GOLDER

Parkland Burnaby Refinery HHRA Study Results

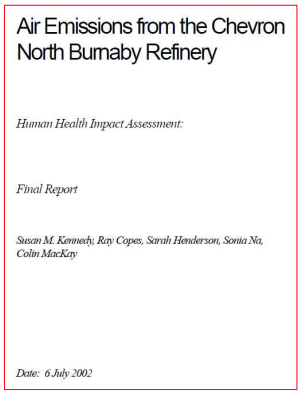

Photo Credit: Andrew Maples

Francis J. Ries, B.Sc. P.Eng.
Theresa Repaso-Subang, HBSc., DABT, ERT, QPRA

March 10, 2022

HHRA Introduction & History

- HHRA: a scientific process that predicts the nature and likelihood of harmful health effects that may occur should people be exposed to chemicals in the environment.
- Two historical health impact assessments performed for Parkland refinery identified key contaminants of concern:
  - Sulphur dioxide
  - Benzene
  - 1,3-Butadiene


Air Emissions from the Chevron North Burnaby Refinery

Human Health Impact Assessment:

Final Report

Susan M. Kennedy, Ray Copes, Sarah Henderson, Sonia Na, Colin MacKay

Date: 6 July 2002


fraserhealth

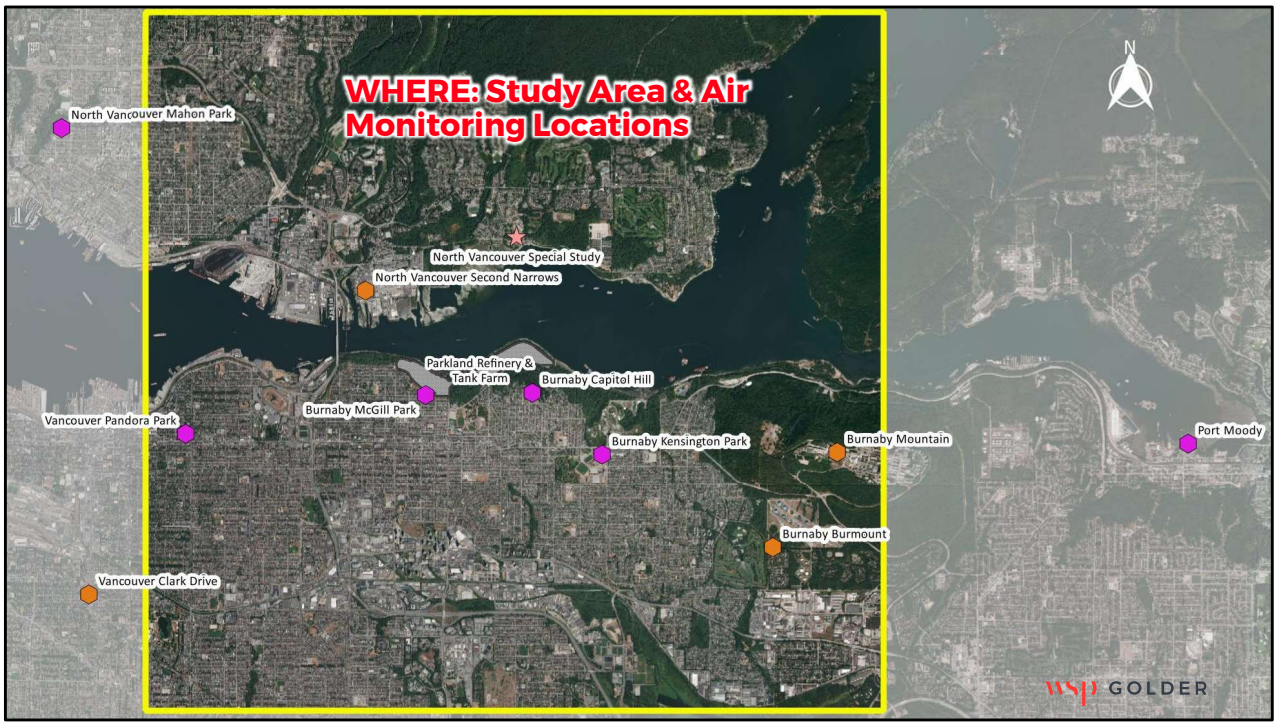
AIR QUALITY & HEALTH IMPACT ASSESSMENT UPDATE

Chevron CAP September 18, 2013

metrovancouver
SERVICES AND SOLUTIONS FOR A LIVABLE REGION

A human health risk assessment, or HHRA ,is a scientific process that predicts the nature and likelihood of harmful health effects that may occur should people be exposed to chemicals in the environment. An air emissions HHRA identifies contaminants of concern that are emitted by a particular source, in this case the Parkland refinery, and looks to the health science literature to understand the types of health risks posed by these contaminants, as well as threshold levels or acceptable risk levels for exposure. With that knowledge in hand, the HHRA then assesses the amount of these contaminants that people in the study area are exposed to, and determines whether those exposures exceed acceptable risk levels.

There have been two previous health assessments performed for the Parkland Refinery: one in 2002 by a group of researchers at UBC, and an update in 2013 performed by staff at Metro Vancouver and Fraser Health. A key result of these studies was the identification of three key contaminants of concern: sulphur dioxide, benzene and 1,3-butadiene.



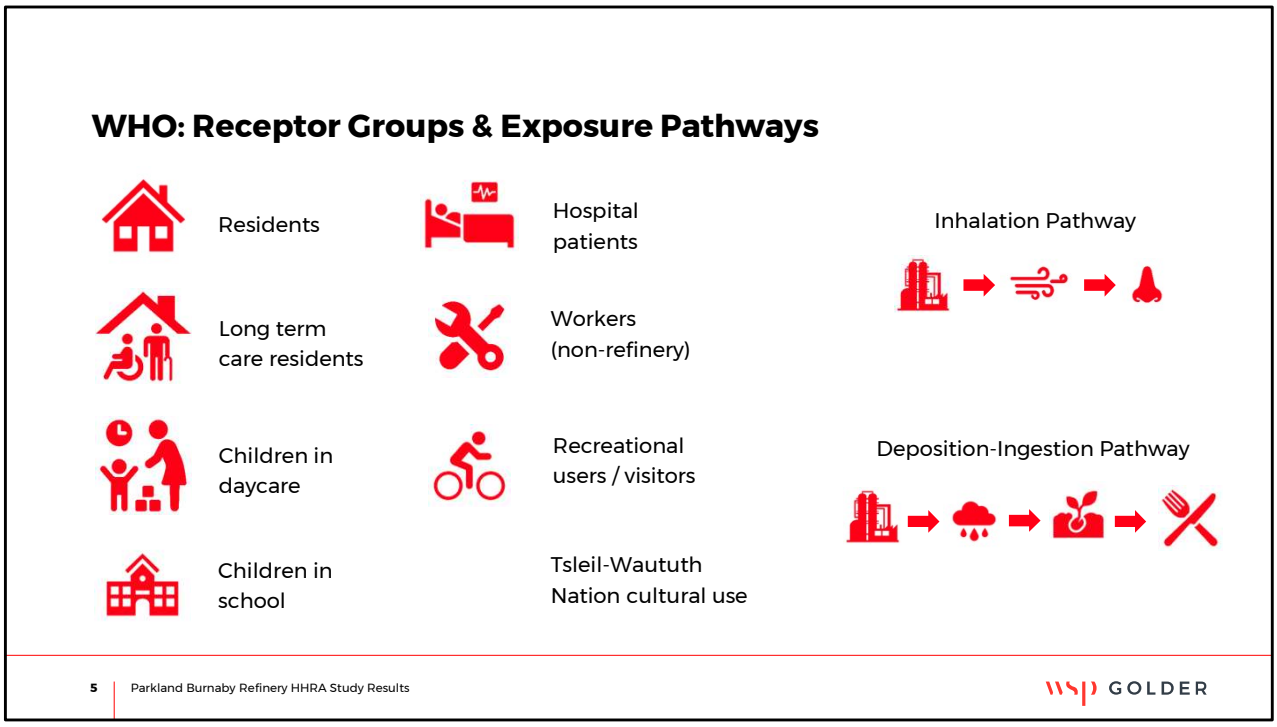
The study area for the current Parkland HHRA is a box that extends 5km on each side of the refinery, as shown in the figure. This figure also includes markers indicating the locations of Metro Vancouver air quality monitoring stations in or near the study area. Stations shown in pink were used in our study, and those show in orange were excluded due to heavy influence of non-refinery sources on those stations. Note that details such as the study area size and shape and inclusion of monitoring stations were included in an HHRA workplan that was reviewed and approved by Metro Vancouver and Fraser Health.

WHAT: Contaminants of Potential Concern

COPC	Primary Health Effects	Sources (Metro Vancouver Top 5)
Sulphur Dioxide (SO_2)	Respiratory	
Nitrogen Dioxide (NO_2)	Respiratory	
Fine Particulate Matter ($PM_{2.5}$)	Respiratory, Circulatory	
Benzene	Hematic, Carcinogenic	
1,3-Butadiene	Respiratory, Carcinogenic	

The 5 contaminants of concern, or COPC selected for including in the HHRA are shown here. These were selected based on results of the previous health studies for the refinery, as well as the emissions changes proposed in Parkland's permit amendment application. The primary health effects for each COPC are shown, with respiratory effects being common to 4 of the 5 COPC. Circulatory and blood effects were also identified, and benzene and 1,3-butadiene were identified to be carcinogenic.

The table also identifies the top 5 regional sources of the COPC based on Metro Vancouver's most recent emissions inventory. Sulphur dioxide is the only COPC of the 5 for which the Parkland refinery is the largest regional source. For all other COPC, sources such as marine shipping, cars and trucks, non-road engines, residential wood burning and other industry are the key regional sources, with the Parkland refinery contributing a relatively small amount of regional emissions.



The HHRA looked at a range of different groups, known as receptors, who might experience different amounts and durations of exposure to the COPC included in the assessment. Groups assessed included residents, seniors in long term care, children in daycare, children in school, hospital patients, non-refinery workers, recreational users, and Tsleil-Waututh Nation members engaging in cultural practices on lands in the study area.

The assessment also looked at different ways in which the receptors could be exposed to COPC emitted by the refinery. The primary pathway assessed was inhalation of COPC, but we also did a screening assessment of deposition of COPC onto soils, which could lead of ingestion of COPC via soils or plants grown in those soils.

WHO: Receptor Groups & Exposure Pathways

- Residents
- Long term care residents
- Children in daycare
- Children in school
- Hospital patients
- Workers (non-refinery)
- Recreational users / visitors
- Tsleil-Waututh Nation cultural use

Inhalation Pathway

Deposition-Ingestion Pathway

The results of our deposition screening assessment indicated that the amounts deposited were so low that they would not result in significant soil accumulation, even over many decades, so we didn't carry forward the deposition pathway, and instead focused on the inhalation pathway in our assessment.

WHEN: Study Scenarios

Scenario	Time Period	Data Source	COPC	Scenario Purpose
Ambient Monitoring 2017-2019	2017 - 2019	MV Monitoring	SO_2, NO_2, $PM_{2.5}$, Benzene, 1,3-Butadiene	Risks based on most recent measurements
Current Permit Maximum	Today	MV Monitoring, Dispersion Modelling	SO_2, NO_2, $PM_{2.5}$	Theoretical maximum risks, current permit
Amended Permit Maximum	Future with amended permit (2025)	MV Monitoring, Dispersion Modelling	SO_2, NO_2, $PM_{2.5}$	Theoretical maximum risks, amended permit
Amended Permit Normal	Future with amended permit (2025)	MV Monitoring, Dispersion Modelling	SO_2, NO_2, $PM_{2.5}$	Average risks, amended permit

The HHRA looked a 4 different scenarios when determining the amount of COPC that receptors could be exposed to. The first scenario utilized Metro Vancouver air quality monitoring data from 2017 to 2019, which was the most recent set of validated data available at the time of our assessment. The scenario looked at measured levels of all 5 COPC from seven different monitoring locations.

The other three scenarios are directly related to Parkland's current permit amendment application. For these scenarios, we used a computer-based air dispersion model to predict the levels of sulphur dioxide, nitrogen dioxide, and fine particulate matter throughout the study area based on emissions of these contaminants from the refinery. The Current Permit Maximum scenario represents the theoretical maximum emissions authorized by Parkland's current air permit, and the Amended Permit Maximum scenario represents the theoretical maximum emissions requested to be authorized by the permit amendment application. Note that both of these scenarios assume that all sources at the refinery emit their maximum authorized amount at the same time, which is not possible in real-world refinery operation, so we also included the Amended Permit Normal scenario, which represents typical refinery operation expected under the proposed permit amendment.

KEY RESULTS: Sulphur Dioxide

Scenario	Predicted Acute Health Risks			Refinery Contribution	
	Elevated?	Area	Hours Per Year	Study Boundary (5km)	Receptor Nearest Refinery
Ambient Monitoring 2017-2019	Yes	Capitol Hill Harbourview	8	N/A	N/A
Current Permit Maximum	Yes	Area near shore on both sides of Burrard Inlet	4	70%	98%
Amended Permit Maximum	Yes	Single recreation location near Area 2 fenceline	2	41%	95%
Amended Permit Normal	No	None	0	22%	90%

Without the refinery included, "background" SO_2 levels are 7% of acceptable acute health risk level.

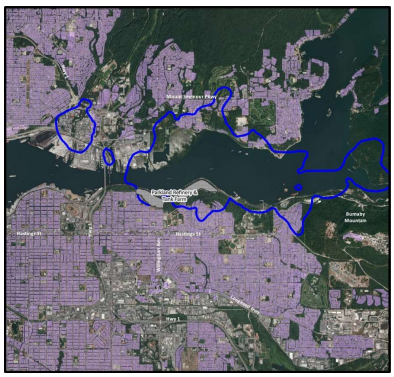
GOLDER

In reviewing study results, we start with sulphur dioxide, the contaminant for which the refinery is the largest regional source. The results table used here shows 4 pieces of information: First, the "Elevated" column provides an indication of whether the assessment predicted health risks above acceptable levels anywhere in the study area, for any period of time. The "Area" column indicates where elevated levels of risk were predicated, and the "Hours per Year" column indicates the total number of hours during which elevated risks were predicted, out of 8760 hours per year. Finally, the refinery contribution columns indicate the percentage of predicted exposure for a given COPC that the refinery is responsible for, both at the edge of our the study area 5km from the refinery, and at the receptor location nearest to the refinery.

For sulphur dioxide, the Ambient Monitoring scenario results indicate that measured sulphur dioxide levels at Metro Vancouver's Capitol Hill Harbourview Park station exceeded our acceptable risk criteria for an average 8 hours per year during the 2017-2019 period. This is result is somewhat consistent with our predictions from the Current Permit Maximum scenario, which predicts elevated levels near the shore on both sides of Burrard inlet for a maximum of 4 hours per year for any given receptor. The Amended Permit Maximum and Normal scenarios illustrate the positive impacts of the emissions reductions associated with the amendment, with predicted risks dropping below acceptable levels for all but single location immediately beside the refinery.

KEY RESULTS: Sulphur Dioxide

Current Permit Maximum

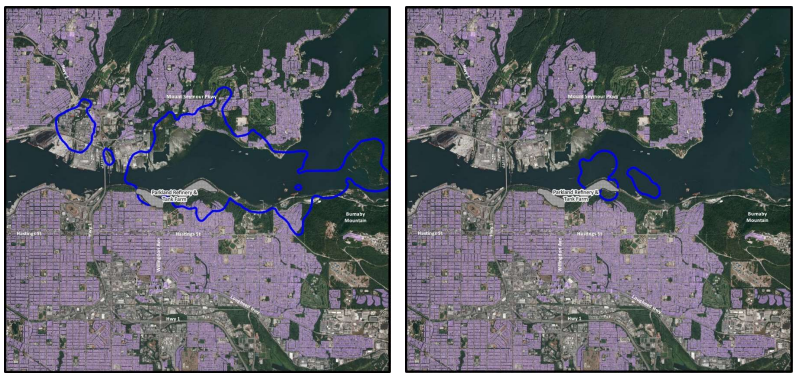


Area inside blue outline has predicted health risks exceeding acceptable levels for at least 1 hour per year.

Maps can help to visualize the change in predicted sulphur dioxide levels after the implantation of Parkland's requested permit amendment. The area enclosed in the blue line on this map had predicted health risks exceeding acceptable levels for at least 1 hour per year under the Current Permit Maximum scenario.

KEY RESULTS: Sulphur Dioxide

Current Permit Maximum >> **Amended Permit Maximum**



Area inside blue outline has predicted health risks exceeding acceptable levels for at least 1 hour per year.

With the implementation of the sulphur dioxide emission reduction in the Amended Permit Maximum scenario, this area shrinks significantly, and no longer overlaps with any of our identified receptor locations, except for a single TransCanada trail segment very near the refinery.

KEY RESULTS: Sulphur Dioxide

Current Permit Maximum >> **Amended Permit Maximum** >> **Amended Permit Normal**

Area inside blue outline has predicted health risks exceeding acceptable levels for at least 1 hour per year.

Finally, if we look not at the maximum authorized emissions under the amended permit, but instead at the average emissions expected, the Amended Permit Normal scenario shows no areas out side the refinery fenceline with predicted risks above acceptable levels.

KEY RESULTS: Nitrogen Dioxide – Refinery + All Other Sources

Scenario	Predicted Acute Health Risks			Refinery Contribution	
	Elevated?	Area	Hours Per Year	Study Boundary (5km)	Receptor Nearest Refinery
Ambient Monitoring 2017-2019	No	None	0	N/A	N/A
Current Permit Maximum	Yes	Majority of study area	1288	5%	50%
Amended Permit Maximum	Yes	Majority of study area	1165	4%	45%
Amended Permit Normal	Yes	Half of study area	701	2%	31%

Without the refinery included, "background" NO_2 levels are 95% of acceptable acute health risk level.

GOLDER

Now we look at the results for nitrogen dioxide, which present a different picture than sulphur dioxide. The Parkland Refinery is a relatively small source of nitrogen dioxide on a regional scale, but emissions from sources such as marine vessels, cars and trucks, non-road engines and building heating mean that background levels nitrogen dioxide are high, almost 95% of the acceptable risk level before we include refinery emissions.

For the Ambient Monitoring scenario, none of Metro Vancouver's monitoring stations in the study area measured nitrogen dioxide levels exceeding the acceptable risk level. For all three of our modelled permit scenarios, we see that predicted risks for the refinery plus all other sources are elevated throughout much of our study area, for a significant number of hours out of the year. We do see a reduction in the area impacted, annual number of hours, and refinery contribution under the Amended Permit scenarios, indicating that emissions reduction associated with the permit have a positive impact.

Given the predominant impact that non-refinery sources have on nitrogen dioxide risks across all three permit scenarios, we focused subsequent on investigations in on the refinery itself.

KEY RESULTS: Nitrogen Dioxide – Refinery Only

Scenario	Predicted Acute Health Risks		
	Elevated?	Area	Hours Per Year
Ambient Monitoring 2017-2019	No	None	0
Current Permit Maximum	No	None	0
Amended Permit Maximum	No	None	0
Amended Permit Normal	No	None	0

- High background levels of non-refinery NO_2 are primary driver of predicted cumulative refinery + background health risks:
- High background levels of NO_2 are out of control of refinery.
- Upgrades associated with amended permit predicted to produce modest reduction in cumulative risks;

GOLDER

If we consider emissions of nitrogen dioxide from the refinery only, we see that none of the Permit scenarios exceed acceptable levels of risk for any receptor. This puts the focus squarely on the high nitrogen dioxide background levels resulting from other emission sources outside Parkland Refinery control, as these are the primary driver of predicted nitrogen dioxide health risks shown on the previous slide. As previously stated, despite the high background levels, the upgrades associated with the permit amount do result in modest reduction in cumulative risks.

KEY RESULTS: Fine Particulate Matter

Scenario	Predicted Acute Health Risks			Refinery Contribution	
	Elevated?	Area	Hours Per Year	Study Boundary (5km)	Receptor Nearest Refinery
Ambient Monitoring 2017-2019	No	None	0	N/A	N/A
Current Permit Maximum	No	None	0	4%	33%
Amended Permit Maximum	No	None	0	3%	28%
Amended Permit Normal	No	None	0	1%	10%

Without the refinery included, "background" $PM_{2.5}$ levels are 47% of acceptable acute health risk level.

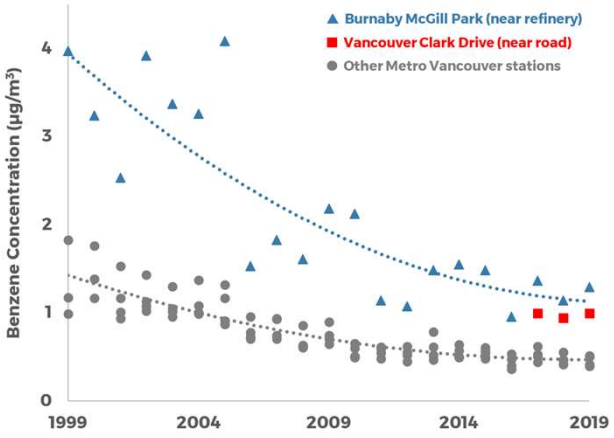
GOLDER

Explanation of results for fine particulate matter is more straightforward, because none of the scenarios assessed showed predicted health risks above acceptable levels. As for nitrogen dioxide, non-refinery sources were the primary driver of fine particulate matter health risks, even at the receptors closest to the refinery.

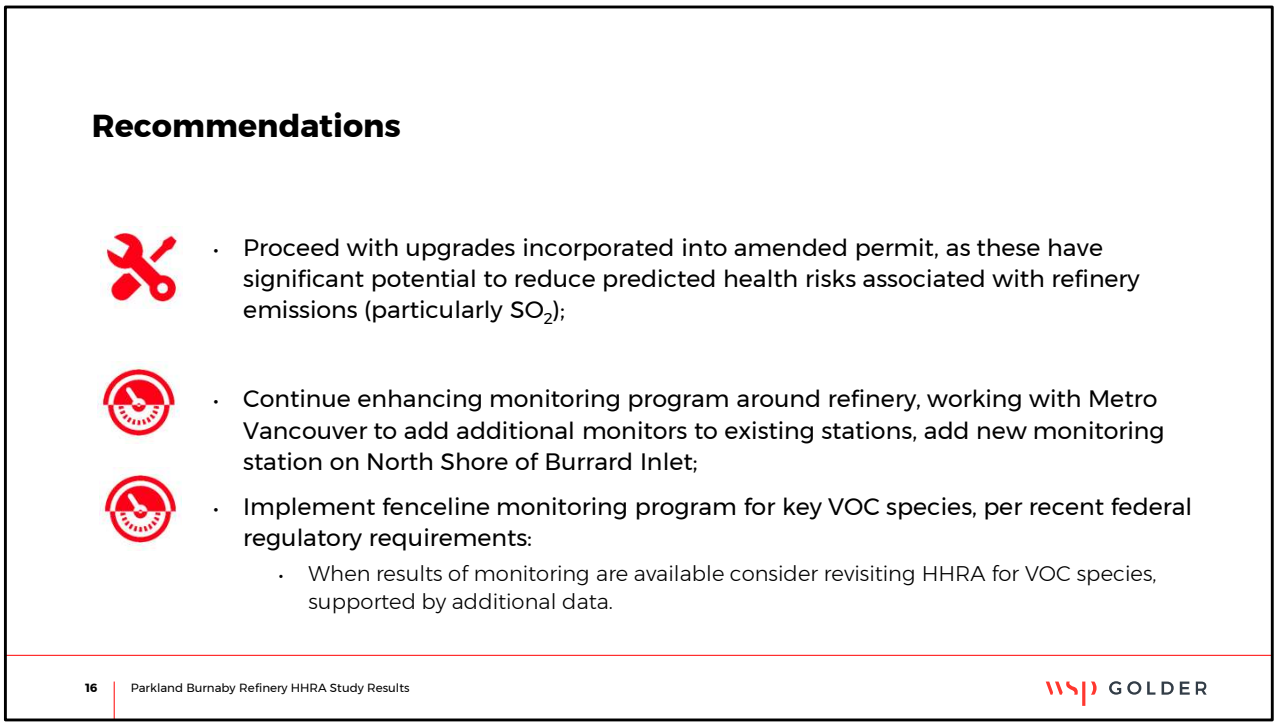
KEY RESULTS: Benzene & 1,3-Butadiene

Ambient Monitoring 2017-2019

COPC / Exposure Period	Predicted Health Risks	
	Elevated?	Hours Per Year
Benzene - Acute	No	0
Benzene - Chronic	No	0
1,3-Butadiene - Acute	No	0
1,3-Butadiene - Chronic	No	0



Looking at results for Benzene & 1,3-Butadiene, the two COPC identified as carcinogens, we see that predicted health risks based levels measured at Metro Vancouver's North Burnaby McGill Park station did not exceed acceptable levels for either pollutant. This result is different from the 2002 study, primary because we see a strong downward trend in measured Benzene & 1,3-Butadiene levels near refinery and throughout Metro Vancouver since the 2002 study. It should be noted that levels of Benzene remain higher near the refinery relative to other regional monitoring locations, with the exception of these located near major roads. Levels of 1,3-Butadiene are no longer elevated near refinery.



With the preceding results in mind, WSP offers the following key recommendations:

1) Proceed with the emissions reduction upgrades incorporated into the amended permit, as these have significant potential to reduce predicted health risks associated with refinery emissions (particularly sulphur dioxide);

2) Continue enhancing the air quality monitoring program around refinery, working with Metro Vancouver to add additional monitors to existing stations, add new monitoring station on North Shore of Burrard Inlet;

3) Implement fenceline monitoring program for key volatile organic compound species, as required by recent federal regulatory requirements. This will provide monitoring data in a large number of locations around the refinery, which will fill in potential gaps in the current monitoring, which is currently conducted at a single location. When results of the fenceline monitoring are available, we recommend that Parkland consider revisiting the HHRA for volatile organic compound contaminants benzene and 1,3-butadiene, supported by the additional data.

GOLDER

Questions?

wsp.com