia website, 2010. www2.news.gov.bc.ca/news_releases_2009-2013/2010TCA0005-000310.htm

¹² Conversations with Crescent Entertainment, Omni Film, and the BC Film Commission, April 2011.

¹³ As above.

¹⁴ BC Input-Output Model. See www.bcstats.gov.bc.ca/StatisticsBySubject/Economy/BCInputOutputModel.aspx

Agriculture

Impacts to the agriculture sector can occur both directly and indirectly from fine particulate matter via impacts to plant/crop health. Indirectly, the haze from fine particles reduces the total radiation reaching the earth, increasing the diffuse radiation.¹⁵ When deposited on plant surfaces fine particulate matter can disrupt growth, delay flowering time, reduce the number and area of leaves, and reduce fruit production.¹⁶ Although much study has been devoted to determining the impacts of particulate matter deposition on plant function and yields, very few researchers have specifically investigated how targeted visual air quality management can benefit agriculture. It is estimated that visual air quality-focused improvements could enhance crop yields in eastern China by 5 to 30%, possibly more if the indirect effect by aerosols and other air pollutants also significantly affects crop yields.¹⁷ By comparison, in 1994 ARA Consulting Group Inc. and Bovar Concord Environmental examined the impact of ozone on agricultural crop production and estimated that annual crop losses averted for seven major crops in the Lower Fraser Valley ranged from 1.1 to 2.7%.¹⁸

In 2006, total crop receipts in B.C. were over \$1.1 billion, \$889 million of which was generated by non-greenhouse crops.¹⁹ Assuming that half of these receipts originate in the Lower Mainland and improvements in visual air quality give rise to a modest 1.1% increase in crop yields, the local agricultural industry could increase revenues by **\$5 million per year** (2006 dollars) as a result of visual air quality improvements.

Health

The health burden of air pollution in the Lower Mainland is substantial, with outdoor air pollution estimated to result in between 15 to 150 deaths per year.²⁰ In addition, a study by the Canadian Medical Association estimated that in 2008 in BC alone, air pollution would cause 306 acute premature deaths, 1,158 hospital admissions, 8,763 emergency department visits, 2,526,900 minor illnesses, and 62,112 doctor's office visits.²¹

To protect visual air quality, it will be necessary to reduce fine particulate matter concentrations below the Canada-wide Standards for PM_{2.5}, as well as the PM_{2.5} objectives for BC and Metro Vancouver. Since PM_{2.5} is a non-threshold pollutant, health effects can occur at any level.²² Therefore, *any* improvement in PM_{2.5} levels will yield health benefits.

¹⁵ Grantz, D.A., Garner, J.H.B., Johnson, D.W., 2003. *Ecological effects of particulate matter*. Environment International 29, 213– 239.

¹⁶ Raj, A., Kulshreshtha, K. Srivastava, P. K., Mohanty, C. S. 2010. *Leaf surface structure alterations due to particulate pollution in some common plants*. Environmentalist 30,18–23.

¹⁷ Chameides, W.L., Yu, H., Liu, S.C., Bergin, M., Zhou, X., Mearns, L., Wang, G., Kiang, C.S., Saylor, R.D., Luo, C., Huang, Y., Steiner, A., Giorgi, F., 1999. *Case study of the effects of atmospheric aerosols and regional haze on agriculture: An opportunity to enhance crop yields in China through emission controls?* Proceedings of the National Academy of Sciences 96, 13626–13633. See www.pnas.org/content/96/24/13626.full.

¹⁸ ARA Consulting Group Inc. and BOVAR-CONCORD Environmental, 1994. *Clean Air Benefits and Costs in the GVRD*. GVRD, BC Ministry of Environment, Lands and Parks and Environment Canada.

¹⁹ BC Ministry of Agriculture, 2007. *2006 Fast Facts*.

²⁰ British Columbia. Provincial Health Officer. 2004. *Every Breath You Take...Provincial Health Officer's Annual Report 2003*. Air Quality in British Columbia, a Public Health Perspective. BC Ministry of Health Services, Victoria.

²¹ Canadian Medical Association 2008. *No Breathing Room: National Illness Costs of Pollution*. See www.healthyenvironmentforkids.ca/resources/no-breathing-room-costs-of-air-pollution

²² Pope III, A., Dockery, DW. 2006. *Health Effects of Fine Particulate Air Pollution: Lines that Connect*. J Air Waste Manage Assoc 56: 709-742. See www.environmental-expert.com/Files%5C6477%5Carticles%5C6906%5C1152006criticalreview.pdf

Health Canada and Environment Canada have assessed the human health and economic benefits associated with visual air quality improvement (due to changes in PM_{2.5} concentrations) in the Lower Mainland using the Air Quality Benefits Assessment Tool (AQBAT). Developed by Health Canada, AQBAT is a computer simulation tool that assigns a concentration response function, a statistically derived estimate of the percent excess health endpoints associated with a unit increase in pollutant concentrations, to various health endpoints in the specific region. This study has estimated the human health and economic benefits using multi regression models to establish the relationship between light extinction and PM_{2.5}. The AQBAT model estimates that the human health and welfare benefits of improving hourly PM_{2.5} levels by 10% would add up to \$11.5 billion (2010 dollars) from 2015 to 2035 (an average of **\$545 million per year**).

Aboriginal Values

Carlson (2009)²³ determined that the Aboriginal people of the Lower Fraser Valley have distinct concerns over declining visual air quality associated with increased air pollution. These interviews determined that Aboriginal peoples have a spiritual need to see the mountains, see from the mountains, and be seen by the “mountain mother” who watches over the people and the returning sockeye salmon.

Carlson recommends an assessment of the impacts that degraded visual air quality could have on First Nations economic ventures related to cultural tourism. First Nations land values and the aboriginal film production industry could also be impacted if visual air quality degrades.

Other Co-benefits

It should be noted that visual air quality management options will likely target PM_{2.5} precursors, including emissions of black carbon, nitrogen dioxide, sulphur dioxide, volatile organic compounds and ammonia. These pollutants can affect soil and water quality and ultimately impact wildlife and ecosystem health. A valuation of these co-benefits has not been attempted here.

CONCLUSION

It is clear that improvements in visual air quality have economic value in BC’s Lower Fraser Valley. Poor visual air quality can negatively impact important sectors of the local economy such as the tourism, agriculture, film and real estate industries. On the other hand, improvements in visual air quality can benefit these sectors. Efforts to improve visual air quality will also yield significant health, cultural and environmental co-benefits.

²³ Carlson, K. T., 2009. *Mountains that See, and that Need to Be Seen: Aboriginal Perspectives on Degraded Visual air quality Associated with Air Pollution in the BC Lower Mainland and Fraser Valley. A Traditional Knowledge Study.* Prepared for Environment Canada. See www.clearairbc.ca/visibility/Documents/Aboriginalperspectives.pdf