Addressing Concerns about the Health Effects of Gas-Fired Power Generation on Vancouver Island

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The Proposed Power Project

- 265 MW base load. 295 MW peak load.
- High efficiency natural gas fired combined cycle power plant (55%).
- Best available control technology:
  - NOx: SCR with aqueous ammonia.
  - CO: Combustion control.
  - VOC: Combustion control.

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Visualization of Plant

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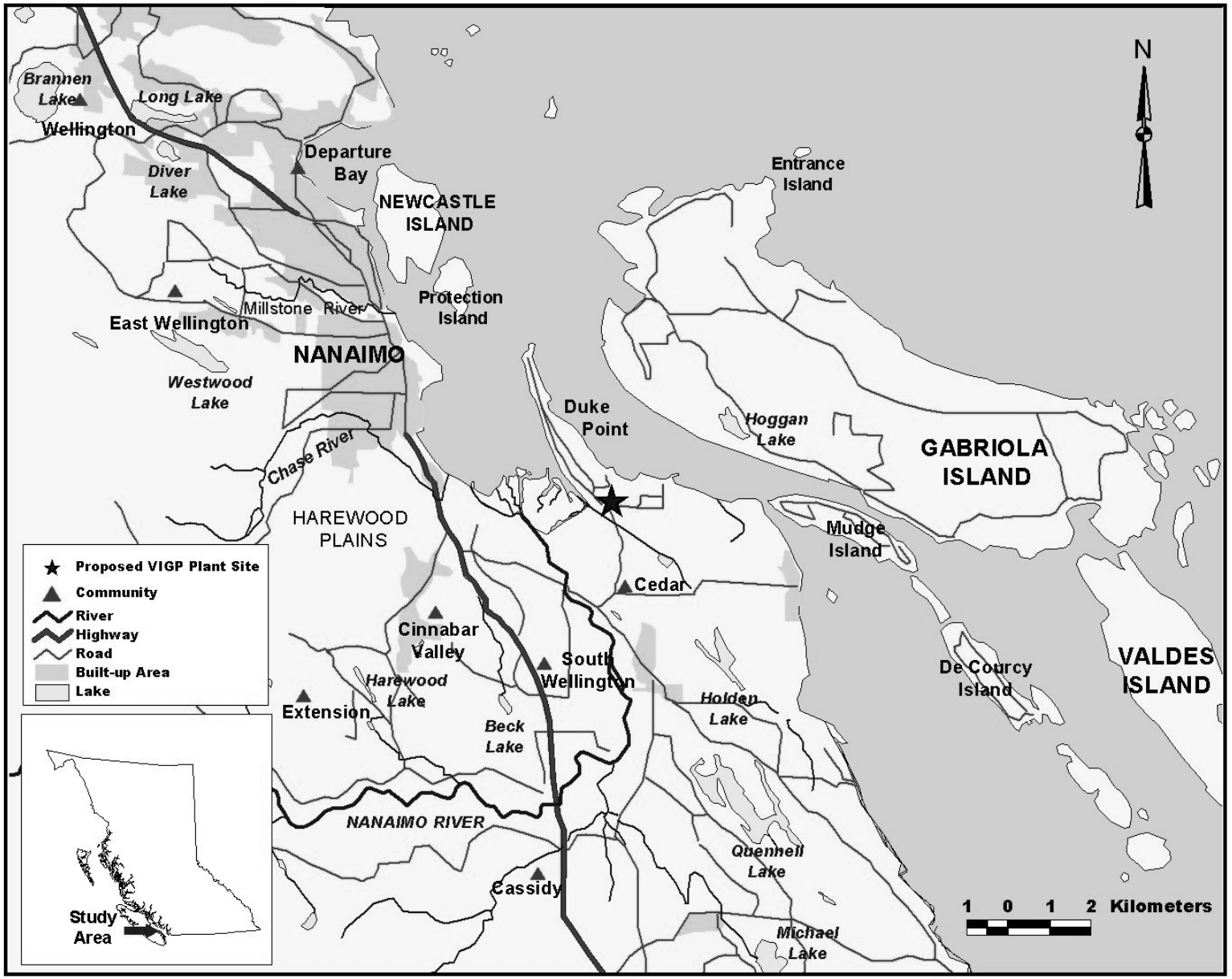

Plant Site Location

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HIA Methods and Scope

- No provincial guidelines existed for project health impact assessments (HIA). (Some guidance is now available)
- Method developed through consultation with health agencies: Vancouver Island Health Authority (lead agency) and Provincial Ministry of Health Planning
- Agreed to scope and methods for:
  - Noncancer hazard index
  - Cancer risk
  - PM10 & PM2.5 mortality & morbidity

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Non-cancer Health Risks

- Considered acute (1-hour average) and chronic (annual average) health effects.
- Hazard index technique with Reference levels and impact pathways from California OEHHA.
- Target organs:
  - Respiratory system, Cardiovascular system, Central nervous system, Eye (acute)/Skin (chronic), Reproduction system, Kidney-Renal system, Gastrointestinol/Liver and Immunological system.

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Cancer Health Risks

- Cancer health risk for 44 yr and 70 yr exposure to carcinogenic air pollutants.
- Unit risk factors reviewed - used California OEHHA.
- Excluded chemicals with less than 1 in 10 million cancer risk potential.

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Initial PM Health Risk Methods

- Change in daily PM concentration, national base rates and total population.
- Mortality risk - 1999 Science Assessment Document
- Hospital admissions - AQVM 3.0 Methods

PM10	**Inc. Rel Risk**	**Base Rate**
Mort:	0.8%/10 μg/m^3	18.4/million/day
RHA:	0.49%/10 μg/m^3	16.0/million/day
CHA:	0.46%/10 μg/m^3	14.4/million/day
PM2.5		
Mort:	1.4%/10 μg/m^3	18.4/million/day
RHA:	0.74%/10 μg/m^3	16.0/million/day
CHA:	0.7%/10 μg/m^3	14.4/million/day

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Additional PM Mortality Assessment

- Mortality based on predicted change in annual PM2.5 concentration.
- Health Canada requested analysis using America Cancer Society cohort study, Pope et. al 2002.
- Relative risk =4.1%/10 $\mu g/m^3$ for ages 30 and older
- Local statistics on all cause death rate for ages 30 and older (1991-2001).
- Local population profile 61% age 30 and older (1991-2001).

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Exposure Assumptions

- Cancer/Noncancer: Continuous exposure to maximum concentrations at peak power. Max occur within 500 m of the plant site and are 2 times for 1-h and 4 times annual average those in community areas.
- PM impacts based on cumulative exposure above LOAEL:
  - Same method as used in Sc. Assess. Doc. PM Assessment.
  - Baseline 4 yr average of Standardized SUM(daily PM10>25 $\mu g/m^3$) & SUM(daily PM2.5>15 $\mu g/m^3$).
  - Predicted primary and secondary PM.
  - PM impact based on increase in SUM PM10 & SUM PM2.5.

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Acute Inhalation Hazard Indices

Pollutant	Target Organ							
	Resp.	**CV/BL**	**CNS**	**Eye**	**Repro.**	**Kidney**	**GI/LV**	**Immun.**
Acrolein	0.0689	--	--	0.0689	--	--	--	--
Ammonia	0.0047	--	--	0.0047	--	--	--	--
Carbon Monoxide (CO)	--	0.0026	--	--	--	--	--	--
Formaldehyde	0.0154	--	--	0.0154	--	--	--	0.0154
Nitrogen Dioxide (NO_2)	0.0609	--	--	--	--	--	--	--
Sulphur Dioxide (SO_2)	0.0047	--	--	--	--	--	--	--
Total Acute Hazard Index:	0.1546	0.0026	--	0.0891	--	--	--	0.0154

Notes:

Resp - Respiratory System; CV/BL - Cardiovascular/Blood; CNS - central nervous system; Repro. – Reproductive System; Kidney - Renal System; GI/LV - Gastrointestinal/Liver; Immun. - immunological system.

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Chronic Inhalation Hazard Indices

Pollutant	Target Organ							
	Resp.	CV/BL	CNS	Skin	Repro.	Kidney	GI/LV	Immun.
Acetaldehyde	0.0002	--	--	--	--	--	--	--
Acrolein	0.0051	--	--	0.0051	--	--	--	--
Ammonia	0.0018	--	--	--	--	--	--	--
Formaldehyde	0.0113	--	--	0.0113	--	--	--	--
Nitrogen Dioxide (NO_2)	0.0014	--	--	--	--	--	--	--
Sulphur Dioxide (SO_2)	0.0001	--	--	--	--	--	--	--
Total Acute Hazard Index:	0.0198	--	--	0.0163	--	--	--	--

Notes:

Resp - Respiratory System; CV/BL - Cardiovascular/Blood; CNS - central nervous system; Repro. – Reproductive System; Kidney - Renal System; GI/LV - Gastrointestinal/Liver; Immun. - immunological system.

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Hazard Risk Assessment

- Conservative estimate of acute hazard <0.3
- Conservative estimate of chronic hazard <0.1
- These are less than HI risk threshold of 0.5, the guideline when excluding background exposure.
- In community areas:
  - Acute inhalation HI is less than 0.02
  - Chronic inhalation HI is less than 0.002

Cancer Risk

- 0.07 per 100,000 population - 44 year risk from inhalation, soil ingestion, dermal contact and infant ingestion of mothers milk.
- 0.06 per 100,000 population - 70 year risk from inhalation, soil ingestion and dermal contact.

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PM2.5 Health Impacts

- For SUM PM>LOAEL and predicted max Δdaily PM2.5= 0.3 μg/m^3 (primary+secondary):
  - Mortality per 100,000: 0.003 cases/year.
  - RHA per 100,000: 0.0014 cases/year.
  - CHA per 100,000: 0.012 cases/year.
- Long-term PM2.5 mortality using Pope et al. 2002 & predicted Δannual PM2.5 (per 100,000):
  - Nanaimo 0.008 μg/m^3 0.02 cases/year
  - Cedar 0.02 μg/m^3 0.06 cases/year
  - Gabriola Isl. 0.005 μg/m^3 0.02 cases/year

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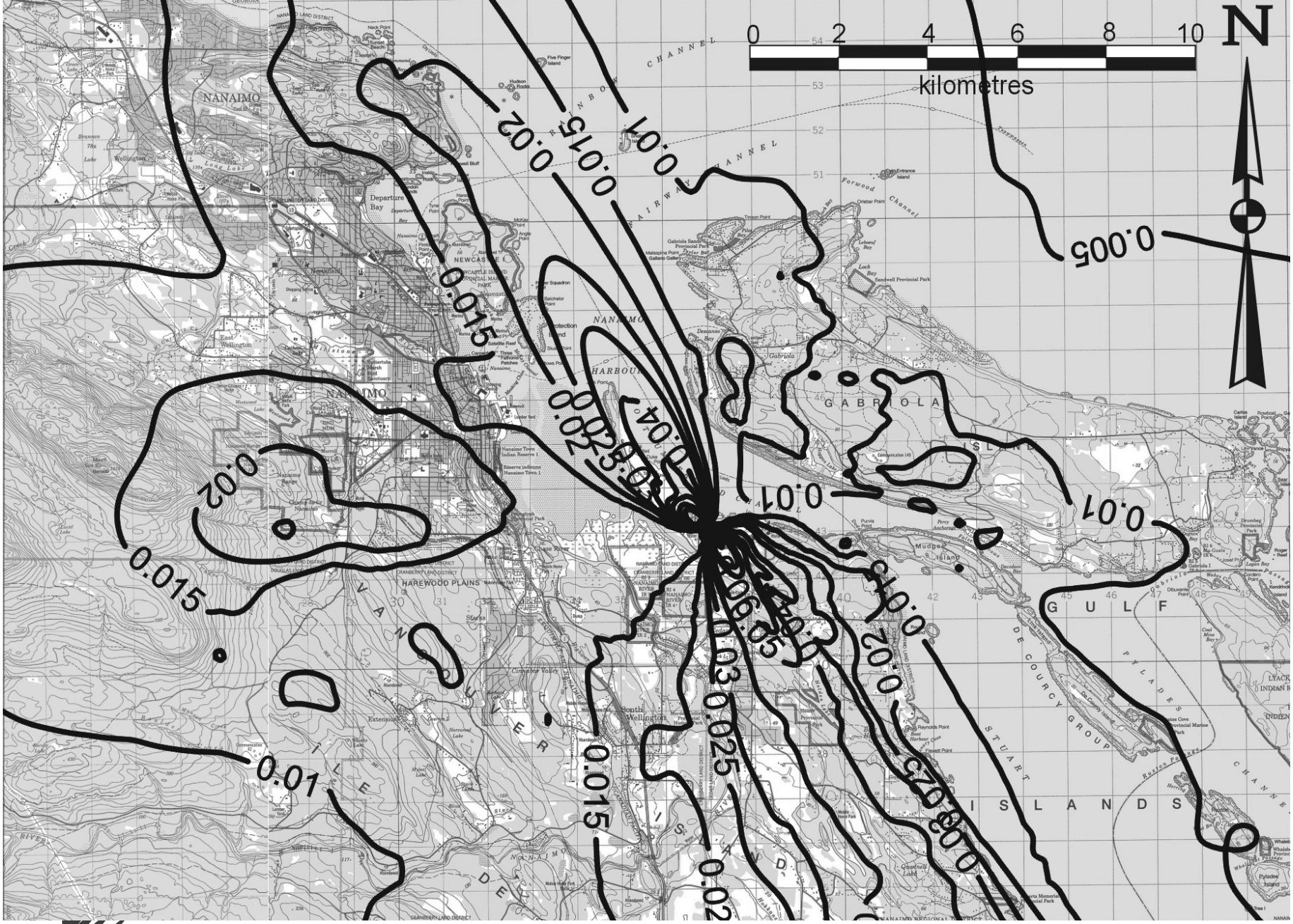

Incremental PM2.5 Mortality per year per 100,000

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Some of the Concerns & Issues Raised

- What is the uncertainty in the modelled pollutant concentrations & impacts?
  - Compounding of uncertainty in models of meteorology, emission rates and CALPUFF dispersion predictions.
  - Are assumptions sufficiently conservative to reflect all unknowns .
- What level of health risk is acceptable?
  - Health agencies struggled with how to use the quantified risks as BC guidelines or policies have not been developed.
  - The process was inefficient and not very effective.
  - There is a need for criteria on what risks are acceptable to streamline the analysis and health assessment processes for major projects.

Some of the Concerns & Issues Raised

- PM2.5 and PM10 health impacts:
  - There was a high level of concern by the public about health impacts from PM.
  - How much of an increase in PM2.5 is acceptable, if there is no threshold for impacts to human health?
  - Is the Canada Wide Standard for PM2.5 adequately protective of human health?
- How should modelled pollutant concentrations be combined with ambient monitoring results? Health agencies were unfamiliar with use of dispersion modelling results.

Summary and Conclusions

- Provincial review agencies concluded that VIGP would not have a measurable impact on air quality and health. Health Canada concluded the project would have limited adverse public health impacts.
- Conditions require monitoring of stack emissions and an ambient air quality monitoring program.
- Experience with the project indicates that work is needed to streamline and improve project HIAs in BC.
- Need guidelines, standard methods and evaluation criteria acceptable to agencies that can be applied across the province.