Review of Environmental Impact Assessment (EIA)

Human Health Risk Assessment (HHRA)

Benga Mining Ltd Grassy Mountain Coal Project

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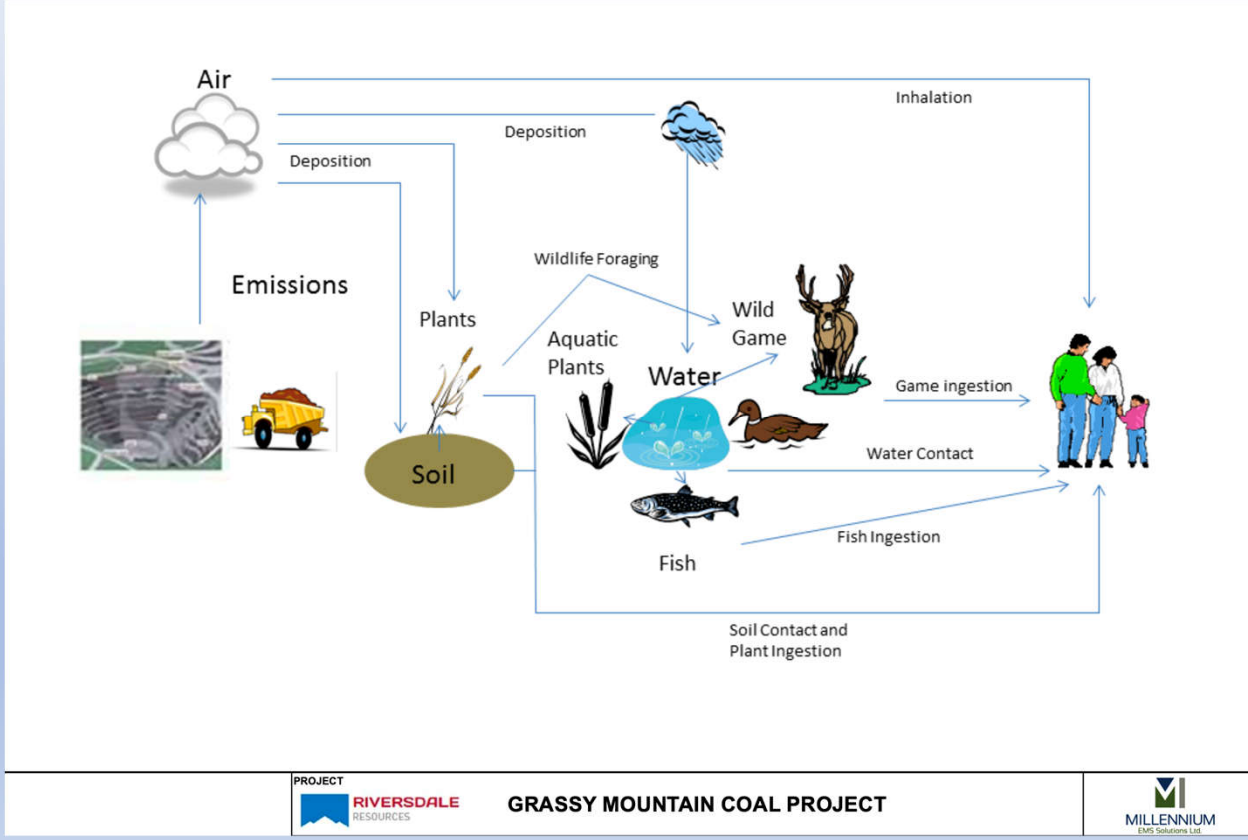
Introduction

- Grassy Mountain EIA covers many topics
- My work reviews the risk to Human Health
- I have reviewed the Human Health sections of the EIA as well as other published literature I consider relevant not contained in the EIA
- My main concern is that the Project EIA does not recognize a large body of literature associating MTR mining with human health impacts.

The process the EIA uses to estimate risk to human health

- Predicts the nature & concentrations of project pollutants emitted to the immediate mine environment (air, water, land)
- Mathematically models pollutant dispersion (ie dilution)
- Estimates pollutant dilution in surrounding communities and recreational areas
- Compares estimated exposures to ‘safe’ exposure levels
- If the modelled value is lower, then no human health risk is predicted
- When the modelled value is greater than the ‘safe’ reference value, then a significant risk to human health is flagged for further assessment
    - Often further refinement of the HHRA assessment will lead to decreased ‘conservatism’ in underlying assumption



The human health risk assessment within the Project EIA concludes '***no impact***'

"The emissions from the Project are not predicted to pose a risk of adverse health effects at the receptor locations accessible to the general public. While risk quotients greater than 1.0 were predicted, they were identified to occur within the Mine Permit Boundary, an area assumed to be inaccessible by the public during construction and operation of the mine or were due to existing baseline emissions with minimal contribution from the Project. Due to the conservative assumptions applied in the air dispersion modelling and HHRA, the risk results outside the RSA-MPOI were not considered great enough to be indicative of a risk of potential adverse health effects."

Weakness to Benga's EIA prediction of ***"no significant human health"*** effect

- Uncertainties and complexity inherent in human health risk assessment
- Relying solely on modelled data - a NARROW SCOPE OF ENQUIRY
- The Project EIA does not address real world human health impacts arising from existing MTR mining operations

Complexity of multi-step HHRA process

- Identification of chemical emissions.
- Estimation of emission concentrations to air, water and land
- Estimation of dilution rates. This is particularly problematic in the Crowsnest Pass area of Alberta where local Chinook winds can be very strong and challenge the validity of models used to predict emission rates and pollution dispersion.
- Estimation of exposure dose (inhalation, ingestion, absorption)
- Estimation of 'safe' exposure limits – these are derived from a combination of sources from Canada, US, Europe and international organizations (e.g. WHO). Safe standards are obtained using:
  - Epidemiological studies
  - Occupational exposure risks relating to health and safety of the workforce
  - Animal toxicology studies
  - Where there is no published limit for a particular chemical, a limit from a similar surrogate chemical is used.
- Estimation of human health risk from individual chemical Vs chemical group exposures
- Estimation of risk to human health from exposure to mixtures of chemicals
- Potential synergism
- Ever-evolving understanding of the health impacts of pollutants on healthy and compromised people
  - Asbestos, lead, benzene, hexavalent chromium, smoking, etc.

Benga HHRA's assessment of human health impacts is narrow in scope

Human Health Impact Assessments can be broader in scope

"Baseline and/or predictive (modelling) information needs to be compared to the potential effects likely to be caused by the project. To obtain this information, the types of indicators required are direct measures of health (e.g., cancer incidence, injuries, changes in stress levels, etc.) and indirect measures of health (e.g., levels of toxic chemicals in human tissues, discharges of hazardous substances to the environment, etc.). To get a better understanding of the health indicators…."

Health Canada, WHO, USA CDC

Coal in Appalachian Mountains

- MTR mining started in 1960s and accelerated from 1990s to present
- Large population base
- Many health studies associating MTR with human health impacts have been published

Peer-reviewed studies showing public health problems in Appalachian coal mining areas:

1. Hendryx M, Ahern M, Nurkiewicz T. Hospitalization patterns associated with Appalachian coal mining. *Journal of Toxicology and Environmental Health Part A,* 2007, 70, 2064-2070.
2. Hendryx M, Ahern M. Relations between health indicators and residential proximity to coal mining in West Virginia. *American Journal of Public Health*, 2008, 98, 669-671.
3. Hendryx M. Mortality rates in Appalachian coal mining counties: 24 years behind the nation. *Environmental Justice*, 2008, 1, 5-11.
4. Hendryx M, O'Donnell K, Horn K. Lung cancer mortality is elevated in coal mining areas of Appalachia. *Lung Cancer*, 2008, 62, 1-7.
5. Hendryx M. Mortality from heart, respiratory and kidney disease in coal mining areas of Appalachia. *International Archives of Occupational and Environmental Health*, 2009, 82, 243-249.
6. Hendryx M, Ahern M. Mortality in Appalachian coal mining regions: the value of statistical life lost. *Public Health Reports*, 2009, 124, 541-550.
7. Hendryx M, Zullig K. Higher coronary heart disease and heart attack morbidity in Appalachian coal mining regions. *Preventive Medicine*, 2009, 49, 355-359.
8. Hendryx M, Fedorko E, Anesetti-Rothermel A. A geographical information system-based analysis of cancer mortality and population exposure to coal mining activities in West Virginia, United States of America. *Geospatial Health*, 2010, 4, 243-256.
9. Palmer MA, Bernhardt ES, Schlesinger WH, Eshleman KN, Foufoula-Georgiou E, Hendryx MS, Lemly AD, Likens GE, Loucks OL, Power ME, White PS, Wilcock PR. Consequences of mountaintop mining. *Science*, 2010, 327, 148-149.
10. Zullig KJ, Hendryx M. A comparative analysis of health-related quality of life (HRQOL) for residents of US counties with and without coal mining. *Public Health Reports*, 2010, 125, 548-555.
11. Cain L, Hendryx M. Learning outcomes among students in relation to West Virginia coal mining: an environmental "riskscape" approach. *Environmental Justice*, 2010, 3, 71-77.
12. Hitt NP, Hendryx M. Ecological integrity of streams related to human cancer mortality rates. *EcoHealth*, 2010, 7, 91-104.

Publications continued (2)

13. Ahern M, Mullett M, MacKay K, Hamilton C. Residence in coal-mining areas and low-birth-weight outcomes. *Maternal and Child Health Journal*, 2011, 15, 974-979.
14. Epstein PR, Buonocore JJ, Eckerle K, Hendryx M, Stout BM, Heinberg R, Clapp RW, May B, Reinhart NL, Ahern MM, Doshi SK, Glustrom L. Full cost accounting for the life cycle of coal. *Annals of the New York Academy of Sciences,* 2011, 1219, 73-98.
15. Zullig K, Hendryx M. Health-related quality of life among central Appalachian residents in mountaintop mining counties. *American Journal of Public Health*, 2011, 101, 848-853.
16. Hendryx M. Poverty and mortality disparities in central Appalachia: mountaintop mining and environmental justice. *Journal of Health Disparities Research and Practice*, 2011, 4(3), 50-59.
17. Ahern M, Hendryx M, Conley J, Fedorko E, Ducatman A, Zullig K. The association between mountaintop mining and birth defects among live births in Central Appalachia, 1996-2003. *Environmental Research*, 2011, 111, 838-846.
18. Esch L, Hendryx M. Chronic cardiovascular disease mortality in mountaintop mining areas of central Appalachian states. *Journal of Rural Health*, 2011, 27, 350-357.
19. Hendryx M, Wolfe L, Luo J, Webb, B. Self-reported cancer rates in two rural areas of West Virginia with and without mountaintop coal mining. *Journal of Community Health*, 2012, 37, 320-327.
20. Ahern M, Hendryx M. Cancer mortality rates in Appalachian mountaintop mining areas. *Journal of Environmental and Occupational Science*, 2012, 1(2), 63-70.
21. Hendryx M, Ducatman AM, Zullig KJ, Ahern MM, Crout R. Adult tooth loss for residents of US coal mining and Appalachian counties. *Community Dentistry and Oral Epidemiology*, 2012, 40, 488-497.
22. Hendryx M, Fulk F, McGinley A. Public drinking water violations in mountaintop coal mining areas of West Virginia, USA. *Water Quality, Exposure and Health*, 2012, 4, 169-175.
23. Knuckles TL, Stapleton PA, Minarchick VC, Esch L, McCawley M, Hendryx M, Nurkiewicz TR. Air pollution particulate matter collected from an Appalachian mountaintop mining site induces microvascular dysfunction. *Microcirculation*, 2013, 20, 158-169.

Publications continued (3)

22. Hendryx M. Personal and family health in rural areas of Kentucky with and without mountaintop coal mining. *Journal of Rural Health*, 2013, 29, S79-S88.
23. Hendryx M, Innes-Wimsatt KA. Increased risk of depression for people living in coal mining areas of Central Appalachia, USA. *Ecopsychology*, 2013, 5(3), 179-187.
24. Kurth L, McCawley M, Hendryx M, Lusk S. Atmospheric particulate matter size distribution and concentration in West Virginia coal mining and non-mining areas. *Journal of Exposure Science and Environmental Epidemiology*, 2014, 24, 405-411.
25. Hendryx M, Luo J. An examination of the effects of mountaintop removal coal mining on respiratory symptoms and COPD using propensity scores. *International Journal of Environmental Health Research*, 2015, 25, 265-276.
26. Kurth L, Kolker A, Engle M, Geboy N, Hendryx M, Orem W, McCawley M, Crosby L, Tatu C, Varonka M, DeVera C. Atmospheric particulate matter in proximity to mountaintop coal mines: sources and potential environmental and human health impacts. *Environmental Geochemistry and Health*, 2015, 37(3), 529-544.
27. Luanpitpong S, Chen M, Knuckles T, Wen S, Luo J, Ellis E, Hendryx M, Rojanasakul Y. Appalachian mountaintop mining particulate matter induces neoplastic transformation of human bronchial epithelial cells and promotes tumor formation. *Environmental Science and Technology*, 2014, 48, 12912-12919.
28. Hendryx M, Entwhistle J. Association between residence near surface coal mining and blood inflammation. *The Extractive Industries and Society,* 2015, 2, 246-251.
29. Hendryx M. The public health impacts of surface coal mining. *The Extractive Industries and Society*, 2015, 2, 820-826.
30. Hendryx M, Holland B. Unintended consequences of the Clean Air Act: mortality rates in Appalachian coal mining communities. *Environmental Science and Policy*, 2016, 63, 1-6.
31. Hendryx M, Yonts S, Li Y, Luo J. Mountaintop removal mining and multiple illness symptoms: A latent class analysis. *Science of the Total Environment*, 2019, 657, 764-769.

Summary views from these 33 human health studies:

Mountaintop removal coal mining in central Appalachia, is associated with human health problems:

- *Higher cancer rates*
- *Higher heart and lung disease rates*
- *Higher kidney disease rates*
- *Higher rates of birth defects*
- *Higher levels of impaired functioning due to health problems*

The pattern of results shows that:

- *Health problems are present after statistical adjustment for age, smoking, obesity, poverty, education, availability of doctors, and other risks*
- *Health problems are most severe in areas where amounts of mining are greatest*
- *Health problems in mountaintop removal mining areas are worsening in more recent years versus earlier years*
- *Health problems are present for men, women and children and reflect more than occupational exposure.*

Dr Michael Hendryx personal communication (Appendix B of my report)

US Federal government commissioned a meta-analysis of literature

Boyles, AL, et al. Systematic review of community health impacts of mountaintop removal mining.
Environment International 2017, 107:163-172

Appendix C to my report

Scope of US Federal government meta analysis of human health impacts associated with MTR mining

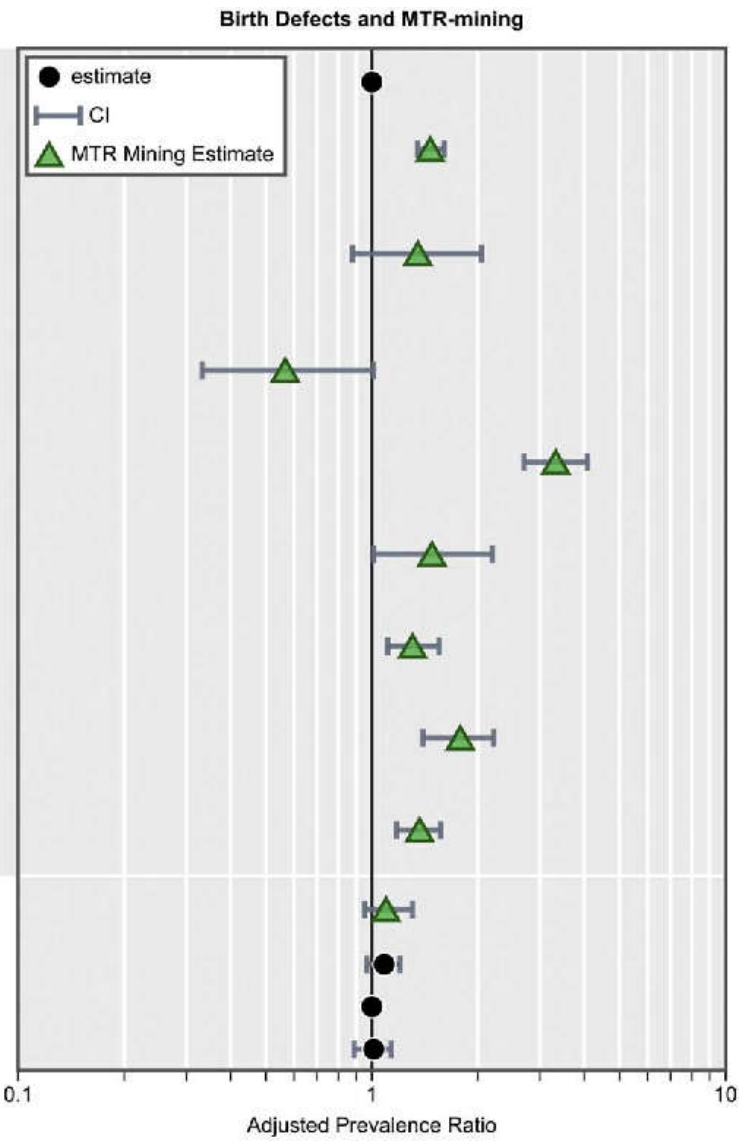
Literature search captured 3,088 studies, whittled down to include:

33 most relevant human studies

- 29 community
- 4 occupational

Each of the 33 papers was read by two objective qualified reviewers using strict criteria. A 3rd senior reviewer on hand to arbitrate disagreement

Study	Design	Population	Outcome	Group
Ahern (2011b)	Cohort (Retrospective)	National Center for Health Statistics natality data	any congenital anomaly	non-mining
			any congenital anomaly	mountaintop mining 2000-2003
			central nervous system congenital anomalies	mountaintop mining 2000-2003
			chromosomal congenital anomalies	mountaintop mining 2000-2003
			circulatory/respiratory congenital anomalies	mountaintop mining 2000-2003
			gastrointestinal congenital anomalies	mountaintop mining 2000-2003
			musculoskeletal congenital anomalies	mountaintop mining 2000-2003
			urogenital congenital anomalies	mountaintop mining 2000-2003
			other congenital anomalies	mountaintop mining 2000-2003
Lamm (2015)	Cohort	Live births in West Virginia	birth defects	Mountaintop mining area
			birth defects	44 Hospitals
			birth defects	nonmining area
			birth defects	6 Hospitals



Adapted from Boyles 2017 Selected prevalence ratios for birth defects from MTR-mining studies

USA government meta-analysis study

- Identifies many published studies associating human health impacts with MTR mining operations
- Recognizes each of the studies contain limitations
- Concludes no unequivocal health study has yet been undertaken to fully investigate health impacts caused by exposure to MTR pollutants

Precautionary principal

A comprehensive health study collecting robust human health data to correlate with robust exposure data does not exist.

Applying the precautionary principal should guide us towards consideration of these studies, and assuming MTR mining may well impact human health

Summary

- The Project EIA concludes **human health impacts not expected**
- The Project EIA based the conclusion of **'no impact' on modelled data** and has not taken into account any published human studies reporting human health impacts from similar MTR mining operations in Appalachia.
- There are many reasons why modelled data **cannot predict with certainty** human health impacts
- The human health risk assessment contained in the Project EIA presents only a **partial picture**. It does not mention nor take into account the plethora of available real world human health studies associating MTR mining with significant health impacts
- **Real world epidemiological health** studies in Appalachia should be regarded as having **equal or higher value than estimated impacts** derived from modelled data
- I urge the Hearing Panel to look beyond the limited modelling HHRA predictions contained in the Project EIA, and **consider as relevant the Appalachian MTR health studies** to better understand potential health impacts from the proposed Grassy Mountain Coal Project