NATIONAL ENERGY BOARD

IN THE MATTER OF

**the *National Energy Board Act*,
R.S.C. 1985, c. N-7, as amended, ("*NEB Act*")
and the Regulations made thereunder;**

AND IN THE MATTER OF

**the *Canadian Environmental Assessment Act, 2012*,
S.C. 2012, c. 37, as amended,
and the Regulations made thereunder;**

AND IN THE MATTER OF

**an application by Trans Mountain Pipeline ULC
as General Partner of Trans Mountain Pipeline L.P.
(collectively "Trans Mountain")
for a Certificate of Public Convenience and Necessity and
other related approvals pursuant to Part III of the *NEB Act***

TRANS MOUNTAIN EXPANSION PROJECT
REPLY EVIDENCE

August 2015

**To: The Secretary
The National Energy Board
444 — 7th Avenue SW
Calgary, AB T2P 0X8**

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ABBREVIATIONS AND ACRONYMS

This table lists the abbreviations and acronyms used in this reply evidence.

Term	Meaning
AAAQO	Alberta Ambient Air Quality Objectives
AAQO	Ambient Air Quality Objective
AB	Alberta
ACT	Alberta Culture and Tourism
AEGL	Acute Exposure Guideline Level
AER	Alberta Energy Regulator
AFC	Alberta Fire Code
AIHA	American Industrial Hygiene Association
AIRA	Aleutian Islands Risk Assessment
AIS	Automatic Information System
ALARP	As low as reasonably practical
ALIB	Adams Lake Indian Band
AMOP	Arctic and Marine Oilspill Program
ANPC	Alberta Native Plant Council
AOOS	Alaska Ocean Observing System
APEGBC	Association of Professional Engineers and Geoscientists of British Columbia
API	American Petroleum Institute
AQO	Air Quality Objective
ARD	acid rock drainage
ASB	Alberta Sweet Blend
ASCE	American Society of Civil Engineers
asl	above sea level
ATK	Aboriginal Traditional Knowledge
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	all-terrain vehicle
AWB	Access Winter Blend
AWNTB	Asini Wachi Nehiyawak Traditional Band
BA	before-after
BACI	Before-after-control-impact
bbl	barrel
bbl/d	barrels per day
BC	British Columbia
BCBC	British Columbia Building Code
BC CDC	British Columbia Conservation Data Centre
BCFC	British Columbia Fire Code
BCIT	British Columbia Institute of Technology
BC MOE	BC Ministry of Environment
BC OGC	British Columbia Oil and Gas Commission
BCWF	British Columbia Wildlife Federation
BGC	BGC Engineering Inc
BLL	blood lead level
BMP	best management practice
Board	National Energy Board
BOCF	Bulk Oil Cargo Fee
BROKE	Burnaby Residents Opposing Kinder Morgan Expansion

Term	Meaning
BS&W	base sediment and water
BSC	Bird Studies Canada
BSF	Biological Sensitivity Factor
BSSC	Building Seismic Safety Council
BTEX	benzene, toluene, ethylbenzene, and xylenes
BTM	Baseline Thematic Mapping
CAAQS	Canadian Ambient Air Quality Standard
CAC	criteria air contaminant
CAER	Community Awareness and Emergency Response
CAPP	Canadian Association of Petroleum Producers
CAPTEX	Cross Appalachian Tracer Experiment
CARB	California Air Resources Board
CBoC	Conference Board of Canada
CC	conventional crude
CCA	Capital Cost Allowance
CCG	Canadian Coast Guard
CCME	Canadian Council of the Ministers of the Environment
CCO	control centre operator
CCPS	Center for Chemical Process Safety
CEA Act, 2012	*Canadian Environmental Assessment Act, 2012*
CEPA	Canadian Energy Pipelines Association
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFHOP	conceptual fish habitat offset plans
CFN	Coastal First Nations
CGLAP	Collaborative Group of Landowners Affected by Pipelines
CHOA	Cultural Heritage Overview Assessment
CI	control-impact
CIB	Coldwater Indian Band
CLB	Cold Lake Blend
CLC	Civil Liability Convention
CLWB	Cold Lake Winter Blend
CMAQ	Community Multi-scale Air Quality
CMFN	Cheam First Nation
CN	Canadian National
CNS	central nervous system
CO_2	carbon dioxide
CoB	City of Burnaby
COPC	chemicals of potential concern
COS	California Oil Spill
COSBC	Chamber of Shipping of British Columbia
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CP	Canadian Pacific
CPCN	Certificate of Public Convenience and Necessity
CPM	Computational Pipeline Monitoring
CPUE	catch per unit effort
CRA	commercial, recreational or Aboriginal
CREW	Cascadia Region Earthquake Workgroup
CSA	Canadian Standards Association

Term	Meaning
cSt	Centistokes
CT	Cowichan Tribes
CU	Conservation Unit
CV	coefficient of variation
CWC	credible worst-case
CWCS	credible worst-case scenario
CWFN	Chawathil First Nation
DAS	distributed acoustic sensing
DFO	Fisheries and Oceans Canada
dilbit	diluted bitumen
DNV	Det Norske Veritas
DPM	diesel particulate matter
DQERA	Detailed Quantitative Ecological Risk Assessment
DTS	distributed temperature sensing
DWT	deadweight
EC	Environment Canada
ECA	emission control areas
ECHO	Enhancing Cetacean Habitat and Observation
EEDI	Energy Efficiency Design Index
EGS	ecosystem goods and services
EHS	environment, health and safety
EMF	Energy Modeling Forum
EMP	Emergency Management Plan
ENGO	environmental non-governmental organization
EPP	environmental protection plan
ERA	ecological risk assessment
ERCB	Energy Resources Conservation Board
ERP	Emergency Response Plan
ERPG	Emergency Response Planning Guideline
ESA	Environmental and Socio-Economic Assessment
ETEX	European Tracer Experiment
EVOS	Exxon Valdez Oil Spill
EVOSTC	Exxon Valdez Oil Spill Trustee Council
FBE	fusion bond epoxy
FER	Friends of Ecological Reserves
FFA	Flood Frequency Analysis
FIMP	Facility Integrity Management Plan
FLoC	frequency of loss of containment
FOE US	Friends of the Earth United States
FOSET	Fisherman Oil Spill Emergency Team
FPGA	PGA-specific amplification/deamplification factor
FVRD	Fraser Valley Regional District
GC/MS	gas chromatography/mass spectrometry
GCC	Grasslands Conservation Council
GDP	gross domestic product
Genwest	Genwest Systems, Inc.
GEV	Generalized Extreme Value
GHG	greenhouse gas
GML	Métis Nation of Alberta Gunn Métis Local 55

Term	Meaning
GMPE	ground-motion prediction equation
GNOME	General NOAA Operational Modeling Environment
GoC	Government of Canada
Golder	Golder Associates Ltd.
GRP	geographic response plan
GRS	geographic response strategy
GT	gross ton
GVRD	Greater Vancouver Regional District
GWU	George Washington University
H3D	three-dimensional hydrodynamic model
HAZID	hazard identification workshop
HazOp	Hazards and Operability
HCA	high consequence area
HDD	horizontal directional drilling
HF	High Frequency
HFO	heavy fuel oil
HHRA	Human Health Risk Assessment
HMM	Hatch Mott MacDonald
HNS	Hazardous and Noxious Substances
HP	horsepower
HRA	*Historical Resources Act*
HRIA	Historical Resources Impact Assessment
HSE	Health and Safety Executive
HVP	high vapour pressure
IACF	International Association of Fire Chiefs
IARC	International Agency for Research on Cancer
IB	Indian Band
IBA	Important Bird Area
ICA	Integrated Cultural Assessment
ICBC	Insurance Corporation of British Columbia
ICP	Incident Command Post
ICS	Incident Command System
IDLH	Immediately Dangerous to Life and Health
IEA	International Energy Agency
IES	Illuminating Engineers Society
IEUBK	Integrated Exposure Uptake Biokinetic
IHS	IHS Global Canada Limited
ILCR	incremental lifetime cancer risk
ILI	in-line inspection
IMO	International Maritime Organization
IMP	Integrity Management Program
INEL	Idaho National Engineering Laboratory
Intrinsik	Intrinsik Environmental Sciences Inc.
IOPCF	International Oil Pollution Compensation Fund
IOS	Individual Ownership Sketch
IQR	Inter quartile range
IR	information request
IRA	Increased Response Area

Term	Meaning
ISB	*in situ* burning
ISCMV	Invasive Species Council of Metro Vancouver
ISL	ISL Engineering and Land Services Ltd.
ISLMS	Integrated Safety and Loss Management System
ISO	International Standards Organisation
ISSG	Invasive Species Specialist Group
ISTOP	Integrated Satellite Tracking of Pollution Program
ITOPF	International Tanker Owners Pollution Federation
IVM	Integrated Vegetation Management
IWMS	Integrated Wildlife Management Strategy
JASCO	JASCO Applied Sciences
JRP	Joint Review Panel
kbbl	kilobarrel
KFN	Katzie First Nation
km	kilometre
km/h	kilometres per hour
KMC	Kinder Morgan Canada
LEL	lower explosive limit
Levelton	Levelton Engineering Ltd
LFV	Lower Fraser Valley
LFVAQCC	Lower Fraser Valley Air Quality Coordinating Committee
LGL	LGL Limited Environmental Research Associates
LiDAR	Light Detection and Ranging
LML	lowest measured level
LNIB	Lower Nicola Indian Band
LOAEL	lowest-observed-adverse-effect level
LOU	Letter of understanding
LSA	local study area
LUOMS	Lyackson Use and Occupancy Mapping Study
LYFN	Lyackson First Nation
m^3/d	cubic metres per day
m^3/s	cubic metres per second
MARCS	Marine Accident Risk Calculation System
MARPOL	International Convention for the Prevention of Pollution from Ships
MBA	Mutual Benefit Agreement
MCR	maximum cumulative ratio
MCTS	Marine Communications and Traffic Services
MEIT	Marine Emission Inventory Tool
MERMEF	Marine Environmental Research and Monitoring Endowment Fund
MF	mature forests
MFN	Michel First Nation
MIACC	Major Industrial Accidents Council of Canada
MIB	Musqueam Indian Band
MIP	Model Inter-comparison Project
ML/ARD	metal leaching and acid rock drainage
MLBV	mainline block valves
MMPP	Marine Mammal Protection Program
MN	Matsqui First Nation

Term	Meaning
MNBC	Métis Nation of British Columbia
MOE	Ministry of Environment
MOV	motor operated valve
MPB	Mountain Pine Beetle
MPOI	maximum point of impingement
MRA	Movement Restricted Area
MREMP	Marine Research and Environmental Monitoring Program
MRL	Minimal Risk Level
MSB	Mixed Sweet Blend
MSC	Meteorological Service of Canada
MSDS	material safety data sheets
mt	metric tonnes
MV	Metro Vancouver
MWLAP	Ministry of Water Land and Air Protection
NAAQS	National Ambient Air Quality Standard
NAPS	National Air Pollution Surveillance
NAS	National Academy of Science
NASP	National Aerial Surveillance Program
NBCC	National Building Code of Canada
NEB	National Energy Board
NEBA	net environmental benefit analysis
NEB Act	*National Energy Board Act*
NFC	National Fire Code of Canada
NFPA	National Fire Protection Association
NGO	Non-governmental organization
NHC	Northwest Hydraulic Consultants Ltd.
NHRM	Natural Hazard Management
NIB	Nooaitch Indian Band
NM	nautical miles
NOAA	National Oceanic and Atmospheric Association
NOAEL	no-observed-adverse-effect level
NRCan	Natural Resources Canada
NRES	National Emergency Response System
NS NOPE	North Shore No Pipeline Expansion
NSEMO	North Shore Emergency Management Office
NWR	North West Redwater
NWWG	National Wetlands Working Group
OCIMF	Oil Companies International Marine Forum
OCP	Official Community Plan
OCS	Outer Continental Shelf
OECD	Organisation for Economic Co-operation and Development
OEHHA	Office of Environmental Health Hazard Assessment
OF	old field
OGMA	old growth management area
OHF	oil handling facility
OMA	Oil Mineral Aggregate
OPR	Onshore Pipeline Regulations
OSCAR	Oil Spill Containment and Response

Term	Meaning
OSRS	Oil Spill Response Science
PAG	potentially acid generating
PAH	polycyclic aromatic hydrocarbons
PBPK	physiologically based pharmacokinetic
PCA	Parks Canada Agency
PCEM	post-construction environmental monitoring
PCM	Post-construction Monitoring
PGA	peak ground acceleration
PGL	Pottinger Gaherty Environmental Consultants Ltd.
PGV	peak ground velocity
PHC	petroleum hydrocarbon
PID	proportional, integral, and derivative
PIPEUP	Pro Information Pro Environment United People Network
PM	particulate matter
PMV	Port Metro Vancouver
PoE	Pathways of Effects
PPA	Pacific Pilotage Authority
PPC	proposed pipeline corridor
PPE	personal protective equipment
ppb	Parts per billion
ppm	parts per million
PPU	Portable Pilotage Unit
PQRA	Preliminary Quantitative Risk Assessment
PTFN	Pacheedaht First Nation
QA	quality assurance
QC	quality control
QHHRA	qualitative human health risk assessment
QRA	quantitative risk assessment
RAR	Riparian Areas Regulation
RCA	Rockfish Conservation Area
RD&D	research, development, and demonstration
ReV	Reference Value
RfC	Reference Concentration
RMLBV	remote mainline block valves
RMP	Reclamation Management Plan
RMR	rock mass rating
RMS	root-mean-square
RMSE	root-mean-square error
RO	Response organization
ROE	Return on Common Equity
RP	Responsible Party
RQD	Rock Quality Designation
RRZ	Riparian Reserve Zone
RSA	Regional Study Area
RsC	Risk-specific Concentration
RSC	Royal Society of Canada
RTTM	Real-Time Transient Modelling
RWDI	Rowan Williams Davies and Irwin Inc.
SARA	*Species At Risk Act*

Term	Meaning
SCADA	Supervisory Control and Data Acquisition
SCAT	Shoreline Clean-up Assessment Technique
SCBA	self-contained breathing apparatus
SCC	Species of Conservation Concern
SCCS	Scientific Committee on Consumer Safety
SCENIHR	Scientific Committee on Emerging and Newly Identified Health Risks
SCHER	Scientific Committee on Health and Environmental Risks
SEEMP	Ship Energy Efficiency Management Plan
SEI	Sensitive Ecosystems Inventory
SFU	Simon Fraser University
SLHHRA	screening-level human health risk assessment
SLR	sea level rise
SN	Squamish Nation
SO_2	sulphur dioxide
SOA	special operating area
SOPEP	Ship Oil Pollution Emergency Plan
SOPF	Source Oil Pollution Fund
SRES	Salmon River Enhancement Society
SSN	Stk'emlupsemc te Secwépemc Nation
SUG	Seismic Use Group
SWAN	Simulating Waves Nearshore
SWFS	Supplemental Wetland Function Study
SWWYTAF	South West Wyoming Technical Air Forum
TACMP	Traffic and Access Control Management Plan
TAN	total acid number
TBM	tunnel boring machine
TC	Transport Canada
TCEQ	Texas Commission on Environmental Quality
TCP	Traffic Control Plan
TEK	traditional ecological knowledge
TERA	TERA Environmental Consultants
TFDC	Tk'emlups Forestry Development Corporation
TFN	Tsawwassen First Nation
THC	total hydrocarbon
The City	The City of Edmonton
the Project	Trans Mountain Expansion Project
TLBCC	Tofino-Long Beach Chamber of Commerce
TLRU	traditional land and resource use
TLU	traditional land use
TMEP	Trans Mountain Expansion Project
TMPL	Trans Mountain pipeline
TMRU	traditional marine resource use
TMX	Trans Mountain Expansion
TPAH	total polycyclic aromatic hydrocarbon
Trans Mountain	Trans Mountain Pipeline ULC as general partner of Trans Mountain
TRC	TERMPOL Review Committee
TSEP	Tanker Safety Expert Panel
TSS	traffic separation scheme

Term	Meaning
TTML	Ts’elxweyeqw Tribe Management Limited
TUC	Transportation and Utilities Corridor
TUS	Traditional Use Study
TVOC	total volatile organic compounds
TWFN	Tsawout First Nation
TWG	Technical Working Group
TWN	Tsleil-Waututh Nation
TWS	temporary workspace
U.S.	United States
UC	Unified Command
UNB	Upper Nicola Band
UPI	Universal Pegasus International
USCG	United States Coast Guard
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet
UWR	Ungulate Winter Range
VC	Valued Components
VCE	Vapour Cloud Explosion
VCU	vapour combustion unit
VOC	volatile organic compound
VRU	vapour recovery unit
VTRA	Vessel Traffic Risk Assessment
VTS	Vessel Traffic Services
WAC	Washington Administrative Code
WAF	water accommodated fractions
WCMRC	Western Canada Marine Response Corporation
WCP	Wetland Compensation Plan
WCSS	Western Canada Spill Services
WFMP	Wetland Follow-up Monitoring Program
WMR	Wright-Mansell Research
WSC	Water Survey of Canada
WSDOE	Washington State Department of Ecology
WTP	willingness to pay
WVMP	Weed and Vegetation Management Plan
YF	young forest
YS	small young forest

1.0 INTRODUCTION

Trans Mountain Pipeline ULC (Trans Mountain) is providing Reply Evidence in response to certain evidence filed with the National Energy Board (NEB) by intervenors in regard to the Trans Mountain Expansion Project (TMEP). Trans Mountain also responds in this Reply Evidence to certain letters of comment filed by commenters and will be providing further responses in its Argument to those letters of comment that are filed later in August 2015.

Trans Mountain relies on the evidentiary record established to date and provides reply in respect of new issues raised by intervenors in their evidence. Trans Mountain does not accept or agree with all statements made by intervenors in their written evidence or commenters in their letters of comment. However, Trans Mountain does not respond to every point or position asserted by intervenors or commenters with which it disagrees. Trans Mountain's silence on any matter does not indicate acceptance or endorsement of any particular position and Trans Mountain reserves its right to address any relevant matters in argument.

Numerous intervenors and commenters filed evidence and letters of comment, respectively, relating to topics that are outside the List of Issues for the Project or beyond the NEB's legislated mandate. This evidence includes but is not limited to information relating to environmental and socio-economic effects associated with upstream activities and downstream use, as well as information related to the continued operation of Line 1 under its current operating conditions. As per the NEB's previous rulings regarding these matters (063 - NEB Ruling No. 25 - Motions requesting that the Board include in the List of Issues the environmental and socio-economic effects associated with upstream activities and downstream use [Filing ID A61912]; A081 - NEB Ruling No. 33 - Motions to compel full and adequate responses to the first round of intervenor information requests [Filing ID A63066]; A155 - NEB Ruling No. 63 - Motions to compel full and adequate responses to the second round of intervenor information requests [Filing ID A69687]; A160 - NEB Ruling No. 67 - Motions to compel full and adequate responses to intervenor Round 2(b) information requests and information requests on the TERMPOL Report [Filing ID A69796]; A163 - NEB Ruling No. 69 - Motions to compel full and adequate responses to intervenor Round 2(c) information requests [Filing ID A69925]; A173 - NEB Ruling No. 74 - Motions to compel full and adequate responses to intervenor Round 2(d) information requests [Filing ID A70397]), Trans Mountain does not provide reply to these matters as are they are not within the scope of the NEB's assessment of the TMEP.

This Reply Evidence is organized by topic in the following sections:

1.0 Introduction
2.0 Project Need & Economic Feasibility
3.0 Corporate Structure
4.0 Corporate Liability
5.0 Tariffs
6.0 Stakeholder Engagement and Communications
7.0 Aboriginal Engagement
8.0 Landowner Relations
9.0 Landowner & Other Compensation
10.0 Pipeline System & Engineering Design
11.0 Pipeline Geotechnical Assessment
12.0 Pipeline Engineering Assessments
13.0 Pipeline Corridor & Routing

14.0 Watercourse Crossing Design
15.0 Seismic Hazards
16.0 Pipeline Construction Planning & Execution
17.0 Compliance with Municipal By-Laws
18.0 Pipeline Reactivation
19.0 Construction Safety and Security
20.0 Facility Engineering and Design
21.0 Facility Siting
22.0 Systems Operations, Control, and Leak Detection
23.0 Pipeline Oil Spill Risk Assessment
24.0 Facility Risk Assessment
25.0 Fate and Behaviour of Oil
26.0 Costs of an Oil Spill
27.0 Economic Costs of an Oil Spill
28.0 Environmental Assessment Methods
29.0 Soil and Soil Productivity
30.0 Agricultural Lands
31.0 Surface Water/Hydrology
32.0 Groundwater Quality and Quantity
33.0 Air Quality
34.0 Acoustic Environment/Noise
35.0 Fish and Fish Habitat
36.0 Wetlands
37.0 Vegetation
38.0 Wildlife and Wildlife Habitat
39.0 Heritage Resources
40.0 Aboriginal Traditional Use
41.0 Social and Cultural Well-Being
42.0 Human Occupancy and Resource Use
43.0 Community Health
44.0 Infrastructure and Services
45.0 Human Health Risk Assessment
46.0 Ecological Risk Assessment
47.0 Environmental Compliance Program
48.0 Environmental Protection Planning
49.0 Environmental Net Benefits
50.0 Post-Construction Monitoring
51.0 Environmental Monitoring
52.0 Marine Spill Modelling
53.0 Marine Sediment and Water Quality
54.0 Marine Fish and Fish Habitat
55.0 Marine Mammals
56.0 Marine Birds
57.0 Aboriginal Traditional Marine Use
58.0 Marine Commercial, Recreation and Tourism Use
59.0 Marine Transportation
60.0 Marine Risk Assessment
61.0 Marine Spill Liability Compensation
62.0 Marine Emergency Preparedness And Response

63.0 Emergency Management Program
64.0 Early Works

Attachment 1.01 Reply to Simon Fraser University: “Hazards to Simon Fraser University Associated with the Trans Mountain Expansion Project: A Gap Analysis” (David Etkin, Kaz Higuchi, Sarah Thompson, Markus Dann)

Attachment 1.02 Reply to Dr. Catherine Douglas and the Pro Information Pro Environment United People Network: “Economic Costs and Benefits of the Trans Mountain Expansion Project (TMX) for BC And Metro Vancouver”

Attachment 1.03 Reply to the City of Burnaby: “Burnaby Fire Department Trans Mountain Tank Farm Tactical Risk Analysis”

Attachment 1.04 Reply to the City of Burnaby: “Assumptions of Trans Mountain Pipeline ULC for the Trans Mountain Expansion Project in the City of Burnaby”

Attachment 1.05 Reply to the City of Abbotsford, City of Burnaby, City Coquitlam, City of Surrey, Township of Langley: “Cost Impact of the Trans Mountain Expansion on Lower Mainland Municipalities”

Attachment 1.06 Reply to City of Vancouver: “Potential Economic Impact of a Tanker Spill on Ocean-Dependent Activities in Vancouver”

Attachment 1.07 Reply to Tsleil-Waututh Nation, Tsawout First Nation, Upper Nicola Indian Band: “An Assessment of Oil Spill Risks for the Trans Mountain Expansion Project”

Attachment 1.08 Reply to the City of Vancouver, Tsleil-Waututh Nation, and Metro Vancouver: “Oil Spill Trajectory Modeling Report in Burrard Inlet for the Trans Mountain Expansion Project”, Genwest Systems Inc. Edmonds, Washington, USA 98020 (Genwest Report)

Attachment 1.09 Reply to City of Vancouver, Tsleil-Waututh Nation, Living Oceans Society: “Fate and Effects of Oil Spills from the Trans Mountain Expansion Project in Burrard Inlet and the Fraser River Estuary” and “Fate and Effects of Oil Spills from the Trans Mountain Expansion Project in the Gulf Islands, Strait of Juan de Fuca, and Fraser River”

Attachment 1.10 Reply to the City of Vancouver, Tsleil-Waututh Nation, City of Burnaby, Metro Vancouver: “Technical Analysis of Oil Spill Response Capabilities and Limitations for the Trans Mountain Expansion Project”

Attachment 1.11 Reply to Upper Nicola Indian Band: “Inland Oil Spill Response Logistics Analysis”

Attachment 1.12 Reply to Tsawout First Nation, Upper Nicola Band and Living Oceans Society: “Public Interest Evaluation of the Trans Mountain Project”

Attachment 1.13 Reply to City of Vancouver, Tsleil-Waututh Nation, Metro Vancouver: “Air Quality Impacts from Simulated Oil Spills in Burrard Inlet and English Bay”

Attachment 1.14 Reply to Shxw’owhamel First Nation: “Accufacts Pipeline Integrity Management Operation and Maintenance Report”

Attachment 1.15	Reply to Shxw'owhamel First Nation: "Mark West Spill Risk Assessment Report"
Attachment 1.16	Reply to Shxw'owhamel First Nation: "Review of Trans Mountain Expansion Project Groundwater Issues Associated with Ohamil I.R. 1 and Peters I.R. 1 and 2"
Attachment 1.17	Reply to City of Surrey and Metro Vancouver: "Environmental Assessment of Pipeline Placement Options Within and Adjacent to Surrey Bend Regional Park"
Attachment 1.18	Reply to Living Oceans Society: "Review of Kinder Morgan Pipeline Expansion Project Application – Human Health Impact Assessment: Expert Report"
Attachment 1.19	Reply to Matsqui First Nation: "An Assessment of Impacts from the Trans Mountain Expansion Project on Matsqui First Nation"
Attachment 1.20	Reply to Environment Canada: Section 2.0: Species at Risk, Migratory Birds and Wetlands

Where Trans Mountain refers to draft conditions in its Reply Evidence, it refers to the version of the draft conditions released by the NEB in April 2014 (Filing ID A3V8Z8). Trans Mountain provides comments on the updated draft conditions released by the NEB on August 12 as an appendix to this Reply Evidence.

2.0 PROJECT NEED & ECONOMIC FEASIBILITY

2.1 Introduction

This section of Trans Mountain's Reply Evidence addresses a number of topics related to the need for and economic feasibility of the Project, on which certain intervenors submitted evidence. The topics covered and the intervenors to whom this Reply is addressed include:

- International Demand for Oil (Need for the Project): Separate evidence of Dr. Kathryn Harrison and Dr. Mark Jaccard, filed on behalf of the City of Vancouver
- Corporate Income Taxes: Articles written by Ms. Robyn Allan, appended to the evidence of the City of Burnaby
- Dutch Disease: Evidence of Dr. Catherine Douglas, filed on behalf of the City of Vancouver
- Refining/Upgrading Economics: Evidence of Unifor

The following sections deal with the above topics in the sequence presented.

2.2 International Demand for Oil

Dr. Harrison and Dr. Jaccard submitted separate evidence on behalf of the City of Vancouver, but both address the outlook for world demand for oil and suggest that demand will likely begin to fall in the near future.

The evidence of Dr. Kathryn Harrison (Filing ID A4L7W8) suggests that, as a result of increasingly stringent environmental regulations in many countries around the world, the global demand for oil may peak as soon as 2020 and begin to fall thereafter. Dr. Harrison also states that, if this happens, the demand for Canadian heavy oil will likely experience a greater fall than light crudes. Dr. Harrison also expressed her views about the outlook for petroleum demand in specific markets, including the USA (California in particular), Japan, South Korea, China and India, and expressed the view that the demand outlook will be less robust than envisaged by Trans Mountain.

The evidence of Dr. Mark Jaccard (Filing ID A4L7X1) presents an outlook for oil demand in a scenario in which Canada takes action to reduce its greenhouse gas (GHG) emissions by 17% by 2020 and 65% by 2050. Dr. Jaccard concludes that:

> "Evidence from the world's leading independent energy-economy-emissions models shows that oil sands expansion will not occur as global leaders, including the government of Canada, fulfill their commitment to prevent a greater than 2° C increase. The price path of oil will be far below the level necessary to induce expansion of the oil sands, and therefore the TMEP will not be 'used and useful' " (pages 19 and 20 of Dr. Jaccard's evidence, paragraph 6.29).

The outlooks presented by both Dr. Harrison and Dr. Jaccard are not realistic and are inconsistent with the most credible international base case assumptions, articulated in the following sub-sections.

2.2.1 An Appropriate Scenario for Assessing Future Demand for Oil

On page 3 of her filed evidence, Summary of Conclusions, lines 4 – 8, Dr. Harrison states:

> "*If the international community maintains its commitment to limit climate change to 2C, it is projected that international demand for oil will peak as early as 2020 and decline thereafter.* ***In this scenario****, it is likely that demand for Canada's bitumen would experience a greater decline than light crudes due to heavy oil's greater cost and higher emissions, both at the point of production and downstream combustion*." [bolding added]

Dr. Harrison's statement refers to a particular scenario, known as the "450 Scenario" in the International Energy Agency's (IEA) 2014 edition of its annual World Energy Outlook (WEO2014).

As part of WEO2014, the IEA publishes three scenarios of progressively ambitious carbon dioxide (CO_2) outcomes: 1) a "Current Policy Scenario" which takes into account polices that have been actually enacted by governments at the time of the analysis; 2) a "New Policies Scenario or Baseline Scenario" which takes into account commitments and plans that have been announced or enacted by governments; and, 3) a "450 Scenario" which assumes governments enact policies which meet a goal of 450 parts per million (ppm) of CO_2 by 2040. The IEA specifies that the New Policies Scenario is their baseline scenario.

As stated by the IEA in WEO2014:

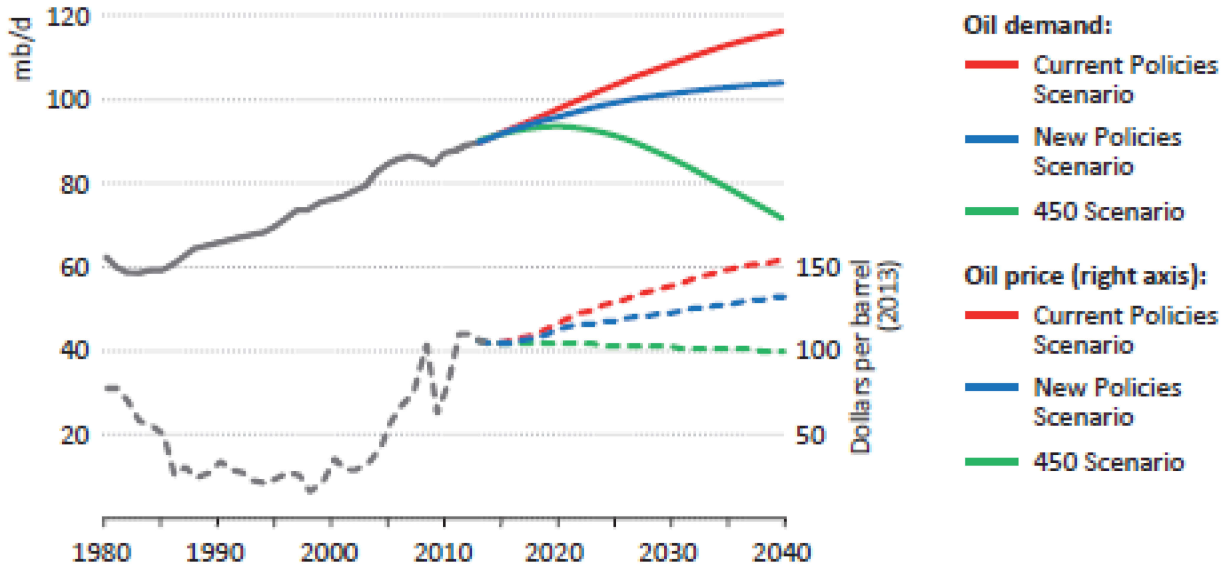
> "The New Policies Scenario is the <u>central scenario</u> of WEO-2014. It takes into account the policies and implementing measures affecting energy markets that had been adopted as of mid-2014, together with relevant policy proposals, even though specific measures needed to put them into effect have yet to be fully developed. These proposals include targets and programmes to support renewable energy, energy efficiency, and alternative fuels and vehicles, as well as commitments to reduce carbon emissions, reform energy subsidies and expand or phase out nuclear power." (WEO2014, page 36) [Emphasis added.]

The scenario that Dr. Harrison is assuming in her evidence is the 450 Scenario, in which it is assumed that the international community takes actions to achieve ambitious targets for GHG reductions. This scenario is not the New Policies Baseline Scenario that the IEA uses in its 2014 World Energy Outlook. As stated by the IEA:

> "The 450 Scenario takes a different approach, adopting a specified outcome – the international goal to limit the rise in long-term average global temperature to two degrees Celsius (2 °C) – and illustrating how that might be achieved. The scenario assumes a set of policies that bring about a trajectory of greenhouse-gas emissions from the energy sector that is consistent with the goal." (WEO2014, page 38)

In other words, in the 450 Scenario the IEA conducted a hypothetical exercise to determine what would be required to meet the goal of limiting the concentration of greenhouse gases in the atmosphere to 450 ppm of CO_2. As discussed further below, the IEA does not assume that the 450 Scenario is most likely to transpire with respect to world energy demand.

Figure 2-1 compares the world oil demand and crude price forecasts, for each of the three scenarios included in the IEA WEO2014, and illustrates the wide difference between the New Policies Baseline and 450 Scenarios.



Source: WEO2014, Figure 3.1, page 97.

Figure 2-1 IEA WEO2014 World Oil Demand and Oil Price by Scenario

Table 2-1 provides the IEA's projections for world oil demand in its New Policies Baseline Scenario and in its two alternative Scenarios for select years.

TABLE 2-1

WORLD OIL DEMAND (MB/D)
IEA WORLD OIL OUTLOOK 2014*

		New Policies Baseline		Current Policies		450 Scenario	
	2013	2020	2040	2020	2040	2020	2040
OECD**	41.5	40.2	31.3	40.9	35.7	39.5	21.5
Non-OECD	41.6	48.2	63.1	49.4	70.4	46.7	43.9
Bunkers***	7.0	7.6	9.5	7.7	10.4	7.3	6.5
Total	90.1	96.0	103.9	99.8	120.2	95.5	80.7

* Adapted from IEA World Energy Outlook 2014, Table 3.1, page 96
** Organisation for Economic Co-operation and Development
*** Includes international marine and aviation fuels

As shown in Table 2-1, the IEA New Policies Baseline Scenario is projecting that world oil demand will grow from the 2013 level of about 90 mb/d to about 104 mb/d (a 15% increase) by 2040. By comparison, the 450 Scenario forecasts a reduction to about 81 mb/d (a decrease of 10%) by 2040.

IHS Global Canada Limited (IHS) understands the New Policies Baseline Scenario to be the IEA's Central or most probable scenario. Although oil demand is projected to fall from 2013 levels by 10 mb/d in the OECD countries by 2040 in this scenario, oil demand grows rapidly in non-OECD countries by over 20 mb/d over the same period. Non-OECD countries include Africa and Latin America, but the bulk of this Non-OECD growth is projected to occur in Asian markets that will be accessible through the TMEP.

The IEA makes the following statement concerning overall energy demand (not just oil) in the Executive Summary to its 2014 World Energy Outlook:

> "Global energy demand is set to grow by 37% by 2040 in our central scenario, but the development path for a growing world population and economy is less energy-intensive than it used to be. In our central scenario, growth in global demand slows markedly, from above 2% per year over the last two decades to 1% per year after 2025; this is a result both of price and policy effects, and a structural shift in the global economy towards services and lighter industrial sectors. The global distribution of energy demand changes more dramatically, with energy use essentially flat in much of Europe, Japan, Korea and North America, and rising consumption concentrated in the rest of Asia (60% of the global total), Africa, the Middle East and Latin America. A landmark is reached in the early 2030s, when China becomes the largest oil-consuming country, crossing paths with the United States, where oil use falls back to levels not seen for decades." (IEA, World Energy Outlook, Executive Summary, page 1, November 2014)

IHS believes that the New Policies Baseline Scenario provided by the IEA, the most respected independent global authority on world energy matters, is a far more likely scenario to unfold than the 450 Scenario assumed by Dr. Harrison. As noted above, the New Policies Baseline Scenario incorporates the expected impacts of announced climate change policies, including national pledges to reduce greenhouse gas emissions, up to the point at which the analysis for the 2014 World Energy Outlook was completed.

The City of Vancouver requested Dr. Jaccard to address the following questions regarding the impact of national and international climate policies on future development of and demand for oil sands bitumen production:

1. "*Proceeding on the assumption that Canada will take action to meet its international commitments to limit the rise in global temperatures by the end of this century to 2° C (the 2° C cap"), what impact would this action have on the future development of and demand for oil sands bitumen?*

2. *What are the implications for the global energy market and, more specifically, the demand for oil sands bitumen if other governments outside of Canada introduce and enforce climate policies sufficient to meet the 2° C cap?"*

With respect to the first question, IHS is of the view that the scenario that Dr. Jaccard was asked to investigate cannot be relied upon to assess the market need for the Project, and especially within the timeframe (up to 2037) used by Trans Mountain to analyze the Project. As stated by Dr. Jaccard in his evidence:

> "Forecast modeling by Environment Canada in its report Canada's Emissions Trends 2013 shows that Canada thus far lacks sufficient climate policies to achieve its 2020 target." (Filing ID A4L7X1, page 6, lines 7-9)

> "To reduce emissions to the commitment level of 612 Mt CO by 2020, Canada would need to apply a carbon price of $50 (Cdn $2013) in 2015 and increase it annually by $35 to reach $225 in 2020." (Filing ID A4L7X1, page 8, lines 11-14)

There are only two provinces that impose a carbon tax in Canada. And such carbon taxes are not universally employed even in those provinces. The actual carbon price in Alberta in 2015 is $15/Mt. The Alberta government has recently announced that it will increase the price to $20/Mt in 2016 and to $30/Mt in 2017. However, these carbon prices apply only to the large identified emitters in the province. On an aggregate basis, the carbon price in Alberta is lower than these prices. BC is the only other province that currently imposes a carbon tax, which is $30/MT. These carbon prices are considerably below the levels that Dr. Jaccard is assuming in his analysis ($50/Mt in 2015, $85/Mt in 2016 and $115/Mt in 2017). Therefore, there is a clear disconnect between Dr. Jaccard's assumed scenario and the facts.

In undertaking his analysis, Dr. Jaccard relied on Energy Modeling Forum "[EMF] 27," which refers to a study conducted by the Energy Modelling Forum, organized out of Stanford University in California. The purpose of EMF 27 is stated in the Preface and Introduction to the project as follows:

> *"This Special issue of Climatic Change documents the main findings of Energy Modeling Forum Model Inter-comparison Project (MIP) number 27 (EMF 27) entitled "The EMF27 Study on Global Technology and Climate Policy Strategies". This study focused on the development and cross model comparison of results from a new generation of comprehensive international climate policy intervention scenarios focusing on technology strategies for achieving climate policy objectives. These scenarios enabled the community to exercise enhanced modeling capabilities that were focused on in previous EMF studies on the international trade implications of climate policies; the representation of technological change; and the incorporation of multi-gas mitigation and land use emissions and mitigation policy alternatives."* (Weyant and Kriegler 2014)

In other words, Dr. Jaccard's analysis is based on a hypothetical exercise, EMF 27, which is similar to the IEA's 450 Scenario, in that it was based on a formulation of various climate policy "intervention scenarios" that focused on achievement of a particular policy objective. Although Dr. Jaccard's analysis responds to the question posed to him by the City of Vancouver, his analysis was not based on a most likely or even a realistic scenario, and it certainly cannot be relied upon to assess the likely market need for the Project.

As discussed above, IHS is of the view that the "New Policies Baseline Scenario" undertaken by the IEA is a much better representation of the likely future for the world energy industry. As shown in Table 2-1 above, in this Scenario world oil demand grows from the current 90 mb/d to about 104 mb/d in 2040. In contrast, the scenario investigated by Dr. Jaccard is akin to a hypothetical "What If?" scenario and, as such, it should be given little weight.

The nature of the demand forecast he relies on also undermines the reliability and credibility of Dr. Jaccard's conclusions with respect to the outlook for crude oil prices. Dr. Jaccard's outlook for oil prices is based on a prediction that world oil demand will fall:

> "The median values from a multi-model study show that climate policies would have the effect of lowering global oil demand from almost 90 million barrels per day in 2013 to 63 million barrels per day in 2050. This falling demand would lead the average world oil price to fall to below $40 (2013 $US) per barrel by 2040." (Filing ID A4L7X1, page 6, lines 7-9)

With growing demand for oil, it is very unlikely that the price of oil will fall to the levels projected by Dr. Jaccard. In the response to NEB IR No. 4.2 (Filing ID A4K4W3), IHS provided more details on its latest crude price and supply forecasts. IHS does not anticipate a decline in the demand for crude oil, nor a permanent decrease in the price of crude oil over the long-term forecast period to 2035. The IHS planning scenario incorporates a growing demand outlook for crude oil in the Asian region through at least 2035. It is notable that, as shown in Figure 2.1, even the IEA's 450 Scenario forecasts crude prices in the US$100 (constant $2013) range by 2040, with much higher prices for the New Policies Baseline Scenario.

The IEA's New Policies Baseline Scenario projections are generally consistent with the evidence submitted by IHS, particularly that there will be growth in overall petroleum demand over the next 20-25 years in Asian markets. In its World Energy Outlook, the IEA projects that oil demand will grow in China by about 5.3 mb/d from its base year of 2013 to 2030, and that oil demand will grow in India by about 3.3 mb/d over the same time period, for a combined increase of 8.6 mb/d (IEA World Energy Outlook 2014, page 98). In its written evidence, IHS projected that demand in China and India would grow by about 9.0 mb/d by 2030, based on 2012 as its base year. The IEA projected that the total growth in oil demand in the Asian market over this time period will be a little over 10 mb/d. These projections clearly illustrate that the evidence of IHS is comparable and consistent with the New Policies Scenario relied on by the IEA.

Furthermore, Trans Mountain notes that 13 knowledgeable shippers have entered into firm long-term contracts for 708,000 bpd of the Project's capacity. Such contracts are inconsistent with the assumptions of Jaccard and Harrison. In other words, very large knowledgeable companies are making significant financial commitments based on a different market outlook than the hypothetical scenario assumed by Drs. Harrison and Jaccard.

In conclusion, IHS is of the view that the scenarios assumed by both Dr. Harrison and Dr. Jaccard are very unlikely to transpire, especially within the timeframe to 2037 that Trans Mountain's analysis was based on, and are simply hypothetical scenarios. IHS believes that the projection of world oil demand in the IEA's New Policies Scenario, which is the IEA's base case scenario, is more representative of the likely future path of world demand for oil. IHS also notes that the New Policies scenario is broadly consistent with the evidence submitted by IHS. Lastly, the New Policies scenario takes into account national pledges to reduce greenhouse gas emissions up to the point that the study was completed, and thus it incorporates the likely consequences of these policies and commitments to reduce GHGs.

2.2.2 Inappropriate Models for Assessing Crude Oil Demand in Markets Served by TMEP

The analysis undertaken by Dr. Jaccard uses large-scale energy-economy-emissions models and does not incorporate any analysis of what is actually occurring in the oil markets that will be served by the TMEP. Dr. Jaccard explains his approach as follows:

> *"the TMEP project ignores the energy market implications of commitments by Canada and other countries to achieve the global GHG and temperature targets.*
>
> *In this submission, I rectify this omission by presenting analysis undertaken by myself and graduate students under my direction, most recently in the production of two master's theses in the School of Resource and Environmental Management at Simon Fraser University. The first thesis applies a widely-used energy-economy-emissions model (that I created 25 years ago), called CIMS-Canada, to estimate the carbon price Canada needs to achieve the government's 2020 and 2050 GHG commitments. This research shows that the production costs of oil sands will increase significantly to the year 2020, and even more significantly in the following three decades.*
>
> *The second thesis uses data from a set of leading global energy-economy-emissions models to estimate: (1) the global carbon price, (2) the global demand for oil, (3) the world oil price, and (4) the production cost of oil sands, all of which result from Canada and other countries keeping their commitment to prevent temperatures from rising more than 2° C."* (see Appendix B to the Written Evidence of Dr. Mark Jaccard, Summary, page 1-2)

The models employed by Dr. Jaccard are top-down models and they do not include any analysis of how specific markets served by the TMEP such as China, India, British Columbia (BC), Washington State and California will meet their energy needs. These global models may be of use to help policy makers examine, at a high level, the potential impacts of different environmental policies. However, they are not well-suited to evaluating the market need for or the economic feasibility of the TMEP, or whether the market access provided by the pipeline will enable Canadian crude to successfully serve a particular market.

2.2.3 Other Considerations Impacting the Demand Outlook for Oil

Dr. Harrison provided evidence that there will be ongoing improvements in energy efficiency and the increasing use of renewable over the next 25 years, and that this will impact the demand for oil. Dr. Jaccard stated that the costs of developing the oil sands will increase dramatically as producers are required to comply with increasingly strict carbon standards/taxes, and that these cost increases will render the oil sands uneconomic over time. In this section, we address each of these points separately.

2.2.4 Impact of Energy Efficiency Improvements on World Oil Demand

Dr. Harrison states that it is likely that there will be ongoing improvements in fuel efficiency in the coming years and that, consequently, oil demand will begin to decline:

> "With respect to transportation fuels, this is evident in a roughly 50% tightening of fuel economy limits in the decade from 2015 to 2025, with a very high degree of

> convergence between developed and rapidly developing country standards. Policies already announce have the potential to reduce fuel consumption in industrialized countries, while further strengthening of transportation policies in response to international climate agreements and national commitments could yield reductions even in rapidly growing markets in China and India." (Filing ID A4L7W8, page 2, lines 24 – 27, and page 3, lines 1 – 3)

IHS agrees with Dr. Harrison that it can be expected there will be significant and ongoing improvements in energy efficiencies, and also expects that there will be rapid growth in the use of renewables such as wind power and solar over the next 25 years and beyond. However, it is important to understand that continued modest growth in petroleum demand is consistent with rapid growth in the use of renewables and improved energy efficiency. In a world in which energy demand is growing, renewable energy use could expand rapidly and capture most of the growth in demand, while some of the growth in demand is captured by petroleum. The two views are consistent and not at all incompatible.

As projected by the IEA in its New Policies Baseline Scenario, overall energy demand will certainly grow in the foreseeable future as the world population and average incomes grow. As incomes grow, people consume more energy and, although there will be ongoing improvements in efficiency, the net result of increased population growth and increases in wealth will be an overall increase in energy consumption. As stated by the IEA in its 2014 World Energy Outlook in the quote cited earlier, there is expected to be a slowing in the growth in energy demand because of "price and policy" effects, but the net result of global economic growth is an overall increase in energy use.

When petroleum began to be produced in large volumes, it assumed a large market share in applications where it was a superior energy source to other fuels. For example, in the transportation sector, petroleum is superior to coal in the sense that it provides considerably more energy per volume, is easier to transport and burns much more cleanly. Yet, more than 100 years later, coal usage is at an all-time record high and is still widely used despite rapid growth in petroleum use throughout this period. The fuel mix tends to change relatively slowly over time although the use of new energy sources may grow rapidly within the overall mix. Therefore, while Trans Mountain agrees that there will be rapid growth in the use of renewables, it does not mean that petroleum use will fall, particularly over the next 25 years.

Lastly, we note that petroleum is mainly used in transportation and at this point in time, vehicles powered by liquid fuels still comprise almost the entire vehicle fleet in the world. While there will be rapid growth in alternative-fuel vehicles, petroleum is still expected to dominate the transportation fuels market for many years to come. Most new vehicles currently being manufactured are designed to run either on gasoline or diesel. These vehicles, which will be sold over the foreseeable future, will operate for 10 to 20 years, thereby ensuring that petroleum will continue to dominate the transportation market over this time period.

In conclusion, ongoing improvements in energy efficiency are compatible with a world in which petroleum demand grows modestly and the use of renewable energy sources grows rapidly.

2.2.5 Oil Sands Production Costs

Dr. Jaccard also projects that the cost of extracting oil from the oil sands will rise sharply as carbon taxes are rapidly increased to meet international targets for a worldwide carbon budget:

> "Achieving Canada's 2050 target would require a carbon price that climbed to \$300 per tonne of CO_2 by 2025 and \$500 per tonne of CO_2 by 2050 (Canadian 2013 dollars). These carbon prices would increase new "in situ" oil sands production costs by almost 50%." (Direct Written Evidence of Dr. Mark Jaccard, page 4, lines 18-21)

IHS disagrees with Dr. Jaccard's projection that the costs of oil sands production will grow rapidly as a result of rapidly increasing carbon taxes; as discussed in Section 2.1 above, there is no evidence that carbon prices will increase as rapidly as Dr. Jaccard is assuming in his hypothetical scenario. While IHS agrees that it is possible that there will be further increases in carbon taxes in the future, there is no evidence to indicate that the levels will be anywhere near those Dr. Jaccard estimates in his models. If carbon taxes do not increase as much as Dr. Jaccard speculates, the impact on oil sands costs would be correspondingly lower.

IHS also notes that it appears that Dr. Jaccard has not allowed for any ongoing efficiency improvements including energy efficiency in the extraction of oil from the oil sands over time, which would result in cost reductions and CO_2 reductions and a partial offset to any increases in carbon taxes.

2.2.6 Future Demand for Oil in Specific Pacific Rim Markets

Dr. Harrison submitted testimony on the outlook for oil demand in a number of Pacific Rim markets, including: i) California; ii) China and India; and iii) Japan and South Korea. In this section we address in turn her comments on the outlook for oil demand in each of these market areas. We then discuss the need that crude oil producers in western Canada have for market diversification and the significance of their commitments to long-term transportation contracts, as demonstration of adequate demand in the markets to be served by the TMEP. We then conclude with our view that the evidence prepared by IHS is far more reliable as a guide to the future demand for crude oil in these markets than the evidence submitted by either Dr. Harrison or Dr. Jaccard.

2.2.7 Outlook for Oil Demand in California

Dr. Harrison states that it is likely that the demand for petroleum will fall in California and suggests that, consequently, there will be declining demand for Canadian heavy crudes in this market. For example, she stated that: "*Nondiscretionary mandates for regulators to achieve legislative emissions targets can be expected to yield continually more stringent standards and continually declining demand for oil*." (Filing ID A4L7W8, page 3). In Trans Mountain's view, this interpretation is misleading.

Trans Mountain agrees that the demand for crude oil will likely fall slowly over time in California. The 2013 Direct Evidence of Mr. Steven Kelly of IHS (Filing ID A3S0R1) stated that the demand for crude oil in California "*is forecast to decrease, largely due to mandated fleet efficiency improvements which will reduce gasoline demand*." However, as noted in Mr. Kelly's evidence, the California market is well-suited to processing Canadian heavy oil:

> "The California refining industry is among the most complex regional refining industries in the world, and features extensive heavy oil upgrading capability. Many refineries were originally developed to process heavy California crude oils, but as the use of fuel oil was phased out of the utility sector, refineries added coking capacity in order to eliminate fuel oil sales. As shown in Table A-7, there

> are 18 California refineries with approximately 2.0 million B/D of crude oil distillation capacity, most of which is in coking configurations." (page 32, lines 1-8)

The traditional supply to refineries in the Pacific Northwest and California from domestic production in Alaska and California has been continually falling (Kelly 2013, Chart A-7, p.33), with the shortfall increasingly being made up by imports from the Middle East. Imports from Canada have been relatively low to date, although they have been growing. The TMEP will provide enhanced access to the Californian market and, as stated by Mr. Kelly, it is highly likely that Canadian producers will be successful in selling growing volumes of crude oil into the California and Pacific Northwest markets, once market access is improved by construction of the TMEP (Kelly 2013, page 33, lines 18-24).

In the response to NEB IR No. 1.4 (Filing ID A3W9H8), Trans Mountain acknowledged that the market potential for Western Canadian heavy crude in California may be impacted by mandated greenhouse gas intensity constraints in the state. However, it does not follow from Dr. Harrison's observation that the overall demand for crude oil in California is projected to fall that there will not be increased demand for Canadian heavy crude oil in that market. An understanding and analysis of the dynamics of that market, as contained in Mr. Kelly's evidence, suggests that it can reasonably be expected that there will be market opportunities for Canadian heavy crude oil in California, to displace imports from the Middle East and to replace declining US production.

2.2.8 Outlook for Oil Demand in China and India

Dr. Harrison made some general statements in her evidence about government policies intended to reduce carbon emissions in China and India.

> "China has begun to match globally-leading fuel economy standards, aggressively promote electric vehicles, and commit to national carbon pricing." (Filing ID A4L7W8, page 4, lines 16-18)

> "Although emissions from developing countries peak somewhat later than OECD countries under the 450 ppm scenario, China's emissions will need to peak not long thereafter. And when that occurs, China's consumption of oil can be expected to decline significantly." (Filing ID A4L7W8, Appendix A, "Review of Destination Country Policies with Potential to Impact Demand for Canadian Oil Exports" paragraph 63, page 32)

> "India is turning its attention to climate change and it seems inevitable that targets will increase in stringency in years to come, although the rate with which that will occur is uncertain." (Filing ID A4L7W8, page 4, lines 21 – 23)

Dr. Harrison does not conduct any analysis of the energy markets in China and India, nor does she explain how these countries will meet their energy needs in the future, other than to make general statements that change is likely to come. In Trans Mountain's view, this is not a credible basis for projecting oil demand in these countries, or evaluating the market need for the Project.

In contrast, Mr. Kelly included in his evidence a forecast that shows refinery demand in China, Japan and India from 2005 to 2030 (Kelly 2013, Figure A-8, page 34). The forecast indicates that, taking 2012 as a base, refinery demand will increase in China by about 6 mb/d by 2030

and in India by about 3 mb/d, while demand will fall in Japan (discussed later in more detail) by about 1 mb/d. Therefore, there would be a net increase of about 8 mb/d in refinery demand when considering just these three countries. Trans Mountain believes that these projections from IHS provide a reasonable outlook for future oil demand in these Asian markets.

2.2.9 Outlook for Oil Demand in Japan and South Korea

Trans Mountain agrees with Dr. Harrison that the demand for petroleum in Japan is likely to fall in the coming decades. Mr. Kelly's evidence stated that the outlook for crude oil refinery runs in Japan is for a decline from about 3 mb/d in 2012 to about 2 mb/d in 2030 (Kelly 2013, Figure A-8, page 34). Similarly, Trans Mountain agrees with Dr. Harrison's statement that crude oil demand in South Korea will likely decline in the coming decades. However, there are two important factors that should be considered in evaluating the potential implications of this for the need for the TMEP, as outlined below.

First, Mr. Kelly's evidence did not project large sales of Western Canadian crude into these two markets. No benefits were assigned to crude exports to these countries, although the potential does exist for opportunistic sales there. Therefore, Trans Mountain's evidence that there will be more than adequate market demand for crude oil transported on the TMEP does not depend on projected sales into Japan or South Korea.

Second, a distinction needs to be made between a decline in the overall demand for petroleum, in the two selected Asian countries, and the broader potential demand for Canadian crudes in the region. Western Canadian crude has historically had extremely limited transportation access to Asian markets. Once transportation access is enhanced through the TMEP, it can be expected that Western Canadian crudes will find opportunities in large growing markets in Asia, as well as other markets such as Japan and South Korea.

2.2.10 Producers' Need for Diversification and Shippers' Contractual Commitments

The evidence submitted by IHS is that over the forecast period to 2037 petroleum demand can be expected to be relatively stagnant in the US but will grow rapidly in Asia, particularly in China and India, the world's two most populous countries. The IEA's projections for oil demand in Asia in its baseline case, the New Policies Scenario, are consistent with the evidence submitted by IHS, and are contrary to Dr. Harrison's suggestions.

The Canadian oil pipeline network was historically built to serve the US market, with the largest volumes flowing from the Western Canada Sedimentary Basin to the Chicago/Wood River areas. The marketplace is clearly changing as U.S. demand is flattening and US domestic oil production has grown rapidly. While the evidence submitted by IHS projected that Canadian crude oil exports to the US can be expected to grow significantly, through displacing imports from other countries, there is clearly a need for Canadian producers to diversify their markets.

In this changing marketplace, it is essential that Canadian oil producers and the transportation infrastructure adapt to the changing patterns of demand and supply. The shippers who have made the financial commitments through long-term firm transportation contracts with Trans Mountain have clearly demonstrated their belief in the need to diversify their markets. Trans Mountain also notes that the shippers who have made these commitments are knowledgeable parties that are keenly aware of energy market dynamics, including initiatives to reduce GHGs, as well as the details of refinery markets to be served by the TMEP. Trans Mountain is of the view that the contractual and financial commitments to the Project made by shippers provide the

strongest evidence of the existence of viable markets to be served by the TMEP. In contrast to the outcomes of global models based on hypothetical scenarios, these commitments are a very strong demonstration of the need for the Project.

2.2.11 Conclusions

Trans Mountain is of the view that the evidence provided by both Dr. Harrison and Dr. Jaccard that the future world demand for oil will fall is based on unlikely hypothetical scenarios. Trans Mountain believes that the outlook for world oil demand produced by the IEA in its baseline scenario, the New Policies Scenario, provides a far more likely outlook. This outlook incorporates the impacts of announced environmental policies and it projects that demand for oil will fall in Western Europe, the US and Japan, but will rise rapidly in the growing Asian economies, including China and Japan. This changing pattern of demand highlights the need for the TMEP, which responds to producers' need for diversification by providing access to Pacific Rim markets.

Trans Mountain supports the evidence submitted by IHS, which is generally consistent with the New Policies Baseline Scenario of the IEA, and which is based on credible and objective analysis of refining markets accessible to the TMEP. IHS's evidence indicates that it can be reasonably expected that there will be growth in Asian refining markets accessible to the Project over the first 20 years of operation, and that there will be market opportunities in California and the Pacific Northwest over this timeframe. The TMEP will provide a vital link between western Canadian crude supply and the vast Pacific Rim market; the facilities are needed and will be used and useful over the life of the Project.

2.3 Corporate Income Taxes

There were two articles written by Ms. Robyn Allan that were appended to the evidence of the City of Burnaby (Filing IDs A4L8H3 and A4L8H4). Ms. Allan asserts that, primarily because of its corporate structure and ownership, Trans Mountain, Kinder Morgan Canada (KMC), KMP and KMI will pay very little corporate income taxes in Canada related to the Project. Ms. Allan also disputes the claim, which she indicated that Kinder Morgan made in the TMEP Application, that the Expansion project will result in Trans Mountain paying about $100 million a year in federal and provincial corporate income taxes. In addition, Ms. Allan suggests that Trans Mountain falsely presents itself to Canadians as a significant tax contributor. Ms. Allan also concludes that, based on her research, there is nothing that supports the claim that the TMEP represents a net financial benefit to federal and provincial public treasuries; rather, she suggests that Kinder Morgan drains financial wealth from the economy and does not pay its fair share of taxes.

Ms. Allan provides a very inaccurate and misleading view of the expected tax obligations of Trans Mountain and its partners, over the construction and operating life of the TMEP. In addition, the corporate tax and other fiscal benefits associated with the construction and operation of the TMEP, as estimated by the Conference Board of Canada, go well beyond the corporate taxes paid or payable by Trans Mountain.

2.3.1 Conference Board Estimates of Corporate Taxes Payable

The response to Allan R IR No. 1.1.7ww (Filing ID A3X5V9) outlines how the federal and provincial fiscal impacts were estimated by the Conference Board. The Conference Board did not estimate the corporate taxes paid directly by Trans Mountain in its direct evidence (Filing

ID A3S0R1), but instead modelled the corporate taxes that would be expected to arise from the combined direct, indirect and induced gross domestic product (GDP) impacts of the project. This is because the Conference Board model is not designed or intended to forecast the corporate taxes paid by a particular business, but is rather based on industry averages for the pipeline and other industries impacted by the construction and operation of the Project. However, in response to NDP IR No. 2.1.4n (Filing ID A4H8V7), the Conference Board disaggregated the results of the analysis presented in their Direct Evidence, as outlined below.

The estimated corporate tax revenues from the operations of the Project estimated by the Conference Board should be understood in the context of two important factors. First, the estimated corporate income taxes of approximately $1.5 billion over the first 20 years of operations (or $77 million per year) includes three components:

1) the increase in corporate taxes paid directly by Trans Mountain;

2) the increase in corporate taxes paid by affected businesses in Trans Mountain's supply chain; and,

3) the increase in corporate taxes paid by businesses who benefit from increased consumer spending as a result of the wages and salaries earned by people employed directly or indirectly by the project.

The Conference Board estimates that Trans Mountain would account for approximately $965 million in total ($48 million per year), or 63% of the Canadian corporate income taxes estimated for the 20-year operational phase of the Project. This reflects the average corporate taxes paid by the Canadian oil pipeline industry, which are embedded in the model results, and is not based on company specific factors that may be unique to Trans Mountain. The remaining 37% of the corporate taxes are accounted for by businesses in Trans Mountain's supply chain and those that are affected by the related consumer spending.

Second, Trans Mountain's corporate income taxes for the operational phase represents only 8.1% of the total corporate taxes of $11.9 billion estimated for the Project by the Conference Board, and only 5.2% of the $18.5 billion in total estimated fiscal benefits. The total fiscal benefits include corporate and personal income taxes, royalties and indirect taxes, associated with development and operations of the Project, and higher producer netbacks. The majority of the fiscal benefits associated with the project are expected to come from the higher netbacks that upstream oil producers would receive as a result of the market access that the TMEP would provide and the alleviation of oil transportation constraints in Western Canada.

2.3.2 Trans Mountain's Estimates of Corporate Taxes Payable

The expected corporate taxes associated with the Project, which were developed by Trans Mountain itself, were addressed in the response to NDP IR No. 2.1.4m (Filing ID A4H8V7). Trans Mountain developed a projection of the current and future corporate income tax expense for the first five years of operation of the Project, which was prepared in response to NEB Ruling No. 33, Allan R IR No 1.08(d), Attachment 1 (Filing ID A4D3G3), as summarized in the table below.

Trans Mountain's Corporate Income Tax Estimates for the First 5 Years of Operation of the TMEP, $CAD millions					
	Year 1	Year 2	Year 3	Year 4	Year 5
Current Tax	0	1	63	76	88
Future Tax	106	109	51	43	36
Total Tax Obligation	106	110	114	118	124

The current income tax expense provided in the table is an accounting concept that provides an indication of the cash taxes that will be paid by Trans Mountain and its partners for the particular year. Similarly, the future income tax expense provided in the table is an accounting concept that provides an indication of the taxes that are deferred and will be paid by Trans Mountain and its partners in a future year. Taken together, the current income tax expense and the future income tax expense represent the total tax obligation of Trans Mountain and its partners for the particular year. For the purpose of this response and simplicity of analysis, Trans Mountain assumed the current income tax expense represents cash tax paid in the year and future income tax expense represents tax payments deferred to a future year.

It is notable that the low cash taxes estimated for the first two years are followed by three years of significant and increasing cash taxes, so that the average cash corporate tax over the first five years of operation is approximately $46 million per annum. It is also notable that, while cash taxes are very low in the first two years, deferred taxes are high in the early years and decline over the following three years. It is important to understand why this is the case, and what it means for Trans Mountain's corporate tax liabilities over the life of the Project.

The cash tax payable in any particular year by Trans Mountain is not representative of Trans Mountain's full obligation to pay tax, whether on a forecast or historical basis. Trans Mountain and its partners file income tax returns in accordance with the Canadian *Income Tax Act* and respect the requirements by which they are bound. The *Income Tax Act* defines how income tax is determined and, at a very high level, taxable income can be summarized as income less deductions. Included in deductions is an annual amortization of capital costs (Capital Cost Allowance [CCA]).

In times of significant capital investment, such as during the construction of the $5.4 billion Project, there are significant capital costs incurred that are not fully deducted from income in the year they are incurred; instead, they are deducted from income over time. In the early years of operations, the annual deduction for CCA may be large, resulting in lower taxable income and lower cash taxes payable. Over time, as the deductions for CCA are utilized taxable income is expected to increase, resulting in larger cash tax payments in future years. This pattern is consistent with what Trans Mountain expects in the early years of its operations as illustrated in the table above.

This is a very important concept when considering cash tax payments in any particular year. Low cash tax payments in initial years reflect the result of a significant capital investment in the Canadian economy, for which the resulting tax obligation will be spread over a period of time and not in one particular tax year. Therefore, it should not be concluded, as Ms. Allan did, that Trans Mountain will not be paying its fair share of taxes. If taxes are deferred in the early years, they will eventually be paid in later years, as is typical of projects that involve large capital investments.

2.3.3 Conclusions

The average $48 million per year of corporate taxes accounted for by Trans Mountain, which was estimated by the Conference Board over the first 20 years of operation, can be compared to the $46 million annual average cash taxes and $114 million of total tax obligation estimated by Trans Mountain for the first 5 years of operation. Furthermore, Trans Mountain expects its annual total corporate tax obligation to grow after the first 5 years of operation, and for cash taxes to represent a growing percentage of the total.

Contrary to the views expressed by Ms. Allan, Trans Mountain and its partners file income tax returns in accordance with the Canadian *Income Tax Act* and respect the requirements by which they are bound. Trans Mountain believes that the $46 million per year in corporate taxes estimated by the Conference Board over the first 20 years of operation, and the $114 million per year of total corporate income tax obligation estimated by Trans Mountain over the first 5 years of operation alone, represent a significant and fair contribution to federal and provincial government revenues.

Ms. Allan's assertions that Trans Mountain will not be paying its fair share of corporate taxes are simply inaccurate and misleading. Furthermore, when all of the fiscal benefits that the Project will generate are taken into account, particularly those flowing from higher netbacks to producers, the contributions to the Canadian economy associated with the construction and operation of the Project can be expected to be very significant.

2.4 Dutch Disease

The written evidence of Dr. Catherine Douglas (Filing ID A4Q0A6) addresses the potential macroeconomic effects on the Canadian economy of the resulting increased reliance on oil exports associated with the Project. On page 5 of her Evidence, Dr. Douglas stated "*that scholarly research points to concerns that Canada may be experiencing negative economic impacts due to forces referred to as 'Dutch Disease'…There may be costs to the overall resiliency of the regional and national economy through an increased dependency on the energy exports. Such costs are not included in socio economic impacts evidence submitted by Kinder Morgan*…" Dr. Douglas goes on to suggest that Canada may be better off in terms of long-term economic growth by reducing its dependency on energy, and stimulating investment and employment in higher value added industries.

As noted by Dr. Douglas, this issue was addressed in the Wright Mansell reply evidence prepared for the Northern Gateway Project (Filing ID A4Q0A9), which was appended to the written evidence of Dr. Douglas. Trans Mountain supports the views and conclusions on this issue that were expressed on pages 25-31 of the Wright Mansell report, which were based on a review of the empirical evidence. The Wright Mansell report concluded that: "…*notions of the existence and importance of Dutch Disease in the case of Canada are mainly conjecture. Dutch Disease is more of a theoretical possibility than a real and substantial policy issue in the case of Canada. Quite simply, the empirical evidence is far from complete and often subject to conflicting results. Much more clear from the studies is that, overall, the expansion of the oil and gas sector has been and remains a very important driver of the Canadian economy*." (Wright Mansell, page 30).

Trans Mountain also believes that the conclusion reached in the Wright Mansell report with respect to the Northern Gateway Project also applies to the TMEP: "As a single project aimed at diversifying markets for Western Canadian oil it is not credible that it would or could drive growth

of the entire resource sector to a degree required to create Dutch Disease." (Wright Mansell, page 8).

Based on research and analysis completed by the Conference Board of Canada, to be valid the Dutch Disease argument in the context of the TMEP requires numerous links, all of which would have to hold true:

- first, this argument assumes that TMEP will increase the total exports of Canadian oil to markets;
- second, that Canadian oil exports have a direct impact on the value of the Canadian dollar versus the US dollar;
- third, that any increase in the value of the dollar hurts the competitiveness of Canadian exporters and thus reduces exports (to the US in particular); and,
- fourth, that the Canadian economy experiences a net loss in economic output in such a scenario.

It is very unlikely that all of these assumptions will hold simultaneously.

One of the most common fallacies with respect to the Dutch Disease argument is that oil prices are driving movements in the Canadian dollar. It is true that the Canadian dollar strengthened in the mid-2000s when oil prices were rising, but a wide variety of commodities, including agricultural products and non-energy minerals, experienced rising prices over the same period during which oil prices rose. As well, the US dollar weakened against a wide variety of currencies in the 2000s; indeed, this was one of the factors that contributed to rising commodity prices. Thus, many factors other than oil prices influence the value of the Canadian dollar.

Canada's trade relationship with the US is also influenced by many factors other than the value of the dollar. The single biggest factor in recent years has been the large impact of China on trade within North America. China has had dramatic implications for global trade flows and is a major factor in why Canada's trade performance with the US has lagged. (Conference Board of Canada 2012). As such, a simple diagnosis of Dutch Disease to describe Canada's trade performance in recent years is not credible.

In summary, the Conference Board of Canada view is that there is no credible evidence that Canada is suffering from "Dutch Disease," and there is certainly no evidence that the TMEP would be large enough to make an impact on the Canadian economy to contribute to such a disease.

2.5 Upgrading and Refining

The written evidence of Unifor (Filing ID A4L6C6) asserts that the Project will undermine investment in domestic bitumen upgrading and refining activities and that, as a consequence, Canada will forego related economic and employment benefits. Unifor goes further and asserts that the Project will threaten the security of supply to existing Canadian refineries, and it could contribute directly to the future loss of additional refining capacity. Unifor did not present an economic case for upgrading, nor did they demonstrate how the current policy and regulatory context results in adverse environmental and social effects and reduced benefits to Canadians, other than stating that this is the case.

Trans Mountain is not an expert in upgrading economics, and did not retain IHS to provide expert views on the economics of upgrading. Furthermore, the economics of upgrading is not within the scope of this proceeding as it is not relevant to the NEB's List of Issues. Despite this, Trans Mountain generally addressed the issue in response to Taplay C IR Nos. 2.089 and 2.090 (Filing ID A4H9G6).

Bitumen producers are in the best position to assess the economics of upgrading, including its potential to create jobs. Trans Mountain understands that the decision to upgrade bitumen in Alberta is a complex one that must balance many factors. High capital costs in Western Canada and the long distances from refining markets are issues that impair returns on upgrading projects. Further, Trans Mountain respects the decisions made by producers regarding the economics of upgrading. Trans Mountain notes that several upgrader projects in Alberta have been cancelled over the last decade, with the exception of the North West Redwater (NWR) Partnership, which plans to convert bitumen into finished diesel and diluent for bitumen blending. The NWR project is receiving indirect financial support from the Government of Alberta. These facts indicate that producers have determined that in the current environment it is uneconomic to construct upgraders in Canada without government intervention.

As a transporter of crude oil and petroleum products, Trans Mountain respects the decisions that producers make to transport their products to market as heavy oil, diluted blend, synthetic crude oil or refined products. The existing Trans Mountain pipeline (TMPL) transports all of these products and the TMEP will provide additional capacity for each, subject to the needs of the market. Consequently, the Project would in no way inhibit or prevent further investment in domestic upgrading and refining operations. Further, the Project offers significant benefits to Chevron's existing Burnaby refinery in BC, by increasing the amount of spot market transportation capacity available to deliver oil to that facility.

Canada is a significant net exporter of petroleum products. It should be recognized that whether products are transported to market as heavy oil, diluted blend, synthetic crude oil or refined products, there is still a requirement for additional pipeline capacity to facilitate diversified market access. Otherwise, the lost export opportunities will result in foregone production and the associated loss of employment, income and fiscal benefits.

It is Unifor's position that the TMEP should not be approved and is not in the public interest because it fails to capture the full value of petroleum through upgrading and refining. The implication of this position is that Unifor believes the Board should only approve oil pipeline projects that, regardless of market sentiment and economic realities, support domestic upgrading and refining. It is Trans Mountain's belief that the Board or any other government entity should not be engaged in protectionist policy-making designed to subsidize or give preference to domestic upgrading and refining. Whether a particular project supports greater upgrading and refining activity in Canada is a decision best left to the market.

2.6 References

Conference Board of Canada. 2012. "Walking the Silk Road: Understanding Canada's Changing Trade Patterns" The Conference Board of Canada, December 19, 2012.

J. Weyant, E. Kriegler (2014) *Preface and introduction to EMF 27*. Climatic Change (2014). 123:345–352 DOI 10.1007/s10584-014-1102-7.

3.0 CORPORATE STRUCTURE

T'Sou-ke First Nation states in its written evidence that the original TMPL was built in 1952, and until 2005 was owned by BC Gas Inc. (Filing ID A4L5S9; paragraph 61). However, the original TMPL was constructed and owned by Trans Mountain Oil Pipeline Company. Trans Mountain Oil Pipeline Company was incorporated by an Act of Parliament on March 21, 1951. The construction of the TMPL occurred in 1952 and 1953, with the final weld completed on October 13, 1953. On April 12, 1972, Trans Mountain Oil Pipeline Company changed its name to Trans Mountain Pipe Line Company Ltd. It was not until November 11, 1994, that Trans Mountain Pipe Line Company Ltd. was acquired by BC Gas Inc. On December 31, 2002, Trans Mountain Pipe Line Company Ltd. changed its name to Terasen Pipelines (Trans Mountain) Inc. and on April 25, 2003, BC Gas Inc. changed its name to Terasen Inc.

On December 1, 2005, Kinder Morgan Inc. acquired Terasen Inc. who, in turn, owned the TMPL. Terasen Inc. retained its direct ownership in the TMPL until April 30, 2007 when, after a series of transactions, Terasen Inc. sold its ownership interest in the TMPL to KMEP Canada ULC, a wholly owned subsidiary of Kinder Morgan Energy Partners L.P. As of this date, Kinder Morgan, Inc. wholly owns, directly and indirectly, the partnership units of Kinder Morgan Energy Partners, L.P. Kinder Morgan Energy Partners, L.P. indirectly owns the TMPL.

T'sou-ke First Nation also concludes that the Kinder Morgan purchase resulted in a change from a public, collectively motivated company to a private profit-driven company (Filing ID A4L5S9; paragraph 62). However, since inception, the TMPL has been either a directly held public company or a subsidiary of a public company.

T'Sou-ke First Nation states that after Kinder Morgan's purchase of the TMPL, Kinder Morgan changed the service of the pipeline from natural gas to a mix of medium to heavy crude oil from the Alberta oil sands and that over time the TMPL has been used to transport exclusively diluted bitumen (dilbit; Filing ID A4L5S9, paragraph 62). Since inception, the TMPL has transported oil that originated in Western Canada, not natural gas. Starting in 1953, the TMPL transported light crude oil, in the mid-1980s Trans Mountain started regular transportation of refined products, and in the late-1980s Trans Mountain started the transportation of heavy oil. The percentage mix of petroleum (crude oil and refined products) has changed over the years; however, the Kinder Morgan acquisition had no direct impact on the percentage mix of petroleum transported. The TMPL is not and never has been used exclusively for the transportation of dilbit.

4.0 CORPORATE LIABILITY

In its written evidence, Natural Resources Canada references Bill C-46, the *Pipeline Safety Act,* which introduces a suite of new measures to strengthen incident prevention, preparedness and response, and liability and compensation and these measures, taken together, aim to ensure that Canada's federally regulated pipeline safety system is world class and aim to remain so in the future (Filing ID A4Q0V3; paragraphs 57-62).

It should be noted that since Bill C-46 was introduced, it has received Royal Assent on June 18, 2015; however, regulations to support the legislation have not yet been provided.

Bill C-46 is important as it reiterates some provisions that are already a matter of policy and law, such as support for the polluter-pay-principle and unlimited liability in some circumstances. The Bill is also important as it reassures the public by providing clarity with respect to the financial requirements that an NEB-regulated pipeline company will be expected to demonstrate, and by introducing provisions where the pipeline industry as a whole will assist in the event an individual company is unable to meet its obligations. Trans Mountain will demonstrate financial capacity at levels consistent with the legislation and expects the forthcoming regulations will provide additional guidance regarding these financial requirements.

5.0 TARIFFS

Unifor asserts in its written evidence that a recent amendment to Trans Mountain's tariff, which was approved by the Board, puts a Canadian refinery at a competitive disadvantage to US refiners (Filing ID A4L6C6; paragraph 16). Although not written within the scope of the TMEP Application, Trans Mountain would like to respond to this assertion. The tariff amendment referred to by Unifor was proposed in response to the NEB's MH-002-2012 Reasons for Decision where the Board found that the current nomination and capacity allocation procedures are likely contributing to the ongoing apportionment of the TMPL (NEB 2013). In its Decision, the Board directed Trans Mountain to submit its proposed procedures or an explanation of why the procedures in place were adequate. In response to this request, Trans Mountain filed a Tariff Amendment Application regarding Verification Procedures. This application was assessed by the Board through the RHW-001-2013 proceeding. In the RHW-001-2013 Reasons for Decision, the Board provided direction for Trans Mountain to implement certain Tariff amendments regarding verification procedures (NEB 2015). These tariff amendments were necessary to deal with a current Trans Mountain operational issue and were not precipitated by the Application by Trans Mountain for the TMEP. In Trans Mountain's view, the outcome of the RHW-001-2013 is not relevant to any issues on the TMEP list of issues and further, the Board specifically stated in its RHW-001-2013 Reasons for Decision:

> "If unintended impacts arise or if market circumstances materially change, the Board expects Trans Mountain and its shippers to negotiate solutions between themselves. Should the parties fail to reach an agreement, they may bring any concerns forward to the Board for resolution." (NEB 2015)

5.1 References

National Energy Board (NEB). 2013. MH-002-2012: Reasons for Decision, Chevron Canada Limited. July 2013.

National Energy Board (NEB). 2015. RHW-001-2013: Reasons for Decision, Trans Mountain Pipeline ULC on behalf of Trans Mountain Pipeline L.P. January 2015.

6.0 STAKEHOLDER ENGAGEMENT AND COMMUNICATIONS

The following Intervenors provided written evidence relating specifically to stakeholder engagement:

- The Fraser Valley Regional District (FVRD) is asserting that coordinating with two subcontractors on the proposed Trans Mountain Expansion Project will provide strain on the Regional District's fully committed staff (Filing ID A4L8V6).
- Parks Canada expressed its concerns that tourism operators in the Jasper National Park area have not been specifically engaged regarding reactivation activities (Filing ID A4L5U9).
- Grasslands Conservation Council (GCC) of BC raised concerns about consultation and Trans Mountain's response relating to the grasslands region between Jamieson Creek, north of Kamloops, and Merritt, BC (Filing ID A4L6I0).
- The Georgia Strait Alliance provided respondent comments from a survey posted on its website (Filing ID A4Q1K3).
- The City of Burnaby provided a table of responses it had gathered by way of a postcard (Filing ID A4L8G8).

Trans Mountain's response to the evidence provided by FVRD, Parks Canada, the GCC of BC, the Georgia Strait Alliance, and the City of Burnaby are provided below.

6.1 Potential Impacts to Tourism Operators

In its evidence (Filing ID A4L5U9), Parks Canada states that, "Parks Canada is of the view that with the implementation of Trans Mountain's environmental protection procedures and mitigation measures, and the Desired End Results framework, the reactivation plan is not likely to cause significant adverse effects to ecological or commemorative integrity, and visitor experience of Jasper National Park and the Yellowhead Pass National Historic Site." Parks Canada went on to express its concern that there have been no focused discussions with tourism operators in the Jasper National Park area regarding impacts of reactivation activities associated with the proposed expansion and referenced Trans Mountain's response to GoC Parks IR No. 2.147 (Filing ID A4H6A5).

In that response (Filing ID A4H6A5), Trans Mountain explained that its engagement activities to date have focused on communities and topics relating to the proposed new pipeline and facilities. Trans Mountain anticipates that impacts to the tourism industry in Jasper National Park will not be significant as reactivation activities are currently estimated to commence in Q2/Q3 2016 and are anticipated to be minimal. Trans Mountain also referenced in its response the relevant filings that document public events in the Hinton and Jasper areas where tourism operators had the opportunity to provide feedback.

To encourage input into its construction planning, Trans Mountain notified stakeholders in Jasper about specific opportunities to provide their feedback online. In May 2015, Trans Mountain delivered direct mail postcards to 1,010 dwellings in the Municipality of Jasper, and

advertised the online engagement opportunity through online advertisements and promoted tweets geo-targeted to route communities.

Discussions and engagement regarding potential impacts associated with the reactivation of the existing line within Jasper National Park are ongoing.

Trans Mountain's commitment in GoC Parks IR No. 2.147 (Filing ID A4H6A5) was that it would reach out to tourism operators in the Jasper National Park area in Q2/Q3 2015 to involve them in engagement activities pertaining to the reactivation of the existing pipeline segment between Hinton, Alberta (AB) and Hargreaves Station, BC through Jasper National Park. Tourism organizations were invited to a Community Leadership Meeting, held in Jasper, AB, on June 17, 2015, and Trans Mountain intends to follow-up on this meeting with a similar event focused specifically on Tourism Operators in Q3/Q4 of 2015.

6.1.1 Consultation Related to the Lac du Bois Protected Area (Jamieson Creek to Kamloops)

In its written evidence (Filing ID A4L6I0), the GCC of BC raised concerns about consultation and Trans Mountain's response relating to the grasslands region between Jamieson Creek, north of Kamloops, BC, and Merritt, BC. Lac du Bois is one of the two significant areas from Jamieson Creek to Kamloops.

Trans Mountain notes that a detailed assessment of potential impacts to grasslands in the Lac du Bois Protected Area was completed and filed as part of its BC Parks Stage 2 Detailed Proposal Boundary Adjustment Application, a copy of which was provided in Consultation Update No. 3 (Filing IDs A4H1W2, A4H1W3, A4H1W4, A4H1W5, A4H1W6, A4H1W7, and A4H1W8). The BC Parks Stage 2 Detailed Proposal provides additional information regarding stakeholder engagement and routing considerations. On June 19, 2015, Trans Mountain submitted an addendum to its Stage 2 Detailed Proposal to BC Parks. The addendum provides information related to Trans Mountain's proposed benefit and offset priorities as identified through stakeholder engagement, for the protected areas including the Lac du Bois Protected Area. A copy of the addendum is provided as Appendix 6A. Notification of the Stage 2 Detailed Proposal filing was provided to the GCC, other interested stakeholders, and the general public.

Consultation and engagement regarding impacts to grasslands, with a specific emphasis on Lac du Bois, has been comprehensive and extensive. Consultation activities have included a site visit, routing workshops, open houses, a Lac du Bois park-specific workshop, individual meetings, phone conversations, and online information sharing with multiple feedback mechanisms. Participants have included a broad range of stakeholders including local First Nations, BC Parks, Ministry of Forest Lands Natural Resource Operations, Kamloops Naturalist Club, Kamloops Trails Alliance, Thompson Rivers University, the City of Kamloops, the Tranquille Cattleman's' Association as well as impacted landowners. GCC representatives have expressed their interests and concerns about the BC Interior grasslands to Trans Mountain at various consultation events.

6.1.2 Proposed and Alternate Routing in the Kamloops Region (Jamieson Creek to Kamloops)

In its written evidence (Filing ID A4L6I0), the GCC of BC raised concerns about consultation and Trans Mountain's response relating to the grasslands region between Jamieson Creek,

north of Kamloops, BC, and Merritt, BC. The Kamloops Region is one of the two significant areas from Jamieson to Kamloops.

Trans Mountain identified a preferred route through the Kamloops Region as part of its Facilities Application filed with NEB in December 2013. As the preferred route required approval through the BC Parks boundary amendment process, Trans Mountain also identified an alternate route as referenced in NEB IR No. 1.40 (Filing ID A3W9H8).

Prior to filing the Facilities Application, Trans Mountain met with the City of Kamloops to discuss an alternate route through the Westsyde neighbourhood. The City of Kamloops expressed a preference for the Lac du Bois routing in order to avoid disruption to the dense residential area and rural agricultural properties along Westsyde Road. In addition the City of Kamloops was able to identify the least impactful route through Westsyde should the Lac du Bois Stage 2 Detailed Proposal not be approved. The City of Kamloops has indicated it would not allocated staff resources to the detailed assessment of the alternate Westsyde route until a decision from BC Parks has been made.

Westsyde neighbours along the proposed alternate route and the Westsyde Neighbourhood Association have been directly invited to attend public information sessions and workshops. Since the Facilities Application was filed, both the preferred route through Lac du Bois and the alternate route through the Westsyde neighbourhood have been presented for public feedback at the consultation activities described in Table 1.12A.2-35 of NEB IR No. 1 (Filing ID A3W9H8).

A detailed description of the route selection process through the Lac du Bois Protected Area has been described in workshops and meetings. In its letter dated November 14, 2014, provided as Appendix 6B, Trans Mountain indicated the following to the GCC:

> "Route alternatives that did not met construction feasibility were not considered for further detailed routing studies. The route alternative proposed by GCC was considered previously in the preliminary route assessment process, however due to safety and constructability issues, this route was not deemed to be a viable alternative. Furthermore this alternative route suggested by the GCC would not align with Trans Mountain's routing criteria to parallel existing infrastructure where practical."

Routing through the grasslands outside of the Lac du Bois Protected Area follows the existing TMPL right-of-way and meets Trans Mountain's routing objectives.

6.1.3 Proposed Net Benefits Related to Preferred Route (Lac du Bois)

Trans Mountain facilitated discussion about net benefits in each of the BC Parks potentially impacted by the proposed Project. Section 1.11 of Consultation Update No. 3 (Filing IDs A4H1W2 through A4H1W8), describes Trans Mountains engagement regarding BC Parks. Discussions included the identification of potential net benefits and a review that considered each potential option against a number of criteria including alignment with the relevant BC Parks Management Plan.

In its June 19, 2015, addendum (Appendix 6A) to the Stage 2 Detailed Proposal, Trans Mountain included its proposed net benefit priorities for the protected areas, as identified through stakeholder engagement, BC Parks informal information requests (IRs) and various

Traditional Land and Resource Use reports filed with the NEB by Aboriginal communities with interests in the protected areas

The $1,195,000 allocated by Trans Mountain as proposed offsets for Lac du Bois route recognizes that the protected area fulfills a very important conservation role in representing the Thompson Basin and Northern Thompson Uplands Ecosystems. The proposed offsets that address concerns raised by the GCC and other stakeholders include:

- $900,000 - reclamation of the Telus fibre optic right-of-way;
- $100,000 - reclamation of protected area trial or areas damaged by off-road vehicles;
- $75,000 - reduction of unauthorized off-road vehicles and mountain bike activity;
- $75,000 - invasive vegetation survey and management; and
- $45,000 - signage/promotion to enhance cultural and grassland awareness in the protected area.

6.1.4 Respondent Comments Submitted by Georgia Strait Alliance and City of Burnaby

In its evidence submitted, both the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) provided respondent comments they had received from a survey posted on its website and by way of a postcard, respectively. Trans Mountain wishes to reply to the comments provided as evidence.

Trans Mountain wishes to note that the Market Research and Intelligence Association of Canada has defined a professional standard for public opinion research. The respondent comments gathered by the Georgia Strait Alliance and the City of Burnaby do not appear to have been gathered in a rigorously scientific manner and therefore should be viewed as a biased representation of public opinion.

Trans Mountain notes that some of the respondent comments provided as evidence are not relevant to one or more of the issues identified in the NEB's List of Issues for the Trans Mountain Expansion Project, and therefore Trans Mountain has not provided a reply to those comments. Trans Mountain further notes that some respondent comments, specifically regarding the regulatory process, appear to be directed at the NEB, not Trans Mountain.

Respondent comments submitted by the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) have been grouped into the following general themes listed alphabetically in order to provide a response:

Aboriginal Interests

In the table of citizen's comments submitted as evidence by the City of Burnaby's (Filing ID A4L8G8) there was one comment regarding Aboriginal interests; however, no additional context was provided.

As referenced in Nooaitch IB IR No. 1.1.1.04 (Filing ID A3X6S6) Trans Mountain does not presume to define the interests of Aboriginal groups. Rather, through the Aboriginal Engagement Program, Trans Mountain engages with Aboriginal groups to provide comprehensive information to them and seek feedback from them on the Trans Mountain Expansion Project (the Project) and to identify potential impacts of the Project on the assertion of Aboriginal rights, and title governing traditional and cultural use of the land and marine environment. Through this process, Trans Mountain is able to further understand the interests of the group, as related to the Project.

Biodiversity of Marine Life

In the Georgia Strait Alliance supporter comments (Filing ID A4Q1K3), one respondent indicated "The damage from oil spills is catastrophic and will permanently degrade the biodiversity of the marine life with which it comes into contact."

Based upon the results of the comprehensive risk review conducted by Trans Mountain, which includes the study, "A Comparison of the Properties of Diluted Bitumen Crudes with Other Oils" (Technical Report S8 in TR 8C-12, Volume 8C, Filing ID A3S5G7), the transportation of dilbit as proposed by the Project, and with the additional risk reducing measures in place, does not present a unique risk to the marine environment. The study shows that comparing both physical and chemical properties of various oils, the risks to the marine environment from the transport of dilbit by tanker are not significantly different than those of other medium to heavy oils that are currently transported safely in this region.

Construction of Pipeline/Traffic Concerns

The City of Burnaby (Filing ID A4L8G8) provided respondent comments regarding the local impacts of pipeline construction activities and traffic concerns.

As referenced in City of Burnaby IR No. 1.34.04e (Filing ID A3Y2E6), subject to the outcome of the NEB regulatory process, and prior to construction, Trans Mountain will undertake a communications and notification program to ensure local businesses and members of the public are made aware of potential construction impacts including lane restrictions, road closures, and alternate access plans. The Communication and Notification Program will include advertisements, public general notices, area specific information handouts, and local signage as described in the Volume 6B, Environmental Protection Plan (EPP). Please refer to NEB IR No. 1.15a (Filing ID A3W9H8) for additional information.

More details regarding the plan for engagement and communications activities conducted prior to and during construction have been provided in Consultation Update No. 2, which was filed with the NEB in August 2014 (Filing IDs A62087 and A62088).

Diluted Bitumen in Water

In the Georgia Strait Alliance supporter comments (Filing ID A4Q1K3), one respondent indicated "*shippers of the diluted bitumen (dilbit) are clueless as to how it behaves in water*."

Volume 7 of the Application (Filing ID A56025, A3S4V5 to A3S4X2) provides a comprehensive overview of the measures to prevent oil spills, risks related to oil spills, emergency response in the event of a spill, fate and behaviour of spills in both fresh and brackish water, the ecological

and human health risks associated with a spill for both terrestrial and a Westridge marine spill, and a detailed assessment of KMC's financial capacity to respond to a spill.

In May 2013, Trans Mountain conducted applied research on the fate and behaviour of dilbit in a marine environment. In Volume 8C of the Application, Technical Report TC 8C-12 S7 – A Study of Fate and Behavior of Diluted Bitumen Oils on Marine Waters, provides the results of that study.

Disclosure of Response Plans

In the Georgia Strait Alliance supporter comments (Filing ID A4Q1K3), one respondent indicated "*I also find it troubling that Kinder Morgan refuses to disclose their response plans*."

KMC acknowledges the interest of respondents to seek more information about the existing Emergency Management Plan (EMP) documents, and reference materials related to the TMPL system, which is why KMC filed a redacted copy of the existing EMP publicly. In Ruling No. 50 (Filing ID A4G5I9) the NEB determined that it was "*satisfied that sufficient information has been filed from the existing EMP documents to meet the Board's requirements at this stage in the process.*"

The Application, Volume 7, Section 4.8 (Filing ID A3S4V5) outlines the process to enhance KMC's existing EMPs as they relate to the TMPL system to address the needs of the Project. The final programs will be developed in a manner consistent with the NEB's draft conditions related to emergency management (Filing ID A3V8Z8).

Earthquakes- Potential for Damage/Incident

Both the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) provided respondent comments related to the impact to the Trans Mountain system in the event of an earthquake.

As referenced in Amy C IR No. 1.5d (Filing ID A3X5Y6), in the event of an earthquake, the Trans Mountain Control Centre Operator (CCO) would receive notification from either a supervisory control and data acquisition (SCADA) alarm triggered by a seismic switch (there are three located on Trans Mountain's pipeline system at the Burnaby Terminal, Sumas Station, and Laurel Station in Washington State) or from other sources such as the United States Geological Survey (USGS) website. Upon notification, the CCO would immediately determine if any assets are located within the Potential Damage Radius using reports of the earthquake magnitude and location, and the GIS. The Potential Damage Radius is a chart that has been created by Trans Mountain's geotechnical consultant using datasets of historic liquefaction, lateral spreading, landsliding and rockfalls as a result of seismic events worldwide for various levels of seismic activity. The chart provides a first indication of whether potentially damaging wave propagations or ground displacements are likely at the facility locations based solely on the size of earthquake and distance from the epicenter (typically the only information available within minutes of an event occurring) and conservatively assuming a shallow event. If any assets are located within the Potential Damage Radius, an immediate shut-down of all facilities and pipelines within that radius would occur. A plan would then be put into place to inspect each facility and pipeline within the impacted area, including a thorough damage and hazard assessment.

Modern buried steel pipelines with welded joints are less susceptible to damage from seismic wave propagation than other pipeline types (including pre-1950s steel, cast iron, or concrete segmented lines). Permanent ground displacements along the pipeline alignment would be the main indicator of possible pipeline damage.

The pipeline would not be restarted until all inspections confirmed that no permanent ground displacements had occurred on the pipeline route and no other damage was observed on the pipeline or within facilities. In the event that ground displacements are observed on the pipeline route, additional inspections and any necessary repairs would be carried out to confirm the integrity of the piping before returning it to service. Any required repairs to ensure facilities equipment is fit for service would be completed before allowing the facilities to be restarted. Trans Mountain would notify the Transportation Safety Board of Canada any time the pipeline was shut down for safety reasons. Restart of the pipeline would not be permitted until a process was completed to authorize the pipeline restart following a safety shut-down.

Economic Benefits

Both the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) provided respondent comments that question the economic benefits of the Project.

To estimate the economic and fiscal benefits that can be expected from the construction and operation of the Project, Trans Mountain commissioned an independent study by the Conference Board of Canada, which was conducted under the direction of Mr. Glenn Hodgson. The resulting report, *The Trans Mountain Expansion Project: Understanding the Economic Benefits for Canada and its Regions, The Conference Board of Canada*, is provided in Appendix B, Volume 2 of the Application (Filing ID A3S0R1).

The report concludes:

- The development (construction) period is forecasted to boost Canadian GDP by approximately $4.9 billion, with $2.8 billion accruing to BC and $1.4 billion to Alberta. There will be a total of 58,000 person-years of employment generated across Canada during development, with approximately 36,000 in BC and 15,000 in Alberta.
- There will be $646 million in federal taxes generated during the Project development phase and an additional $568 million of provincial taxes, with $309 million received by BC and $168 million by Alberta.
- There will be an overall boost to employment of 50,000 to 65,000 person-years during the first 20 years of operations, with 60% of the jobs being created in BC and 20% in Alberta.
- The operations phase will boost Canadian GDP by at least $13.3 billion over the first 20 years. BC will see the largest impact with a boost of about $8.5 billion, followed by Alberta at almost $4 billion.
- The Project will generate about $1.4 billion in additional tax revenues for the federal government during the operations phase and an additional $1.1 billion in provincial taxes, with BC receiving about $727 million and Alberta receiving about $278 million.

In addition to the tax benefits created at the federal and provincial levels, the Project will also yield benefits to communities along the right-of-way through employment and economic activity,

and generating additional property taxes for the life of the pipeline. As part of the environmental and socio-economic analysis completed by TERA Environmental Consultants (TERA) as presented in Volume 5B (Filing IDs A56004, A3S1R4 to A3S1T0), it was estimated that the additional property taxes generated by the Project will be about $22.1 million (a 103% increase) annually in BC and $3.2 million (a 119% increase) annually in Alberta.

As referenced in City of Port Moody IR No. 1.1.3a (Filing ID A3X5Z8) Trans Mountain is committed to investing in municipalities, education institutions, and regions crossed by the proposed Project. Trans Mountain contributes to initiatives in communities where it operates and has initiated discussions with local governments and organizations to explore additional community benefit opportunities related to its priority areas of community investment, environment and ecological offsets, and education.

Environment Effects

Both the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) provided respondent comments about the environmental impacts of the Project.

As described in Volume 2, Section 4.0 of the Application (Filing ID A3S0R0), protection of the environment is essential to the success of the Project and is a key performance objective of Trans Mountain. Examples of Trans Mountain's commitment to preserving and protecting the environment can be found in the Application, Section 1.2.1.7 (Environmental Stewardship) and Section 1.2.1.8 (Award-winning Projects: The Anchor Loop Expansion) of Volume 2 (Filing ID A3S0Q8). Protection of the environment, through avoidance will always remain the first priority where practical.

After the Application was submitted, work continued on detailed engineering and construction planning, including additional field studies, and to determine regulatory requirements for compensation offsets and consideration for other potential Project investments or local benefits. Trans Mountain also continues to engage with local communities and interest groups about proposed activities in high value areas such as natural areas directly disturbed, rare and sensitive habitat, and/or other areas of value identified by stakeholders.

Homes Expropriated

In the City of Burnaby comments (Filing ID A4L8G8), one respondent was concerned that homes would be expropriated.

As indicated in Volume 2, Section 5.4 (Filing ID A3S0R0), Trans Mountain's objective is to acquire land rights for the Project through voluntary agreements with directly affected landowners. Should Trans Mountain be unable to reach an agreement with the directly affected landowner through voluntary negotiation, under Section 104 of the *NEB Act*, Trans Mountain could apply to the NEB for the right to enter upon the required lands to install the pipeline and register an easement on title. This does not provide Trans Mountain with the ability to expropriate land but it does provide a mechanism to obtain the right to install the pipeline in situations where the company and landowner are unable to reach an agreement. Throughout this process, landowners have legal rights for representing their interests in the company's Application and receive full compensation as outlined in Sections 86 and 97 of the *NEB Act*. In addition, Trans Mountain cannot commence Right of Entry proceedings in advance of receipt of a Certificate of Public Convenience and Necessity from the NEB, and could only commence those proceedings with the approval from the NEB.

The Pipeline Regulation of Canada: A Guide for Landowners and the Public provides a comprehensive guide to the rights of landowners and the regulatory process for pipeline approval and development. This Guide can be obtained at the following website: www.neb-one.gc.ca/prtcptn/lndwnrgd/lndwnrgd-eng.pdf

Impacts to Health

In the City of Burnaby comments (Filing ID A4L8G8), respondents raised concerns relating to health risks associated to the Project.

As referenced in FVRD IR No. 1.19a (Filing ID A3Y2K7), information relevant to human health is located in a number of different places in the Application. This is due in part to the fact that the factors that influence human health ("determinants of health") are varied and include biophysical, social, economic, and institutional factors. It is also due in part to the way in which assessment data is presented in Section 7.0 of Volume 5B (Filing IDs A3S1S7; A3S1S8, A3S1S9), which organizes information around specific Project components rather than around technical disciplines.

However, Technical Report 5D-8 in Volume 5D, the Community Health Technical Report (Habitat Health Impact Consulting Corp. December 2013; Filing ID A3S2L9), PDF pages 1,621 to 1,726 and Technical Report 5D-7 in Volume 5D (Filing ID A3S2L7), the Screening Level Human Health Risk Assessment of Pipelines and Facilities Technical Report (Intrinsik 2013), PDF pages 1,159-1,620 provide complete and uninterrupted human health impact information. The screening-level human health risk assessment (SLHHRA) focuses on issues of potential human exposure to environmental contaminants. The Community Health Technical Report comprises a Health Impact Assessment, and considers the effects of the Project on a wide range of health outcomes that include:

- Socio-economic health effects: mental well-being, alcohol and drug misuse, and demand on and capacity of mental health and addictions services.
- Infectious diseases: sexually transmitted infection rates, infectious respiratory disease rates, and gastrointestinal infection rates.
- Environmental health effects: stress and anxiety related to the perception of contamination.
- Public safety: traffic-related injury and mortality.
- Health care service provision: demand on and capacity of hospitals and health care facilities; and demand on and capacity of emergency medical response.
- Aboriginal health: diet and nutritional outcomes.

A SLHHRA aimed at identifying and understanding the potential health risks to people associated with short-term and long-term exposures to the chemicals that could be emitted from the pipeline and facilities of the Project was completed, and was presented in Technical Report 5D7 in Volume 5D (Filing IDs A3S2L1, A3S2L2, A3S2L5, A3S2L7), Screening Level Human Health Risk Assessment of Pipeline and Facilities Technical Report (Intrinsik 2013). The findings of the SLHHRA indicate that adverse health effects are not predicted for people,

including sensitive or susceptible individuals (*e.g.*, infants and children, pregnant women, the elderly, and individuals with compromised health), as a result of the Project.

Inadequate Spill Response

The Georgia Strait Alliance indicated that (Filing ID A4Q1K3) inadequate oil spill response (*i.e.*, resources and procedures are not sufficient to address the risk) was one of the most frequently cited reasons for opposition to the proposed Project.

As referenced in City Burnaby IR No. 1.07.23a (Filing ID A3Y2E6), pipeline safety is KMC number one priority. As stated in KMC's Environment, Health and Safety (EHS) policy, which can be found in Volume 7, Section 4.2.2 of the Application (Filing ID A3S4V5): "*Every employee is expected to share KMC's commitment to pursue the goal of not harming people, protecting the environment, using material and energy efficiently, and promoting best practices*…"

KMC uses the Incident Command System to respond to emergencies. Under the Incident Command System, the Information Officer is responsible for public notifications in the event of an incident. Public notification priorities are determined based on the type of incident and the impacts it has to the safety of the public. KMC works with local authorities in the event of an emergency to coordinate response, including immediate notifications as required.

Specific communication strategies will depend upon the nature of the incident and would be approved under the Incident Command System. KMC is committed to timely communications with those that are directly impacted by any emergency event. The methods used for informing the public include door to door delivery of information, social media, traditional media, website updates, and a phone hotline. KMC maintains a standby website that can to be activated and populated as needed, the hotline is also ready to go live at the time of an incident. The public is notified about the hotline number via the website, social media and traditional media, along with any information package that may be prepared for distribution to those impacted by an emergency, and/or at open house style events.

Increased Tanker Traffic

Both the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) provided respondent comments the risks associated with an increase in tanker traffic.

A comprehensive risk assessment of the impact of the increase in tanker traffic resulting from the Trans Mountain Expansion Project within the Central Harbour has been carried out by Det Norske Veritas GL (DNV-GL) and is located in the Application, Volume 8C, TR8C-12, TERMPOL 3.15 (Filing IDs A3S5F4, A3S5F6 and A3S5F8). Existing marine traffic for the area was identified based on Automated Information System (AIS) data and other vessel traffic information. The AIS automatically provides information, including the ship's identity, type, position, course, speed, navigational status and other safety-related information, to appropriately equipped shore stations, other ships and aircraft.

Using a combination of economic forecasting, regional project announcements, and interviews, the amount of future traffic has been forecast for 2018, 2020, 2025, and 2030. Interviews were conducted with a number of terminals east of Second Narrows (Imperial Oil Company, Suncor Energy Inc. and Pacific Coast Terminals facilities and others) to validate the estimated traffic of commercial vessels within the Central Harbour. These projected traffic volumes were used in TERMPOL 3.15 to estimate the probability of spills both with and without the proposed Project

traffic for the years 2018 and 2028. The analysis of marine traffic forms part of the Application and can be found in Volume 8C, TR8C-2, TERMPOL 3.2 (Filing ID A3S4R8).

The results of TERMPOL 3.15 show that tanker traffic to the Westridge Terminal is projected to increase from 5 to 34 tankers per month in 2018, constituting an increase of approximately 60 total transits (ingoing plus outgoing tanker transits). The Project-related increase in marine traffic will represent about 16% of total marine traffic in Burrard Inlet in 2018, compared to the current 3%. See Volume 8A, Table 2.2.2 (Filing ID A3S4X4). However, when compared to all forecast traffic using AIS, the increase in traffic as a result of TMEP is estimated to be 9% east of the Second Narrows. The carriage of oil by barges to and from the various oil handling facilities in the Central Harbour is expected to remain the same.

The use of AIS is not mandatory for most recreational vessels; therefore it is possible that the analysis has not accounted for a number of recreational and smaller vessels sailing in this area. Should these vessels have been included in the total count of vessel movements, the percentage of Project tankers in the total count of vessel movements in the Central Harbour would be lower. All vessel traffic, recreational or otherwise, are subject to all maritime traffic regulatory requirements, which are designed to ensure the safety of all users of marine transportation lanes.

As is the case today, it is expected that the operators of small vessels (mainly fishing and recreational vessels), as required by Transport Canada, would continue to follow boating safe practices and the collision regulations and apply good seamanship when operating within Burrard Inlet and as part of that, thereby these vessels will not impede the path of large ships and will in other ways avoid unsafe encounters from developing. As large ships mainly move during certain times of the day only, depending on the tide, not including the non-AIS vessels to the total traffic is not considered as a limiting factor to the overall risk evaluation. Should however, there were to be an encounter between a small/recreational vessel and a large ship, harm would be caused to the small vessel; however there would not be any threat of a cargo oil spill.

The risk assessment estimated that the change in frequency of a vessel incident (any vessel) in the Central Harbour as a result of the Project will be negligible See the Application Volume 8C, Technical Report TR 8C 12 Supplemental TR S12 Section Table 12 and Figure 22 (Filing ID A3S5I9). The quantitative risk assessment considered: marine traffic; weather (a meteorological weather data recording station has been set up at the Westridge Marine Terminal); locational and what-if issues highlighted during the hazard identification workshop (HAZID); and existing and future risk reducing measures.

There are a number of measures in place that reduce safety risks for all vessels related to the increased presence of Project-related marine vessels. The movement of all vessels in excess of 350 gross tons within the Central Harbour must be conducted under the direction of a licensed Canadian pilot. In the case of laden tankers, there is a requirement for two pilots. The pilots are equipped with special navigation tools such as a Portable Pilotage Unit and the tankers must be accompanied by a prescribed number of tugs. The tankers are highly regulated and must also meet strict acceptance standards for the Westridge Marine Terminal, which only accepts modern tankers that meet all international and national rules and regulations, are well maintained and are operated to best industry operating practices (KMC's Tanker Acceptance Standard is provided as an attachment to the response to Belcarra IR No. 1.9, Filing ID A3X6W1). In addition there are a number of local port regulations in place that are meant to

ensure the safe movement of tankers and other vessels. While docked at Westridge Marine Terminal, the loading operations onboard is overseen by a Loading Master with authority to not commence loading (or to cease loading) if the tanker is not meeting recognized safe operating practices.

The effects assessment for the Project-related increase in marine tanker traffic (see the Application, Volume 8A, Section 4.3.11 Marine Commercial, Recreational and Tourism Use, Filing ID A3S4Y3) identifies potential effects to other marine transportation users and marine recreational use. Potential effects assessed included the potential for damage to marine vessels and/or injury resulting from incidents involving Project vessels under normal operations (*i.e*., not spills). Collisions by Project tankers with built infrastructure such as bridges or docks was also considered and deemed to be unlikely due to the manner in which these vessels are conducted, the degree of oversight and scrutiny placed on these vessels and the high degree of mitigation measures, including the use of pilots and tugs, already in place from the various authorities (see the Application, Table 4.3.11-3, Section 4.3.11 in Volume 8A, Filing ID A3S4Y3). The effects assessment lists several mitigation measures (including federally regulated activities and industry best practices) aimed at reducing effects of increases in Project-related marine vessels on other commercial and recreational vessel traffic. These include the following:

- Transport Canada requires all vessels, including tankers, to comply with the International Regulations for Preventing Collisions at Sea (with Canadian Modifications) and other major international maritime conventions.
- Transport Canada requires compliance by all vessels with the *Canada Shipping Act, 2001*, Collision Regulations, the Navigation Safety Regulations pursuant to the Act and other applicable regulations and standards, except Government or Military vessels.
- In Burrard Inlet and other marine areas under its jurisdiction, Port Metro Vancouver (PMV) ensures compliance with PMV's Marine Restricted Area regulations, including "Clear Narrows" regulations.
- Tanker owners have third-party insurance coverage in place to address vessel damage, gear loss or injury.
- Transport Canada and the Transportation Safety Board carry out investigations at the appropriate level in case of a collision between vessels
- BC Coastal Marine Pilots will ensure that all tankers follow transit procedures set out by PMV and the Pacific Pilotage Authority, including escort tug requirements in Burrard Inlet, and timing restrictions for the Second Narrows.

In addition, the cumulative effects assessment of the Project-related increase in marine tanker traffic (see the Application, Volume 8A, Section 4.4.9 Marine Commercial, Recreational and Tourism Use, Filing ID A3S4Y3) identifies the Project's contribution to potential cumulative effects on other commercial and recreational vessel traffic. This assessment considers the increases in marine vessel traffic predicted to occur between 2012 and 2030 in Burrard Inlet.

In order to ensure a high degree of safety at the Westridge Marine Terminal a number of steps have been taken by Trans Mountain:

- DNV-GL conducted a HAZID in Vancouver that was attended by marine and industry experts, regulators, municipal representatives (including the Mayor of Belcarra), and representatives of First Nations amongst others. Unanticipated events were discussed at this event and DNV-GL used the results of the HAZID as input to completing the quantitative risk assessment;
- conducting public engagement and obtaining feedback;
- engaging with local First Nations, whenever possible;
- completion of a quantitative risk assessment;
- designing and siting the proposed dock facility after due consideration of a number of safety factors in a manner that will ensure safety of the terminal, vessel, workers and others;
- conducting a fast time simulation study to test the navigation safety of the proposed dock layout;
- constructing and equipping the facility to global standards both for oil handling equipment and spill prevention;
- committing to operate the facility with a high focus on safety under a regime based on regulatory requirements, local experience and international best practices that have been developed and continually improved since the terminal entered service in 1953 and one that has proven to be comprehensive, well established and effective; and,
- requesting a TERMPOL review and recommending a number of additional risk reducing measures, which include a request to facilitate the development of a "shipping channel" in the eastern section of PMV between Second Narrows and Port Moody. This item is being actively pursued with PMV and a "shipping channel" is currently under review, which will further increase safety of all vessel movements in the Central Harbour.

Jobs - Permanent

Both the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) provided respondent comments that questioned if the pipeline would actually create new jobs in BC.

As referenced in City of Burnaby IR No.1.10.01a (Filing ID A3Y2E6) a significant number of additional tradespeople, terminal operations personnel and other technical and supervisory staff, relative to current levels, will be directly employed to operate and maintain the expanded TMPL system. There will also be a requirement for additional field staff to be employed for various operations and maintenance support roles ranging from engineering to administrative. It is anticipated that an incremental 40 to 45 operations and maintenance personnel will be required at field locations in BC. The additional field operations and maintenance staff will be

recruited sufficiently in advance of the start-up of the expanded TMPL system to allow for appropriate training to take place, including in emergency response. These numbers are preliminary and detailed staffing plans will be developed after the Project is approved.

Liability in the Event of a Spill

Both the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) provided respondent comments that questioned if Kinder Morgan would be held liable in the event of a spill.

As referenced in Del Ponte 1.4g (Filing ID A3Y2J0**)** Canada's oil spill compensation regime is based upon the polluter-pay-principles, and all costs, including any wildlife rescue costs will be paid for by the Responsible Party (Trans Mountain for a pipeline spill, the tanker owner for a tanker spill). In case of ship-source spills, the *Marine Liability Act* establishes the framework for handling marine liability and compensation in Canada and also establishes the Ship-source Oil Pollution Fund (SOPF), which provides funding for spills from all classes of vessels in Canadian waters. Almost $1.3 Billion is available through this SOPF. More information can be found in the Application, Volume 8A, Section 1.4.1.6 (Filing ID A3S4X3) and Volume 8C, TR 8C-15 (Filing ID A3S5J6). Trans Mountain currently has $750 million of spill liability insurance to deal with costs in circumstances where Trans Mountain is deemed the Responsible Party, (refer to the Application, Volume 7 Section 9; Filing ID A3S4V6).

Local Benefits, Including Taxes Paid by KMC

The City of Burnaby (Filing ID A4L8G8) provided respondent comments regarding the lack of taxes paid by Kinder Morgan, the potential for increased taxes for residents of Burnaby and the lack of economic benefits locally.

As referenced in Hackett A IR No. 1.2.2d (Filing ID A3X6G8), residents of communities where construction and operations activities will be carried out, may benefit either directly or indirectly through employment or business opportunities. As a citizen and tax payer within a municipality, province and country, individuals would receive the benefits of the economic stimulus and tax revenues generated by the Project which will help to either offset personal taxes, or provide those jurisdictions with additional revenues for the provision of public services and infrastructure. Please see Volume 2, Section 3.4 of the Application for additional information (Filing ID A3S0R0).

In addition, there are a number of benefits to the City of Burnaby should the Trans Mountain Expansion Project be approved. These include:

- Municipal Taxes - Trans Mountain paid $7,022,000 in annual taxes to the City of Burnaby in 2013, as noted in Table 7.2.7-12, Section 7.2.7 of Volume 5B (Filing ID A3S1S7). If the Project is approved, the projected annual property tax to the City of Burnaby is estimated to be $13,243,000, also noted in the referenced table. The City of Burnaby is projected as the single largest beneficiary of municipal taxes as a consequence of the Project.

- Community Investment - The KMC Foundation has donated almost $2M in grants to youth organizations which support education and art programs benefitting youth in grades K-12 in many communities where KMC operates, as is described in Table 1.7.2, Section 1.7.2 and Table 1.7.4, Section 1.7.4, Volume 3A of the Application (Filing ID A3S0R5). This includes more than $350,000 in community investments in Burnaby since 2007.

- Community Benefits - Trans Mountain is committed to investing in community benefits initiatives in municipalities and regions crossed by the Project. Trans Mountain intends to contribute to community benefits in communities where it operates and has initiated discussions with local governments, education institutions and organizations to explore community benefit opportunities related to its priority areas of community investment, environment and ecological offsets, and education.

- Capital Investment - The Trans Mountain Expansion Project is a $5.5B capital investment, as outlined in Section 3.2.2, Volume 2 (Filing ID A3S0R0). This includes capital costs of approximately $450M for the construction of the Westridge Tank Terminal and approximately $300M for the construction of the Westridge Marine Terminal, to which many of the construction-related benefits will accrue to Burnaby and the local region.

- Employment and Workforce Spending - The Metro Vancouver region will have the largest workforce requirements, with construction activities anticipated during the full construction period. The required workforce in the Metro Vancouver region will average about 655 workers and will peak about 1,200 workers in October 2016. It is estimated that approximately 30% would be local hires, as described in Table 7.2.7-7, Section 7.2.7, Volume 5B (Filing ID A3S1S7). It is estimated that these workers would spend more than $100M locally during construction on goods and services such as accommodations and meals, as is described in Table 7.2.7-13, Section 7.2.7, Volume 3A (Filing ID A3S0R5).

- Ongoing Operations - A significant number of additional tradespeople, terminal operations personnel and other technical and supervisory staff, relative to current levels, will be directly employed to operate and maintain the expanded Trans Mountain system, as noted in Section 4.1, Volume 4C (Filing ID A3S1L1). It is anticipated that 40 to 45 operations and maintenance personnel will be required at field locations in BC, including Burnaby. The additional field operations and maintenance staff, as well as CCOs will be recruited in advance of the start-up of the expanded system, to allow for appropriate training to take place. Overall, the direct, supply chain, and induced effects of operations will support between 50,273 and 65,184 person-years of employment over the first 20 years – or between 2,514 and 3,259 jobs per year, as outlined in Appendix B, Volume 2 (Filing ID A3S0R1). Burnaby's exact share of these effects will depend on future hiring, contracting, and procurement decisions.

There are also a number of benefits to the Canada and its regions should the Project proceed. Some information from these referenced sections of the Application is summarized below:

- Construction - Development of the Project generates direct impacts in the construction sector, supply chain impacts such as purchase of equipment and induced effects which occur when wages from the direct and supply chain effects are spent.

- Employment - Trans Mountain expects to create 108,000 person-years of employment from construction plus the first 20 years of operations across Canada, At least 66,000 person-years of employment will be in BC and at least 25,000 will be in Alberta, including direct, supply chain and induced jobs. At the peak of activity (anticipated to be July 2017), it is estimated the Project will require more than 4,475 direct construction workers in Alberta and BC combined.

- Increased Spending - Project development is anticipated to generate almost $3.3 billion in labour income across Canada (direct, indirect and induced effects combined). Of this, approximately 58% (or $1.9 billion of labour income) will be generated in BC and approximately 30% ($974 million) will be generated in Alberta. The total labour income associated with direct Project-related employment during construction is anticipated to be approximately $1.8 billion, of which approximately $1.2 billion will be in BC and approximately $556 million will be in Alberta.
- Construction-Related Spending - Trans Mountain plans to spend $5.5 billion by the end of construction to complete the line and associated facilities, and a further $2.4 billion to operate it for the first 20 years. BC's economy is forecast to grow by $2.8 billion (GDP) through construction-related spending, and up to $11.3 billion including Project operations through to 2037.
- Access to Global Markets - More broadly, accessing better-paying global markets through the Trans Mountain Expansion Project would raise oil producer revenues and yield addition taxes as outlined in Appendix A, Volume 2 (Filing ID A3S0R1) of the Application. Burnaby and all of Canada would benefit from these additional tax revenues.
- Federal Tax Increases - The estimated tax revenues to the Government of Canada are $2.1 billion over the life of the Project.
- Provincial and Municipal Tax Increases - The Project is also anticipated to generate substantial provincial and municipal tax revenue. Provincial governments' revenues associated with the Project are anticipated to be in the order of $1.7 billion, with BC provincial government receiving $1 billion in provincial taxes and Alberta receiving over $0.4 billion in provincial taxes.

Municipal tax revenues that can support community services and infrastructure are estimated to increase approximately $23 million annually or $460 million over 20 years of operations. In Alberta, municipal property taxes are estimated to increase approximately $3.4 million annually or $68 million over 20 years of operations.

In communities along the proposed pipeline corridor, annual property tax payments to more than 20 local governments and more than 24 Aboriginal communities would jump to $52.4 million from $25.9 million per year at present.

Meaningful Engagement

In the City of Burnaby comments (Filing ID A4L8G8), one respondent stated that the company had failed to meaningfully engage citizens.

Trans Mountain is committed to open, respectful and transparent interactions with communities. From the beginning, Trans Mountain's stakeholder engagement and communication activities have sought to proactively identify and involve stakeholders to the greatest extent possible in the Project. The following documents filed with the NEB provide a record of our extensive efforts to ensure that stakeholders are aware and have had an opportunity to express interests or concerns related to our Project.

- **Volume 3** (Filing ID A55987) of the Trans Mountain Facility Application (the Application), filed with the NEB on December 16, 2013, reported on its engagement activities for the

period of May 2012 through to July 31, 2013; Aboriginal engagement activities for the period of May 2012 through to September 30, 2013; and Landowner Relations for the period of April 2012 through to July 31, 2013.

- **Consultation Update No. 1 and Errata** (Filing ID A3Z8E6), filed with the NEB on March 20, 2014, reported our ongoing engagement activities with Aboriginal groups, landowners and stakeholders conducted during August 1 to December 31, 2013.
- **Consultation Update No. 2** (Filing IDs A62087and A62088), filed with the NEB on August 1, 2014, reported on our ongoing engagement activities with Aboriginal groups, landowners and stakeholders conducted during January 1 to April 30, 2014.
- **Consultation Update No. 3** (Filing IDs A4H1W2 through A4H1W8), filed with the NEB on February 12, 2015, reported on our ongoing engagement activities with Aboriginal groups, landowners and stakeholders conducted during May 1 to December 31, 2014.

Consultation Update No. 4, provided as Appendix 6C, reports on Trans Mountain's ongoing stakeholder engagement activities conducted during January 1 to June 30, 2015 and describes how stakeholder feedback was gathered and addressed. Engagement activities that continue to occur throughout the regulatory process will be provided, as requested by the NEB.

Trans Mountain continues to seek stakeholder feedback on how and when they would like to be engaged regarding the Project. As Trans Mountain becomes aware of new groups or individuals, it proactively reach out to them to determine how best to involve them. Trans Mountain seeks out and engages with stakeholders in a proactive manner. However it is important for stakeholders to make their interests known to Trans Mountain, in order for Trans Mountain to consider their input.

Noise

In the City of Burnaby comments (Filing ID A4L8G8), respondents were concerned about noise during operations.

As referenced in City of Burnaby 1.10.03d (Filing ID A3Y2E6) Trans Mountain will ensure the operation and testing for noise generating equipment meets the local noise bylaws by designing and installing the equipment with appropriate consideration of noise suppression. Additionally, the testing for this equipment is normally done during regular working hours. Detailed mitigation measures for this equipment have not yet been determined as this will be done during the final phase of design and engineering.

World Class Oil Spill Response Capacity

In the Georgia Strait Alliance comments (Filing ID A4Q1K3), respondents questioned the ability to achieve a "World Class Clean-up."

As stated in Strata NW313 IR No. 1.26a (Filing ID A3Y3R5), "Gold Standard" or "World Class" are terms that are an effective means to express a worthy objective which Trans Mountain supports. However, it must be recognized that because of differences in geographic, commercial, technical, and political settings around the world, there is no single formula or example of "gold standard" or "world class" that can be copied from another regime and directly applied to the Canadian context.

Potential for Tankers Leaks

In the Georgia Strait Alliance comments (Filing ID A4Q1K3), respondents were concerned about the consequences of any leak or spill from tankers.

As referenced in May E IR No. 1 (Filing ID A61145), in the 25 years since the Exxon Valdez incident, many safety improvements have been undertaken by governments and the tanker industry. Today a wide range of marine safety measures are in place to ensure the safety of marine transportation in Canada including the transportation of oil on oil tankers. This has helped to ensure that Canada has not experienced a major oil spill. The improvements include:

- Only double hulled tankers are accepted in Canada. These vessels carry the oil cargo in a number of smaller tanks within an inner hull, which reduces the size of any potential spill volumes.
- Tankers movement practices have been refined for added safety such as allocating two licensed pilots to laden tankers and the increased use of escort tugs, often tethered, to help minimize the probability of powered groundings such as the Exxon Valdez.
- Improved technology provides superior bridge navigational aids, situational awareness, and ship control systems (*e.g*., GPS, AIS, radar).
- Increased global standards of training and certification for all seafarers, with additional requirements for those serving on tankers.
- Communications and monitoring of all vessels in Canadian waters, including specific monitoring of defined shipping lanes, is undertaken by the Coast Guard vessel traffic service.
- A government-certified spill response organization must be in place to ensure a prompt response. The certified response organization in BC is the Western Canada Marine Response Corporation (WCMRC).
- Cooperation between nations and further development of joint response plans.

In addition to the above Trans Mountain has also proposed a number of safety measures to Transport Canada and the TERMPOL Review Committee above current measures to help mitigate risk. These are located in Volume 8A, Section 5.3.2 (Filing ID A3S4Y5).

Property Values

In the City of Burnaby comments (Filing ID A4L8G8), respondents were concerned about a drop in property values.

As referenced in Eliesen M IR No. 1.13a (Filing ID A3X6D1), the issue of impacts to property values has been raised during some open houses and through some emails, telephone calls into the Trans Mountain Project office, and in meetings; primarily by adjacent landowners, rather than directly affected landowners. As a result, Trans Mountain has undertaken specific research to address this perceived concern.

A review of previous research papers and articles, prepared by Dr. Tsur Somerville of the University of British Columbia, has been prepared to ascertain what other researchers and experts have found in their investigations of the potential impacts of pipeline development upon private properties. That literature review is included in the response to Amy C IR No. 1.3g (Filing ID A3X5Y6).

In determining whether compensation is applicable to a specific landowner, Trans Mountain is guided by legislative and legal requirements. In general Trans Mountain's practice is to first minimize any potential damages to the extent practical by using and adapting responsive construction and operations practices; and second, provide mitigation to reverse or treat any remaining impacts. Should residual damages remain, Trans Mountain would provide commensurate compensation for damages directly related to and caused by the acquisition of lands, construction of the pipeline, and inspection, maintenance or repair of the pipeline.

Legislative requirements for the TMEP are set out within the *NEB Act*. Those provisions of the *NEB Act* apply specifically to directly affected parties and include:

- Under *NEB Act*, Section 75, "A company shall, in the exercise of the powers granted by this Act or a Special Act, do as little damage as possible, and shall make full compensation in the manner provided in this Act and in a Special Act, to all persons interested, for all damage sustained by them by reason of the exercise of those powers."
- Under the *NEB Act* Section 86, when a company acquires lands for its operations, they are responsible for any damages directly related to and caused by the acquisition of lands, construction of the pipeline, and inspection, maintenance or repair of the pipeline. Under that Section, compensation related to the installation of a pipeline includes compensation for the acquisition of lands, compensation for damages, and indemnification of land owners from all liabilities related to the company's operations. These requirements would apply to the TMEP.
- Under Section 97, factors an arbitration committee would consider in a determination of compensation include the market value of the lands taken both for permanent easement and temporary working space, loss of use of the lands by the owner, damages caused by construction and, noise and inconvenience that can reasonably be expected to arise from the construction. Trans Mountain is incorporating these factors in the compensation framework being developed for the TMEP. Additional information respecting TMEP compensation framework for directly affected landowners can be found in responses to NEB IR No. 1.29 (Filing ID A3W9H8) and CGLAP IR No. 1.7b (Filing ID A3X6A7).

The requirements of the *NEB Act* and company practice is to minimize and mitigate effects upon workers and community members through a variety of construction and environmental practices as documented in the Application, including the Pipeline EPP and Facilities EPP. In addition to construction management personnel, Trans Mountain will have environmental inspectors in place during construction to ensure EPP measures are implemented as needed and as committed to Trans Mountain responsibility for compensation for impacts to adjacent, not directly affected, members of the community would arise should the activities of the company, after efforts to minimize and mitigate effects result in directly related damages as defined in the *NEB Act*.

Should adjacent landowners be of the opinion that the operations related to the TMEP have caused them directly related damages as defined in the *NEB Act*, Trans Mountain would look to the affected parties to provide the company with information and documentation as to the nature and extent of the perceived damages. That information can be provided to the Manager, Land, or Trans Mountain. Using the information received, if Trans Mountain determines that damages resulted from the company's operations, it will provide any commensurate compensation due to the affected party.

Risk of a Fire or Explosion

In the City of Burnaby comments (Filing ID A4L8G8), respondent were concerned about the potential for a pipeline explosion.

As referenced in Wright K IR No. 1.2.4 (Filing ID A3X6W5), Trans Mountain's pipelines are managed through a Pipeline Integrity Management Program that utilizes regular re-evaluations of risk as the basis for identifying and prioritizing assessment and risk mitigation actions. The continual re-evaluation of geohazard threats is an integral part of Trans Mountain's Pipeline Integrity Management Program.

It is also important to bear in mind that the product being transported in the existing pipeline is crude oil. Industry experience has shown that crude oil does not readily ignite in consideration of a potential pipeline release, even in contemplation of a credible worst-case scenario (CWCS) full-bore rupture. By way of illustration, in a report by Dr. F. Jeglic, it was observed that no ignition of spilled product occurred in any of the pipeline ruptures involving low vapour pressure liquid products (the class of product that crude oil falls in) over the twenty-year analysis period reviewed. Please see Wright K IR No. 1.2.4 - Attachment 1 (Filing ID A3X6W6).

Routing and Port Alternatives

In the Georgia Strait Alliance comments (Filing ID A4Q1K3), one respondent suggested Prince Rupert and an alternate port.

As referenced in City of Burnaby IR No. 1.01.01a (Filing ID A3Y2E6) The TMEP is a proposal to expand the existing TMPL system, including the existing terminal facilities. Paralleling and expanding existing facilities reduces new disturbance, uses existing infrastructure and minimizes environmental effects. This is consistent with good project planning and best environmental practices.

While good planning and best practices favour using existing facilities, this does not reduce the rigour of conducting an assessment of the potential impacts associated with the expansion. Early in project planning Trans Mountain tested the basic premise that expanding existing facilities is the most responsible approach to the development. Potential alternative marine terminal locations were considered based on the feasibility of coincident marine and pipeline access, and screened based on technical, economic, and environmental considerations. These alternative locations included Kitimat, BC and Roberts Bank in Delta, BC. Trans Mountain ultimately concluded that constructing and operating a new marine terminal and new supporting infrastructure would result in significantly greater cost, larger footprint, and additional environmental effects, as compared to expanding existing facilities. Accordingly, Trans Mountain did not continue with a further assessment of alternative termini for the Project.

Safety of School Children

In the City of Burnaby comments (Filing ID A4L8G8), respondents were concerned about and the safety of children given the proximity of the proposed pipeline to schools.

As referenced in BTA IR No. 1.4 (Filing ID A3X5X3) KMC's first priority is safety of the public, its employees and contractors, and the environment.

In the unlikely event of a pipeline release on or near school property, KMC would immediately shut down the pipeline to isolate the section of the pipeline that is of concern, thus stopping further release of petroleum. At the same time, emergency services would be contacted immediately and trained KMC technicians would be dispatched to the location to help local authorities secure the area and commence air monitoring to ensure air quality for those in the immediate vicinity.

KMC uses the Incident Command System to respond to emergencies. The Incident Command System provides for seamless coordinated action with government agencies and Aboriginal communities. KMC would work together with the local authority to determine the best course of action to protect the public. Each situation would be different and the response would address the specific circumstances presented.

In addition, Trans Mountain indicated in its response to Doherty D IR No. 1.03l (Filing ID A3Y2K2) that it is open to working with individual schools and School Districts to support their safety efforts and ensure their EPPs and Trans Mountains are coordinated. KMC has a long-standing relationship with the Burnaby School District through its community relations program and pipeline safety program. KMC has made presentations about pipeline safety to the Burnaby School District. In addition, KMC has made presentations to local Parent Advisory Committees about pipeline safety awareness and offered to review the school's emergency response plans. Typical presentations cover such topics as products, location of facilities in the community, safety tips, pipeline damage prevention programs, and steps to take in the event of a spill or suspected spill.

Ultimately, however, it is local schools that make their own emergency plans as directed by the local school board.

Spill Record

Respondent comments in both the Georgia Strait Alliance (Filing ID A4Q1K3) and the City of Burnaby (Filing ID A4L8G8) evidence raised concerns about the company's spill record.

As stated in Eilesen M IR No. M 1.10a (Filing ID A3X6D1), Trans Mountain is required to report incidents that meet a reporting threshold to the NEB. This reporting is done by the operator of the TMPL system, KMC.

While no spills are acceptable, when one does happen, it is cleaned up with the regulatory oversight of the NEB. In addition, the majority of spills happen within KMC's terminal facilities where secondary containment is available and cleanup can be done quickly with very little or no environmental impact and cost.

Over the years, the NEB has revised the spill reporting criteria for pipeline companies. KMC has followed all NEB regulations in terms of reporting pipeline leaks and malfunctions, according to

the rules and thresholds listed below. In keeping with KMC's commitment to transparency, it should be noted that many of the spills reported fall below the required reporting threshold:

- 1999-Current: Release of low vapour pressure hydrocarbons greater than 1.5 m^3; Release of gas or high vapour pressure (HVP) hydrocarbons; and Release resulting in significant adverse effects.
- 1988-1999: Release of oil greater than 1.5 m^3; Release of gas or high vapour (HVP) hydrocarbons; and Release resulting in the discharge of toxic substance in land or into a body of water.
- 1974-1988: Any leak, break, fire or explosion in, or failure of malfunction of pipeline.

From 1961 to the end of 2013, Trans Mountain has reported approximately 82 spills to the NEB, including a number of incidents which were below the reportable threshold. Information on reported incidents to the NEB from 1961 to present is publicly available on the TMEP website (http://www.transmountain.com/).

Urban Impacts

Respondent comments in the City of Burnaby (Filing ID A4L8G8) evidence raised concerns about the impacts of construction for residents in urbanized areas.

As referenced in Taplay C IR No. 1.06 (Filing ID A3Y3S8), Trans Mountain recognizes that working in an urban environment requires greater attention to the potential effects on people due to construction including, but not limited to: traffic and access management; noise management; and preventing, minimizing, or mitigating impacts to existing utilities, residential, commercial, and recreational/community use areas. Volume 5B of the Application - in particular Sections 7.2.3, 7.2.4, 7.2.5, 7.2.7 and 7.2.8 - describe and characterize the potential effects of the TMEP (the Project) on people in proximity to Project activity, including key mitigation measures (Filing ID A3S1S7). The Socio-Economic Management Plan in Appendix C of Volume 6B (Filing ID A3S2S3) summarizes the socio-economic mitigation measures that will reduce effects on the human environment, many of which are focused on managing and reducing effects in an urban environment.

Further, and as described in the Socio-Economic Management Plan in Appendix C of Volume 6B, Trans Mountain will develop and implement an issues tracking process to monitor and respond to Project-related socio-economic issues and opportunities that emerge during construction and reclamation. This is a unique construction-phase measure, and is a direct reflection of the many urbanized environments crossed by or in proximity to the Project. As suggested in NEB Draft Condition 11 as outlined in the NEB's Letter – Draft Conditions and Regulatory Oversight (April 16, 2014) (Filing ID A3V8Z8), this will be called a Socio-Economic Effects Monitoring Program. Please refer to the response to NEB IR No. 1.17d.6 (Filing ID A3W9H8).

Westridge Neighbourhood

In the City of Burnaby (Filing ID A4L8G8), respondents identified themselves as living in the Westridge neighbourhood raised concerns about the proposed expansion.

Trans Mountain has undertaken an extensive engagement and communications program since early 2012 and is committed to ongoing engagement. Trans Mountain has met multiple times with the Westridge neighbours and understands they have concerns specifically regarding the location of the proposed pipeline corridor and the location and design of the Westridge Marine Terminal and dock facilities. Based on feedback from the Westridge neighbours, the proposed pipeline corridor identified in the Application is now an alternate pipeline corridor. Details of that corridor are included within the response to NEB IR No. 1.40 (Filing ID A3W9H8). Respecting their concerns about the Westridge Marine Terminal and dock facilities, Trans Mountain has been working with Project marine engineers to design a facility that would reduce the impact to Northcliffe residents, while at the same time addressing the other design requirements the Project is required to meet.

Trans Mountain is committed to ongoing dialogue to understand and seek opportunities to address their concerns where practical.

6.2 Coordinating Subcontractors

The FVRD is asserting that coordinating with two subcontractors on the proposed Trans Mountain Expansion Project will provide strain on the Regional District's fully committed staff (Filing ID A4L8V6).

Trans Mountain confirms that two engineering design companies are currently engaged on routing and detailed engineering of the proposed new pipeline alignment. The Project also utilizes other companies for their consulting services and expertise focused on geotechnical, environmental, risk engineering, and facilities engineering. There are also a number of internal company experts on matters such as emergency response and safety planning. This assembly of numerous consultants from a number of companies is typical practice on large, complex projects such as the TMEP.

In the case of routing and pipeline design, the FVRD region spans across areas of both engineering consultants' responsibility. These are: an engineering consultant responsible for the Lower Mainland area and one responsible for the Interior and Alberta sections of the proposed Project. Given the work that has occurred by each engineering team to date, and the specific expertise that each adds to the Project, a reassignment of scope for the teams at this time would not be practical.

Technical Working Group (TWG) meetings are intended to have open and transparent communication through the design process to minimize future surprises through both the construction and operational phases of the Project. An initial TWG meeting was held between Trans Mountain's Lower Mainland section engineering design consultant and FVRD on November 3, 2014. In response to FVRD's concerns for a single point of contact, Trans Mountain agreed that the interior section engineering design consultant will be the sponsor of all future TWG meetings. The first meeting with the interior consultant was held March 11, 2015. The Stakeholder Engagement and Communications contact has and will remain consistent.

With regard to construction works, the construction split does not coincide with the engineering split. All of FVRD's territory is currently envisioned to be undertaken by a single contractor, who may utilize several crews or construction spreads, to implement the above described integrated engineering plans. However, construction spreads will split in other communities including Hinton, Blue River, Kamloops, and Langley.

All construction contractors will be required to adhere to consistent constructions standards set by Trans Mountain with input from local governments on topics such as protection of water, dust, noise, emissions, traffic, and road use. There will be a single construction Emergency Response Plan developed by the Prime Contractor and approved by Trans Mountain.

6.3 Summary of New Commitments

- All construction contractors will be required to adhere to consistent constructions standards set by Trans Mountain with input from local governments on topics such as protection of water, dust, noise, emissions, traffic, and road use. There will be a single construction Emergency Response Plan developed by the Prime Contractor and approved by Trans Mountain.

7.0 ABORIGINAL ENGAGEMENT

Adams Lake Indian Band (ALIB), Asini Wachi Nehiyawak Traditional Band (AWNTB), Cheam First Nation (CMFN), Chawathil First Nation (CWFN), Coldwater Indian Band (CIB), Cowichan Tribes (CT), Katzie First Nation (KFN), Lyackson First Nation (LYFN), Métis Nation of Alberta Gunn Métis Local 55 (GML), Métis Nation of British Columbia (MNBC), Matsqui First Nation (MN), Michel First Nation (MFN), Musqueam Indian Band (MIB), Nooaitch Indian Band (NIB), Pacheedaht First Nation (PTFN), Stk'emlupsemc Te Secwépemc (SSN), Stó:lō Collective (Stó:lō), Snuneymuxw First Nation (Snuneymuxw), Squamish Nation (SN), Tsartlip First Nation (Tsartlip), Tsawout First Nation (TWFN), Tsawwassen First Nation (TFN), Tsleil-Waututh Nation (TWN), and Upper Nicola Band (UNB) have raised concerns in their responses to IRs to Natural Resources Canada (NRCan) on July 14, 2015, or in Written Evidence filed with the NEB related to Project engagement including:

- the engagement process and/or timing;
- Project benefits;
- Emergency response management and planning;
- capacity funding;
- the opportunity to provide input; and,
- the potential Project-related effects on the assertion of Aboriginal rights and title governing traditional and cultural use of the land and/or marine environment.

Trans Mountain's response to the concerns expressed by each intervenor are outlined below.

Trans Mountain is committed to continued engagement with Aboriginal communities, groups, associations, councils, and tribes (Aboriginal groups), and the implementation and management of its Aboriginal Engagement Program as outlined in the engagement logs and Project Consultation Updates filed to date:

TMEP Facility Application - Volume 3B Aboriginal Engagement	December 16, 2013	A3S0U5
Consultation Update No. 1 - Part 3 - Aboriginal Engagement	March 20, 2014	A3V3L9
Consultation Update No. 2 - Part 6 - Aboriginal Engagement	August 1, 2014	A3Z8Q1 A3Z8Q2
Consultation Update No. 3 - Part 2 - Aboriginal Engagement	February 3, 2015	A4H1X0
Consultation Update No. 4 - Aboriginal Engagement	August 20, 2105	*Refer to Appendix 7A of this filing*

Included with this filing is Consultation Update No. 4, outlining engagement activities with Aboriginal groups from January 1 to May 31, 2015. Refer to Appendix 7A for a copy of the update.

7.1 Adams Lake Indian Band

Starting May 29, 2012, Trans Mountain has been engaging ALIB on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

ALIB's IR response to NRCan (Filing ID A4RD0, PDF pages 3, 4, 5, and 13) on July 14, 2015, stated Trans Mountain's engagement to date with ALIB has been impersonal, inaccurate, and lacked sincerity. Trans Mountain disagrees with this statement and, as outlined in the engagement logs and Project Consultation Updates filed to date, Trans Mountain has demonstrated its willingness to engage ALIB through all phases of the Project including baseline work, mitigation measures, and aquatic offset requirements.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and Emergency Management; ALIB will be invited to participate in collaboration with other Aboriginal groups located in the region. Trans Mountain is committed to continued engagement with ALIB to discuss the Project and the potential Project-related effects on ALIB.

7.2 Asini Wachi Nehiyawak Traditional Band

Starting October 2013, Trans Mountain has been engaging AWNTB on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

The Written Evidence submitted by AWNTB (Filing ID A4Q3Q8, PDF page 1) states that it is

> "awaiting responses from Trans Mountain regarding:
>
> - AWNTB inquiry into and proposals for preparation of a Traditional Land Use (TLU) study for the Project
> - AWNTB inquiry into the proper contact person to provide a definitive response to the outstanding Archaeological and Heritage Resource Assessment Study deficiency issues raised by AWNTB in the past."

As outlined in the engagement logs included with Consultation Update No. 4, since filing its response to NEB Ruling 72 (Filing ID A70134) on May 21, 2015, Trans Mountain and AWNTB have undertaken additional engagement activities. In an email from Trans Mountain to AWNTB on May 27, 2015, Trans Mountain informed AWNTB that the Lead Archaeologist would be in contact with AWNTB to discuss the studies.

As stated in its response to NEB Ruling 72 and based on recent discussions with AWNTB, Trans Mountain understands that the proposals received from AWNTB are for studies related to historical cultural use of the pipeline right-of-way area and not for studies regarding current use of the lands. Trans Mountain acknowledges the receipt of information from AWNTB regarding traditional land and resource use (TLRU) as filed with its Evidence to the NEB on May 31, 2015; the information contained in the report has been reviewed and incorporated into Project

planning. Trans Mountain reminds AWNTB that it requires current TLRU information to inform Project planning.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; AWNTB will be invited to participate in collaboration with other Aboriginal groups located in the region. Trans Mountain is committed to continued engagement with AWNTB to discuss the Project and the potential Project-related effects on AWNTB.

7.3 Cheam First Nation and Chawathil First Nation

Starting May 29, 2012, Trans Mountain has been engaging CMFN and CWFN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

As included in Volume I of its Written Evidence, (Filing ID A4Q2C6, PDF page 26) on behalf of CMFN and CWFN, Chief Ruth Peters states that "*Chawathil and Cheam share concerns with respect to the Trans Mountain Pipeline Expansion Project the ("TMEP"), which would pass through our core territories, close to our reserves, and through areas over which we have Aboriginal rights and title.*" Specifically, concerns are expressed regarding consultation about emergency response management/spill response planning and Project benefits.

To assist with Project engagement, capacity funds were initially provided to CMFN though a confidential letter of understanding (LOU) on December 18, 2012; the LOU was amended and extended twice. To assist with Project engagement, capacity funds were provided to CWFN though a confidential LOU on February 25, 2013. A confidential joint-LOU was executed with CMFN and CWFN on December 18, 2015, to provide capacity for continued meaningful consultation, negotiations, and additional TLU studies.

Trans Mountain acknowledges that engagement with CMFN and CWFN is ongoing regarding the provision of benefits both within the terms of a Mutual Benefit Agreement (MBA), or those which are specific to the contracting or occupational (including training) requirements or as a result of the Project overall.

Trans Mountain acknowledges the receipt of CMFN and CWFN's information filed confidentially with the NEB. The confidential information has been reviewed and incorporated into Project planning. A summary of the study was filed confidentially with the NEB on August 20, 2015.

On April 14, 2014, CMFN and CWFN attended a TMPL emergency response workshop and on January 28, 2015, team members met exclusively with the CMFN and CWFN working group to discuss EM. The following topics were discussed at the meeting:

- Importance of TLU;
- Studies underway to provide information for the geographic response plans;
- Importance of the local river and users;
- Overview of the Emergency Response Plan (ERP)and Geographic Response Plans that would be constructed;

- Unified command structure used for every emergency; and,
- Possible activities for training and participation.

In their Evidence, CMFN and CWFN expressed concern about the identification of High Consequence Areas (HCAs), Trans Mountain notes that the list of HCAs included in the Facilities Application is an adaption of the US Department of Transportation Pipeline safety regulations; Indian Reserves are designated HCAs.

Trans Mountain is committed to continued engagement with CMFN and CWFN to discuss and address concerns related to emergency management and the ERP. Trans Mountain continues to build and refine the scope for Part III of its engagement program and the engagement activities planned with Aboriginal groups. The goal for Part III is to build on knowledge shared and information exchanged to date, and to undertake an inclusive and accountable process to incorporate feedback from Aboriginal groups and instill confidence in Trans Mountain's EMP. Part III will commence in the later half of 2015 and will continue until March 2016. Engagement activities will focus on sharing current ERP information as well as content for enhancements to the ERP for the proposed Project. Key topics include the Planning Standard, Geographic Response Plans (GRPs), and Fire Response Plans:

1) The Planning Standard is a fundamental document that outlines guiding principles and direction on how Trans Mountain will implement the ERP. KMC currently has a Planning Standard in place that is used for the existing system, which exceeds most industry guidelines. Aboriginal groups will be engaged to review the standard for use with the expanded system. All input and feedback will be considered and incorporated as practical.

2) A GRP is an overarching guiding document that describes immediate response strategies that may be implemented in the period following an incident, and until incident command is established. The objective of these plans is to reduce decision making time during the initial response to an incident so that response strategies can be implemented as soon as possible. KMC intends to modify and enhance the existing pipeline ERP by combining the existing field guide and control points document into GRPs. Four GRPs will be developed, which will align with the four KMC administrative districts: Alberta, North Thompson, Kamloops, and Sumas.

3) KMC has existing Fire Response Plans for all of its terminals and storage facilities across the system including Edmonton, Kamloops, Sumas, Burnaby, and Westridge Marine Terminal. As part of the Expansion Project Trans Mountain will be conducting enhancements to the existing plans to accommodate expanded facilities.

Trans Mountain is committed to continued engagement with CMFN and CWFN to discuss the Project and the potential Project-related effects on CMFN and CWFN.

7.4 Coldwater Indian Band

Trans Mountain has a long history of engagement with CIB as the TMPL system runs through the Coldwater Reserve #1, in which members of the CIB reside. Project engagement commenced with a notification letter from Trans Mountain to CIB on May 29, 2012. A Protocol and Capacity Agreement was executed on October 10, 2014, which provided the terms for

engagement and capacity funding to support the process, and the completion of a TLU and Traditional Knowledge study.

Trans Mountain acknowledges the receipt of CIB's information filed confidentially with the NEB. The confidential information has been reviewed and incorporated into Project planning. A summary of the study was filed confidentially with the NEB on August 20, 2015.

As included in their Written Evidence (Filing ID A4Q0X7), on April 17, 2015, CIB sent a letter to Trans Mountain expressing their concerns that the West Alternative was no longer being considered as an option, and the preferred option was upslope of the reserve, raising concerns with respect to downslope effects. Trans Mountain issued a response letter to CIB on June 17, 2015, to provide clarification on the routing options and invited CIB to attend a meeting to discuss the options and to further understand the concerns of CIB. Refer to Appendix 7B for a copy of the letter. As included in its IR response to NRCan (Filing ID A4R4H0, PDF page 13) on July 14, 2015, CIB believes that meaningful consultation regarding routing has not taken place to date. Trans Mountain disagrees with this statement. Trans Mountain acknowledges information provided to date and remains willing to meet with CIB to discuss routing concerns, as outlined in its June 17, 2015, letter.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; CIB will be invited to participate in collaboration with other Aboriginal groups located in the region. Trans Mountain is committed to continued engagement with CIB to discuss the Project, including routing options, and the potential Project-related effects on CIB.

7.5 Cowichan Tribes

Starting May 29, 2012, Trans Mountain has been engaging CT on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP; CT will be invited to participate in collaboration with other Aboriginal groups located in the region. As outlined in its IR response to NRCan (Filing ID A4R4G1, PDF page 3) on July 14, 2015, CT expects consultation on a number of issues to continue after the NEB hearing process has concluded; Trans Mountain is committed to continued engagement with CT to discuss the Project and the potential Project-related effects on CT.

7.6 Katzie First Nation

Starting May 29, 2012, Trans Mountain has been engaging KFN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

As outlined in the KFN Written Evidence (Filing ID A4L5H7, PDF page 5), Trans Mountain and KFN have been unable to agree on the terms of an agreement, including the provision of funds to be used to conduct a TLU study. Trans Mountain acknowledges the receipt of KFN's information filed confidentially with the NEB. The confidential information has been reviewed and incorporated into Project planning. A summary of the study was filed confidentially with the NEB on August 20, 2015.

In its IR response to NRCan (Filing ID A4R4E8, PDF pages 5 to 7) on July 14, 2015, KFN stated its interest in working with Trans Mountain to address impacts as they arise. KFN set out seven recommendations for Trans Mountain to mitigate impacts. Trans Mountain is committed to continued engagement with KFN to discuss the Project and the potential Project-related effects. Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; KFN will be invited to participate in collaboration with other Aboriginal groups in the region. Project mitigation measures will be reviewed including those that will be utilized to minimize Project-related effects as identified in the KFN TLU study.

Trans Mountain is committed to continued engagement with KFN to discuss the Project and the potential Project-related effects on KFN.

7.7 Lyackson First Nation

Starting May 29, 2012, Trans Mountain has been engaging with LYFN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

A confidential LOU was executed on May 30, 2013, which provided capacity funding for the completion of the Lyackson Use and Occupancy Mapping Study (LUOMS). The study was completed in 2014 and the summary was filed with the NEB on December 1, 2014 (Filing ID A4F5D2). Trans Mountain acknowledges an outstanding commitment to meet with LYFN to discuss the mitigation measures associated with the Project as related to the LUOMS.

It its IR response to NRCan (Filing ID A4R4T3, PDF pages 1, 5, 6, 7, 9, and 10) on July 14, 2015, LYFN indicated mitigation measures have not yet been discussed. Trans Mountain disagrees with this statement as Lyackson has had opportunities to discuss these measures; however, Trans Mountain is committed to meeting with LYFN to discuss mitigation measures, Project-related issues, and the concerns of LYFN.

Additionally, Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP; LYFN will be invited to participate in collaboration with other Aboriginal groups located in the region. Trans Mountain is committed to continued engagement with LYFN to discuss the Project and the potential Project-related effects on LYFN.

7.8 Matsqui First Nation

MN has a long-standing relationship with KMC as the existing TMPL system runs through the Matsqui Main Reserve #2, in which members of the MN reside. Starting May 29, 2012, Trans Mountain has been engaging MN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In its IR response to NRCan (Filing ID A4R3K5, PDF page 2) on July 14, 2015, MN expressed concern regarding routing across the Matsqui Main Reserve #2. Trans Mountain acknowledges the engagement efforts to date regarding routing and the work currently underway with MN to complete an environmental assessment, to inform the route-selection process. Trans Mountain will not route across the Matsqui Main Reserve #2 unless consent is received from the Nation.

Trans Mountain acknowledges the receipt of MN's information filed confidentially with the NEB. The confidential information has been reviewed and incorporated into Project planning. A summary of the study was filed confidentially with the NEB on August 20, 2015.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; MN will be invited to participate in collaboration with other Aboriginal groups located in the region. Trans Mountain is committed to continued engagement with MN to discuss the Project and the potential Project-related effects on MN.

7.9 Métis Nation of Alberta Gunn Métis Local 55

Starting May 29, 2012, Trans Mountain has been engaging GML on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In their IR response to NRCan (Filing ID A4R4D2, PDF pages 11 and 12) on July 14, 2015, GML outlined an interest in procurement, employment, and training opportunities. Trans Mountain issued three letters to GML (refer to Consultation Update No. 4 contained in Appendix 7A of this filing) regarding procurement, employment, and training opportunities related to Project construction. To date, Trans Mountain has received information about one company with an interest in Project-related procurement opportunities, MK Steam Industrial Services Ltd.

Also included in their IR response to NRCan (Filing ID A4R4D2, PDF pages 3 and 6), GML expressed concern with the lack of opportunity to discuss mitigation measures with Trans Mountain to date. Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; GML will be invited to participate in collaboration with other Aboriginal groups located in the region. Trans Mountain is committed to continued engagement with GML to discuss the Project and the potential Project-related effects on GML.

7.10 Métis Nation of British Columbia

Starting November 12, 2012, Trans Mountain has been engaging with the MNBC on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In its Written Evidence (Filing ID A4Q2H2, PDF page 24) submitted to the NEB on May 28, 2015, MNBC states that *"Métis are divided in their stance on the proposed project*." Further, the Evidence reads "*Some citizens who are for the project wish to obtain employment for themselves and their family and community members or are looking at providing contract services. They see that the potential benefits of the project outweigh the environmental risks. However, there are also some citizens who are strongly opposed to the proposed project. They do not believe that the benefits outweigh the risks. They believe that the environmental, economic, social and technical risks are too high."*

A confidential LOU to support the engagement process was executed on September 16, 2013; and through a series of subsequent meetings in-person, over the phone, and via email dialogue, Trans Mountain has had the opportunity to participate in meaningful engagement with the

MNBC. A confidential MBA was executed with MNBC on November 9, 2014, and a letter of Project support was filed with the NEB by the MNBC on November 14, 2014 (Filing ID A4E9K4).

Trans Mountain appreciates its engagement with MNBC to date and is committed to continued engagement to discuss the Project, Project benefits, and the potential Project-related effects on the MNBC.

7.11 Michel First Nation

Starting September 2013, Trans Mountain has been engaging with MFN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

The Written Evidence submitted by MFN claims "*In the absence of meaningful and timely consultation efforts by the Proponent*…"; Trans Mountain disagrees with this statement. A confidential LOU was executed on February 21, 2014, to support the completion of a TLU study for the Project. Trans Mountain has received the completed study and the results have been incorporated into Project planning.

The Written Evidence also states "…*in the absence of the proponent identifying unoccupied Crown lands that remain available to MFN following construction of the project*…". Trans Mountain acknowledges that identifying available Crown lands for use by MFN is an exercise best conducted between MFN and the Crown.

Trans Mountain is committed to continued engagement with MFN to discuss the Project and the potential Project-related effects on MFN.

7.12 Musqueam Indian Band

Starting May 29, 2012, Trans Mountain has been engaging MIB on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In their IR response to NRCan (Filing ID A4R4F0, PDF page 10) on July 14, 2015, MIB stated an interest in reviewing documentation regarding the potential impact to asserted or established Aboriginal rights and inquired about funding to conduct a study. Trans Mountain acknowledges the engagement efforts to date including the offer to enter into an understanding with MIB regarding the Project. MIB sent a letter to Ian Anderson, President, KMC, dated August 2, 2013, formally rejecting an offer of a LOU.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; MIB will be invited to participate in collaboration with other Aboriginal groups located in the region. Trans Mountain is committed to continued engagement with MIB to discuss the Project and the potential Project-related effects on MIB.

7.13 Nooaitch Indian Band

Starting May 29, 2012, Trans Mountain has been engaging NIB on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated

impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In their IR response to NRCan (Filing ID A4R4K1, PDF pages 6 and 7) on July 14, 2015, NIB stated an interest in understanding the economic benefits available to NIB through pipeline construction and operation of the Project. Trans Mountain acknowledges the engagement related to benefits to date, including the information shared through past IR responses. Trans Mountain welcomes the opportunity to meet with NIB at their convenience to learn about the interests, abilities, and capacity of the Band and its membership to participate in the business and employment opportunities that will be available as a result of the Project.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; NIB will be invited to participate in collaboration with other Aboriginal groups located in the region. Trans Mountain is committed to continued engagement with MIB to discuss the Project and the potential Project-related effects on MIB.

7.14 Pacheedaht First Nation

Starting May 29, 2012, Trans Mountain has been engaging with PTFN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In their Written Evidence (Filing ID A4L5K2, PDF page 8), PTFN states that it is concerned with the engagement record with Trans Mountain. Trans Mountain acknowledges past errors and the amendments that have been made to the engagement logs filed with the NEB, at the request of PTFN. Trans Mountain apologizes for these errors.

In response to the letter received by PTFN on May 20, 2015, Trans Mountain acknowledges the errors included in the response table as a result of the November 27, 2014, NEB hearing in Victoria, and held a confidential face-to-face meeting with PTFN on July 16, 2015, to address issues and concerns. A detailed response to all issues raised on the May 20, 2015, letter was provided to PTFN by Trans Mountain on August 11, 2015. Refer to Appendix 7C for a copy of the letter.

Trans Mountain acknowledges the receipt of PTFN's information filed confidentially with the NEB. The confidential information has been previously provided to Trans Mountain, and as such was reviewed and incorporated into supplemental reports and Project planning.

Trans Mountain is committed to continued engagement with PTFN to discuss the Project and the potential Project-related effects on PTFN.

7.15 Stó:lō Collective

Trans Mountain has been engaging with Stó:lō on the Project since April 12, 2012, when an initial Project notification letter was issued to Ts'elxweyeqw Tribe Management Limited (TTML).

Trans Mountain acknowledges that for the purposes of the NEB process, a sub-set of Ts'elxweyeqw Tribe communities are being represented by the Stó:lō Collective (an intervenor in the process) and as outlined in the Written Evidence filed by the Stó:lō Collective, Trans Mountain and Stó:lō have had multiple engagements throughout the hearing process.

In its Written Evidence (Filing ID A4L7A2, PDF page 5), Stó:lō states "*Communities represented by the Stó:lō Collective have been proactively trying to engage with Trans Mountain to ensure Stó:lō interests are heard and potential issues and concerns can be avoided or mitigated*." Trans Mountain disagrees with this statement. More accurately stated, Trans Mountain has proactively engaged with the communities represented by the Stó:lō Collective, with the Stó:lō Collective, and with TTML to ensure Stó:lō interests are heard and potential issues and concerns can be avoided or mitigated. The evidence of the engagement activities, completion of land use studies, and the provision of funding to support engagement is outlined in the engagement logs and Project Consultation Updates filed by Trans Mountain with the NEB throughout the hearing process.

Trans Mountain disagrees with the following statement, included in the Written Evidence submitted by Stó:lō: (Filing ID A4L7C1, PDF page 5):

> "Trans Mountain's reluctance to formalize commitments to the Stó:lō Collective outside of a Mutual Benefit Agreement, to directly involve Stó:lō technical and cultural experts in project mitigation and Environmental Protection Planning (EPP development), emergency response planning, or environmental survey work in order to mitigate concerns pertaining to traditional fisheries, spiritual and cultural sites, wetlands, old growth forests, communication protocols, capacity development, economic development or emergency response procedures."

Trans Mountain has continued to share information with Stó:lō, in response to the information received through the Integrated Cultural Assessment (ICA) Report (including the 89 recommendations); where Stó:lō has requested accommodation for mitigation in addition to the mitigation measures currently in place for the Project, Trans Mountain has offered the opportunity to execute a MBA. A detailed response was provided to Stó:lō by Trans Mountain on March 31, 2015. Refer to Appendix 7D and Appendix 7E for a copy of the letter.

Trans Mountain acknowledges that Stó:lō has been invited to participate in workshops to review and discuss the Project and Project mitigation measures. To participate in half day workshops, Stó:lō requested $25,000-$35,000 per workshop (Filing ID A4L7A2, PDF page 15). Trans Mountain responded to the funding request and offered $1,750.00 to support each workshop: "*Regarding funding for the workshop series, Trans Mountain is prepared to provide funds for the workshop venues, meals, refreshments, and a coordination fee to assist in covering the costs associated with the organization of the workshops. To facilitate Stó:lō participation, it is anticipated that the workshops will occur at Stó:lō facilities. A maximum amount of $1,750.00 per one day workshop is available*."

Trans Mountain acknowledges that to date significant funding has been provided to Stó:lō, by Trans Mountain to support Project engagement. Additionally, Trans Mountain acknowledges that participation funding has been provided by the NEB to Stó:lō to participate in the process.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; Stó:lō will be invited to participate in collaboration with other Aboriginal groups located in the region. Project mitigation measures will be reviewed including those that will be utilized to minimize Project-related effects as identified in the ICA report.

Trans Mountain is committed to continued engagement with Stó:lō to discuss the Project and the potential Project-related effects on Stó:lō.

7.16 Snuneymuxw First Nation

Starting May 29, 2012, Trans Mountain has been engaging Snuneymuxw on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In its response to NRCan (Filing ID A4R4F7, PDF page 5) on July 14, 2015, Snuneymuxw stated that Trans Mountain has not consulted with Snuneymuxw regarding Commitment 941. Trans Mountain is committed to continued engagement with Snuneymuxw to discuss the Project and the potential Project-related effects on Snuneymuxw, including engagement with coastal communities on a community benefits program focused on marine spill response as indicated in Commitment 941.

7.17 Squamish Nation

Starting May 29, 2012, Trans Mountain has been engaging SN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In their IR response to NRCan (Filing ID A4R4D7, PDF pages 9, 10, and 15) on July 14, 2015, SN indicated the lack of capacity to engage in the Project. Trans Mountain acknowledges the draft LOU that was sent to the community for review on May 1, 2013; a letter from SN dated June 2, 2013, was received by Trans Mountain advising they did not want to enter into a formal LOU with Trans Mountain.

Trans Mountain acknowledges the receipt of SN's information filed confidentially with the NEB. The confidential information has been reviewed and incorporated into Project planning. A summary of the study was filed confidentially with the NEB on August 20, 2015.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; SN will be invited to participate in collaboration with other Aboriginal groups. Trans Mountain is committed to continued engagement with SN to discuss the Project and the potential Project-related effects on SN.

7.18 Stk'emlupsemc Te Secwépemc

Starting May 29, 2012, Trans Mountain has been engaging SSN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In their IR response to NRCan (Filing ID A4R4G7, PDF page 6) on July 14, 2015, SSN outlined a number of concerns related to its determination of engagement activities to date. Trans Mountain disagrees with SSN's statement that there has been no engagement on proposed pipeline routing. Trans Mountain acknowledges the engagement efforts with SSN as outlined in the engagement logs and project consultation updates filed with the NEB to date, including routing-focused engagement meetings that took place on April 2, 2014; August 21, 2014; and September 26, 2014.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM, SSN will be invited to participate in collaboration with other Aboriginal groups. Trans Mountain is committed to continued engagement with SSN to discuss the Project and the potential Project-related effects on SSN.

7.19 Stz'uminus First Nation

Starting May 29, 2012, Trans Mountain has been engaging Stz'uminus on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

Trans Mountain acknowledges the receipt of Stz'uminus' information filed confidentially with the NEB. The confidential information has been previously provided to Trans Mountain, and as such was reviewed and incorporated into supplemental reports and Project planning.

In their IR response to NRCan (Filing ID A4R4I1, PDF pages 3 and 8) on July 14, 2015, Stz'uminus outlined a number of concerns related to mitigation measures and marine spill response activities. Trans Mountain believes that our current commitments related to marine response and safety address their concerns; however, Trans Mountain will be hosting regional workshops to discuss the EPP, and Stz'uminus will be invited to participate in collaboration with other Aboriginal groups. Trans Mountain is committed to continued engagement with Stz'uminus to discuss the Project and the potential Project-related effects on Stz'uminus.

7.20 Tsartlip First Nation

Starting May 29, 2012, Trans Mountain has been engaging Tsartlip on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In their IR response to NRCan (Filing ID A4R4H4, PDF page 3) on July 14, 2015, Tsartlip stated Trans Mountain has "*not followed up with Tsartlip regarding Tsartlip's need for jobs, economic development and capacity building*." Trans Mountain disagrees with this statement and, as outlined in Consultation Update No. 4, Trans Mountain has made multiple attempts to share information regarding procurement, employment, and training. Additionally, Trans Mountain has requested that Tsartlip share information regarding the abilities of the Nation and its membership to participate in the business and employment-related opportunities that will arise as a result of the Project. Tsartlip has not provided response.

Trans Mountain is committed to continued engagement with Tsartlip to discuss the Project and the potential Project-related effects on Tsartlip

7.21 Tsawout First Nation

Starting May 29, 2012, Trans Mountain has been engaging with TWFN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP; TWFN will be invited to participate in collaboration with other Aboriginal groups. Trans Mountain acknowledges that TWFN has requested that engagement with Trans Mountain remain confidential, and is committed to continued engagement with TWFN to discuss the Project and the potential Project-related effects on TWFN.

In their Written Evidence (Filing ID A4Q1F9, PDF page 146), TWFN recommended that a forum be created to develop mitigation measures that would address potential effects on TWFN's traditional marine resource use (TMRU). Mitigation categories recommended for consideration during the forum include identification of:

- Alternative for routing and timing of shipping;
- Effects, mitigations, and monitoring places for heritage sites and Tsawout's commercial fishery;
- Effects to food security;
- Socio-economic effects;
- Effects on culture;
- Offsetting projects for the habitat of important traditional subsistence species;
- Effects on hunting, fishing, and gathering activities;
- Promotion of TWFN's subsistence economies and culture;
- Regional cumulative effects assessment;
- Socio-economic post-construction monitoring;
- Employment opportunities and follow-up monitoring;
- Effects of a potential oil spill; and,
- Oil spill and emergency plans.

Trans Mountain will be hosting regional workshops to discuss the EPP, and TWFN will be invited to participate in collaboration with other Aboriginal groups. Trans Mountain is not able to commit to a community-specific forum with TWFN at this time.

Trans Mountain acknowledges that TWFN's request to discuss alternatives for routing and timing of shipping is best addressed with Transport Canada.

Trans Mountain is committed to continued engagement with TWFN to discuss the Project and the potential Project-related effects on TWFN.

7.22 Tsawwassen First Nation

Starting May 29, 2012, Trans Mountain has been engaging TFN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated

impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

Trans Mountain is aware of the TFN Final Agreement, and the resulting rights and obligations. Trans Mountain's understanding of the TFN Final Agreement is based on both reviewing the agreement and on discussions with TFN. Trans Mountain confirms that, in engaging with TFN regarding the Trans Mountain Expansion Project, it took the TFN Final Agreement into consideration.

As included in their Written Evidence (Filing ID A4L7T2, PDF page 2; and Filing ID A4L7T4), TFN states that Trans Mountain has mischaracterized its engagement with TFN through the Aboriginal Engagement Logs, as filed with the NEB to date. Trans Mountain acknowledges the errors and omissions and accepts the updated information filed by TFN. Trans Mountain is committed to continued engagement with TWN to discuss the Project and the potential Project-related effects on TFN, at the request of TFN. Trans Mountain acknowledges correspondence with TWN on October 29, 2014 (Filing ID A4L7T4), whereby TFN stated "*we are not interested in meeting at this point to discuss mitigation measures or potential initiatives that are more appropriately discussed as compensation for infringement on TFN's Treaty Rights*." Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM, TFN will be invited to participate in collaboration with other Aboriginal groups.

7.23 Tsleil-Waututh Nation

Starting in September 2011, Trans Mountain has been engaging TWN on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

In its Written Evidence, TWN included information regarding the NEB process for the Project, including the following statement as excerpted from a letter from NRCan to TWN on August 12, 2013: "*The Crown will utilize the NEB process to identify, consider and address the potential adverse impacts of the proposed Project on established or potential Aboriginal and treaty rights*." In participating in the NEB process, Trans Mountain acknowledges the engagement activities with TWN to date, as outlined in the engagement logs and Consultation Updates filed with the NEB.

In its Evidence, TWN states that "*TWN sent letters to Canada, the NEB, and Trans Mountain inviting them to participate in, and providing them with regular updates on, our assessment of the Project*" (Filing ID A4L5Z8, PDF page 12). As included in its Evidence, TWN and Trans Mountain have exchanged multiple letters regarding the TWN Stewardship Policy and the Project assessment. After multiple attempts at engagement were made by Trans Mountain, the initial invitation to participate was received by Trans Mountain on April 30, 2014 (Filing ID A4L5Z8, PDF page 35). Trans Mountain has informed TWN on three occasions that its ability to participate in the TWN Stewardship Policy process had passed and that it welcomed the opportunity to engage with TWN via the NEB process. To date, TWN has not accepted the invitation from Trans Mountain to meet, nor has Trans Mountain received a response to its latest invitation, a letter issued to TWN on January 23, 2015. Refer to Appendix 7F for a copy of the letter.

Trans Mountain acknowledges the receipt of TWN's information filed confidentially with the NEB. The confidential information has been reviewed and incorporated into Project planning. A summary of the study was filed confidentially with the NEB on August 20, 2015.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; TWN will be invited to participate in collaboration with other Aboriginal groups. Project mitigation measures will be reviewed including those that will be utilized to minimize Project-related effects as identified in the TWN report. Trans Mountain is committed to continued engagement with TWN to discuss the Project and the potential Project-related effects on TWN.

7.24 Upper Nicola Band

Starting May 29, 2012, Trans Mountain has been engaging with UNB on the Project to provide comprehensive information to them, to seek feedback from them, and to identify anticipated impacts of the Project on the assertion of Aboriginal rights and title governing traditional and cultural use of the environment.

Trans Mountain will be hosting regional workshops along the proposed Project corridor to discuss the EPP and EM; UNB will be invited to participate in collaboration with other Aboriginal groups. In its Evidence (Filing ID A4R414), UNB requested continued consultation with Trans Mountain regarding the Project on multiple matters. Trans Mountain acknowledges that UNB has requested that engagement with Trans Mountain remain confidential and is committed to continued engagement with UNB to discuss the Project and the potential Project-related effects on UNB.

7.25 Summary of New Commitments

- Trans Mountain is committed to meeting with LYFN to review mitigation measures as associated with the work completed in the LUOMS.

8.0 LANDOWNER RELATIONS

Evidence filed by some intervenors has referenced issues that have occurred respecting the existing TMPL system. These intervenors include Masanobu Shoji (Filing ID A4L8S5), Collaborative Group of Landowners Affected by Pipelines members Ian Cooke (Filing ID A4L5J5), Brian Kingman (Filing ID A4L5J3), Ron Omichinski (Filing ID A4L5J8), Philip Graham (Filing ID A4L5J9), Christina Kehler (Filing ID A4L5J7), and Pearl Singleton (Filing ID A4L5J6). The specific issues outlined within these interventions relate to the existing TMPL system and are therefore not within the scope of this proceeding. However, as indicated by these intervenors, in each case, Trans Mountain representatives did attempt to meet with and address the concerns identified. In the case of Mr. Shoji, the dispute between him and the company was resolved through negotiation between Trans Mountain, Mr. Shoji and legal counsel for both parties.

Respecting TMEP, Trans Mountain's approach to addressing landowner issues is documented within Volume 2, Section 5 (Filing ID A3S0R0), and Volume 3C (Filing ID A3S0V2) of the Application. Trans Mountain has been diligent in implementing the program and activities identified in these Application sections, and believes the number of interventions and letters of comment received from directly affected private landowners demonstrate the success of those activities in engaging landowners and addressing their concerns.

9.0 LANDOWNER & OTHER COMPENSATION

Written evidence submitted by five intervenors have addressed compensation related issues including potential impacts upon property values, valuation of lands for the purpose of determining the value of land rights sought by Trans Mountain, and potential impacts to adjacent properties not directly affected by the proposed TMEP.

The City of New Westminster (Filing ID A4Q0L5) and the North Shore No Pipeline Expansion (A4L5V1) evidence address potential impacts from the TMEP upon adjacent properties and impacts upon property values as a result of an oil spill.

In response to Port Moody IR No. 2.4.3d (Filing ID A4H8G7), and City of Kamloops IR No. 2.10a (Filing ID A4H8F3), Trans Mountain submitted a review of literature on these topics, and an analysis of the impacts of the Westridge spill on surrounding property values. Respecting the effects of the Westridge Oil Spill in 2007, Dr. Somerville found that:

> The analysis conducted here suggests no permanent effects on property prices or assessed value as a result of the Westridge spill and subsequent remediation. In the approximately six months following the spill, prices and sales activity in the Westridge neighbourhood fell, both in absolute terms, and relative to other neighbourhoods where prices were flat or increased over this period. The negative effect of the spill on local property values appears to be temporary. By early 2014 prices in the Westridge area had recovered sufficiently so that a comparison of the growth in prices between the first half of 2007, prior to the spill, and early 2014 is statistically the same for Westridge and the other neighbourhoods studied in this report. This finding is consistent with there being no permanent effect from the release and clean-up on residential property values.

In conducting an extensive review of pertinent literature on the impacts of pipeline proximity and oil spills on property value, Dr. Somerville found that:

> The small number of studies and variation in results makes it impossible to reach an unequivocal conclusion on the effects of the presence of and proximity to a pipeline on residential property values. The better-executed research finds that in the absence of a pipeline incident, there is no evidence that the presence of a pipeline, gas or oil, lowers estimated property values. In the studies, transaction prices are uncorrelated with distance to a pipeline if there is no recent incident. This literature does not separately identify, measure, or estimate the effect on properties with a pipeline easement, so the absence of a proximity effect should not be interpreted as revealing anything about the effect of a pipeline easement on the market value of a residential property.
>
> Pipeline ruptures that result in leaks, spills, explosions, and environmental damage unambiguously lower the value of affected properties in the immediate aftermath of the event. The magnitude of the decrease varies by study with the nature, intensity, and awareness these incidents. Following a rupture, properties near the affected pipeline but away from the spill site also see lower property values. Remediable incidents appear to lower property values in the immediate area by approximately 5 percent, and this decrease falls the further a property is from the pipeline and the further along the pipeline one is from the incident site.

> The effect of pipeline ruptures on nearby properties dissipates with time. Whether the reduction in residential transaction prices disappears entirely depends on the nature of the spill and the algebraic form of the relationship between property value and distance to the spill location or pipeline and the time from the incident.

In response to landowner and intervenor concerns regarding pipeline impacts on property values, and as recommended as suggested mitigation by the City of New Westminster, Dr. Somerville conducted a third study, **Trans Mountain Pipeline Effects,** examining in detail the potential impacts of the TMPL upon property values in the Lower Mainland of BC. Refer to Appendix 9A for a copy of that report.

Dr. Somerville found in this research that:

> "… single family residential properties with a pipeline easement sell for slightly lower prices than those without, but proximity to an oil pipeline easement does not affect residential property values. The easement unambiguously lowers the market value of residential properties on which it lies, by an average of 5.1 to 5.6 percent. This percentage loss is generally higher for smaller properties and lower for larger properties. When residential properties near to a pipeline have lower transaction prices, the analysis presented here indicates that this results not from the presence of the pipeline easement but from the pipeline easement's land use context. It is the effect of land uses on which there is a pipeline easement, particularly commercial and industrial land uses, which lower the market values of residential properties adjoining the pipeline easement and not the presence of the easement itself."

It is reasonable to expect that properties with pipeline easements generally sell for less than comparable properties that did not have an easement. When an easement is acquired, the landowner is selling a portion of the land rights for that property, so the value of the remaining rights should be expected to be less than an unencumbered property.

Section 5.4, Volume 2 of the Application (Filing ID A3S0R0) addresses the Land Acquisition Program for the Project, and Section 5.4.1.3 specifically addresses the compensation framework developed for TMEP. Trans Mountain's objective for the Expansion Project land rights acquisition program was to establish a compensation framework grounded on legal principles, applicable legislation, court decisions, arbitration committee findings, and generally accepted valuation practices while treating each of our 1,800 landowners along the entire length of the Project fairly.

Our compensation framework is based on bare land value. We are obligated to and are providing each owner with our position on that value in the notice under Section 87(1) of the *NEB Act*. In developing our compensation framework, we recognized that each landowner has unique circumstances and, as a result, we built into the framework the ability to assess and respond individually to landowner-specific land values and have left disturbance damages, including business losses related to construction and operation of the expansion project to be determined as between Trans Mountain and landowners on an occurrence basis. Disturbance damages will be unique to each affected property and be compensated, to the extent they cannot be addressed by mitigation measures, in accordance with the requirements of the *NEB Act.*

In written evidence, Collaborative Group of Landowners Affected by Pipelines (CGLAP) members Ms. Pearl Singleton and Mr. Peter Reus (Filing ID A4L5J4), and Metro Vancouver (Filing ID A4L7Y3) have commented on the methodology for establishing market value for the purposes of determining the value of land rights acquired for the Project and on the payment of that compensation through annual payments.

Mr. Reus has commented that land appraisals should be the basis for establishing market value for the purposes of determining compensation. Metro Vancouver has commented upon the value of the land rights associated with Surrey Bend Park. These topics are addressed specifically in Section 5.4.1.3 of Volume 2 of the Application (Filing ID A3S0R0). Respecting the valuation process undertaken by the Project, market sales are being used as the basis for establishing market values for all classes of property except residential properties. For residential properties, accredited appraisers (with Accredited Appraiser Canadian InstituteI designation as granted by the Appraisal Institute of Canada) have undertaken research to determine the relationship between BC Assessment valuations and market sales, and have found that BC Assessment valuations have been reflective of market sales for bare land. On the basis of that research, for the sake of efficiency and fairness, BC Assessment valuations have been used as the basis for residential properties but employed values have included an uplift to address any undervaluation that may exist. To further support the determination of market values for non-residential properties, Trans Mountain appraisers have continued to gather market sales data throughout the regions the TMEP passes through and have made adjustments where market values have been found to have increased. For properties such as park lands, appraisers take into consideration zoning and development restrictions as well as market values for lands adjacent to but without such zoning. In accordance with Section 75 of the *NEB Act*, Trans Mountain's first obligation is to minimize the damages from the Project; second, mitigate those damages to the extent practicable; and third, provide full compensation for any remaining damages that are caused by the exercise of the powers granted by the Act.

Respecting the payment of compensation annually, Trans Mountain is compliant with *NEB Act* Section 86(2)a and is offering landowners the option of receiving payment, at the option of the owner of the lands, by one lump sum payment or by annual payments based upon the value of the lump sum payment. Trans Mountain is neither required to nor is considering payment of annual rentals for land rights as referenced by Ms. Singleton.

10.0 PIPELINE SYSTEM & ENGINEERING DESIGN

10.1 General

This section of Trans Mountain's Reply Evidence addresses concerns related to the pipeline system and engineering design raised by City of Coquitlam, Metro Vancouver, Environment Canada, and City of New Westminster in their respective intervenor evidence.

10.2 Pipe Cover

10.2.1 Municipal Roads

Trans Mountain refers to the City of Coquitlam's request for a minimum of 2 m cover within municipal roads and road rights-of-way (Filing ID A4Q0I9, Section 5b). As per the detailed discussions, which are ongoing through the TWG process, Trans Mountain is still analyzing the as-built information of City of Coquitlam roads and determining the impacts of this request.

There is significant construction implications and impacts of installing the pipeline with 2 m of cover (*i.e.,* wider trench, longer construction duration, increased trench water management, more construction-related traffic) resulting in a potential increase in impacts to local businesses and to TMEP cost. Trans Mountain is not prepared to commit to this requirement at this stage as it conflicts with the TMEP commitment to Risk Based Design, and existing commitments to construct the pipeline efficiently and minimize impacts. However, Trans Mountain reaffirms its commitment of a minimum cover of 1.5 m within roads in addition to crossing beneath existing infrastructure, which may result in 2 m of cover at specific location on City of Coquitlam's roads. Trans Mountain will continue to collaboratively work with the City through the TWG process to micro-route the pipeline and depth of cover within roads.

10.2.2 Watercourses

Trans Mountain understands the risk of scour in waterways and the potential effects on pipeline integrity as raised by Metro Vancouver in their evidence (Filing ID A4L7Y3, Section 4.14). As part of the detailed design process, watercourse crossings will be designed for scour and bank stability to meet the conditions of a 1 in 200 year flood event. The mitigation will be selected on a case-by-case basis but will include either burying the pipe sufficiently deep or to provide other protection such as bank stabilization. Trans Mountain has already committed to increasing the pipe wall thickness. This is outlined in Volume 4A, Sections 2.9.4 and 3.1.12 of the Application (Filing ID A3S0Y8).

10.3 Block Valves

Trans Mountain is committed to installing remote mainline block valves (MLBVs) at both sides of major watercourse crossings as per the requirements of Canadian Standards Association (CSA) Standard Z662-15. There are currently 21 block valves planned for the Lower Mainland. There are many circumstances where, due to the position of a watercourse within a pipe segment and its associated elevation profile, that potential outflow volume is relatively insensitive to the addition of block valves. Therefore, Trans Mountain does not agree with Metro Vancouver's request to "*place automatic shut-off valves on either side of fish-bearing waterways*" (Filing ID A4L7Y3, Sections 4.6 and 4.14). In addition, Trans Mountain is proposing to use remote MLBVs with check valves on the downstream side of major watercourse crossings, not automatic shut-off valves, as per Volume 4a, Section 3.2.15 of the Application (Filing ID A3S0Y8). Refer to the response to IR motion (Trans Mountain Response to BC Motion to Compel Full and Adequate

Answers to BC IR No. 1.4c; Filing ID A3Z2A6, page 6 of 76), which explains why valve operation should not be automatic.

The iterative process of investigating the potential benefit associated with moving valves closer and/or adding valves is part of the ongoing risk-based design process. Valve locations will be finalized in detailed design and their locations shall be submitted to the NEB and communicated to relevant stakeholders through TWGs. Proposed valve locations have been discussed with municipalities that have engaged with Trans Mountain and have initiated joint TWGs. For example, Trans Mountain is currently reviewing suggestions from City of Abbotsford on a valve location within their city.

The refinement of valve placement and design is only one means by which risk can be managed. Through the risk-based design process that Trans Mountain is implementing, potential risks along Line 2 and the new delivery lines are being identified and prioritized. Working in order of risk priority, mitigation measures that are appropriate to the factor that is responsible for driving risk at each specific location are developed and incorporated into final design. These mitigation measures, once incorporated into the final design, will reduce failure likelihood and/or consequence (and hence risk) by targeting risk mitigation strategies directed at the principal drivers of risk that have been identified in the risk assessment.

The preliminary results of the risk analysis that has been performed on Line 2 and the new delivery lines were provided in tabular format, showing risk at 1 km spacing in Filing IDs A3Z8G5, pages 11-37, A4F5G8 and A4F5F9. These results are characterized as “preliminary” because they represent the results of a risk analysis of a baseline design (*i.e.,* prior to the implementation of all the risk mitigation measures that will ultimately be incorporated into the final design). These risk results serve as a ‘starting point’ for the risk-based design process, which as discussed in Section 5 of the Line 2 risk report (Filing ID A3Z8G1) is an iterative process of risk assessment, identify and prioritize risk, develop mitigation plans, and re-evaluate risk.

The iterative risk-based design approach described above is currently underway and will continue to progress through to completion of detailed design. Until this process is completed, a full list of detailed and specific risk mitigation measures that will be incorporated into the final design, and the risk that is associated with that final design, will not be available. In addition to the mitigation of environmental consequences through the refinement of valve placement and design, some examples of typical risk mitigation strategies include the mitigation of third-party damage through increased depth of cover, increased wall thickness or pipeline markers, and the mitigation of geotechnical threats through threat avoidance.

10.4 Trenchless Segments

Metro Vancouver (Filing ID A4L7Y3, Section 4.5 and 4.14) and City of New Westminster (Filing ID A4Q0L5, Section 3.2) discuss the necessity of the use of horizontal directional drilling (HDD) to avoid sensitive ecosystems and to remain 30 m from fish bearing watercourses.

Trans Mountain is currently investigating alignment options for a number of sensitive ecosystems to minimize impact. Where a trenchless method (such as HDD) is proposed, following preliminary geotechnical investigations, its use will be dependent on geotechnical conditions encountered in the field and sufficient temporary work space required for HDD rig, associated equipment, and pipe strings. Where identified, alternatives will be developed to

provide contingency in the event that the HDD method is not feasible or fails during installation. However, where a trench is required within a riparian zone, Trans Mountain commits to returning any watercourses to their pre-construction configuration and alignment, revegetation within riparian zones compatible with safe pipeline operation, and reclamation of fish habitat. This is outlined in Volume 6B, Appendix C: Reclamation Management Plan, Section 7.3.5 (Filing ID A3S2S3).

The Salmon River crossing is being investigated for installation by HDD to mitigate against effects of potential liquefaction of the river banks and the technical feasibility is dependent on results of further geotechnical boreholes in summer of 2015.

HDD is not a panacea as an installation method for crossing of all watercourses but it can be selectively applied for certain crossings as outlined in Volume 4a, Section 2.11 of Trans Mountain's Application to the NEB (Filing ID A3S0Y8). The minimum installation length for an HDD of a watercourse is about 450 m limited by pipe curvature and to get enough depth underneath the watercourse. HDD installation of most small watercourse can have larger construction footprint/impact and cost significantly more than conventional isolate and open-cut installation methods as they require significantly more construction resources. HDD installation consumes significant volumes of water, has risk of inadvertent drilling fluid loss on the banks and in-stream, and generates waste such as disposal of cuttings and excess drilling fluid displaced by the pipeline. The drilled hole for a NPS 36 pipeline is a minimum of 1.22 m (48 inches).

10.5 Pipeline Buoyancy

Environment Canada (Filing ID A4L8Y6, Section 7.2.2, Recommendations 7-1 and 7-2] recommends that Trans Mountain considers the intensification of heavy precipitation and extreme flooding events on pipeline buoyancy.

An extreme flood event (either during construction or pipeline maintenance), when the pipeline is empty, could theoretically result in a loss of cover over the pipeline along floodplains and at watercourse crossings along the proposed pipeline corridor. Buoyancy control measures are being implemented where such an event has the potential to occur. The specific buoyancy control method to be employed is dependent on soil properties and worst-case water table levels, and will be developed further through detailed engineering. In operation, since the proposed pipeline will be carrying oil and will be buried at sufficient depth, the pipeline will not float to the surface even in areas with prolonged flooding.

Trans Mountain is designing the pipeline for periodic occurrences of heavy precipitation and consequent flooding. Increasing the frequency and intensity of such events does not affect the design of a pipeline, which is designed to withstand numerous occurrences of heavy precipitation and flooding.

10.6 Cathodic Protection

Metro Vancouver's concern (Filing ID A4L7Y3, Section 10.4) about impact to their water mains due to impressed currents from cathodic protection are not unfounded. Close underground metallic structures, like two pipelines, can experience "electrical interference" if one or all of these metallic structures are protected with impressed current cathodic protection system(s). Once such interference is identified it can almost always be mitigated. Trans Mountain has significant experience and learnings over the last 60 years with this issue from the

encroachment of municipal infrastructure and other oil and gas pipelines in the corridor from Edmonton to Burnaby.

The effects of this interference can be mitigated in a number of ways, including:

- bonding between the structures by attaching a test lead to both structures; or
- choosing optimal locations for the impressed current cathodic protection systems of the proposed TMEP pipeline. If the TMEP proposed pipeline cannot be moved away from the Metro Vancouver cathodic system then an option may be to relocate the Metro Vancouver impressed cathodic system so it does not interfere with the proposed TMEP pipeline. In this instance, Trans Mountain would compensate for the cost of the relocation.

Successful resolution to this issue is identification of the interference problem. There are a number of ways interference is identified:

- During the planning stages, such that Trans Mountain can change the plan to mitigate the risk. Trans Mountain has added this issue to the Stakeholder Action List and this issue shall be worked through with Metro Vancouver engineers during TWG meetings.
- During an annual cathodic protection survey. Test leads attached to both (or all) metallic structures allows identification of an interference situation during our annual cathodic protection survey. The attaching of test leads between Metro Vancouver infrastructure and the TMEP shall be discussed in TWGs and progressed towards a mutually agreeable solution.

Trans Mountain has retained a Cathodic Protection Technical expert to oversee the Canadian Pacific (CP) design and implementation, and to mitigate potential interface with municipal infrastructure.

10.7 Contaminated Soil and Corrosion

City of New Westminster (Filing ID A4Q0L5, Section 4.3.3) requests that Trans Mountain conduct contaminated site investigations prior to construction to ensure that the pipeline is not installed in contaminated soil, which could lead to advanced corrosion. Section 35.2 of this report responds directly to the need for contaminated soil site investigations. The EPP from Trans Mountain's original Application to the NEB also details the contingency plan when contaminated soils are encountered during construction (Filing ID A3S2S3, Appendix B).

Trans Mountain recognizes that contamination may be present associated with existing and past land uses and activities, the locations of which may not be readily apparent. However, Trans Mountain is not aware of any past examples, incidents, or studies that document a pipeline leak or rupture resulting from specific contaminants within the soil. In Alberta, 12.7% of pipeline failures between 1990 and 2012 resulted from external corrosion, primarily due to external pipeline coatings failing from either age or excessive production temperatures (AER 2013). Although soil conditions can be a factor in causing external corrosion, advances in external coating systems, such as fusion bond epoxy and other higher performance coating that will be used for the TMEP, in combination with technological improvements in the delivery and

surveillance of cathodic protection have contributed to enhanced pipeline reliability and protection.

The selection of coatings that are compatible with a cathodic protection system is critical in preventing external corrosion. External corrosion is rarely found on a pipeline coated with fusion bond epoxy, in combination with effective cathodic protection. With proper application of the external coating, degradation or disbondment of the coating is unlikely. However, if this was to occur and groundwater was to contact the pipe, the surface of the pipe would still be protected from corrosion by the cathodic protection (Norsworthy 2009).

As discussed in the Risk Report (Filing ID A3Z8G1), an analysis was performed to investigate the sensitivity of the design for Line 2 and the New Delivery Lines to the development and growth of corrosion. This analysis demonstrated the relative lack of sensitivity of external corrosion failure frequency over time, relative to the planned 5-year in-line inspection (ILI) reassessment interval (*i.e.,* the first measureable onset of a non-zero failure probability occurs after the pipeline will have received two ILIs). It was found that given this lack of time-sensitivity to failure, relative to the planned ILI interval, it is reasonable to expect that any external corrosion features that may initiate will be detected before they can reach a critical size so that plans for any maintenance that is required can be developed and implemented as a pre-emptive measure.

Further, Trans Mountain is planning to use thicker pipe in areas with higher risk of third-party damage and for watercourse crossings (as per Table 5.1.8 of Volume 4A; Filing ID A3S0Z5). With an industry-leading, world class design approach, Trans Mountain is confident the risk mitigation strategies in place will negate any perceived or actual risks from existing contaminants on pipeline integrity.

10.8 Summary of New Commitments

Where HDD is selected as a pipeline installation method, Trans Mountain commits to having the entry and exit points more than 30 m away from the watercourse as requested by Metro Vancouver.

10.9 References

Alberta Energy Regulator (AER). 2013. Report 2013-B: Pipeline Performance in Alberta, 1990–2012. August 2013. Calgary, Alberta. 104 pp.

Norsworthy R. 2009. Coatings Used in Conjunction with Cathodic Protection – Shielding vs Non shielding Pipeline Coatings. Prepared for NACE International, Paper No. 4017. Ennis, Texas. 11 pp.

11.0 PIPELINE GEOTECHNICAL ASSESSMENT

11.1 Natural Hazards (Geohazards)

The Written Evidence of the Stó:lō Collective (Filing ID A4L7A2) states that they "are concerned with natural hazards, such as flooding, debris flows, mudslides, rock slides" and that "[t]hese are all regular occurrences within the Fraser Valley and there is extensive local knowledge of these events within Stó:lō communities." Trans Mountain agrees with the Stó:lō Collective that such natural hazards have historically occurred along the pipeline corridor and, as natural processes, will continue to occur in the future. Where such natural hazards are identified, Trans Mountain's approach has been to avoid where practicable, and mitigate where avoidance cannot be accomplished and elevated risk associated with the natural hazard remains. Volume 4A of the Application, Sections 2.9.2 to 2.9.4 (Filing ID A3S0Y8) address natural hazards and their method for incorporation into the routing and design process.

Volume 4A, Section 2.9.3 discusses terrain stability and the process management of natural hazards as follows:

> "Route selection for the new segments of the proposed Line 2 pipeline was conducted so as to avoid or minimize exposure to known locations of slope instability, potential for rock falls, debris flows, seismicity, sedimentation and erosion. These terrain stability considerations along with their standard mitigation measures are summarized in Table 5.1.4 in Appendix D. The entire pipeline route has been evaluated for terrain stability by qualified engineering consultants and the results have been reported in the Terrain Mapping and Geohazard Inventory Report included in Appendix H. This evaluation has included the potential for terrain hazards (geohazards) to initiate outside of the proposed corridor and have an effect on the pipeline as well as the potential for construction and long-term operation of the pipeline to have an effect on the stability of the surrounding terrain. The KMC Natural Hazards Management Program database for the existing TMPL system was also used as a source to identify specific risk areas.
>
> During grading of the new right-of-way, the potential for localized instability and rock fall concerns will be identified. In these instances, qualified geotechnical engineers will review the locations of concern and, where warranted, prepare site-specific mitigative designs.
>
> Through regular patrol of the pipeline right-of-way during operations, slopes will be monitored for potential rock fall, slope instability and slope erosion, and where required, timely mitigation will be implemented."

In relation to seismically induced hazards, Volume 4A, Section 2.9.3 provides:

> "The TMEP Line 2 pipeline and facilities, including tanks, will be designed for seismic loading corresponding to a two per cent probability of exceedance in 50 years (equivalent to a return period of 2,475 years), which is consistent with the current requirements of the National Building Code of Canada.
>
> As part of preliminary studies, a screening level assessment of two of the most dominant seismic hazards, liquefaction potential and seismically induced

> landslides, has been completed along the entire pipeline corridor and is included in the Seismic Assessment Desktop Study Report in Appendix J. Those areas along the route identified as having elevated liquefaction or landslide potential will then have site-specific studies and investigations undertaken during the detailed engineering and design phase to ensure the adequacy of the pipeline design.
>
> Although no active faults (where rupture has occurred in the last 11,000 years) have been identified in BC, studies will be conducted as part of the detailed engineering and design phase in an attempt to further confirm the presence or absence of active faults crossing or running close to the route. In the event that a potentially active fault is discovered, the pipeline design will be site specifically modified to accommodate the direction and possible magnitude of movement across the fault.
>
> At major watercourse crossings, and other areas where lateral spreading as a result of liquefaction has the potential to occur, the pipeline will be designed to resist the potential ground movement (both transient and permanent) associated with the design level event."

Specifically discussing hydrotechnical hazards of watercourse scour and bank stability, Volume 4A, Section 2.9.4 provides:

> "Watercourses crossed by the pipeline have been evaluated, catchment areas calculated and peak flows determined or calculated by a qualified hydrological engineer and the results are included in the Route Physiography and Hydrology Report in Appendix I. During the detailed engineering and design phase, the notable watercourse crossings will be designed for scour and bank stability to meet the conditions of a 1 in 200 year flood event and, as such, the proposed Line 2 pipeline will be sufficiently buried, or otherwise protected, to ensure its longterm integrity."

In order to address and adequately design for the natural hazards along the proposed route, Trans Mountain, with their geotechnical consultants, have also undertaken studies including the preparation of a Quantitative Geohazard Frequency Assessment (Filing ID A3Z8G2). This assessment includes the identification and assessment of 14 categories of geohazards along the complete proposed pipeline route, including flooding, debris flows, earth landslides, and rockslides, and was based on a review of historic data, satellite and airphoto imagery, Light Detection and Ranging (LiDAR), and terrain mapping.

Following from the Quantitative Geohazard Frequency Assessment, teams of geohazard specialists have further reviewed the sites identified and completed field reconnaissance and assessments of those sites with potential activity in the spring and summer of 2015. Additional studies as part of the design process are also underway related to 1) debris flows and debris slides; 2) earth landslides and rockslides; 3) faults; and 4) seismically induced liquefaction and lateral spreading. These studies provide input into the design process to ensure appropriate mitigations are implemented where avoidance cannot be accomplished and elevated risk associated with the natural hazard remains. Likewise, watercourse crossings are being designed to accommodate the greater of the required provincial standard of a 1 in 200 year flood event or the risk criteria as part of risk-based design, including the adoption of strategies

such as the use of trenchless installation methods such as HDD to mitigate the risk associated with flooding, river scour, and river banks with susceptible liquefiable soils.

Natural hazards, such as flooding, debris flows, mudslides, and rock slides, as raised by the Stó:lō Collective, are being identified and mitigated through the Quantitative Geohazard Frequency Assessment, through ongoing detailed investigations at individual sites identified as part of the assessment, and from subsequent field reconnaissance and assessments.

11.2 Climate Effects on Geohazards and Mountain Pine Beetle

In the Witness Statement of Bernadette Wanda Manuel (Filing ID A4Q1T0), Ms. Manuel states that she is “aware that Mountain Pine Beetle (MPB) infestation increases the possibility of landslides and mudflows in our territory due to decreased slope stability and surface water patterns” and that she is “concerned about how this would impact our lands, as well as our watershed, if the pipeline were to be constructed.”

Trans Mountain agrees that MPB infestations and the associated tree mortality may change the hydrological regime and the frequency and magnitude of shallow earth landslides, debris slides, debris flows, and debris floods. However, the construction of the pipeline is unlikely to change the distribution and magnitude of ongoing MPB outbreaks and related changes to watershed hydrology and slope stability.

Very little research has documented or evaluated the degree to which MPB infestations change the hydrology of watersheds in BC, and studies in other areas report increased discharges in rivers rather than destructive landslides and debris flows (Helie *et al.* 2005). The expectation that hydrological regimes will change leading to an increase in landslides, flash floods, and debris flows is largely based on previous research that has identified a link between landslides and denuded hillslopes due to logging practices and wildfire. The removal of trees by logging has been shown to alter the hydrology of watersheds and decrease soil cohesion due to the decay of soil anchoring tree roots. In logged areas, these changes may lead to an increased frequency of landslides; however, some of these observed changes to the hydrology of a logged area are due to logging roads that can concentrate flows and skid trails which create linear channels without obstructions that are easily eroded by water. The occurrence of wildfire can temporarily increase the frequency and magnitude of debris flows; however, an increase in the severity and extent of forest fires following MPB outbreaks has not been documented (Hart *et al.* 2015).

Despite the lack of direct evidence linking MPB outbreaks to an increase in wildfires that change the hydrologic regime leading to an increase in landslides and debris flows, Trans Mountain is aware of these potential hazards that may impact the pipeline. As a precaution, the influence of past MPB outbreaks on channel scour are being incorporated into the design of the pipeline, as described in the following section.

11.2.1 Effect of Climate Change on Channel Scour for Debris Flows and Debris Floods

Climate change can affect scour on alluvial fans in different ways, all of which are indirect. The following general statements on the effects on channel scour due to climate change are applicable to many forms of development in debris flow and debris flood prone terrain:

- Runoff extremes can be expected to increase in different seasons due to different climatic forcing mechanisms. Increases in the frequency and magnitude of runoff extremes will increase stream power, which means the peak flows are able to mobilize larger particles.
- A shift from snowmelt-dominated (nival) to partially snowmelt-dominated, partially rainfall-dominated (hybrid) streamflow behaviour can be expected. This will likely accentuate peak flow hydrographs given the faster response of rainfall-generated runoff. This results in increased stream power, thus an intensification of channel bed scour.
- Drier and warmer summers and warmer winters in most regions along the pipeline route will lead to decreased soil water content along the pipeline route. This will result in forests in the BC interior being more susceptible to forest fires in particular. Forest fires reduce soil infiltration capacity and can lead to the formation of water-repellent soils, both of which can increase runoff magnitude and frequency until new vegetation is established. This can lead to more frequent and more severe scouring events.
- Land use changes such as large-scale logging and tree mortality attributable to beetle infestation may herald hydrological changes in the watershed that can increase runoff rates and thus enhance scour on fans.

The general tendency of a warmer climate with shifts in runoff generating mechanisms is an increase in hydro-meteorological extremes, likely leading to more frequent and more severe scouring events. This emerging trend is recognized and, while it cannot yet be satisfactorily quantified at a watershed scale, it can be addressed by introduction of additional conservatism in pipeline designs at stream crossings. Landscape changes can be a consequence of climate change (beetle infestations due to higher temperatures) or independent (logging). Those changes may indirectly lead to an increase in the severity of scour due to an increase in peak flows, and similarly can be addressed as part of additional conservatism in the pipeline design.

The methods for developing scour estimates for debris flows and debris floods on the TMEP use field-based observations and long-term fan profile development. Many of the fans observed along the proposed corridor have existed for more than 100 years, and have experienced periods of not only extreme precipitation events but also forest fires (particularly in the drier portions of the watershed) and past MPB infestations. Increases in historical scour depths at locations where MPB infestation or forest fire has occurred are reflected in the geohazard analysis for debris flows and debris floods, and are incorporated in the design.

11.2.2 Frequency-based Risk Assessment for Landslides

The landslide types most likely influenced by short-term changes in the surface and near-surface hydrological regime are debris slides and debris avalanches, both of which can result in debris flows. It would be expected that in some locations the deforestation associated with MPB infestation could lead to an increase in the frequency of such landslides due to the decay of roots that increases soil cohesion and causes changes to the hydrology of a

watershed. The potential for debris slides and debris avalanches to impact and damage the pipeline is generally much higher where the pipeline crosses the source area or initiation zone of the slide. Outside these source zones, impacts to the buried pipe are generally less likely or less severe. This means that the potential effects of an MPB infestation on the pipeline, as it relates to debris slides and debris avalanches, would be where the pipeline and the MPB infestation are both in the source area.

At the design level, the frequency-based landslide risk assessment approach includes past increases in shallow landslide frequency for existing areas of MPB infestation when assessing the future frequency of landslides. By using the terrain stability mapping and historical frequency analyses as inputs, the effect of past disturbances by MPB infestation on slope stability along the pipeline route are incorporated into the evaluation of the expected future frequency of shallow landslides in susceptible areas. This approach assumes that a steady-state has been reached in which new infestations are balanced by forest regeneration, so that the total area of deforested slopes (and therefore more susceptible to hydrological triggering of landslides) is constant through time. Since this assumption may not be valid at present, and considering the uncertainty in predicting MPB infestation rates, patterns, and particularly specific locations, it is important that future infestations be identified as part of regular maintenance inspections, so that site-specific assessments can be conducted and any risk-reduction measures applied as required. Through the Natural Hazard Management Program, Trans Mountain looks for changes in triggering conditions that could lead to initiation of geohazards such as landsliding, of which MPB would be such a condition.

11.2.3 Snow Avalanche

In some cases deforestation due to MPB infestation can create new snow avalanche terrain. In general, buried pipelines are not vulnerable to snow avalanche impacts; however, above-ground facilities such as remotely operated block valve sites with equipment mounted on top of the buried valves may be. This means that there is the potential for increased risk due to snow avalanche anywhere that a valve site is located within or downslope of an area deforested by MPB infestation. Again, given the uncertainty in predicting MPB infestation rates, patterns, and most of all specific locations, it is important that future infestations be identified as part of regular maintenance inspections, so that site-specific assessments can be conducted, and any risk-reduction measures applied as required.

11.3 Metal Leaching and Acid Rock Drainage

In UNB's filed evidence (Filing ID A4Q1T2), UNB states:

> *"There is a widely held concern related to acid rock drainage and metal leaching from the pipeline itself. Upper Nicola Band needs confirmation of the measures that will be used to monitor, avoid, and detect these damaging processes;"*

The exposure of rock outcrops and/or excavated bedrock during pipeline construction may leach metals from the exposed rock and/or produce acid rock drainage. To address this potential, Trans Mountain has carried out a metal leaching and acid rock drainage (ML/ARD) desktop and field assessment of the proposed pipeline route in 2013 and 2015 to identify/characterize those units with an increased potential to leach metals and/or produce acidic drainage.

Results of the desktop and field assessment, in conjunction with other programs such as rock excavatability field programs, will be used to develop an ML/ARD Mitigation Toolbox. Reference to this document was originally provided in Trans Mountain Response to Upper Nicola Band IR No. 1.03b (Filing ID A3Y3V1). In particular, the ML/ARD Mitigation Toolbox will highlight pipeline segments that have:

- A high to medium potential to host geologic units capable of metal leaching and/or releasing acidic drainage; and,
- Areas that are expected to produce exposed/excavated rock quantities exceeding the backfill capacity of the pipeline trench.

The ML/ARD Mitigation Toolbox will describe additional sampling/monitoring programs to be conducted before pipeline trenching/excavation, which will be used to assess the site-specific geochemical characteristics of these units and develop appropriate management strategies. The document will provide monitoring/sampling programs to be carried out during pipeline construction/excavation that will confirm these strategies are appropriately applied. A monitoring/sampling program may also be necessary for the post-construction period for the purposes of confirming that the management strategies applied during construction continue to be effective in minimizing the long-term potential for acidic and/or metal-rich runoff.

In response to metal leaching from the pipeline itself, the pipeline will be protected from corrosion and metal deterioration by the application of a fusion bond epoxy (FBE) coating system on the outer surface of the pipeline to act as a barrier to the environment. Several studies have confirmed the ability of FBE coatings to enhance corrosion resistance (*e.g.*, Darwin and Scantlebury 2002; Malik *et al.* 2002). In addition, a cathodic protection system will be in place to protect the pipeline from corrosion in areas where coating defects may be present. With the application of a protective coating on the pipeline and a supplementary cathodic protection system, metal leaching from the pipeline surface is not expected to be a concern.

11.4 Geotechnical Considerations with Construction of a Tunnel Through Burnaby Mountain

11.4.1 Potential to Destabilize Burnaby Mountain

In the Written Evidence of Lisa Craig (Filing ID A4L6S1), Ms. Craig provides the following commentary regarding construction of the proposed route and the potential to destabilize Burnaby Mountain:

> *"This is an environmentally sensitive area that is protect by the City of Burnaby. This process will disrupt this area for years to come, possibly permanently, and could potentially destabilize the mountain, threatening the safety of SFU students, faculty and staff and the surrounding residents."*

Proposed tunneling to route the pipeline expansion through Burnaby Mountain will be completed entirely from portals within the Burnaby and Westridge Terminal facilities. There will be no impact to the Burnaby Mountain Conservation Area lands through clearing or any other construction activities. The tunnel will be backfilled to prevent the development of a conduit for groundwater flow.

With respect to the potential to destabilize the mountain, Trans Mountain does not agree that construction of the Burnaby Mountain Tunnel would have a negative impact on the stability of the mountain slopes. Trans Mountain has designed the proposed trenchless pipeline alignment options to be situated in the undisturbed bedrock below the base of the historic landslide feature described in Clague *et al.* (2015; Filing ID A4H2F8):

> "There remains the risk of landslides owing to the steepness of the terrain and the evidence of past events; however, it is unlikely that a large slump that might retrogress back from the top of the mountain could occur, even during a large earthquake. We base this opinion on the fact that the slumps on the north side of Mount Burnaby are many thousands of years old; they probably date to the end of the Pleistocene."

Drawings 1 and 2 submitted in response to the City of Burnaby (Filing ID A4H8D3) clearly identify the plan location of the historic landslide scarp and provide a cross-section through the escarpment illustrating the scarp failure plane of the historic landslide feature in relation to the proposed pipeline alignment.

Trans Mountain would also like to note that the expert evidence submitted by the City of Burnaby (Filing ID A4L8G9) on PDF Page 27 of 28 agrees with this position and states that *"No fatal flaw exists in terms of the tunnel caving and having disruption to surface. This is not possible due to the depth of cover exceeding 100 m."*

11.4.2 Review of Geotechnical Site Investigation Data

Evidence filed by the City of Burnaby (CoB) pertains to a Geotechnical Review of Burnaby Mountain Tunnel Option (Filing ID A4L8G9) undertaken by CoB's consultant Pakalnis & Associates (Pakalnis). The following paragraphs clarify the position of Trans Mountain and provide responses specific to the individual points identified in the CoB evidence relating to the adequacy of geotechnical information collected as part of the site investigation program undertaken in 2014.

On page 3 of their report, Pakalnis presents a bulleted list of comments regarding the site investigations and geological interpretation along the proposed Burnaby Mountain Tunnel.

Pakalnis Page 3, Bullet 1 states "*It must be noted that the recovery of the core from HMM-BH-02 was ~50% and the rock quality ranged from Q~0.2 to Q~7."*

Trans Mountain disagrees with the statement that core recovery was 50% from HMM-BH-02. Average recovery was significantly higher than 50% as reported in BGC Engineering Inc.'s Site Investigation Report (Filing ID A4H2E9). Specifically, in the zone 10 m above and 10 m below the tunnel elevation, only two intervals representing less than 3 m of core had recovery of less than 75%. In addition, the Rock Quality Designation (RQD) of the same zone, which is defined as the length of intact rock core pieces longer than 0.1 m divided by the length of the interval was greater than 50% for all but five intervals. The cumulative length of those five intervals represents less than 4 m of the 186.4 m borehole. A review of televiewer logs (Appendix C, Filing ID A4H2F1) shows that the borehole wall conditions in intervals with core recovery less than 75% are consistent with those in zones of 100% recovery and therefore, the poor core recovery is likely due to drilling action and mechanical damage as opposed to *in situ* ground conditions. An increase in natural fractures from intervals with good recovery to those with poor to fair recovery was not observed. In the digital caliper televiewer log for the conglomerate

sections of good and poor to fair recovery the matrix material is intact (not washed away). Also, for both the conglomerate matrix and the sandstone units the amplitude of reflected ultracoustic waves, which can be used as an analogue for density and strength (ALT 2012), is not significantly different between zones of good recovery and zones of poor to fair recovery. Accordingly, the observations are accurate over the elevation of the tunnel alignment and the values are representative. The calculated Q values in the zone 10 m above and 10 m below the tunnel elevation indeed exhibit large variability from 0.2 to greater than 40; variability in the rock mass properties will be addressed as part of design in the Geotechnical Baseline Report prepared by the tunnel designers documenting expected ground conditions.

Pakalnis Page 3, Bullet 2 states "*The core logs for HMM-BH-02 show the variability in the rock mass particularly as the TBM will incur primarily conglomerates, however, also sandstones/other units which are variable in rock quality (Q/RMR) and have a direct impact on the performance of the tunneling machine in terms of potential squeeze/closure/ground behavior/support requirements/advance."*

Trans Mountain agrees that the rock mass encountered is of variable quality and the tunnel boring machine (TBM) selected for construction will need to be capable of dealing with the range of expected ground conditions. Histograms will be generated by HMM as part of the Geotechnical Baseline Report to characterize expected variability in ground conditions along the tunnel alignment during the detailed design phase of the Project. This is standard practice for the tunneling industry. As indicated by Pakalnis (Appendix I, Page 21), expected conditions in the tunnel face could be investigated by additional boreholes from surface, or using probe holes drilled from the tunnel face during construction.

Pakalnis Page 3, Bullet 3: *The report states "Q values have been derived based on the proposed tunnel invert elevation for discussion purposes only and are not to be used for design." This requires further explanation…*

The Q profiles provided in BGC's report were developed using industry standard practice for geotechnical core logging. For each profile, representing a single borehole, the depth of cover at the tunnel invert was estimated to select a stress reduction factor to be applied to the entire borehole length in order to evaluate variation in rock mass quality. Therefore, the Q values presented cannot be simply applied to an area of the tunnel with a higher or lower depth of cover. Q data, which is displayed on the borehole logs provided in Appendix B of Filing ID A4H2F1, has not had joint water or stress reduction factors applied to it and cannot be extrapolated outwards from the boreholes. The tunnel design team has used the data presented in the referenced Site Investigation Data Report to develop a Geotechnical Baseline Report, which documents the anticipated ground conditions for the tunnel to be used for design and contractor negotiations.

Pakalnis Page 3, Bullet 3: "*… Note what confidence does the geotechnical consultant have in terms of characterizing Q/RMR for the 2km of tunnel from a single drillhole."*

Trans Mountain has completed four boreholes in the vicinity of the proposed Burnaby Mountain Tunnel, all of which are displayed on DWG 02 of Filing ID A4H2E9. HMM-BH-01 was terminated short of the tunnel elevation. Results from boreholes HMM-BH-01, HMM-BH-02, and HMM-BH-03 show consistent ranges of rock mass conditions. The results of these boreholes are also consistent with published literature describing the Huntingdon Formation (Mustard and

Rouse 1994). At this level of study the amount of data available is sufficient to evaluate feasibility of tunneling.

Pakalnis Page 3, Bullet 4: "*The tunnel route should be shown on all drawings i.e. Logs/photos/discussions as this is the location that one is assessing in terms of stability and required characterization at the tunnel horizon."*

Trans Mountain does not believe that this is necessary. The presentation of the tunnel alignment in the format of a longitudinal profile is the typical industry practice. Highlighting of the tunnel elevation in each log and core photo is not standard practice as this can be simply confirmed by the reader with the longitudinal profile. The tunnel elevation is highlighted in each of the Q profile charts (Figures 5 to 8; Filing ID A4H2E9).

Pakalnis Page 3, Bullet 5: "*The revision should have been made evident in the report indicated as "Final" and submitted November 26, 2014…"*

The decision to issue a revision to BGC's Site Investigation Report with the inclusion of fall 2014 data was made after the initial report was submitted to the NEB and in response to questions from both the NEB and from intervenors.

Pakalnis Page 4, Final paragraph: "*… however, in my professional opinion [the revised report] does not enable one to determine the rock mass characteristics (RMR/Q) to be expected along the tunnel as largely only one (1) drill hole is available HMM-BH-02 to characterize 2 km of tunnel routing."*

Trans Mountain is confident that sufficient information has been gathered regarding the bedrock of Burnaby Mountain to effectively assess the feasibility of completing the Burnaby Mountain Tunnel. This includes three boreholes that intersect the tunnel elevation along the proposed route: HMM-BH-02 (0+900m), HMM-BH-03 (0+220m), and at the north end of the tunnel HMM-BH-05 (2+200m); unfortunately HMM-BH-01 (1+500) did not reach the tunnel depth. Nonetheless, the data from all four boreholes has been combined with other published and unpublished information (Mustard and Rouse 1994; Frontier 2014; SFU 2015) to develop a geological model of subsurface conditions along the proposed Burnaby Mountain Tunnel. Based on the gentle dip of the sedimentary units and consistency in observed rock mass conditions between boreholes, it is reasonable to project rock mass properties between boreholes and along the proposed tunnel alignment as shown in DWG 02 (Filing ID A4H2E9).

Pakalnis Page 4, Final paragraph: "… *future drilling is expected with subsequent evaluation."*

Future drilling that is planned for the Burnaby Mountain Tunnel will be completed from the planned portal locations and will not require land access to City of Burnaby property, including the Burnaby Mountain Conservation Area. A second phase of site investigation for the Burnaby Mountain Tunnel has always been part of the project work plan. The results of the second phase of investigation are not required by HMM to evaluate feasibility of tunneling, but to collect detailed information at each of the tunnel portals for development of construction plans. Pakalnis indicates that additional site investigations were not mentioned in BGC's November 26, 2014, Site Investigation Report, but that statement is incorrect. That report was finalized while HMM-BH-01 and HMM-BH-02 were being drilled, and indicated that the geologic interpretation would be updated as additional information became available, including the results of the underway drilling campaign (Page 10, Paragraph 1).

Pakalnis Appendix I, Page 21, Bullet 2: "*It is required to know/interpret RMR/ground conditions along the length of the tunnel…"*

As discussed in response to Pakalnis Page 3 Bullet 2, Trans Mountain agrees that the rock mass rating (RMR) and ground conditions encountered is of variable quality, and the TBM selected for construction will need to be capable of dealing with the range of expected ground conditions. Histograms will be generated by HMM as part of the Geotechnical Baseline Report to characterize expected variability in ground conditions along the tunnel alignment at the detailed design phase of the project. This is standard practice for the tunneling industry. As indicated by Pakalnis (Appendix I, Page 21), expected conditions in the tunnel face could be investigated by additional boreholes from surface, or using probe holes drilled from the tunnel face during construction, or through conservative assumptions as part of the tunnel design.

Pakalnis Appendix I, Page 21, Bullets 3, 6, and 7: "*Low surface cover at north and south of Tunnel Option 2A, the preferred route, along with a weak cover required the potential for steel liners within the tunnel. The Barnet Highway undermining requires a detailed assessment in terms of methodology and geotechnical characterization. The effect of tunneling in proximity of the "scarp" should be identified and mitigated.*

The "scarp" may have the potential effect on the confinement of tunnel as not only have to look at profile along tunnel but to scarp to the NE at the Kask area.

Plan for tunneling in proximity of weak material, low overburden and high risk infrastructure such as Barnet/Inlet Hwy has to be detailed."

Trans Mountain agrees with comments that a detailed construction plan will be required that should include support classes to deal with weak materials and low cover, as are anticipated at the north end of the tunnel. However, this is beyond the scope of the site investigation data report and the level of detail required for an assessment of tunneling feasibility.

Pakalnis Appendix I, Page 21, Bullet 4 and Page 22, Bullet 1: *"Data from HMM-BH-01 and HMM-BH-02 should be incorporated into the study by BGC."*

This was addressed in Revision I of BGC's report, which includes data from all four boreholes that had been drilled at the time of issue.

Pakalnis Appendix I, Page 21, Bullet 5: "*Require a 3D representation of the entire area showing the tunnel, topo, infrastructure along with the geotechnical profile in 3D."*

A two-dimensional (2D) profile drawing showing the tunnel, topography, and geotechnical interpretation, as presented in the BGC report, is the industry standard presentation style for this type of data.

11.5 References

Darwin, A.B., and Scantlebury, J.D. (2002) Retarding of corrosion processes on reinforcement bar in concrete with an FBE coating. *Corrosion and Corrosion Monitoring* 24(i), p73-78.

Hart, S.J., Schoennagel, T., Veblen, T..T., Chapman, T.B., 2015, Area burned in the western United States is unaffected by recent mountain pine beetle outbreaks, Proceedings of the National Academy of Sciences, 112(14):4375-4380.

Helie, J.F., Peters, D.L., Tattrie, K.R., Gibson, J.J., 2005, Review and Synthesis of Potential Hydrologic Impacts of Mountain Pine Beetle and Related Harvesting Activities in British Columbia, Mountain Pine Beetle Initiative Working Paper 2005-23, Natural Resources Canada, Canadian Forest Service, Victoria, British Columbia, Canada.

Malik, A.E., Anjijani, I., Ahmed, S., and Al-Muaili, F. (2002) Corrosion and mechanical behavior of fusion bonded epoxy (FBE) in aqueous media. *Desalination* 150(iii), p247-254.

12.0 PIPELINE ENGINEERING ASSESSMENTS

The written evidence of Lisa Craig (Filing ID A4L6S1) indicates that "*No plans have been outlined to determine the state of the existing pipeline and its ability to withstand higher flow*." This statement is incorrect. TMEP has included the above referenced information in the "Active TMPL NPS 24 and NPS 30 Segments to be incorporated into TMEP Line 1 *Service – Engineering Assessment*" (Filing ID A4A7Q3).

Trans Mountain has provided the relevant information in the engineering assessment including:

- Pipeline Specifications;
- Proposed Hydraulic Profiles and Historical vs Future Operation;
- Operating and Maintenance Records including:
  - Hydrotest Failure Information;
  - Operating Information;
  - In-service Leaks and Ruptures;
  - ILI History;
- KMC Integrity Management Program including:
  - Corrosion Management Approach:
    - § ILI Monitoring;
    - § Excavation and Repair Criteria;
  - Crack Management Approach:
    - § ILI Monitoring;
    - § Crack Severity Levels for Reassessment;
    - § Excavation and Repair Criteria for Crack-like Anomalies;
- Fitness for Service Assessments including:
  - Metal Loss:
    - § External Corrosion Control;
    - § Metal Loss Incidence Charts;
    - § Corrosion Growth Rates;
  - Cracking:
    - § Crack Management Results;
  - Mechanical Damage:
    - § Third-party Damage Prevention; and

- Planned Activities.

The above assessment includes results of the inspections including the safety factors for metal loss and cracking threats following the most recent ILI inspections, and including proposed future inspections and mitigation activities including cathodic protection assessments. The factors of safety are presented in Tables 5.3 and 5.4 in Engineering Assessment (Filing ID A4A7Q3) for maximum operating pressures and proposed operating pressures for Line 1, respectively. These factors of safety exceed the minimum factor of safety for new pipelines of 1.25 as required by CSA Z662.

The increase in throughput is primarily due to the reduction in viscosity of the anticipated line fill for Line 1 and not due to increasing operating pressures. The assessment shows that the new operation will have some change in the normal operating pressures on segments of the line; however, these changes result in slightly higher normal operating pressures and slightly lower normal operating pressures along Line 1 after completion of TMEP. These changes are consistent with moving heavy crudes away from Line 1 service into the proposed Line 2. Most of the pipeline will normally be operating well below its licensed maximum operating pressure.

Trans Mountain believes the above information, along with information on the ongoing Integrity Management plans included in the Application and in subsequent filings, provides the NEB with the information it requires to assess the viability of the operation of the existing pipeline system with proposed increase in flows on completion of the expansion.

13.0 PIPELINE CORRIDOR & ROUTING

13.1 General

This section of Trans Mountain's Reply Evidence addresses concerns related to the pipeline corridor and routing raised by Metro Vancouver, City of New Westminster, FVRD, City of Abbotsford, City of Surrey, City of Edmonton, Coldwater Indian Band, GCC, and Yarrow EcoVillage in their respective Intervenor Evidence.

Trans Mountain is committed to working collaboratively with all infrastructure owners and operators to minimize or eliminate impacts of the proposed pipeline. Trans Mountain has proven this commitment with the roll out of the TWG meetings, which are frequent and ongoing, and have thus far proved very successful. As per Metro Vancouver's request (Filing ID A4L7Y3, Section 8.8), Trans Mountain is committed to continuing these through the design and construction phases of the Project.

13.2 Avoidance of Sensitive Ecosystems

Metro Vancouver's evidence (Filing ID A4L7Y3, Sections 4.7 and 4.14) discusses rerouting to avoid sensitive ecosystems, which have been a major focus of Trans Mountain's design methodology since the Project's inception. Examples of rerouting to avoid sensitive ecosystems include HDD underneath the Hope Redwoods Natural Area and a HDD underneath the City of Surrey park, which is west of S&R Sawmills on the Fraser River. Where Trans Mountain was unable to avoid routing through sensitive ecosystems, construction methods and practices have been explored and developed to minimize the required work space and right-of-way required, and the impacts within the affected zones. There are many examples of this including Surrey Bend Regional Park, in which a custom construction methodology will be implemented to only intrude 6 m into park land, which shall be completely rehabilitated, as well as Douglas Taylor Park and Sumas Mountain where the temporary workspace (TWS) has been reduced by 10 m in width (as much as feasibly possible) even with existing side slope.

City of New Westminster's evidence (Filing ID A4Q0L5, Section 3.2) requests a re-route of the pipeline such that it is not within 30 m of fish bearing watercourses. Unfortunately, it is impossible to define a corridor from Edmonton, AB to Burnaby, BC that does not cross many fish bearing watercourses. However, in light of Metro Vancouver's and City of New Westminster's concerns about the Brunette Valley Watershed, significant trenchless sections have been designed to minimize vegetation impacts and surface disturbance within the watershed.

13.3 Fraser Valley Regional District

Trans Mountain understands the concerns that Ms. Allison Stewart of the FVRD outlines in her affidavit (Filing ID A4L8V6) regarding scope split within FVRD and have already taken measures to address them. Ms. Stewart was concerned that Trans Mountain has defined a construction spread break in the middle of Electorate Area D of FVRD and that this split would increase the workload imposed on FVRD having to work with two separate engineering consultants and construction contractors, as well as potential discrepancies between engineering and construction standards.

Before the first TWG meeting with FVRD on June 4, 2015, Trans Mountain clarified that Universal Pegasus International (UPI) representative Mr. Brendan Osorio as the single

engineering contact with whom FVRD will need to communicate and confirmed that there would be only one TWG moving forward. Trans Mountain confirms that the Project has a single set of standards and specifications, and that all drawings issued to FVRD will be to the same standard. Please also refer to Section 6.0 (Stakeholder Engagement) of Trans Mountain's Reply Evidence.

13.4 Yarrow EcoVillage, Chilliwack

Trans Mountain acknowledges Yarrow EcoVillage's (Filing ID A4Q1L3, Section 2.1) concerns regarding lack of detailed routing information provided thus far for their property. On July 15, a Trans Mountain Land representative met with representatives of the Yarrow EcoVillage to present a notice under Section 87(1) of the *NEB Act* and an Individual Ownership Sketch (IOS) for Yarrow EcoVillage, which clearly outlined the routing on the property including TWS limits. Trans Mountain confirms that the pipeline will remain within the existing right-of-way and the centre line of the proposed pipeline will be 6m offset from the existing pipeline, on the southern side.

13.5 Sandy Hills, Abbotsford

Trans Mountain does not agree with the portion of the Affidavit of Mr. Phillip Blaker, on behalf of the City of Abbotsford (Filing ID A4L6D1), where it is claimed that Trans Mountain has not provided the actual location of the existing TMPL within the existing right-of-way. During the TWG meetings, held between Trans Mountain and the City of Abbotsford (with Mr. Blaker in attendance), Trans Mountain provided alignment sheets for the full length of the pipeline through the City of Abbotsford. On these alignment sheets the existing pipeline location is clearly marked. The existing pipeline nominally sits 6 m south of the northern border of the right-of-way, with these clearances varying through curves. These meetings took place on March 27 and May 4, 2015.

The proposed TMEP pipeline centreline, which is also shown on these drawings, is at this stage only an approximate alignment. As noted within Mr. Blaker's affidavit, Trans Mountain is still completing geotechnical studies that will inform the trenchless design team of the geological constraints for a possible trenchless solution through the Sandy Hills area. These constraints will inform the feasibility of a trenchless solution, as well as potentially affect the design of a trenchless solution, which would in turn affect the placement of the pipeline within the right-of-way.

The TWS required through this region is also heavily dependent on the feasibility of a trenchless solution and the parameters imposed by the geological conditions. Trans Mountain will continue to work closely with the City of Abbotsford through the TWG meetings to ensure they are kept up to date and involved with all decisions in this area. Trans Mountain expects to have all the information available to make these decisions in Q3 2015.

13.6 Surrey Bend Regional Park, Surrey

Metro Vancouver (Filing IDs A4L8C4, A4L8C5, and A4L8C6) and the City of Surrey (Filing IDs A4Q2J6, A4Q2J7, A4Q2J8, A4Q2J9, and A4Q2K0) co-commissioned (and both submitted) a report on a routing assessment of the section of the TMEP that runs through Surrey Bend Regional Park. This report was also submitted by Mr. Hugh Hamilton as part of the City of Surrey's Intervenor Evidence (Filing IDs A4Q2K2, A4Q2K3, A4Q2K4, A4Q2K5, A4Q2K6). Trans Mountain provided a separate Reply to this report, which can be located in Attachment 1.17

(Reply to City of Surrey and Metro Vancouver "Environmental Assessment of Pipeline Placement Options Within and Adjacent to Surrey Bend Regional Park."

13.7 Port Mann Main No. 2/Colony Farm Regional Park, Coquitlam

Trans Mountain acknowledges that within the vicinity of Colony Farm Regional Park there is an overlap in construction schedules between the end of Port Mann Main No. 2 work and the start of construction of the proposed Fraser River HDD for the Project (Filing ID A4L7Y3, Section 10.6).

To mitigate this issue, Trans Mountain will change the sequence of large HDD crossings to delay the Fraser River crossing such that the work on the north shore of the Fraser River in preparation for the HDD would not begin until 2017. If the Metro Vancouver project is delayed, then the two construction contractors will manage the interface issues during the construction period.

13.8 Schooner St. Coquitlam

Trans Mountain has maintained a consistent approach to proposed routing throughout the Project (Filing ID A3S0Y8, Section 2.8.1) and the routing criteria utilized through the City of Coquitlam are consistent with these criteria. Although it was not practical to follow the existing TMPL through the City of Surrey due to residential development, when the proposed pipeline crosses the Fraser River into Coquitlam and proceeds west along Hartley Avenue it meets the existing TMPL right-of-way at Schooner Street. To be consistent with the route selection process filed with the NEB, "wherever feasible, install the Line 2 segments on or adjacent to the existing TMPL easement" (Filing ID A3S0Y8, Section 2.8.1), Trans Mountain proposes that the proposed pipeline corridor would proceed north along Schooner Street. Once the corridor reaches United Boulevard on Schooner Street it turns west as it is no longer possible to follow the existing TMPL right-of-way further north as it heads into a residential area in the City of Coquitlam.

The City of Coquitlam requested a revision of the proposed corridor (Filing ID A4Q0I8, Section 3.a) to avoid impacts to prominent businesses, industrial vacancies and proximity of City utilities within Schooner Street. The City of Coquitlam requests that Trans Mountain re-route the proposed TMEP corridor out of Schooner Street to travel north between Hartley Avenue and United Boulevard on either the Insurance Corporation of British Columbia (ICBC) parking lot (1575 Harley Avenue and 1750 United Boulevard) or Brigantine Drive.

At this stage Trans Mountain is not prepared to relocate the proposed TMEP corridor away from the existing right-of-way along Schooner Street as it contravenes the routing criteria set out in the application to the NEB. The current route reduces the amount of new rights-of-way imposed on the City of Coquitlam, which shall reduce impacts to the City's future development. Furthermore, the reduction in business impact to those on Schooner Street would be transferred to either ICBC or those on Brigantine Drive if relocated.

However, this proposal from the City of Coquitlam has merit and warrants further investigation and study. To accommodate this in an efficient manner, Trans Mountain is requesting approval from the NEB (consistent with a similar condition in GH-4 001-2012) for the preferred pipeline corridor with a condition that concurrent with the filing of the Plan, Profile and Book of Reference pursuant to Section 33 of the *NEB Act*, Trans Mountain will also file with the Board a description

of any proposed detailed route alignment that is located outside of Trans Mountain's preferred corridor, as well as supporting information for the re-route including:

- an environmental alignment sheet at an appropriate scale, clearly depicting the proposed 10 route re-alignment;
- a schedule for filing the results of pre-construction surveys for wildlife species at risk within 12 areas that were not previously assessed;
- an environmental and socio-economic assessment (ESA); and
- the details of consultation activities with the public and Aboriginal groups undertaken in respect of any rerouting.

Trans Mountain will provide copies of the above filings to interested parties.

Trans Mountain recommends that a Condition specific to this location in the City of Coquitlam be created to further investigate the alternate routes as recommended and report back to the NEB 90 days after the issuance of a Certificate.

13.9 Coquitlam Landfill/Eaglequest Golf Course, Coquitlam

Trans Mountain acknowledges Metro Vancouver's concerns (Filing ID A4L7Y3, Sections 9.3 and 9.5) with regards to the alignment of the proposed TMEP corridor near the Coquitlam Landfill lands and the impact to the underground infrastructure in this area. Following discussions in the TWG meetings that have been held with Metro Vancouver over the past few months, a number of alternative alignments are currently being investigated with Metro Vancouver in this area. These options have been discussed with, and proposed by, Metro Vancouver representatives. Trans Mountain has committed to undertake necessary ground surveys to identify location of existing infrastructure and will further work with Metro Vancouver before confirming the final proposed alignment. In addition, Trans Mountain commits to continuing working with Metro Vancouver to confirm an appropriate solution.

13.10 Brunette River, City of New Westminster/Coquitlam

The City of New Westminster's evidence (Filing ID A4Q0L5, Sections 3.1.2 and 3.1.3) outlines their concern for the Project's effects on trail connections and the proposed pedestrian crossing as part of the Sapperton Green development, as well as the proximity of the TMEP corridor to the Brunette River. The City requests that the pipeline is installed either 30 m from the top of the bank of the river or to the east of the railway tracks. Trans Mountain can confirm that the current design addresses all of these concerns: the pipeline remains trenchless (apart from a section within an industrial facility far back from the river) from Eaglequest Golf Course in Coquitlam to City of Burnaby land that is over 110 m away from the bank of the river.

13.11 Feasibility of Abandoning Existing Pipeline Through the City of Surrey

In written evidence filed by the City of Surrey (TMP-TMX Routing Options and Feasibility of Abandoning Existing Pipeline through City of Surrey - Associated Engineering; Filing ID A4Q0Q6), Associated Engineering asserts that, because of the age of the existing TMPL, it is nearing the end of its useful life. Associated Engineering provides no evidence to support this

assertion. Trans Mountain does not agree with the statement nor is this assertion supported by regulatory codes, practices, and standards.

While the replacement of the existing TMPL is not within the scope of this proceeding, Trans Mountain offers the following response to the report.

On page 9, Associated Engineering states that:

> "The cyclical nature of these transients reduces the allowable hoop stress of the pipe wall material over time."

This statement is factually incorrect. The pipe wall material itself does not degrade over time due to pressure fluctuations when operated within the maximum allowable operating limits as described in the CSA Z662 standard and the *Onshore Pipeline Regulations*. This is recognized within the standards and regulations, and there is no requirement to reduce the hoop stress or maximum operating pressures based on the age of the pipeline. Pressure cycle induced fatigue can occur where there are defects present in the pipeline or the long seam welds of the pipeline where the hoop stresses are the highest. Defects can appear along the circumferential welds; however, the stresses on circumferential welds are much lower than those on the long seam welds (approximately 50% lower based on engineering stress calculations for pipelines). To manage these issues Trans Mountain includes a cracking monitoring and mitigation program that includes the use of multiple ILI technologies to assess for potential cracking. Where potential cracking is located Trans Mountain completes excavations, assesses the pipeline, and completes repairs. The use of multiple inspection technologies (rather than reliance on a single inspection technology) is an industry-leading approach. In addition, Trans Mountain utilizes a pressure cycling monitoring program to monitor the pressure cycling on the pipeline system and assess the inspection frequency to determine whether the inspection cycles are appropriate or need to be modified. Trans Mountain believes this program is effective at managing the cracking threat.

On page 9, Associated Engineering also states that:

> "The long term impact of these stresses is demonstrated in micro-failures at connections such as valves, couplers, expansion joints, welds and elbows. As these components deteriorate, the number of failures will increase over time."

Associated Engineering provides no evidence to support the above statement. Trans Mountain is unsure of what Associated Engineering is referring when it states that these stresses are demonstrated in micro-failures. Trans Mountain is aware of the concept of micro-failures that occur in micro-structured materials (*i.e.,* computer chips), but does not believe this concept is applicable to cross country transmission pipelines. For a defect to fail in service the defect would have to grow to a size that would not be considered micro (defined as subcritical in pipeline terminology). The size of the defect that would rupture the mainline pipe and pipe bends are well beyond the minimum detection limits of the ILI technologies. To address the integrity of the pipeline facilities such as valves, elbows, instrument piping, and couplings, Trans Mountain utilizes a facilities inspection program and preventive maintenance programs to address and mitigate concerns in these areas. Trans Mountain again believes this is an effective approach at managing the risks associated with equipment connected to the pipeline system.

On page 9, Associated Engineering states that:

> "The interior of oil pipelines can be eroded as some petroleum products are known to be abrasive."

This statement infers that either the changes proposed by Trans Mountain or the historical operation of the pipeline has led to erosion of the pipeline system. Associated Engineering does not provide evidence to support this statement. Products that are shipped on the TMPL system must meet contractual base sediment and water content requirements. These requirements ensure that the sediment content is below the level that would have potential to cause erosion in the pipeline.

Trans Mountain has submitted evidence to support that the products in the existing pipeline are acceptable for the proposed operations including the "Active TMPL NPS 24 and NPS 30 Segments to be Incorporated into TMEP Line 1 Service – Engineering Assessment" (Filing ID A4A7Q3). Trans Mountain has also submitted the Transportation Research Board report "Assessing the Effects of Diluted Bitumen on Pipelines" (Amy C. IR No. 1.16a – Attachment 2; Filing ID A3X5Z0). The Engineering Assessment demonstrates that the metal loss mitigation activities conducted by Trans Mountain have been effective at mitigating the potential for metal loss to occur (both internal and external metal loss) and that Trans Mountain has been successful at maintaining a safety factor above the minimum safety factors for new pipeline construction. The Transportation Research Board (Filing ID A3X5Z0, pages 74 and 75) concluded that "*The committee does not find any causes of pipeline failure unique to the transportation of diluted bitumen. Furthermore, the committee does not find evidence of chemical or physical properties of diluted bitumen that are outside the range of other crude oils or any other aspect of its transportation by transmission pipeline that would make diluted bitumen more likely than other crude oils to cause releases.*"

On page 9, Associated Engineering further states that:

> "Reportedly, KM takes the opportunity when the TMP is uncovered, to inspect and recoat (if necessary) that portion of the pipeline; however, in the long section through the residential area, the condition and effectiveness of exterior coating is likely unknown."

Associated Engineering has provided no information to support these statements. As described in the Engineering Assessment "Active TMPL NPS 24 and NPS 30 Segments to be Incorporated into TMEP Line 1 Service – Engineering Assessment" (Filing ID A4A7Q3) submitted by Trans Mountain, the coating condition of the pipeline based on inspections and assessments completed to date is that the coating is in generally good condition. Trans Mountain completes cathodic protection test station surveys on the pipeline system on an annual basis as well as completes cathodic protection close interval surveys on a 5 year cycle. The surveys indicate that the coating is in generally good condition and the cathodic protection system is effective at helping to mitigate external corrosion concerns. As well, the ILI results do not show any increased degradation of the pipeline in this area, and therefore there is no basis to conclude that the condition of the pipeline coating in this area is any different than the other portions of the system and it appears that the coating is generally in good condition. The assessment shows that the factor of safety along the section on the existing pipeline coming into Surrey is generally higher than other segments of the pipeline supporting that the coatings are in good condition (*i.e.*, that the pipeline is not experiencing higher levels of degradation due

to coating loss). The report also outlines that the corrosion growth rates in this area are similar to those along other sections of the pipeline, again indicating that there is little or no difference in the rates of corrosion in this area.

On page 9, Associated Engineering states that:

> "KM has stated in the past that it performs regular inspections on the interior of the pipe using technologies available to them; however, the exterior condition of the pipe is typically estimated based on previous instances of excavation during construction or during KM's periodic testing."

This statement is incorrect and indicates a lack of knowledge or understanding in the use of in-line inspection technologies. The statement above infers that the in-line inspection tools are only capable of assessing the internal surface of the pipeline and that the condition of the external surface of the pipeline must be inferred or estimated based on excavations. This is incorrect. The in-line inspection technologies that assess metal loss, pipe geometry, and cracking are able to look at both the internal surface and external surface of the pipe, as well as mid wall features such as laminations or inclusions.

Associated Engineering states on page 9 of their report that the pipeline was constructed in the 1950s and was not designed or constructed to current standards. Although it is true, the pipeline was constructed in 1952 under the regulations in place at that time, the design standard CSA Z662 recognizes this and provides the following direction in Section 1.5 of the standard:

> "The requirements of this Standard are applicable to the operation, maintenance, and upgrading of existing installations; however, it is not intended that such requirements be applied retroactively to existing installations insofar as design, materials, construction, and established operating pressures are concerned."

Trans Mountain is required to operate and maintain the pipeline system in accordance with the requirement of the current version of CSA Z662 and the *Onshore Pipeline Regulations*. This includes the requirements for Integrity Management Programs that are designed to ensure the pipelines are properly maintained in accordance with the requirements of the design standard and regulator code. The operation of the pipeline and the integrity management/maintenance programs used by Trans Mountain are designed to conform to these regulations and codes.

Over the last 50 years the operation and maintenance of the pipeline system have continued to evolve in accordance with the regulations and have improved with the use of new technologies such as high resolution in-line inspections. Associated Engineering asserts that the probability of a failure occurring is significantly higher than it was 60 years ago. This is incorrect. The use of current high resolution inspection technologies have improved the ability of operators to proactively monitor and maintain the pipeline systems, and have increased the safety of all pipelines including pipelines that are over 50 years old. Trans Mountain believes that the programs that it has implemented are effective at maintaining the safe operating margins of the pipeline system, and that this is supported by the Operating History of the pipeline in which Trans Mountain can demonstrate through an analysis of its' leak history improved safety performance attributable to introduction of technological improvements.

On page 9, Associated Engineering states that:

> "It is unlikely the TMP was designed to meet current seismic design standards."

The existing TMPL route has been assessed by a geotechnical consultant to determine locations where earthquake ground motion could potentially trigger liquefaction and slope instability in the vicinity of the pipeline. Potential locations identified from the assessment have been assessed to determine the magnitude of expected permanent ground displacements and settlements, as well as magnitude of liquefaction, if a 2475-year return period seismic event were to occur (as per current 2015 seismic design standards levels determined by Natural Resources Canada).

From the assessments completed, a total of seven locations were identified as requiring a detailed elastic-plastic structural analysis of the pipeline to determine if the pipeline would rupture due to the expected ground displacement. Four of these assessments have been completed, with the remaining three planned to be completed in 2015. Mitigation has already occurred at the Fraser River Crossing for the existing TMPL, resulting in its replacement with an HDD beneath the river in 2003, and additional mitigations will be completed at any sites that are considered vulnerable to failure from the structural assessments.

On page 9, Associated Engineering states that:

> "It is unlikely the TMP was designed to withstand the bending stresses induced by soft soils that are known to exist along the pipeline route through parts of the City. The impacts of soft soils are a significant design issue in Lower Mainland communities."

The existing TMPL route has been assessed by a geotechnical consultant to determine locations of highly compressible "*susceptible soils*." For the 13.996 km of pipeline that runs through the City of Surrey, 719 m of the pipeline is considered to be located within susceptible soils. These locations are more closely monitored for activities within the vicinity of the pipeline to ensure that potential ground movements are minimized.

In addition, high resolution in-line inspection tools run through the entire TMPL system on regular intervals and are capable of determining the strain on the pipeline. Analysis is completed between successive in-line inspection tool runs to determine locations of strain differential, indicating possible pipeline movement. For the existing TMPL through the City of Surrey, one location had been identified at the King Road crossing that showed higher strains that could not be accounted for (pipe was resting on a sewer line due to settlement). This location has since been mitigated and remote monitoring of the strains on the pipeline at this location continues to this day.

The information placed on the record by Trans Mountain validates that the existing TMPL system is appropriately managed and monitored as required by the CSA Z662 and *Onshore Pipeline Regulations*. There is no evidence that indicates these pipeline segments are nearing their end of life nor is there evidence to suggest that the pipeline should be replaced.

13.12 Whitemud Drive Corridor, City of Edmonton

In Clause 1.09 of the written evidence submitted by the City of Edmonton (the City; Filing ID A4Q1Q4) to the NEB, dated May 27, 2015, the City objects to Trans Mountain's proposed use of the Whitemud Corridor. In Clause 5.14c) of the evidence, the City states that if the NEB permits use of the Whitemud Corridor, that a condition be attached to the Order that pipeline alignment modifications proposed by ISL Engineering and Land Services Ltd. (ISL) in a report attached as Tab B to the evidence be adopted.

The following points are relevant to Trans Mountain's choice of the preferred route through the Whitemud Corridor:

- Use of the Whitemud Corridor is consistent with the general routing approach taken through the City of Edmonton, where use of corridors was selected versus use of the existing Trans Mountain easement in order to avoid high density urban areas to the extent possible. Use of the Edmonton Transportation and Utilities Corridor (TUC) versus the existing Trans Mountain easement demonstrates this approach.
- Trans Mountain has always viewed the Whitemud Drive option to be similar to the TUC by virtue of the existing and proposed roadway development as well as existing and proposed associated infrastructure mostly oil, gas, and water pipelines as identified in Clause 2.12 of the City evidence. In addition, Clause 2.15 of the City evidence identifies a proposed ATCO gas pipeline that is expected to be installed in Whitemud Corridor prior to TMEP.
- During the first year of discussions between Trans Mountain and the City, the City favoured the Whitemud alternative and no major conflicts were apparent.
- It is Trans Mountain's view that there would be less direct impact to the adjacent landowners realized during construction along the busy corridor of Whitemud Drive versus the pipeline corridor through Lewis Estates.
- Trans Mountain does acknowledge that adjacent landowners along Whitemud Corridor that are within 30 m of the proposed TMEP pipeline are potentially impacted as per Clause 3(ii) of the City evidence after TMEP is placed in operation if they plan to undertake ground disturbance activities. However, landowners should make use of Alberta One Call prior to such activity, regardless of whether TMEP pipeline is in place or not, and is therefore not an additional burden. The easement/licence of occupation for TMEP on the City lands will likely be less than 18 m and will not overlap onto private property adjacent to Whitemud Corridor. TWS outside the easement width will be required during construction and could overlap with some private lands. These will be subject to negotiation with affected landowners. Therefore, KMC's Design and Landscaping Guidelines (the Landscape Restrictions) Tab D in evidence does not apply to private lands adjacent to Whitemud Corridor.

The pipeline alignment modifications proposed in the Whitemud Corridor are generally contained in Section 4.5 of the ISL report. In recent consultation with the City, Trans Mountain has proposed forming a joint Technical Committee to work towards resolution of issues with the Whitemud Corridor identified in the evidence, including issues related to pipeline alignment.

Specific sections of the report (Sections 4.5.1, 4.5.2, 4.5.3, and 4.5.4) deal with depth of the pipeline as opposed to pipeline routing. The depth issues are driven by the potential of a future substantial grade lowering of Whitemud Drive to allow for an interchange at Guardian Road. As the slopes adjacent to Whitemud Drive will need to be designed to match existing grade at the back property line of existing residential and commercial properties, Trans Mountain believes that by keeping as close as reasonable to the property lines, pipeline depths acceptable to both parties can be achieved. The depth of pipeline issues identified in Section 4.5 will be a topic for the Technical Committee.

Section 4.5.6 of the report proposes a shift in location and angle of the proposed pipeline crossing of Whitemud Drive. Trans Mountain believes that an agreement on alignment within the applied corridor can be achieved as an output of the Technical Committee.

Placement and elevation of the proposed pipeline across and along 215 Street are mentioned in Sections 4.5.7 and 4.5.8 of the ISL report. No specific alignment changes are proposed in the report; however, the Technical Committee can work to understand and resolve interference issues in this area.

In Section 4.4.1 of the ISL report, interference between proposed future abutments for the Guardian Road over Whitemud Drive bridge are identified with a proposed solution of extending the bridge deck and moving the abutments. Trans Mountain believes a more cost effective solution can be collaboratively developed through the Technical Committee.

Recently, more detailed information as described in the ISL report has been provided by the City of Edmonton regarding their updated Whitemud Drive Expansion plans. Although Trans Mountain acknowledges that more difficulty with respect to constructability is realized due to this more detailed information, as noted in the written aforementioned evidence response, Trans Mountain believes a resolution can be achieved for most or all of the issues noted by the City in their written evidence.

Based on the evidence submitted by the City of Edmonton (Filing ID A4Q1Q4), Trans Mountain commits to further investigation of the Lewis Estates alternative. Accordingly, Trans Mountain is requesting approval from the NEB (consistent with a similar condition in GH-4 001-2012) for the preferred pipeline corridor with a condition that concurrent with the filing of the Plan, Profile and Book of Reference pursuant to Section 33 of the *NEB Act*, Trans Mountain will also file with the Board a description of any proposed detailed route alignment (*i.e.,* the Lewis Estates option), as well as supporting information for the re-route including:

i) an environmental alignment sheet at an appropriate scale, clearly depicting the proposed route re-alignment;

ii) a schedule for filing the results of pre-construction surveys for wildlife species at risk within areas that were not previously assessed;

iii) an ESA; and,

iv) the details of consultation activities with the public and Aboriginal groups undertaken in respect of any rerouting.

Trans Mountain will provide copies of the above filings to interested parties.

13.13 Coldwater No. 1 Indian Reserve

In their written evidence (Filing ID A4Q0W6), the Coldwater Indian Band correctly stated that in addition to paralleling the existing pipeline within the Trans Mountain right-of-way, four other alternative routes were considered in the vicinity of the Coldwater Indian Reserve No. 1. The written evidence is also correct in its description of the four alternative route options, and in identifying them in a manner consistent with the naming used in the application. The four route alternatives assessed were the TMPL Modified Alternative, the West Alternative, the East Alternative, and the Modified East Alternative. Trans Mountain does however disagree with

several of the points in the route decision timeline as laid out in Coldwater's written evidence and maintains its position that the East and Modified East Alternate route options are better suited to the Project than the previously rejected West Alternate.

The process by which Trans Mountain has developed the proposed pipeline corridor of the expansion pipeline is described in Volume 4A, Section 2.8 of the Application (Filing ID A3S0Y8). The initial desktop routing studies originally identified three route options, the East route, the West route, and the on-reserve modification to the TMPL route. These routes were shared with Coldwater in May of 2013, and submitted as evidence by the band (Filing ID A4Q0X3). Trans Mountain also consulted on these route options with the wider community with an open house event in Merritt in the spring of 2013.

Trans Mountain's assessment of these three route options against the routing criteria established for the Project and detailed in the application in Volume 2A, Section 4.2.2 (Filing ID A3S0R0) ranked them in descending order of preference as: the Modified TMPL route, the East route, and lastly the West route. The Modified TMPL route was preferred due to its maximal use of the existing Tran Mountain right-of-way, its shorter length, its avoidance of the more populated area of the Coldwater No. 1 reserve, and its traversing of generally more favourable terrain staying closer to the valley bottom and avoiding the slopes encountered by the other route options. The East route was preferred over the West route due to its greater use of the existing Trans Mountain right-of-way, its shorter length, and its avoidance of two additional crossings of the Coldwater River. The Coldwater River has a very limited biological window for instream work due to the combination of fish species present. For this reason, trenchless crossing installations were recommended for both of the potential Coldwater River crossings on the West Alternate, conditional on the completion of a favourable geotechnical investigation and feasibility analysis.

During the summer of 2013, consultation with private landowners south of the Coldwater No. 1 reserve suggested a preference for the addition of the fourth route option, the Modified East route.

Within the Project Application submitted in December, 2013, the proposed pipeline corridor mapping is shown to follow the East Alternate alignment. Volume 5A, Section 4.2 (Filing ID A3S1L4) included a map and table of comparative metrics for the four route options (Figure 4.2-5 and Table 4.2-5). While the text of Section 4.2.3 stated that while the proposed corridor is following the East Alternate, the TMPL Modified Alternate would be the preferred if agreement could be reached with the Coldwater Indian Band. The Modified East Alternate is also stated to be under consideration. The West Alternate option is not mentioned in the text and by its omission should be inferred to no longer be under consideration.

In May 2014, the Trans Mountain responses to NEB IR No. 1.84a provided updated corridor route mapping, which along with a revised proposed pipeline corridor, explicitly depicted all of the alternative pipeline corridor options under consideration (Filing IDs A3W9Q5 and A3W9Q6). At Coldwater Indian Reserve No. 1 the mapping showed a revision of the previously proposed pipeline corridor to change from the East Alternate to the Modified East Alternate. The Modified TMPL Alternate was included as an alternative pipeline corridor. Neither the East Alternate nor the West Alternate was shown as routes that remain under consideration.

In June 2014, Trans Mountain's response to Coldwater Indian Reserve No. 1.2 (Filing ID A3Y2I0) addressed only the Modified East Alternate and the Modified TMPL Alternate in

requests that specifically asked about all route options, as these two remained as the only routes under consideration.

Coldwater's assertion that they were only informed of the dropping of the West Alternate in March 2015 is not reflected by the record, which indicated that this route has not been under consideration since before the filing of the Application in December 2013, and has at no point been part of a corridor presented by Trans Mountain for the Board's consideration.

The Coldwater evidence also included a letter to Trans Mountain dated April 17, 2015 (Filing ID A4Q0X7) to which a reply had not been received. A reply letter from Trans Mountain to Coldwater dated June 17, 2015 is included here as Appendix 7B.

On July 29, 2015, Trans Mountain provided an updated response to NEB IR No. 3.017a (Filing ID A4R8Z4) in which it was indicated that the TMPL Modified Alternative is no longer under consideration and the sole proposed pipeline corridor in the area will remain on the Modified East Alternate.

13.14 Summary of New Commitments

- Trans Mountain confirms that the proposed pipeline will remain within the existing right-of-way and the centre line of the proposed pipeline will be 6 m offset from the existing pipeline, on the southern side.
- Trans Mountain will change the sequence of large HDD crossings to delay the Fraser River crossing such that the work on the north shore of the Fraser River in preparation for the HDD would not begin until 2017 to avoid overlap with Metro Vancouver's work in the Colony Farm Regional Park area.
- Trans Mountain has committed to undertake necessary ground surveys to identify the location of existing infrastructure and will further work with Metro Vancouver before confirming the final proposed alignment of TMEP in the vicinity of the Coquitlam Landfill.

14.0 WATERCOURSE CROSSING DESIGN

14.1 Selection of Primary Watercourse Crossing Method

Item 46 in the Northwest Hydraulic Consultants Ltd. (NHC) report submitted as Intervenor Evidence by the Nooaitch Indian Band (Filing ID A4Q0F4) recommends that "Hydraulic isolation should be required for any small- to medium-sized streams, which are hydraulically connected to fish habitat, regardless of whether there are fish or fish habitat at the crossing location."

Trans Mountain can confirm that hydraulic isolation will be implemented for any small-to-medium-sized streams that are hydraulically connected to fish habitat, regardless of whether there are fishes or fish habitat at the crossing location, unless flow volumes exceed threshold limits for open-cut with flow isolation methodologies or site conditions preclude the ability to isolate the watercourse. Where conditions preclude flow isolation methodologies, either HDD or open-cut without flow isolation will be implemented. Table I-1 (Site-Specific Mitigation Measures for Watercourses Encountered within the Pipeline Corridor in Alberta) and Table I-2 (Site-Specific Mitigation Measures for Watercourses Encountered within the Pipeline Corridor in British Columbia) in Volume 6B (Pipeline EPP; Filing ID A3S2S3) of the NEB Application outlines the Primary and Contingency Pipeline Crossing Method proposed for the Project. The aforementioned tables will be updated in the final Pipeline EPP to be filed with the NEB 90 days prior to construction in accordance with NEB Draft Condition 29 (Filing ID A3V8Z8).

Item 47 in the NHC report indicates that "*flow thresholds used in the decision making process should be defined more precisely" and "the selected flow thresholds should be explicitly tied to a quantifiable acceptable level of risk.*"

Trans Mountain did not use a risk-based approach for determining crossing methodology with respect to flow thresholds. Instead, Trans Mountain is using the industry standard Best Management Practices approach for determining the best methodology for watercourse crossings, which is consistent with the guidelines presented in the Pipeline Associated Watercourse Crossings (CAPP *et al.* 2012).

Trans Mountain is also using industry accepted "flow thresholds" for the various isolation methodologies, which are less than 1 m^3/sec for the isolated dam and pump methodology, and less than or equal to 8.0 m^3/sec for isolated flume/superflume methodologies.

For all watercourses that were assessed as part of the Stage 2 Review Process, Trans Mountain used first order approximation of monthly flow statistics to support the construction planning of watercourse crossings. The hydrological information is contained in the Route Physiography and Hydrology Report issued on November 28, 2013 and filed as Volume 4A, Appendix I of the NEB Application. (Filing IDs A3S1D8, A3S1D9, A3S1E0, A3S1E1, A3S1E2, A3S1E3, A3S1E4, A3S1E5, A3S1E6, A3S1E7, A3S1E8, A3S1E9, A3S1F0, A3S1F1, A3S1F2). The hydrological information has since been updated to reflect findings of the detailed engineering and design phase. It is understood that because of the complexity of hydrological processes involved in the generation of streamflow, monthly flow averages are inherently variable. Daily streamflow records published by the Water Survey of Canada (WSC) were aggregated to compute monthly statistics. Three monthly statistics were provided, namely the mean, and the 25th and 75th percentiles. Monthly streamflow statistics at the watercourse crossings were estimated following either of two distinct approaches: proration or regional average. Proration was generally preferred and was used when a single representative

hydrometric station was located along the watercourse of interest. Streamflow statistics were linearly scaled with the basin area. Proration is typically characterized by a higher level of confidence associated with streamflow statistics. A regional approach was used when proration was not possible. The regional approach is based on streamflow statistics derived at a number of representative hydrometric stations in the vicinity of the proposed pipeline crossing. Stations were deemed representative based on geographic proximity to the crossing, and basin size. Because these hydrometric stations may be gauging flows from basins of diverse sizes, streamflow was first normalized by dividing it by basin area. This resulted in unit flow rates in $m^3/s/km^2$ that are independent of basin size. Once averaged among regional hydrometric stations, monthly average flows were reported to the pipeline crossing by multiplying them with the basin area at the pipeline crossing. Predictions of monthly streamflow statistics using the regional approach should be regarded as more uncertain compared to those derived from proration.

With the aforementioned flow data, all watercourse crossings are assessed (refer to Volume 4A, Section 2.11 - Watercourse Crossing Method Selection of the NEB Application; Filing ID A3S0Y8) using various information such as, but not limited to, data gathered from the fisheries assessment phase, data gathered from the routing phase, local knowledge, mapping, imagery, flow data, and site-specific reconnaissance where deemed required. In Stage 1 (refer to Volume 4A, Section 2.11.1 - Stage 1: Initial Screening Process of the NEB Application) any watercourses identified as meeting the Stage 2 requirements (triggers) were subjected to the more detailed Stage 2 Review Process as identified in Volume 4A, Section 2.11.2 – Stage 2: Review Crossings of the NEB Application (Filing ID A3S0Y8). Accordingly, as part of the planning process, a proposed preferred crossing technique is chosen for each watercourse in either Stage 1 or the Stage 2 process.

Furthermore, Trans Mountain will obtain real time flow measurements immediately prior to commencing any mid-sized and large open-cut crossing using the isolation methodology. If flow volumes are within the threshold limits for the respective isolation methodology and the weather forecast (typically a 2 to 5 day forecast) is favourable, the crossing will then be initiated. If flow volumes exceed the threshold limits for isolation or the weather forecast is unfavourable, a decision will then be made to either wait for flows to subside and/or a favourable weather window (if an available biological window remains) or implement the contingency methodology process as required.

14.2 Primary Watercourse Crossing Method (Como Creek, Mundy Creek, Dawes Hill Creek, and Nelson Creek)

In City of Coquitlam's filed evidence (Filing ID A4Q0I9), City of Coquitlam states:

> "Trans Mountain has acknowledged that there are construction options available for watercourse crossings and has identified some considerations on which site-specific decisions may be made. It has identified Como Creek in its Preliminary Watercourse Stage 2 Review but not indicated a primary crossing method, or construction timing. It has also not included Mundy Creek, Dawes Hill Creek or Nelson Creek on this review list. Similarly, in the Watercourse Crossing Summary, only Como Creek and Nelson Creek are included."

Crossing methods have been determined during the detailed design and engineering phase. The proposed crossing method of Como Creek is a span across the creek using culverts.

Therefore, the pipeline will be laid atop the culverts. The proposed construction timing for the crossing of Como Creek is scheduled during the least risk window (August 1 to September 15). The proposed crossing method of Dawes Hill Creek and Nelson Creek is isolation with fish salvage during the least risk window (August 1 to September 15). Mundy Creek is a tributary to Dawes Hill Creek and is not directly crossed by the proposed Line 2 route.

Trenchless techniques such as HDD were proposed based on environmental and constructability considerations. For instance, the proposed crossing method for the Fraser River at Port Mann is an HDD for which the exit point and staging area are located north of the Mary Hill Bypass. As a result, the proposed Line 2 pipeline route does not encroach or cross the Coquitlam River Wildlife Management Area (Government of BC 2015), which greatly reduces the impacts to the environment in this area. Although Trans Mountain acknowledges some limitations to the HDD crossing method, it remains the preferred crossing method of the Fraser River at Port Mann.

14.3 Hydrotechnical Hazard Assessment

NHC were retained by Nooaitch to prepare a review of the Project Application, and specifically Volume 4A, Appendix I: Route Physiography and Hydrology Report (Filing ID A3S1D8). In Nooaitch's filed evidence (Document ID C258-9-1; Filing ID A4Q0F4), NHC states:

> "24. The Hydrotechnical crossing overview maps should specify the gauge(s) used for regional analysis or flood frequency analysis, the climate station(s) used for precipitation estimates, and frequency distribution fitting(s) used in flood frequency analysis at each crossing.
>
> 26. Peak and seasonal flow estimates for all remaining crossings in gauged catchments should be reviewed to ensure the most applicable local flow record was used unless precluded by deficiencies in the record. If the most applicable local flow record was not used, the analyses should be re-done to meet this criterion.
>
> 27. The Project Application should clarify which gauges were used for estimating peak flows in ungauged catchments.
>
> 28. For crossings in gauged catchments, the Project Application should include information related to the gauge record(s) used for hydrologic characterization, including gauge name and location, watershed area, period of record, etc. Details of the hydrologic analysis methodology for each crossing should also be included, such as the selected distribution fitting."

As provided in the response to NEB IR No. 2.102a (Filing ID A3Z4T9):

> "The intent of the Route Physiography and Hydrology Report is to provide a high level perspective on the hydrological variability encountered along the TMEP. It does not include an assessment of the potential for bed scour and lateral erosion of rivers (or other hydrotechnical hazards), nor was the intent of the report to provide crossing design information. During detailed engineering, scour will be assessed using a number of quantitative methods that require information on the channel substrate, morphology, cross-section data, channel gradient, and peak

> flows. While the hydrology assessment completed as part of the referenced report allows an assessment of peak flows, other parameters require a site visit and survey data in some instances in order to undertake detailed assessments. Bank erosion will also be assessed quantitatively using historical air photographs supplemented by site investigations. The results from the scour and bank erosion assessments will be incorporated into the determination of suitable depth of cover to prevent scour under the 1:200 year event and appropriate setback distances for bends. As part of these detailed assessments, historic monthly hydrographs will be developed to assist in evaluating construction methods including suitability for isolation."

While the hydrological assessment completed in the Route Physiography and Hydrology Report provides an initial assessment of peak and monthly average flows, these estimates have been revised in light of additional data and detailed analyses, including on a site-specific basis for each of the proposed horizontal direction drilled crossings such as for the Nicola River HDD (Filing ID A4I6G1).

Climate data were provided in the Route Physiography and Hydrology Report to illustrate the climatic variability along the proposed Line 2 route. Although climate data were not further analyzed in the hydrotechnical design report, physiographic zones were used as a surrogate to stratify climate variability.

Flood quantiles were derived using a standard Flood Frequency Analysis (FFA) approach. The Generalized Extreme Value (GEV) distribution was used for its theoretical basis in predicting extreme values. FFA's took as input annual instantaneous peak flows recorded at hydrometric gauges operated by WSC.

A site-specific approach was used to estimate flood quantiles. For the gauged watercourses crossed by the proposed Line 2 route, proration based on catchment area was used to estimate flood quantiles and monthly flow statistics. For smaller ungauged watercourse crossings along the proposed Line 2 route, a regional approach based on representative hydrometric gauges was adopted. Hydrometric gauges were selected based on:

- the record length of instantaneous peak flow measurements;
- whether flows were regulated by an upstream reservoir;
- their geographic proximity to the proposed pipeline crossing of interest, and
- their proximity in terms of catchment size between the gauged catchment, and the ungauged catchment related to the proposed pipeline crossing of interest.

A subset of representative hydrometric gauges was carefully selected for every watercourse intercepting the proposed Line 2 route. However, given the general scarcity of streamflow data available along the proposed Line 2 route, uncertainty associated with extreme flow quantiles is expected.

A similar approach was adopted to estimate monthly average flow statistics. While acknowledging the significant variability inherent to monthly flow estimates, the pipeline design engineers responsible for the design of watercourse crossings used monthly average flow statistics to support construction planning. Streamflow measurements will be conducted

immediately before the planned construction period. At crossings where the measured discharge is sensibly larger than its predicted value, the pipeline engineers will either delay construction or implement the contingency crossing method.

Characteristics of hydrometric gauges used in the analysis of mid- to large-sized catchments will be reported in the hydrotechnical design report, whether proration or a regional approach was used.

14.4 Crossing Design

In Nooaitch's filed evidence (Filing ID A4Q0F4), NHC states:

> "44. The criteria for 'notable' crossings should be clarified. All crossings of streams with fish habitat (or which are hydraulically connected to streams with fish habitat), crossings deemed to have more than minimal scour or erosion potential, or where pipeline failure could impact human safety or infrastructure should be included in this category. In defining 'notable', it should be understood that catchment size and channel dimensions are often insufficient for assessing hydrotechnical risk at crossings.
>
> 45. Design criteria for bank erosion at 'notable' crossings should be specified. The criteria should include a minimum setback of pipeline sagbends from the existing top of bank. This minimum setback should be related to stream characteristics. For example, larger crossings and those with sensitive fish habitat, lateral stability of the channel should be assessed for historical trends in lateral bank migration to determine minimum setbacks. For crossings in laterally unstable channels, sagbends should be setback outside the active floodplain. At smaller crossings with no indication of lateral instability, it would be reasonable to select a minimum setback distance related to the bankfull width."

As provided in the response to NEB IR No. 2.104c (Filing ID A3Z4T9):

> "The selection criteria used to define notable crossings was based on those crossings with a catchment area of greater than 50 km^2 to represent crossings with higher potential for susceptibility to hydrotechnical hazards."

The term "notable" was used to extract a subset of larger watercourses to illustrate the hydrological and physiographic variability along the proposed Line 2 route. It was not intended to provide an exhaustive list of watercourse crossings.

The detailed design and engineering phase as it pertains to hydrotechnical design included two steps:

- the characterization of hydrotechnical hazards at watercourse crossings; and
- the provision of design recommendations in the form of minimum depth of cover and setback distances away from the banks of the watercourse.

Hydrotechnical hazards including inundation, scour, channel degradation, bank erosion, avulsion, and encroachment were characterized at all watercourse crossings identified along the

proposed Line 2 route. The 200-year event was used as design basis along the proposed Line 2 route, although the well-accepted 1894 flood of the Fraser River, associated with a return period of 500 years as provided by the BC Ministry of Environment was used to estimate inundation and scour potentials for all watercourses located in the Lower Mainland, which cross the proposed Line 2 route. Design recommendations were formulated at all identified watercourse crossings where at least one of the listed hydrotechnical hazards could impact the proposed Line 2 pipeline during its lifespan. Watercourse crossings were classified in three categories:

- atypical crossing deign;
- typical crossing design; and
- no design.

Watercourse crossings were assigned to the “no design” category when detailed analyses revealed that none of the above mentioned hydrotechnical hazards had the potential to impact the proposed Line 2 pipeline during its lifespan. The 1.2 m minimum depth of cover specified in Table 4.9 of CSA, Oil and Gas Pipeline Systems Standard Z662 (CSA 2011) was adopted for these crossings.

Watercourse crossings were assigned to the “typical crossing design” category when detailed analyses revealed that bed scour and channel degradation were active hydrotechnical hazards at the crossing, and that a 1.2 m minimum depth of cover may not be sufficient to prevent exposure of the proposed Line 2 pipeline during its lifespan. Typically, a 1.5 m minimum depth of cover would be recommended for these watercourse crossings, along with overbend setback distances from the channel banks equal to at least 2 m.

Watercourse crossings were assigned to the “atypical crossing design” category when detailed analyses revealed that bed scour, channel degradation, bank erosion, and/or avulsion were active hydrotechnical hazards at the crossing. Setback distances were specified after analysis of bank erosion and avulsion potentials at the crossing to prevent the exposure of overbends due to the lateral migration of the channel through time.

14.5 Watercourse Design Flood Versus Exposure Flow

In City of Vancouver’s filed evidence (Filing ID A4L7V8), the City of Vancouver states a key issue of their concern and cites Appendix 5 (Association of Professional Engineers and Geoscientists of BC’s [APEGBC’s] 2012 Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC; Filing ID A4L7W3) as:

> “The proposed design standards for pipeline construction and the safety measures proposed are of significant concern for Vancouver. For this reason, Vancouver raised questions in the Information Request process about Trans Mountain’s decision to design the pipeline at all river crossings other than the Fraser River to withstand a 200 year flood event rather than the higher flood design standard recommended by the Association of Professional Engineers and Geoscientists of BC in the 2012 guidance document “Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC”. The guidance document identifies a design standard for high consequence failures where there is a “high loss potential” or “very high loss potential” of 1:1000 to 1:2500.”

APEGBC's (2012) Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC were prepared to support the BC Ministry of Forests, Lands and Natural Resource Operations objectives of reducing or preventing injury, human trauma, and loss of life and to minimize property damage from flooding events. The guidelines define a flood as a condition in which a watercourse overtops its natural or artificial confines and covers land not normally under water. The hazard and risk assessment methods addressed in the guidelines are geared towards planning of residential development on floodplains and alluvial fans. The guidelines do not provide guidance on methods to select the depth of cover for pipelines and are silent on methods of assessment for scour.

Trans Mountain's proposed design basis for trenched watercourse crossings is to provide a minimum depth of cover of 1.2 m and, where the potential depth of scour exceeds this value, a depth of cover sufficient to prevent pipeline exposure during a 200-year flood event. These criteria meet or exceed standards of practice for pipeline design in BC and Alberta.

It is important to note that the 200-year flood event is not equivalent to the frequency of loss of containment (FLoC) for the pipeline. The 200-year flood event provides an upper bound estimate of the spatial probability of impact (*i.e.,* the probability of pipeline exposure). The product of the probability of exposure and the vulnerability of the pipeline to damage if exposed provides an estimate of the frequency FLoC. The vulnerability is a function of pipeline and watercourse characteristics. The vulnerability of large diameter steel pipelines when exposed in floods is typically less than 0.01, and measures such as use of heavy-wall pipe and concrete coatings can further reduce the vulnerability. Upper bound estimates of FLoC at proposed TMEP watercourse crossings will typically be less than 0.00005 (1 in 20,000) and at most watercourse crossings the estimated FLoC will be less than 0.00001 (1 in 100,000).

14.6 Flood Risk and Scour

14.6.1 Brunette River

In City of New Westminster's filed evidence (Filing ID A4Q0L5), the City of New Westminster states a key issue of their concern as:

> "The route along the north and east bank of the Brunette River is within an area that experiences flash flood conditions, and which may need future dyking and/or riparian enhancement in the future with sea level rising."

The City of New Westminster's suggested mitigation includes:

> "Ensure that entrance and exit locations for HDD sections are above the potential water level during flood conditions, considering also the role of climate change on rising sea level (and lower Fraser) levels, and how those could influence future flood risk."

The proposed primary crossing method of Brunette Avenue is HDD. The proposed entry point of the HDD borepath is located at an approximate elevation of 8.5 m above sea level (asl) while the proposed exit point is located at an approximate elevation of 8.2 m asl.

Volume 4A, Section 2.9.4 of the Application (Filing ID A3S0Y8) describes the design basis for scour and bank stability for flood events as follows:

> "During the detailed engineering and design phase, the notable watercourse crossings will be designed for scour and bank stability to meet the conditions of a 1 in 200 year flood event and, as such, the proposed Line 2 pipeline will be sufficiently buried, or otherwise protected, to ensure its long-term integrity."

As provided by the Greater Vancouver Regional District, the 200–year flood magnitude at the mouth of the Brunette River is 82 m^3/s. A hydraulic model of the Brunette River based on Manning's equation was developed in the vicinity of the entry point by BGC results from the base case scenario defined by current sea level conditions and a 200-year flood event in the Brunette River predict a 200-year flood water level of approximately 4.3 m asl in the vicinity of the proposed entry point. Therefore, neither the proposed entry point nor the proposed exit point, located down-river from the proposed entry point, would be subject to flooding caused by a 200-year flood event in the Brunette River.

The effects of climate change and sea level rise (SLR) in particular on the resulting water level profile along the Fraser River were studied by the BC Ministry of Forests, Lands and Natural Resource Operations. The mouth of the Brunette River is located along the Fraser River between the Patullo and Port Mann bridges, approximately 39 km upstream of the mouth of the Fraser River.

Results of the study indicate that the influence of SLR decreases as distance away from the ocean increases. At the mouth of the Brunette River, an SLR of 1.5 m caused a raise in the resulting 500-year flood water level of the Fraser River from approximately 4.0 m asl to approximately 4.8 m asl. Such a scenario would conservatively raise the predicted water level in the Brunette River in the vicinity of the proposed entry point from 4.3 to 5.1 m asl.

Therefore, it is not anticipated that either of the proposed entry and exit points would be subject to flooding caused by a 200-year flood event in the Brunette River, concurrent with a 500-year flood event in the Fraser River, and a 1.5 m SLR compared to current conditions.

14.6.2 Coldwater River and Thompson River

In Nooaitch's filed evidence (Filing ID A4Q0F4), NHC state:

> "58. Site-specific estimates of designs scour depths and concept-level designs should be included in the Project Application for all crossings with fish, fish habitat or connection to fish habitat; substantial hydrotechnical risk of exposure; or potential for pipeline failure to impact human safety or infrastructure.
>
> 59. Re-alignment of the HDD crossing for Coldwater River at RK 958 should be considered to reduce the risk of pipeline exposure due to erosion and channel avulsion.
>
> 60. The HDD crossing design for Thompson River at RK 847 should be reviewed to assess the risk of avulsion and lateral bank erosion on the south bank near the entry point. Unless there is low risk of erosion or channel avulsion, the pipeline should be buried below the 1 in 200 year scour depth throughout the floodplain.

61. The HDD crossing design for Coldwater River at RK 958 should be reviewed to address lateral channel instability in the Coldwater River floodplain. The pipeline should be buried below the 1 in 200 year scour depth throughout the floodplain. 62. The HDD crossing design for Coldwater River at RK 958 should be reviewed to address potential lateral instability on the alluvial fan near the HDD exit point. If the fan is active, the pipeline should be buried below the 1 in 200 year scour elevation throughout the active area.

62. The HDD crossing design for Coldwater River at RK 958 should be reviewed to address potential lateral instability on the alluvial fan near the HDD exit point. If the fan is active, the pipeline should be buried below the 1 in 200 year scour elevation throughout the active area."

Site-specific recommendations for minimum depth of cover will be included in the hydrotechnical design report for all watercourse crossings identified along the proposed Line 2 route. Minimum depth of cover incorporates estimated bed scour and channel degradation potentials.

Hydrotechnical hazards were evaluated at the crossing of the Thompson River at RK 847 and summarized in a report titled Preliminary Geotechnical HDD Feasibility Assessment, Thompson River at V10 RK 846.8 (Filing ID A4I6H8). Based on a historical assessment of bank stability, and current vegetation on the banks of the river, erosion is not considered a hazard in the vicinity of the proposed crossing. Moreover, the channel is restricted within a wide floodplain at the proposed crossing and has a limited capacity for lateral migration or avulsion due to presence of urban development on both channel banks and confinement from high (>100 m) fluvial terraces that dominate the river valley. No relic channel scars have been identified in the vicinity of the crossing. Given these observations, avulsion is not considered a hazard at the proposed crossing. Irrespective of the limited potentials for avulsion and bank erosion at the proposed crossing, the proposed borepath remains at depths that exceed the expected 200-year scour depth.

Hydrotechnical hazards were evaluated at the crossing of the Coldwater River at RK 958 and summarized in a report titled Preliminary Geotechnical HDD Feasibility Assessment, Coldwater River 1 at V10 RK 957.9 (Filing ID A4I6E2). In this report, bank erosion and avulsion were identified as active and characterized as follows:

- Significant lateral migration of the channel (up to 120 m at the reach scale, and about 20 m at the crossing) was observed over the past 65 years.
- Relic channel scars were identified approximately 250 m upstream and 300 m downstream of the crossing. Hydraulic modelling indicated that the right bank of the river could be overtopped by the design flood event, which could lead to the incision of an avulsion channel in the northern terrace given its relative flatness.

Given the magnitude of historical rates of lateral migration of the channel, and that the proposed entry and exit points of the HDD borepath are located approximately 175 m away from the current active channel, bank erosion at the proposed Line 2 pipeline crossing is not considered a hazard.

Given the potential for avulsion along the right bank of the channel, a minimum depth of cover of 2.0 m was recommended to the north of the entry point, and across the river's floodplain. No significant hydrotechnical hazards were found in relation to the alluvial fan near the proposed exit point.

14.7 Hydrological Regime of the Nicola River

In Nooaitch's filed evidence (Filing ID A4Q0F4), NHC state:

> "25. Peak and seasonal flow estimates for the Nicola River crossing at RK-928 should be re-done using the gauge Nicola River at Outlet of Nicola Lake (WSC 08LG065)."

Trans Mountain agrees that the hydrometric gauge Nicola River at Outlet of Nicola Lake (WSC 08LG065) is the most representative of conditions at the proposed crossing of the Nicola River. As such, instantaneous peak flows recorded at this gauge were used in a FFA to derive flood quantiles including the 200-year peak flow used as design basis. The GEV distribution was fit onto the instantaneous peak flow records using the linear moment method of inference. Resulting flood quantiles are presented in Table 14-1.

TABLE 14-1

FLOOD QUANTILES AT HYDROMETRIC GAUGE 08LG065

Return Period (Years)	Flood Quantiles (m^3/s)
2	30
5	43
10	50
25	57
50	61
100	64
200	67

These flood quantiles were subsequently prorated to the proposed crossing of the Nicola River. The resulting 200-year instantaneous peak flow estimated at the proposed crossing is 71 m^3/s. It is important to note that although flow recorded at hydrometric gauge 08LG065 are representative of those at the proposed crossing, they are regulated by the upstream reservoir, and as such do not represent natural conditions.

Results from a dam break and inundation study by Golder Associates Ltd. (Golder) reported a dam breach outflow controlled by the hydraulic characteristics of the approach channel and equal to 122 m^3/s. Although peak flow is expected to attenuate as the flood wave travels downstream, attenuation was assumed negligible between the dam and the location of the proposed pipeline crossing. Therefore, a peak flow equal to 122 m^3/s was used as design basis for the estimation of hydrotechnical hazards at the proposed crossing. Using a peak flow value of 70 to 73 m^3/s as design basis, as recommended by NHC, as opposed to the retained 122 m^3/s would likely result in underestimating the magnitude of hydrotechnical hazards and in the provision of an inadequate crossing design.

Hydrometric gauge 08LG065 was however deemed representative of average flow conditions and was used to estimate monthly average flows to support construction timing. Note that average flow dynamics is only relevant to the construction of the trenched contingency crossing method of the Nicola River. Note that HDD was retained as the primary crossing method and related construction techniques are virtually insensitive to flow conditions at the time of construction.

Daily streamflow records were aggregated by month and statistics such as average and median flow, and upper and lower quartiles were provided. Monthly flow statistics calculated at the gauge were prorated linearly to the location of the proposed crossing based on catchment area. As stated above, monthly flow statistics were determined to support the construction schedule. The inter quartile range is the difference between the upper quartile and the lower quartile (Table 19-2). It contains 50% of the flow variability within each month and illustrates the breadth of streamflow dynamics.

Monthly flow averages provided in the Physiography and Hydrology Report at the proposed crossing of the Nicola River was derived from a regional analysis, leading to underestimating monthly averages for the months of May and August, and overestimating monthly averages for the months of June and July. Revised monthly flow statistics based on daily records at hydrometric gauge 08LG065 are summarized in Table 14-2.

TABLE 14-2

MONTHLY FLOW STATISTICS AT THE PROPOSED CROSSING OF THE NICOLA RIVER

	Average Discharge (m^3/s)	Median Discharge (m^3/s)	Lower Quartile (m^3/s)	Upper Quartile (m^3/s)
Jan	1.6	1.4	1.2	2.2
Feb	1.9	1.5	1.2	2.3
Mar	2.5	1.5	1.2	2.5
Apr	4.1	2.3	1.4	4.9
May	16.8	16.7	4.9	23.9
Jun	18.0	14.6	7.0	25.5
Jul	7.2	5.2	3.6	9.0
Aug	4.1	3.3	2.9	4.1
Sep	2.5	2.3	2.0	2.9
Oct	2.1	2.0	1.6	2.5
Nov	2.0	1.9	1.5	2.4
Dec	1.7	1.5	1.1	2.2

14.8 References

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15.0 SEISMIC HAZARDS

15.1 Project Design Basis

In their Written Evidence, Burnaby Residents Opposing Kinder Morgan Expansion (BROKE) (Filing ID A4L6U4) express concern regarding the Project's seismic design basis.

As described in the Project's seismic assessment desktop study (Application Volume 4A, Project Design & Execution - Engineering, Appendix J - Seismic Assessment Desktop Study Report, Filed with the NEB December 16, 2013, Filing ID A3S1F6), the Project will be designed to withstand:

- The larger of:
  - Ground motions with a 1:2,475 annual exceedance probability, as provided by the National Building Code of Canada (NBCC), modified to reflect site conditions. The 2010 NBCC ground-motion model is currently in force. An updated ground-motion model is due to be released in 2015.
  - Deterministic ground-motion predictions for credible earthquake sources modified to reflect site conditions. Trans Mountain defines a credible earthquake source as having been demonstrably active within the Holocene epoch. Trans Mountain will consider median values from the three alternative ground-motion prediction equations for western Canadian earthquake sources proposed for the 2015 NBCC by Atkinson and Adams (2013).
- Permanent ground displacement, transient ground displacement, and seismic wave propagation arising from earthquakes that produce design-level ground motions.

15.1.1 Model Selection

The Project's seismic hazard assessment uses values from the 2010 NBCC model, as it is the model currently in force. In June 2014, the Canadian Commission on Building and Fire Codes (2014) released 1:2,475-year seismic hazard values from the 2015 model for public comment, not engineering use. Peak ground acceleration (PGA) and spectral acceleration at time ($S_a(T)$) values (units of gravitational acceleration [g]) for selected locations along the pipeline route from the proposed 2015 and current 2010 models are presented in Table 15-1.

TABLE 15-1

PEAK AND SPECTRAL ACCELERATIONS FROM THE 2015 AND 2010 NBCC SEISMIC HAZARD MODELS AT THE 1:2,475 HAZARD LEVEL

Location	Model	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)	PGA
Simon Fraser University (SFU)	2015	0.77	0.67	0.39	0.24	0.076	0.027	0.33
	2010	0.93	0.63	0.32	0.17	N/A	N/A	0.46
New Westminster	2015	0.80	0.70	0.40	0.24	0.077	0.027	0.35
	2010	0.99	0.66	0.33	0.17	N/A	N/A	0.49
Surrey 88th Ave. & 156 St.	2015	0.79	0.69	0.39	0.24	0.076	0.027	0.34
	2010	1.00	0.69	0.33	0.17	N/A	N/A	0.52
Cloverdale	2015	0.80	0.70	0.40	0.24	0.077	0.027	0.35
	2010	1.10	0.72	0.33	0.17	N/A	N/A	0.54
Langley	2015	0.77	0.67	0.39	0.24	0.076	0.027	0.35
	2010	1.10	0.71	0.33	0.37	N/A	N/A	0.53
Abbotsford	2015	0.70	0.60	0.35	0.22	0.071	0.025	0.31
	2010	0.99	0.66	0.32	0.17	N/A	N/A	0.49
Chilliwack	2015	0.54	0.45	0.28	0.17	0.062	0.021	0.24
	2010	0.76	0.52	0.30	0.16	N/A	N/A	0.36
Hope	2015	0.36	0.30	0.20	0.13	0.051	0.017	0.17
	2010	0.63	0.47	0.28	0.15	N/A	N/A	0.29
Merritt	2015	0.21	0.18	0.13	0.09	0.037	0.011	0.10
	2010	0.34	0.26	0.16	0.09	N/A	N/A	0.17
Kamloops	2015	0.15	0.12	0.09	0.06	0.029	0.009	0.07
	2010	0.28	0.17	0.10	0.06	N/A	N/A	0.14
Jasper	2015	0.29	0.19	0.10	0.05	0.017	0.005	0.13
	2010	0.24	0.14	0.07	0.04	N/A	N/A	0.12
Hinton	2015	0.28	0.18	0.10	0.04	0.015	0.005	0.00
	2010	0.24	0.14	0.06	0.04	N/A	N/A	0.12
Edson	2015	0.17	0.11	0.06	0.03	0.009	0.004	0.09
	2010	0.15	0.08	0.04	0.02	N/A	N/A	0.08
Stony Plain	2015	0.12	0.07	0.04	0.02	0.006	0.003	0.07
	2010	0.10	0.06	0.03	0.01	N/A	N/A	0.04
Edmonton	2015	0.10	0.06	0.04	0.02	0.005	0.002	0.06
	2010	0.10	0.06	0.03	0.01	N/A	N/A	0.04

In general, the 2015 model provides smaller ground and short-period spectral accelerations, and larger long-period spectral accelerations, in southwestern British Columbia. Elsewhere, the 2015 model provides equivalent or slightly larger ground and spectral accelerations. The 2010 model does not provide peak ground velocity, nor does it provide spectral accelerations at 5 and 10 second periods.

As stated in a response to Natural Resources Canada IR No. 1.02.0 (Filing ID A3X6G0), the Project will use the latest edition of the NBCC, as applicable to the structures and locations in effect at the time of design/construction. If the 2015 model comes into force before final design and construction, the Project may elect to adopt smaller design ground motions in southwestern British Columbia. In some locations, the 2015 model's ground motions might be smaller than those which might be produced by credible local earthquake sources, whereas the 2010 model's ground motions might have been larger. There, the deterministic ground motions would govern the Project's seismic design. Section 15.2 provides more details on which local earthquake sources would govern the design-level ground motions at particular sites.

15.1.2 Return Period Selection

The Project has adopted the 1:2,475 annual exceedance probability ground motions as its design basis, except where a credible local earthquake source could produce larger ground motions. As reiterated by BROKE (Filing ID A4L6U4, page 14):

> *…similar seismic design standards have been adopted by FortisBC for buried natural gas pipelines (2,500 year return period), and by BC Ministry of Transportation for seismic retrofit of existing highway bridges (475 year return period), and by the Greater Vancouver Liquefaction task force (2,475 year return period). Also, the American Lifelines Alliance guidelines for water, and oil and natural gas pipeline systems have 475 to 2,475 year return periods based on the assigned societal importance of the pipeline, and the Canadian Highway Bridge Design Code for new highway bridges uses a 2,475 year return period.*

BROKE cites dams and nuclear power plants as high consequence facilities to which higher design standards are often applied. For example, the International Commission on Large Dams recommends that high-consequence dams - those that would present a great societal hazard in the event of failure - be designed to withstand earthquake ground motions with a 1:10,000 annual exceedance probability. BC Hydro is beginning a program to re-build or retrofit each of their 41 hydroelectric dams to withstand an earthquake equivalent to a 1:10,000-year event. The consequences of a failure of a large dam or nuclear power can include widespread economic impacts and casualties. In citing these cases, BROKE attempts to show that Trans Mountain's proposed design standard is insufficient.

BROKE also describes geohazard risk-tolerance criteria used by the District of North Vancouver (North Vancouver), and refers to similar criteria used in the United Kingdom, Hong Kong, Australia, and the Netherlands. BROKE (Filing ID A4L6U4, page 15) provides the following details for North Vancouver's criteria:

> *The Official Community Plan (OCP) contains formal risk tolerance criteria developed by the community to help guide decision making in areas exposed to natural hazards. The task force proposed that new developments be subject to a risk tolerance criteria of 1:100,000 risk to life per year for individuals.*

In citing risk-tolerance standards, BROKE fails to note that risk is not the same as hazard. Risk is the product of a hazard's likelihood and its consequences (CSA 2015). The actual recommendation to North Vancouver Council (Dercole 2009) proposes that seismic design refer to 1:475 and 1:2,475 hazard levels for existing and proposed development, respectively. The 1:100,000 risk tolerance criterion cited by BROKE is not a seismic hazard criterion.

15.1.3 Design Parameters

The Project's seismic hazard assessment (Filing ID A3S1F6) describes earthquake hazard in terms of PGA. The assessment also describes moment magnitude (M_w) ranges for historical earthquakes, and expected magnitudes for subduction-interface, in-slab, and shallow-crustal events.

Seismic design guidelines for pipelines (*e.g.,* American Lifelines Alliance 2001 and 2005; Honegger and Nyman 2004; O'Rourke and Liu 2012) recommend using:

- Peak ground velocity (PGV) to evaluate the effects of seismic wave propagation. Note that there is a "lack of a single reported case of failure of ductile, full penetration welded natural gas or liquid hydrocarbon pipeline attributable to seismic wave propagation alone" (Honegger and Nyman 2004, page C2-16).
- PGA for liquefaction and landslide triggering.
- Earthquake magnitude, distance, and PGA for permanent ground displacement due to liquefaction or landsliding.
- Earthquake time histories for transient ground deformation and detailed finite-difference analysis of permanent ground displacement. Honegger and Nyman (2004) state that modern, continuous, welded-steel oil transmission pipelines are not vulnerable to transient ground deformation.

BROKE (Filing ID A4L6U4, page 16) states:

> *PGA and PGV only convey the maximum amplitude of shaking experienced. Other important metrics, such as the time duration or dominant frequency of strong shaking, are not known from PGA or PGV.*

Spectral accelerations are not relevant to a buried pipeline. A buried pipeline is, by definition, encased in the ground. It is not free to oscillate in tune with its weight and stiffness, as a building or other above-ground structure might be. Thus, ground shaking amplitudes like PGA and PGV - not amplitudes at any particular spectral frequency - are the relevant design parameters for the pipeline itself. Short-period spectral accelerations and velocities might apply to above-ground structures related to the pipeline (*e.g.*, pump and valve stations). Long-period spectral accelerations apply to taller or less-stiff above-ground structures (*e.g.*, very tall buildings, bridge towers, long above-ground pipeline segments, etc.), not to a buried pipeline.

The duration of strong shaking determines, in part, the amount of permanent ground displacement where landslides or liquefaction are triggered by seismic shaking. Earthquake magnitude and site PGA determine whether or not landslides (APEGBC 2010) or liquefaction (Boulanger and Idriss 2014) occur. Magnitude is a proxy for shaking duration in state-of-practice ground displacement models for landslides (Bray and Travarasou 2007) and liquefaction (Youd *et al.* 2002; Zhang *et al.* 2004). Thus, the seismic hazard parameters used by the Project are appropriate for pipeline design; other parameters, while important for other purposes, are irrelevant here.

15.2 Comparing Deterministic Scenarios to the Project Design Level

BROKE present ground motion predictions for deterministic in-slab and shallow-crustal earthquake scenarios to identify which might produce PGA or PGV in excess of the Project's 1:2,475 design basis. BROKE also describes, in general terms, the potential effects of shaking duration, long-period ground motions, aftershocks, landslides, and liquefaction during an M 9 subduction-interface event. Metro Vancouver (Filing ID A4L7Y3) and its consultant, Zoetica Environmental Consulting Services (Filing ID A4L8C2), question whether an M 9 subduction-interface event would produce unacceptable ground motions and displacement. These issues are explored below for each earthquake type.

15.2.1 In-Slab Earthquakes

BROKE (Filing ID A4L6U4, page 18) presents distances at which ground motions from hypothetical in-slab earthquakes would exceed those predicted by the upcoming 2015 model at Burnaby Mountain. The 2015 model's ground motion estimate is derived from a combination of three alternative ground-motion prediction equations (GMPEs) (Atkinson and Adams 2013). However, BROKE's distance predictions refer to only the upper alternative GMPE. The middle and lower alternative equations do not yield PGA > 0.33 g at any epicentral distance.

Table 15-2 reproduces BROKE's estimates for epicentral distance that yields PGA **> 0.33 g** using the upper GMPE alternative, and adds annual rates of earthquakes of that magnitude or larger within that distance, based on magnitude-recurrence relationships for the 2015 model (Halchuk *et al.* 2014). The M 7.5 distance estimate provided by BROKE is omitted: the in-slab source zone's upper-bound magnitude-recurrence curve is truncated at M 7.5, so M 7.5 or larger in-slab earthquakes are not credible, and their rate is effectively zero.

TABLE 15-2

EPICENTRAL DISTANCES AND ANNUAL RATES FOR IN-SLAB EARTHQUAKES THAT COULD PRODUCE PGA > 0.33 g USING THE UPPER ALTERNATIVE GMPE

Magnitude	Distance (km)	Rate Within Source Zone	Rate Within Epicentral Distance to Burnaby Mountain
7.00	-	5.2×10^{-3}	n/a
7.25	40	9.0×10^{-4}	1.6×10^{-4}

Using the weighted average of magnitude-recurrence relationships for the Georgia Strait - Puget in-slab source zone (Halchuk *et al.* 2014), an in-slab earthquake close enough to produce PGA in excess of the 2015 NBCC model predictions at Burnaby Mountain should occur, on average, once in about 6,000 years (the inverse of the rate for M 7.25 earthquakes).

The upper and middle GMPE yield PGV larger than the 2015 NBCC model prediction (0.5 m/s) for magnitude 7.5 earthquakes at epicentral distances of 63 and 40 km, respectively. However, M 7.5 in-slab earthquakes are not considered reasonable given the most current seismological information (Halchuk *et al.* 2014). In other words, there are no credible in-slab scenarios which would generate PGV in excess of the 2015 NBCC model prediction at the Project's 1:2,475 design level.

Trans Mountain agrees with BROKE's statement that the seismic risk to TMEP infrastructure from in-slab earthquakes is negligible to low.

15.2.2 Shallow-Crustal Earthquakes

15.2.2.1 Scenario Likelihoods

BROKE (Filing ID A4L6U4, page 19) presents epicentral distances at which ground motions would exceed the 2015 NBCC model prediction at Burnaby Mountain, for a range of shallow-crustal earthquake magnitude scenarios. As with in-slab earthquakes, BROKE offers predictions only for the upper alternative GMPE, and does not place those predictions in context with the probability of each scenario (*i.e.*, each magnitude-distance pair). Table 15-3 adds critical epicentral distances for the central and lower alternative GMPEs and earthquake rates within those critical distances for scenarios producing PGA > 0.33 g. Rates are obtained from the Vancouver Island - Coast Mountains source zone's magnitude-recurrence curves, using the source model's assumption of uniform hazard distribution within each source zone (Halchuk *et al.* 2014). The M 7.75 increment value provided by BROKE is omitted: Halchuk et al (2014) assign M 7.7 as the maximum magnitude for their upper-bound magnitude-recurrence curve alternative, and therefore, M 7.75 is not reasonable.

TABLE 15-3

SHALLOW-CRUSTAL EARTHQUAKE EPICENTRAL DISTANCES (km) AND RATES (EVENTS PER YEAR) TO PRODUCE PGA > 0.33 g FOR THE UPPER, CENTRAL, AND LOWER ALTERNATIVE GMPES OVER A CREDIBLE RANGE OF MAGNITUDES

Magnitude	Upper Alternative		Central Alternative		Lower Alternative	
	Distance	Rate within Distance	Distance	Rate within Distance	Distance	Rate within Distance
5.50	3	6.3×10^{-6}	-	0	-	0
5.75	4	7.3×10^{-6}	-	0	-	0
6.00	5	7.4×10^{-6}	4	4.7×10^{-6}	-	0
6.25	8	1.2×10^{-5}	6	6.7×10^{-6}	-	0
6.50	10	1.2×10^{-5}	10	1.2×10^{-5}	8	7.4×10^{-6}
6.75	16	1.8×10^{-5}	13	1.2×10^{-5}	10	6.9×10^{-6}
7.00	20	1.5×10^{-5}	16	9.7×10^{-6}	16	9.7×10^{-6}
7.25	25	1.1×10^{-5}	25	1.1×10^{-5}	20	6.7×10^{-6}
7.50	35	3.9×10^{-6}	32	3.2×10^{-6}	25	2.0×10^{-6}

15.2.2.2 Aftershocks

BROKE describes a scenario in which an M 7 earthquake within 5 km of Burnaby Mountain is followed by one M 6-7 and two M 5-6 aftershocks, all of which could produce PGA in excess of 0.33 g. Using the conservative upper GMPE and assuming the aftershock sequence for an M 7 or larger mainshock is as described by BROKE, such an event might occur once in about 48,000 years. The PGV threshold exceedance rate is lower than that for PGA.

15.2.2.3 Strait of Georgia Fault Scenario

BROKE (Filing ID A4L6U4, page 20) presents ground motion predictions for Burnaby Mountain from a hypothetical M 7.7 scenario - the largest magnitude considered credible by Halchuk *et al.* (2014) anywhere within the Vancouver Island-Coast Mountains source zone - applied to the Strait of Georgia fault. BROKE uses those ground motions to support a statement about the fault being capable of producing ground motions at soft-ground sites in excess of the 2015 NBCC model results. However, BROKE provides no rationale for applying this magnitude to the

Strait of Georgia fault. There is no geological or seismological evidence to support this scenario. Also, BROKE fails to understand that the project's design intent is to account for site conditions.

BROKE also presents ground motion predictions for an M 7.3 scenario on the Strait of Georgia fault, and acknowledges that they are likely lower than the 2015 NBCC model predictions.

15.2.2.4 Boulder Creek Fault Scenario

BROKE (Filing ID A4L6U4, page 20) correctly finds that ground motions predicted for a credible M 6.8 scenario on the Boulder Creek fault, 16 km from the proposed TMEP through Sumas, will not exceed the 2010 NBCC model predictions, but could exceed those predicted by the 2015 model. As described in the Project's seismic hazard assessment and re-iterated in Section 15.1 above, the Project's design intent is to use the higher of the in-force probabilistic values or deterministic values. Accordingly, site-specific designs will refer to the Boulder Creek fault scenario where its ground motions exceed the in-force NBCC model in force at the time of detailed design and construction. To date, site-specific liquefaction investigations (Filing ID A4K0Z3) around Sumas have used the higher 2010 NBCC values. Accordingly, Trans Mountain believes the risks associated with earthquakes along the Boulder Creek fault have been suitably addressed and residual risk will be negligible to low.

15.2.2.5 Sandy Point, Drayton Harbor, and Birch Bay Fault Scenarios

BROKE (Filing ID A4L6U4, page 21) states:

> *For a M ≥ 7 earthquake on the Sandy Point, Drayton Harbour or Birch Bay Faults, the seismic risk to the TMEP infrastructure is considered as moderate to high.*

However, BROKE provides no evidence to support M ≥ 7 earthquakes on these faults. As described in the Project's seismic hazard assessment, the maximum trace lengths support characteristic magnitudes between 6 and 6.5; these would produce ground motions lower than the 2015 NBCC model predictions at the TMEP. Trans Mountain disagrees with BROKE's assessment of risk for these faults.

Given the shallow-crustal recurrence rates and the assessment of BROKE's scenarios described above, Trans Mountain considers the seismic risk to TMEP infrastructure from shallow-crustal earthquake as low.

15.2.3 Subduction-Interface Earthquakes

BROKE (Filing ID A4L6U4, page 22) finds that earthquake ground motions from earthquakes along the Cascadia subduction zone should be smaller than the NBCC 1:2,475 hazard along the TMEP corridor. BROKE identifies three other concerns related to great subduction earthquakes: shaking duration, long-period ground motions, and time-dependent shaking hazards.

15.2.3.1 Long-Duration Shaking

BROKE (Filing ID A4L6U4, page 22) cite Raghunandan and Liel (2012) to describe the impact of long-duration shaking as follows:

> *In a modelling study of Pacific Northwest building types the median collapse capacity of the ductile (post-1970) buildings is ~40% less when subjected to subduction earthquake recordings with long durations compared to crustal earthquakes of the same intensity.*

In summarizing their study, Raghunandan and Liel (2012, page 131) state:

> *For a ductile concrete building having a period of 1s, this difference in ground shaking durations corresponds to 40% reduction in median collapse resistance.*

The 40% difference cited by BROKE is not for all structures; it refers specifically to ductile concrete buildings with 1 s periods, *i.e.,* those that are about 30 m in height (BSSC 2003). This applies to neither the pipeline nor the associated above-ground infrastructure. BROKE fails to cite a collapse capacity appropriate to TMEP infrastructure. While there is a relationship between building vulnerability and shaking duration, the effect on TMEP infrastructure is not as implied by BROKE.

15.2.3.2 Long-Period Ground Motions

As described in Section 15.1.3 above, and in Trans Mountain's response to BROKE IR No. 2.6k (Filing ID A4H7Z4), the pipeline is not adversely affected by long-period ground motions as it is encased in the ground. Permanent ground displacement, not ground shaking severity, is the parameter of interest in buried pipeline design.

15.2.3.3 Time-Dependent Shaking Hazards

BROKE (Filing ID A4L6U4, page 22) cites Seeman *et al.* (2008) in stating:

> *The probability of Cascadia megathrust aftershocks exceeding moderate shaking (MMI V) is 17-70% and strong shaking (MMI VI) is 1-6% in Vancouver.*

Seeman *et al.* (2008) estimate that the probability of very strong shaking (MMI VII) in Vancouver is less than 0.5% in the 12 months after a Cascadia subduction-interface earthquake. These probabilities are conditional upon the subduction-interface earthquake's occurrence; their actual probability is the conditional probability multiplied by the annual probability of an interface event. The probability of an M 9 subduction-interface earthquake during the next 50 years is 0.17 (Kulkarni *et al.* 2013); the associated annual probability is about 0.37%, or 1:270. So the probabilities of the MMI V, VI, and VII aftershock scenarios described by BROKE are about 0.06-0.2%, 0.004-0.02%, and less than 0.002%, respectively.

The 2015 NBCC model predicts 0.33 g PGA in Burnaby at the 1:2,475 hazard level; this corresponds with MMI VII (Wald *et al.* 1999). The annual probability of a Cascadia subduction earthquake aftershock that produces comparable ground shaking is about 1:50,000. Potentially damaging Cascadia earthquake aftershocks are too unlikely to warrant explicit design consideration.

15.2.3.4 Ground Displacement and Pipeline Vulnerability

Metro Vancouver (Filing ID A4L8C0) and its consultant, Zoetica (Filing ID A4L8C2), describe the environmental impact of ground displacement associated with liquefaction or lateral spreading during an M 9 subduction-interface earthquake. Zoetica (Filing ID A4L8C2, page 93) state that M 9 scenario models by Cascadia Region Earthquake Workgroup (CREW; 2013) found that:

> *…if such an earthquake struck, many of the region's refined fuel terminals and numerous pump stations along the pipeline system will suffer damage, with ground displacement causing numerous breaks and leaks in both crude- and refined-product pipelines.*

The Cascadia scenario refers to existing pipeline infrastructure all along the Pacific Northwest coast, from northern California through to southwestern British Columbia. Neither CREW (2013), Zoetica, nor Metro Vancouver have evaluated the proposed TMEP; Zoetica and Metro Vancouver have simply extrapolated CREW's general, region-wide comment to the Project.

The Project's seismic hazard update (Filing ID A4K0Z3) used site-specific geotechnical data and earthquake hazard parameters used in the 2010 NBCC model at the 1:2,475 hazard level to estimate ground displacement. As described above, and as acknowledged by BROKE, the 2010 model's ground-motion predictions are larger than median values predicted by the three alternative GMPEs of Atkinson and Adams (2013) for any known credible earthquake source, including subduction-interface earthquakes. An M 9 subduction-interface event might trigger liquefaction at some of the highest-susceptibility sites along the proposed route; however, the 2010 1:2,475 hazard values used in the seismic hazard update should yield larger displacements. Thus, ground displacement triggered by an M 9 subduction-interface earthquake would not affect infrastructure designed in accordance with the Project's seismic hazard update. Any forthcoming revisions that incorporate the 2015 NBCC model's lower hazard values will also incorporate deterministic scenarios, including shallow-crustal and subduction-interface events.

15.3 Amplification Factors

The 2010 NBCC provides spectral acceleration amplification/deamplification factors (F_a). Typical practice in the Lower Mainland region, such as the Greater Vancouver Liquefaction Task Force (2007), is to modify PGA for site conditions using F_a. This practice exists because when the 2010 NBCC came into force, there had not been enough data/research to support the development of a PGA-specific amplification/deamplification factor (F_{PGA}). This use of F_a is fundamentally incorrect and inconsistent because F_a is intended to modify short period structural response for site classes other than the reference ground condition (Site Class C). PGA, however, is not a spectral parameter but is the acceleration at the ground surface. It does not reflect the response of a structure above the ground surface. Hence using spectral acceleration F_a factors to amplify/deamplify PGA to account for site response effects is not fundamentally correct. Since NBCC 2010 came into force, much more earthquake response data has been compiled to develop these site factors (Choi and Stewart 2005; Stewart and Seyhan 2013). Hence it is an expected advancement to use appropriately developed F_{PGA} factors for PGA amplification/deamplification, rather than using inappropriate F_a factors.

The new site factors including F_{PGA} reported by Stewart and Seyhan (2013) have been approved by the Provisions Update Committee of the Building Seismic Safety Council and are expected to appear in the 2015 National Earthquake Hazards Reduction Program

Recommended Seismic Provisions Update by the Federal Emergency Management Agency in the United States. Generally, the techniques and technologies contained in this resource document have been largely diffused into model building codes and several standards, including the American Society of Civil Engineers ASCE-7, Minimum Design Loads for Buildings and Other Structures (ASCE 2003). The new version of ASCE-7 standard is targeted to be sent out for public comment in late 2015 with the goal of publishing the standard in Fall 2016. These factors have also been implemented in the NGA-West2 GMPEs (Boore *et al.,* 2013), used in the 2014 update of the U.S. Geological Survey's National Seismic Hazard Maps (Petersen *et al.* 2014). A similar approach for defining F_{PGA} factors will most likely be part of the 2015 or 2020 NBCC update.

Table 15-4 compares F_{PGA} factors proposed by Stewart and Seyhan (2013) with F_a factors recommended by NBCC 2010 for site classes and PGA ranges generally applicable for liquefaction assessment in the Lower Mainland. For Site Class E, F_{PGA} factors are greater than F_a factors; for Site Class D, F_a factors are greater. Site Class C is the reference site class with F_{PGA} and F_a factor of unity. For all Site Class and PGA combinations in the table (except one: Site Class D at PGA=0.5), the difference between F_{PGA} and F_a is less than ±10%. Due to this mixed observation, it cannot be concluded that one set of factors may produce more conservative liquefaction triggering outcome over the other set of factors. In addition, as described earlier, the application of spectral acceleration amplification factor, F_a, to PGA is not fundamentally correct. Hence, the TMEP project decided to use the more applicable set of amplification factors for liquefaction triggering assessment.

TABLE 15-4

COMPARISON OF F_{PGA} AND F_A AMPLIFICATION FACTORS

	PEER, Stewart and Seyhan 2013			NBCC, 2010		
	F_{PGA}			F_a		
Site Class	PGA=0.3	PGA=0.4	PGA=0.5	PGA=0.3 [S(a)~0.61]	PGA=0.4 [S(a)~0.82]	PGA=0.5 [S(a)~1.02]
C	1	1	1	1	1	1
D	1.08	1	0.92	1.16	1.1	1.1
E	1.33	1.17	1	1.28	1.06	0.9

15.4 Seismic Hazard Mitigation

Doherty (Filing ID A4L8U3) describes damage during past earthquakes in Nepal (2015) and Alaska (1946 and 1964), including effects on pipeline infrastructure (page 5) as follows:

> *We have evidence from earthquakes in Alaska that serious harm occurred in the past. Pipelines burst, oil tanks burned, and the area was in chaos for a considerable amount of time. On April 1, 1946, a massive 8.1 earthquake in Alaska triggered a Pacific-wide tsunami that killed 159 people, and caused $26 million in damages. A 9.2 earthquake in Alaska in 1964, also triggered a tsunami of similar intensity. The area continues to have earthquakes regularly, and industry has built facilities well above standard as a means of lessening the harm of yet another significant earthquake.*

Doherty (Filing ID A4L8U3, page 6) uses these examples as a rationale for the following:

> *I would like Trans Mountain to commit to using construction standards well above the accepted standards to ensure we do not experience serious outfalls resulting from a quake of similar intensity. This means using piping that is of greater quality than standard piping.*

As indicated in the Risk Assessment Report for Line 2 and the New Delivery Lines, (Filing ID A3Z8G1), Trans Mountain is committed to undertaking a risk-based design approach with respect to selection of pipe wall thickness and other mitigation responses to seismic hazards. Risk-based design is a rigorous approach that goes beyond the minimum requirements of the CSA Z662 code. It is an industry-leading, world class design approach that will enable the design team to identify potential risks along Line 2 and the new delivery lines, and to pre-emptively adopt mitigation measures at the design phase to address those risks.

The preliminary seismic assessment desktop study (Filing ID A3S1F6) investigated seismic hazards related to liquefaction and seismically triggered landslides along the proposed TMEP corridor. The liquefaction hazard potential was classified for different areas along the corridor based on the findings from this desktop study as “very high,” “high,” “moderate,” “low” or “very low.” Detailed liquefaction triggering and lateral-spread displacement analyses, based on site-specific subsurface geotechnical investigations, were completed at sites with “very high” liquefaction potential and filed with the NEB (Filing ID A4K0Z3). Similar assessments are ongoing at sites with comparatively lower liquefaction potential.

Lateral spread displacement predictions will be compared against the acceptable displacement associated with the pipe’s stress and strain capacity, and will determine whether the pipeline remains within the allowable design limits according to industry codes and standards. If the pipeline response is outside the allowable design limits, then design mitigation measures will be assessed. Examples of potential mitigation measures include: pipe material, pipe wall thickness, mechanical protection (such as concrete coating), reduced welding imperfection allowances, and construction methodology (such as appropriate earthen backfill materials to limit restraint of the pipeline). Re-alignment of the pipeline route at a site-specific location is also a design solution employed to address geohazard and seismic mitigation.

TMEP pipeline, including line pipe and heavy-wall pipe (but excluding facilities pipe), will be made of low carbon, high strength, low alloy, Grade 483 steel. The nominal pipe size (NPS) 42, 36, 30 pipe will be manufactured in accordance with CSA Z245.1, Steel Pipe and KMC Standard MP2120 Main Line Pipe Material. All mainline pipe will be manufactured using standard manufacturing procedures for longitudinal and/or helical seam (spiral) submerged arc welded pipe with controlled rolling practices utilized to improve strength, ductility, weldability, and toughness properties of the pipe.

These mitigation measures, once incorporated into the final design, will reduce failure likelihood and/or consequence (and hence risk) by targeting risk mitigation strategies directed at the principal drivers of risk that have been identified in the risk assessment. The iterative risk-based design approach described in the documents cited above is currently underway, and will continue to progress through to detailed design. Until this process is completed, a full list of detailed and specific risk mitigation measures that will be incorporated into the final design, and the risk that is associated with that final design, will not be available.

15.5 Seismic Hazard Considerations for the Burnaby Mountain Tunnel

Doherty (Filing ID A4L8U3, page 6) states:

> *…Trans Mountain must build the Burnaby Mountain tunnel with access to make repairs in the case of ruptures or other emergencies. Double piping may help ensure the environment is not damaged by leaks, ruptures, or spills.*

As outlined in Project and Technical Update No. 4, Westridge Delivery Pipelines Routing Update, Filed with the NEB on December 1, 2014 (Filing ID A4F5D5), Trans Mountain intends to backfill the tunnel with impermeable concrete for two reasons: to prevent the tunnel becoming a flow path for groundwater; and to block the flow of oil products in the low-likelihood event of a leak. Further information on this, as well as justification to why further secondary containment within the tunnel against leaks is not required, can be found in Trans Mountain's response to NEB IR No. 3.103 (parts c, e, g, and j) (Filing ID A4H1V2), filed with the NEB on February 3, 2015. These responses outline the risk analysis and discussions of alternative options with regards to leak containment. As such, methods such as heavy walled piping and access to the tunnel to undertake repairs are not necessary.

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16.0 PIPELINE CONSTRUCTION PLANNING & EXECUTION

16.1 General

This section of Trans Mountain's Reply Evidence addresses the Intervenor Evidence submitted by Metro Vancouver, City of Coquitlam, City of New Westminster, City of Abbotsford, Yarrow EcoVillage, and Calvin Taplay related to construction planning and execution for the pipeline portion of the Project.

16.1.1 Construction Standards

Metro Vancouver (Filing ID A4L7Y3, Section 5.11) emphasizes that all survey work, pre-construction investigations, pipeline construction and post-construction works should be undertaken to standards reflecting best practices for ecologically sensitive lands. Trans Mountain acknowledges this suggestion and confirms its commitment to undertake the Project to the standards as set out in the Trans Mountain EPP (Filing ID A56013).

16.1.2 Stakeholder Requirements and Approvals

Both Metro Vancouver (Filing ID A4L7Y3, Section 8.8) and City of Coquitlam (Filing ID A4L9H8, Section 4a) filed evidence concerning Trans Mountain complying with their bylaws, requirements, and approvals. Trans Mountain reaffirms that it will endeavour to comply with all applicable local bylaws, requirement, and approvals. Trans Mountain has initiated this process by commencing TWGs with both parties in which local bylaws and requirements have been discussed in detail. Trans Mountain will continue to maintain a consistent and collaborative working relationship with both the City of Coquitlam and Metro Vancouver throughout the regulatory review process, and will further continue this through the construction and operation phases if the Project is approved.

16.1.3 Construction Schedule Conflicts

Based on the current Project schedule and the evidence submitted by Metro Vancouver (Filing ID A4L7Y3, Section 8.7), Trans Mountain acknowledges that there will be schedule overlap in construction activities on the TMEP with the following Metro Vancouver projects:

- North Road Trunk Sewer
- North Surrey Interceptor 104 Ave Extension
- West Ridge Pump Stations 1 and 2 Upgrades

The Stoney Creek Sanitary Trunk Capacity Upgrading and North Surrey Interceptor Port Mann Section Replacement are due to commence after construction work for TMEP has been completed.

Trans Mountain plans to build the proposed pipeline in a manner that does not adversely affect ongoing construction projects in or adjacent to the proposed corridor. In addition to working closely with Metro Vancouver through a TWG to mitigate potential conflicts, Trans Mountain will facilitate the necessary coordination between its contractor and Metro Vancouver's contractor(s) to prevent interference with work space requirements, construction methods and working areas.

16.1.4 Construction Temporary Workspaces

Metro Vancouver (Filing ID A4L7Y3, Section 4.3 and 4.14) impressed the requirement for no net loss of habitat, quoting in Section 4.8 that it expects 468,548 m^2 of permanent habitat loss as a result of the Project. Trans Mountain does not agree with Metro Vancouver's analysis as it utilizes several incorrect assumptions, including:

1. That Trans Mountain shall be using a standard 45 m construction cross-section throughout the entire route through Metro Vancouver. This is incorrect as there are extensive areas where the proposed right-of-way and temporary work space areas have been reduced substantially to minimize impact on environmentally sensitive areas, parks, infrastructure, and in response to stakeholder concerns. In addition, there are several trenchless sections that avoid disturbance to environmentally sensitive areas completely.

2. That Trans Mountain shall have zero success in re-establishing vegetation and habitat within the temporary construction zones (Filing ID A4L7Y3, Section 4.8). Trans Mountain does not agree with this assumption as it is committed to rehabilitate these areas completely and similar projects have had great success rehabilitating areas disturbed by construction. As well, Trans Mountain has extensive experience revegetating environmentally sensitive areas disturbed by pipeline construction such as those associated with the TMX Anchor Loop Project in Jasper National Park and Mount Robson Provincial Park.

3. That Trans Mountain shall have zero success in re-establishing vegetation and habitat within the new right-of-way (Filing ID A4L7Y3, Section 4.8). Trans Mountain will re-establish vegetation along the right-of-way, although there is a restriction on the height of vegetation permitted to grow on pipeline right-of-way for right-of-way identity and operational pipeline access.

16.1.5 Access Post-Construction

Trans Mountain shares Metro Vancouver's concern of public access along the pipeline right-of-way after construction (Filing ID A4L7Y3, Section 5.11). Trans Mountain will install industry standard signage and gates to detour the public from entering the right-of-way.

In particularly sensitive areas, such as Surrey Bend Regional Park, Trans Mountain has committed to retracting the requirement of a permanent maintenance access road, such that it does not become an unwanted public access trail and the entire area will be revegetated.

16.2 Chilliwack

16.2.1 Yarrow EcoVillage

As discussed in Section 13 (Pipeline Corridor and Routing) of this Reply Evidence, the IOS, which shall be presented to Yarrow EcoVillage before end of July, will clarify the corridor width, right-of-way and TWS dimensions described in Yarrow EcoVillage Reply Evidence (Filing ID A4Q1L3, Section 2.1.4) (refer also to Section 13 of Reply Evidence). The 150 m wide corridor refers to a study corridor and the possible location of the proposed centreline of the pipeline within that corridor, and has no effect on the right-of-way or workspace. Although there is a 150 m wide corridor through the Yarrow EcoVillage property, Trans Mountain plans to place the

pipeline within the existing 18 m TMPL right-of-way, 6 m to the south of the existing pipeline. Trans Mountain will purchase an additional 18 m right-of-way over the top of the existing right-of-way, which will be used for the construction of the new pipeline. In addition to this, additional TWS of varying dimensions will be required to construct the pipeline, all of which will be clearly defined on the IOS.

Yarrow EcoVillage's concern about access to the south portion of their property (Filing ID A4Q1L3, Section 3.5.1) will be addressed by the construction contractor during the duration of the construction activities. Trans Mountain commits to maintaining access to the south portion of the property at all times throughout the construction process.

Trans Mountain addresses all of Yarrow EcoVillage's other concerns within Section 30 (Agricultural Lands) of this Reply Evidence.

16.3 Abbotsford

16.3.1 General

Trans Mountain acknowledges the City of Abbotsford's concern (Filing ID A4L6E0) regarding the effect of the existing and proposed pipelines on the cleaning of drainage and irrigation infrastructure and has actively engaged with the City on this issue in TWG meetings. This concern was brought to the attention of Trans Mountain on March 27, 2015 during the first TWG meeting and was discussed in detail during the May 4, 2015 TWG meeting. There are several issues that need to be taken into account when evaluating the possible solutions, including the burial depth of the existing TMPL.

The action item from the May 4, 2015 TWG meeting was that the City of Abbotsford was going to evaluate its road and drainage/irrigation infrastructure needs and provide a proposal to Trans Mountain to replace some trenchless road crossings with open-cut methodology, in return for Trans Mountain installing culverts across the right-of-way for certain drainage and irrigation ditches. Trans Mountain has now received this proposal from the City and will work with the City through the TWG meetings to come to an agreement on the issue. Trans Mountain is confident that it can work collaboratively with the City of Abbotsford to come to a mutually beneficial solution to resolve this concern.

16.3.2 Sandy Hills

Trans Mountain acknowledges the City of Abbotsford's concern (Filing ID A4L6D1) about constructing through the Sandy Hills residential neighbourhood and agrees with Mr. Philip Blaker's affidavit regarding the status of the geotechnical investigation in the area. Three geotechnical holes were completed throughout Sandy Hills neighbourhood between May 5, 2015 and May 14, 2015, the last hole completed just before the open house that Mr. Philip Blaker attended on May 14. The results of the geotechnical investigation, however, have not been completed by the geotechnical engineering consultant. Once the geotechnical results have been submitted to the TMEP trenchless design team, the proposed trenchless design can be evaluated to determine if it is constructible. The geotechnical results are expected to be processed and the feasibility confirmation completed by Q3 2015. Trans Mountain will keep the City of Abbotsford informed of the development of the geotechnical results and the trenchless design and reaffirms its commitment to proceed with a trenchless installation through the Sandy Hills neighbourhood if it is technically feasible.

16.4 Coquitlam

16.4.1 Colony Farm Regional Park

Both the City of Coquitlam (Filing ID A4L9H8, Section 2.a) and Metro Vancouver are of the view that Trans Mountain must not affect Colony Farm Regional Park as part of the Project. Initially, Trans Mountain had proposed using a small portion of Colony Farm Regional Park as TWS for the HDD pullback string for the Fraser River crossing. Trans Mountain has worked collaboratively with both parties through TWGs, as well as CP Rail, who own two adjacent spur lines and part of an adjacent access road, to try and address this concern.

Trans Mountain is currently undertaking a detailed construction study to determine if it is possible to remain outside of Colony Farm Regional Park by using large cranes situated on the adjacent railway access road to elevate the pullback over the southwest corner of the park and use the CP Rail spurs for the majority of the pullback. This is a complex solution, with many variables including the necessity for a weld in the pipe string during pullback. Trans Mountain has not yet completed this study and shall continue to keep both Metro Vancouver and the City of Coquitlam informed of all developments.

16.5 Burnaby

16.5.1 Emergency Access

Mr. Calvin Taplay (Filing ID A4L9H5, Numbers 8 and 9) raised concerns about emergency vehicle access if the Burnaby Streets Alternative option is undertaken. Trans Mountain's preferred route of a tunnel through Burnaby Mountain was selected and designed to address this concern and others by minimizing the effect to residents of Burnaby, including emergency access during construction. The Burnaby Mountain Tunnel route is the preferred route currently before the NEB.

If the Burnaby Mountain Tunnel route is not approved by the NEB, Trans Mountain will work with the City of Burnaby to create a construction plan to ensure that the access of emergency vehicles during construction on Burnaby Streets Alternative would not be impeded.

16.5.2 Clear Cuts Within Burnaby

Mr. Calvin Taplay (Filing ID A4L9H5, Number 10) raised concerns about the effect of the Burnaby Streets Alternative causing large permanent clear cuts on Burnaby Mountain and adjacent Westridge Park at Inlet Drive and Hastings St. Trans Mountain reiterates its preference is the Burnaby Mountain Tunnel route, which requires no vegetation loss on either of the aforementioned areas. Additionally, the Burnaby Streets Alternative does not require any vegetation losses on Burnaby Mountain as the pipeline is planned to be placed within the Burnaby Mountain Parkway along the section that is adjacent Burnaby Mountain.

For the vegetated area adjacent to Westridge Park at Inlet Drive and Hastings St, there would be a 10 m right-of-way in which the vegetation would be affected. The additional TWS required to build the pipeline would be replanted after construction.

16.6 Summary of New Commitments

- Trans Mountain commits to maintaining access to the south portion of the Yarrow EcoVillage property at all times throughout the construction process.

- Trans Mountain will work with the City of Abbotsford through the TWG meetings to come to an agreement on the issue of the effect of the existing TMPL and proposed Project on the City of Abbotsford's drainage/irrigation infrastructure. Trans Mountain is reviewing the City of Abbotsford's proposal for the City to replace some trenchless road crossings with open-cut methodology, in return for Trans Mountain installing culverts across the right-of-way for certain drainage and irrigation ditches.

17.0 COMPLIANCE WITH MUNICIPAL BYLAWS

The City of Burnaby (Filing ID A4L8G5) and the City of Coquitlam (Filing ID A4Q0I9) raised concerns regarding the issue of Trans Mountain compliance with municipal bylaws for the TMEP.

As a federally regulated entity under the *NEB Act*, if Trans Mountain is granted a Certificate of Public Convenience and Necessity for the TMEP, it will proceed to apply for all federal, provincial and municipal permits and authorizations that are required by law. As noted by the NEB in Ruling No. 40 (Filing ID A63788), federally regulated pipelines are required, through operation of law and the imposition of conditions by the NEB, to comply with a broad range of provincial laws and municipal bylaws. To this end, Trans Mountain intends to work collaboratively with municipalities, including the City of Burnaby and the City of Coquitlam, to understand the application and operation of municipal bylaws and standards to the construction and operation of the TMEP.

18.0 PIPELINE REACTIVATION

Parks Canada Agency (PCA) filed intervenor evidence regarding TMEP reactivation activities occurring in Jasper National Park (Filing ID A4L5U9). Trans Mountain notes that the summary of reactivation activities described in Section 2 (pages 3 and 4) of PCA's evidence includes the main categories of work that will be occurring but is missing Natural Hazard Mitigation as described in Volume 4A, Section 3.6.5 (Filing ID A3S0Y9).

Section 5 (pages 6 and 7) of PCA's evidence describes potential impacts on cultural resources and Aboriginal interests. In the interest of protecting these resources, PCA has suggested the mitigation of impacts by avoidance. Until ILI is complete and the locations of anomalies are determined, it is not known if there will be any potential impacts on cultural resources and Aboriginal interests. However, such impacts may be anticipated and mitigation measures will address any potential occurrences. The specific locations of investigative digs will not be known until the later part of 2016 or early 2017. Once the locations are known, PCA and those First Nations that may have interests will be notified.

A similar situation applies to the hydrostatic testing of the pipeline. The pipeline through Jasper National Park will be segmented with consideration, in part, to elevation changes and internal pressures. The segments will be designed such that impacts to cultural resources and Aboriginal interests will be avoided at the endpoints of each segment. However, the hydrostatic test of each segment could result in the need for pipeline repair at any presently undetermined location. Mitigation plans will address those known location impacts and contingency plans for those potential occurrences that may result. Hydrostatic testing will be done in early 2018.

Section 8 (page 8) of PCA's evidence describes the submission of a final engineering assessment in 2016 after the ILI repair program and hydrostatic testing is complete. These activities are presently scheduled for 2017 and 2018; therefore, the Engineering Assessment cannot be completed until 2018. Please refer to the schedule in GoC EC IR No. 2.024a (Filing ID A4H6A5 page 60 of 467). The Engineering Assessment will be completed and submitted to the NEB and PCA in 2018.

Section 8 (page 8) of PCA's evidence states all existing manual MLBVs would be replaced with automated MLBV. The statement is inconsistent with both Trans Mountain's plans regarding MLBV replacement and PCA's statement included in Section 2 (page 4) of its evidence. To clarify, Trans Mountain has proposed to automate several valves, not necessarily all, and this description is consistent with Section 2 of PCA's evidence of Section 2. At this time, there are no plans to replace and automate all valves. Also, there are presently no plans to replace any of the existing manual valves. Please refer to GoC Parks IR No. 1.13 (Filing ID A60810).

PCA has suggested 12 potential conditions for possible consideration for inclusion in any approval which PCA issues in respect of the reactivation of the Project.

Generally, the term "planned commencement of reactivation" used by PCA is presumed to apply to the time before the commencement of reactivation activities. Otherwise, the planned reactivation is to be after the activities and assessments are complete in 2018.

In response to the potential conditions suggested by PCA, Trans Mountain submits:

- Condition A – PCA identifies the need for a complete application. Trans Mountain will submit a complete application at least 104 days prior to the commencement of reactivation

activities. Multiple applications will be required for individual activities or grouping of activities. The applications will be staged in respect of the timelines for development and implementation of the activities.

- Condition B – PCA has suggested Trans Mountain undertake and file a quantitative risk assessment at least 30 days prior to the planned commencement of reactivation. Trans Mountain cannot provide a quantitative risk assessment 30 days prior to the planned commencement of reactivation. A meaningful risk assessment requires pipeline integrity data derived from assessments, such as ILI, which will only be available after all reactivation activities have been completed. Trans Mountain's current risk algorithm expresses risk as the product of failure frequency and consequences. Failure frequency is included in a quantitative format whereas the outcome of consequences is expressed as qualitative index scores, consistent with the fact that there is no universally recognized or adopted means of quantifying the chiefly environmental and socio-economic consequences that would be associated with a crude oil spill. The risk assessment therefore becomes semi-quantitative.

  Trans Mountain will complete a semi-quantitative risk assessment prior to the completion of reactivation in 2018, once all integrity assessment data that are necessary to undertaking this analysis are in hand.

- Condition C – PCA has suggested Trans Mountain will implement or cause to be implemented all of the policies, practices, programs, mitigation measures, recommendation and procedures for the protection of ecological integrity and commemorative integrity/cultural resource management that were included in or referred to in its application or as otherwise agreed to during questioning or in its related submissions. Trans Mountain agrees with this suggestion. Trans Mountain will achieve this by preparing an EPP that is specific to the planned reactivation activities. The Reactivation EPP will be implemented during the physical works associated with reactivating the deactivated 24" pipeline through Jasper National Park. The Reactivation EPP will be based on an updated version of the EPP that was prepared for the TMX Anchor Loop Project in combination with the Operations and Maintenance EPP that has been prepared for ongoing operations and maintenance works in Jasper National Park.

- Condition D – PCA has suggested Trans Mountain shall file with PCA an updated project-specific EPP and Restoration Plan at least 30 days prior to the planned commencement of reactivation. Trans Mountain, as stated in the response to Condition C above, Trans Mountain will prepare a Reactivation EPP. The Reactivation EPP will be provided to PCA a minimum of 30 days prior to the commencement of reactivation activities.

- Condition E – PCA has suggested that Trans Mountain shall notify PCA 14 days prior to the commencement of reactivation. Trans Mountain agrees and will notify PCA 14 days prior to commencement of specific Reactivation activities.

- Condition F – PCA has suggested a potential condition that specifies that activity timing restrictions for wildlife shall apply unless otherwise advised by PCA. Trans Mountain will outline all applicable wildlife timing constraints in the Reactivation EPP. Consultation with PCA will take place if any of the planned physical activities associated with reactivation are scheduled to take place in locations where wildlife timing constraints are applicable and there is a conflict between the schedule for the planned activities and the wildlife timing constraints. It should be noted that some reactivation activities are unobtrusive (*e.g.*, ILI)

and Trans Mountain submits that these activities could be conducted during any time of the year without impacting wildlife rutting, calving, rearing, denning, or other biologically sensitive phase or activity.

- Condition G – PCA has suggested that Trans Mountain shall submit the Fisheries and Oceans Canada (DFO) Compensation Plan with PCA at least 14 days prior to the planned start of excavation at watercourses identified in the Plan. Trans Mountain agrees and will provide PCA the DFO Compensation Plan if serious harm is expected and offsetting is deemed necessary by DFO.

- Condition H – PCA has suggested a potential condition of approval would be the requirement to file for review and approval a post-construction monitoring program that will conclusively show that all MO/DERs have been accomplished or not. Trans Mountain is proud of the success of its post-construction monitoring program that was implemented following the TMX Anchor Loop Project. As such, Trans Mountain will model the post-reactivation monitoring program after the post-construction monitoring program that was implemented for the TMX Anchor Loop Project.

- Condition I – PCA also suggested that a potential condition would be the requirement to submit for review and approval a pre- and post-reactivation Follow-up Program for wetland function. Trans Mountain will prepare and submit to PCA a pre- and post-reactivation Follow-up Program for wetland function as specified in its written evidence.

- Condition J – PCA stipulated in its written evidence a potential condition that describes the actions that Trans Mountain will follow in the event that previously unidentified contaminated sites are discovered during the construction phase of the Reactivation Program. Trans Mountain will submit a Remediation Plan as specified in its written evidence within 45 days of discovery of a previously unidentified site where contaminated soil and/or groundwater are discovered during reclamation activities. Trans Mountain will agree to clean up contaminated materials if located on its right-of-way or workspace required for reactivation activities. However, if the contaminated site extends off the pipeline right-of-way or if the source of the contamination is the responsibility of others, Trans Mountain will not commit to cleaning up these sites.

- Condition K – PCA requested that measures be taken to identify and respond to the presence of historic First Nations and Métis cultural resources during the design and construction phases of the Reactivation Program. Trans Mountain will ensure best practices are employed. Trans Mountain shares PCA's interest in the preservation of historic First Nations and Métis cultural resources. As such, Trans Mountain will draw on knowledge gained during the TMX Anchor Loop Project and will implement, as necessary, the applicable mitigation and/or contingency measures that will be provided in the Reactivation EPP. In this effort, Trans Mountain will endeavour to ensure PCA's satisfaction as it relates to the protection of historic First Nations and Métis cultural resources during the physical works associates with the Reactivation Program.

- Condition L – PCA has suggested a potential condition that requires Trans Mountain to generally schedule reactivation activities outside of the summer peak tourist season and to minimize traffic conflicts along existing access routes reactivation work will generally occur outside of summer peak tourist season. However, exceptions are expected that will be

based on, in part, environmental conditions and resource optimization. Traffic conflicts will be minimized to the extent practicable.

18.1 Summary of New Commitments:

- Trans Mountain will submit a complete application at least 104 days before the commencement of reactivation activities.
- Trans Mountain will complete a semi-quantitative risk assessment before the completion of reactivation in 2018, once all integrity assessment data that are necessary to undertaking this analysis are in hand.
- Trans Mountain will implement or cause to be implemented all of the policies, practices, programs, mitigation measures, recommendation and procedures for the protection of ecological integrity and commemorative integrity/cultural resource management that were included in or referred to in its application or as otherwise agreed to during questioning or in its related submissions through an EPP that is specific to the planned reactivation activities.
- Trans Mountain will prepare a Reactivation EPP which will be provided to PCA a minimum of 30 days before the commencement of reactivation activities.
- Trans Mountain shall notify PCA 14 days prior to the commencement of reactivation activities.
- Trans Mountain will outline all applicable wildlife timing constraints in the Reactivation EPP. Consultation with PCA will take place if any of the planned physical activities associated with reactivation are scheduled to take place in locations where wildlife timing constraints are applicable and there is a conflict between the schedule for the planned activities and the wildlife timing constraints.
- Trans Mountain will provide PCA the DFO Compensation Plan if serious harm is expected and offsetting is deemed necessary by DFO.
- Trans Mountain will prepare and submit to PCA a pre- and post-reactivation Follow-up Program for wetland function.
- Trans Mountain will submit a Remediation Plan within 45 days of discovery of a previously unidentified site where contaminated soil and/or groundwater are discovered during reclamation activities. Trans Mountain will agree to clean up contaminated materials if located on its right-of-way or workspace required for reactivation activities. However, if the contaminated site extends off the pipeline right-of-way or if the source of the contamination is the responsibility of others, Trans Mountain will not commit to cleaning up these sites.

19.0 CONSTRUCTION SAFETY AND SECURITY

Mr. Calvin Taplay expresses concern with access to residences for emergency vehicles and first responders in the event of an emergency (Filing ID A4L9H5):

> "The construction would cut off access to the fire lane servicing my townhouse complex exposing 72 units to potential danger in terms of response for either ambulances, fire trucks or other first responders."

Mr. Taplay's concern is the same expressed by Ms. Hannah Varto in Varto H IR No. 1.4.B4.1 and No. 1.4.B4.2 (Filing ID A3Y3V6) regarding general access to residential areas by residents and in the event emergency vehicle access is required; Mr. Paul Dayson's question in Dayson P IR No. 1.2.1b and No. 1.2.1c (Filing ID A3X6C5) regarding emergency response delays to his neighbourhood; the FVRD's IR regarding maintaining emergency access at all times (Filing ID A3Y2K7 and in City Burnaby IR No. 1.35.05b regarding maintenance of two way traffic [Filing ID A3Y2E6]); and is similar in nature to that expressed in City of Abbotsford IR No. 1.21a (Filing ID A3X5Z2), which addresses emergency vehicle access, specifically to and from the Mt. Lehman fire hall. Concerns of a similar nature were also raised by the City of Coquitlam (City of Coquitlam IR No. 1.G.6; Filing ID A3X5Z4), which addresses access for emergency responders in the event of an emergency.

As noted in Volume 4B, Section 5.2.3 (Filing ID A56004), which addresses the mitigation of traffic management concerns, Traffic and Access Control Management Plans (TACMPs) will be developed for the Project. Further information on traffic mitigation can be found in Appendix C of the Socio Economic Management Plan (Volume 6B; Filing ID A56013). TACMPs will have an Incident Plan section that will consider potential impacts to emergency vehicle access and service to the community. TACMPs will include a Public Information Plan section to ensure that municipalities, emergency response providers, and the general public are made aware of any potential traffic impacts or disruptions by the Project. The TACMPs will further require development of localized Traffic Control Plans (TCPs); to be completed after detailed engineering and construction planning of the project.

Specific TCPs for localized areas will be developed in consultation with provincial and municipal representatives, and will take into account community concerns noted in the ongoing consultation process including emergency vehicle traffic continuity. Emergency vehicle routes to all areas of a community, or procedures to be implemented in an emergency situation, will be available at all times during the Project and as detailed in the TCPs. Access for emergency services will be a critical component for the TACMP and local TCPs. The plans will require coordination with emergency service providers to ensure access and services are available at all times, including for partial lane closures or detours if required.

The City of Coquitlam identifies concerns with emergency responder access and response times (Filing ID A4Q0I9):

> "In addition to the direct traffic impacts of TMEP construction on Coquitlam residents, business owners, and the general motoring public who need to drive near where the TMEP is proposed to be constructed, there is the potential for TMEP construction to affect critical municipal services like fire/rescue services.
>
> In its Application, Trans Mountain has provided limited, general information about the contents of its emergency response plans. Trans Mountain has stated that

> finalized plans will be prepared in advance of commissioning and operating the TMEP. In addition to plans for responding to emergencies that occur once the proposed pipeline is operational, the City's emergency response planning must account for the impacts of major infrastructure construction, such as the TMEP, on emergency services response times during the entire construction process.
>
> As a result of concerns about emergency response times during the PMH1 Project, for approximately 90 days the City of Coquitlam utilized a temporary fire and emergency response station in order to maintain satisfactory response times."

Trans Mountain notes that the City of Coquitlam noted similar issues in City of Coquitlam IR No. 1.G.6 (Filing ID A3X5Z4) and City of Coquitlam IR No. 2.E.1 (Filing ID A60791).

At this time, Trans Mountain anticipates finalized TACMPs and localized TCPs will ensure, through engineered TCP design or use of alternate routing, continued availability of roadways for use by emergency vehicles to meet municipal emergency response requirements. Consultation with municipal officials and emergency response providers will occur through TWGs, including discussion around current municipal emergency response objectives. If, through detailed planning, it is determined that the City of Coqutilam emergency response times cannot be reasonably maintained, or that potential disruptions to access within the TMEP construction zones will occur, Trans Mountain would support the establishment of a temporary fire and emergency response station.

19.1 Summary of New Commitments

- If, through detailed planning and discussion and consultation with the City of Coquitlam in the TWGs, it is determined that emergency response times cannot be reasonably maintained, or that potential disruptions to access within the TMEP construction zones will occur, Trans Mountain would support the establishment of a temporary fire and emergency response station.

20.0 FACILITY ENGINEERING AND DESIGN

20.1 Tide Level

The Intervenor evidence submitted by the City of Vancouver included the "City of Vancouver Coastal Flood Risk Assessment" report that was prepared by Northwest Hydraulic Consultants (Filing ID A4L7W6). Section 4.5.1: Tide Water Levels included information related to tide levels in the Vancouver area. However, Trans Mountain notes that report Section 2.1: Physical Setting, Figure 1, Study Areas for City of Vancouver Coastal Flood Risk Assessment did not include the Burrard Inlet east of the Iron Workers Memorial Bridge (formerly Second Narrows Bridge), which is where the proposed Westridge Marine Terminal expansion is located. Accordingly, the scope of the report does not include the Westridge Marine Terminal.

Trans Mountain also notes that the high tide that occurred on December 17, 2012, referred to in the Northwest Hydraulic Consultants report (Filing ID A4L7W6) Section 5.3.1: December 2012 King Tide, was slightly lower than the highest recorded tide for Vancouver. Design of Westridge Marine Terminal will take into account the extreme recorded tide range as well as other factors that can affect water levels such as waves and global SLR, as described in detail below.

20.2 Sea Level Rise

The "City of Vancouver Coastal Flood Risk Assessment" report that was prepared by Northwest Hydraulic Consultants, Section 3.1: Sea Level Rise, also included information related to the future sea level in the Vancouver area. The report states "*The sea level rise policy for BC recommends assuming a 1 m rise in global mean sea level between the year 2000 and 2100 (Ausenco Sandwell 2011a) as shown in Figure 2*." Consideration has been given to a rise in sea level as a possible result of climate change, which Trans Mountain has outlined in the responses to various IRs.

Trans Mountain notes that City of Burnaby IR No. 1.04.03a (Filing ID A3Y2E6) requested a description of the design elements that incorporate climate change into design of the proposed Westridge Marine Terminal expansion. Trans Mountain's interpretation is that City of Burnaby IR No. 1.04.03a (Filing ID A3Y2E6) is related to allowances in design assumptions for the possible effects of climate change. At Westridge Marine Terminal, consideration has been given to a 50 cm rise in sea level as a possible result of climate change. Refer to Volume 4A, Section 3.4.4.3.2 of the Facilities Application (Filing ID A3S0Y9). Otherwise, Trans Mountain will base the design of the proposed pipelines, Burnaby Terminal, and Westridge Marine Terminal on the climatic design data provided in the British Columbia Building Code (BCBC), as applicable and other available and applicable meteorological and oceanographic information (*i.e.*, tides and water levels, wind, wave activity, and currents) also discussed in Volume 4A, Section 3.4.4.3.2 of the Facilities Application (Filing ID A3S0Y9).

District of North Vancouver IR No. 2.1.3a (Filing ID A4H8L7) requested the scientific rationale for using a 0.5 m SLR threshold at Westridge Marine Terminal. Trans Mountain indicated the rationale for using a 0.5 m SLR threshold for the conceptual design of the proposed expansion of Westridge Marine Terminal is the following statement by DFO, Institute of Ocean Sciences (Thomson *et al.,* 2008, page iv), "Based on present mean rates of SLR and a projected 30 cm rise in mean eustatic sea level during the 21st Century, relative sea level in Vancouver, Victoria, and Prince Rupert will undergo a mean rise of 20 to 30 cm by 2100 with a range (90% confidence interval) of 10 to 50 cm due to uncertainties in oceanic and land motions." Trans

Mountain may consider more recent studies or guidelines during the detailed engineering and design phase and before finalizing the height of the dock structures.

Trans Mountain's response to the District of North Vancouver IR No. 2.1.3b (Filing ID A4H8L7) was that the potential for SLR at Westridge Marine Terminal will be accounted for in the detailed design primarily by ensuring that the deck elevation of the structures is set high enough to avoid flooding or wave damage should the predicted SLR occur. The cargo loading arms and the dock mooring hooks and fenders will also be checked to ensure they can accommodate the complete range of vertical motion expected for all of the classes of vessels that may call at Westridge Marine Terminal over its planned life, with consideration of the combined effects of draft and trim changes, tides, storm surge / draw-down, wave action, and SLR.

GoC EC IR No. 1.014a (Filing ID A3Y2K9) asked for details on the origin of the 0.5 m projection for local SLR. Trans Mountain's response was that there are a range of credible estimates for SLR in the scientific literature, and the value of 0.5 m was selected based on Thomson *et al.* (2008) as a reasonable basis for planning the marine facilities at Westridge Marine Terminal. While the engineering design of Westridge Marine Terminal is not yet complete and some of the key parameters such as dock elevations have yet to be finalized, in general, the effects of SLR on the marine structures are not expected to be significant (Thomson *et al.* 2008).

For preliminary planning purposes, the present top of deck elevation of the proposed Westridge Marine Terminal loading platforms is set at +9.1 m above chart datum. This is more than 4.0 m higher than the present high tide level of +5.0 m. This deck elevation is well above the maximum water level expected even after accounting for the maximum 100-year storm waves occurring simultaneously with extreme high tide, regardless of whether 0.5 m or 1.0 m is assumed as a value for SLR. In either case, wave overtopping is not expected to be an issue. Even if the actual amount of SLR exceeds projections, there are a number of adaptive strategies that can be applied if necessary in the future to mitigate these effects without compromising the safety of operations of Westridge Marine Terminal.

City of Vancouver IR No. 1.06.07g (Filing ID A3Y2G6) asked for the long-term plan for managing SLR over the life of the Project. Trans Mountain indicated that Volume 4A, Section 3.4.4.3.2 of the Facilities Application (Filing ID A3S0Y9) describes the rationale for the proposed 50 cm SLR consideration for Westridge Marine Terminal, discussed in the response to City of Vancouver IR No. 1.06.07f. As such, Trans Mountain believes the proposed allowance will be adequate for the very long term. If and when an actual SLR trend can reliably be used to predict a rise of greater than 50 cm, before the anticipated end of life of Westridge Marine Terminal, future adaptive measures will be considered, at that time, to address the issue. As the 50 cm allowance will be initially included in the design of Westridge Marine Terminal, an ongoing plan, other than to monitor the sea level trend, will not be necessary.

20.3 Flooding

The "Written Evidence Submission of Environment Canada to the National Energy Board" Section 7.2.2 (Filing ID A4L8Y6) projected changes of project sensitive climate parameters, included information related to pipeline infrastructure that could be adversely affected by extreme flooding events. Trans Mountain notes that flood events can occasionally cause pipeline exposure and buoyancy concerns; however, flooding will not be an issue at terminals and pump stations for the following reasons:

- Site grading and storm water drainage will be designed and constructed to direct storm water to a common collection area away from operating areas.
- Pump station and terminals generally do not have watercourses with underground pipeline crossings beneath them. In the event that such a crossing is required within a pump station or terminal, the crossing will be designed in accordance with standard engineering practices, including measures to prevent erosion.

20.4 Considerations for Potential Light and Noise Issues

The "Affidavit of Julie Pavey, District of North Vancouver," Section 12: Other Community Concerns (Filing ID A4Q0E9), included concerns related to the proposed Westridge Marine Terminal expansion and designated vessel anchorages having the potential to create noise and light issues for residents. When detailed design has progressed to the point where mechanical equipment can be selected, a predictive noise modelling study will be done and the results will be used to determine if any noise reduction measures are required. Trans Mountain will also conduct an area lighting study that will include consideration of impact to the surrounding communities. Additional information regarding potential noise and light issues for residents is included in the responses to various IRs.

NEB IR No. 2.012a (Filing ID A3Z4T9) requested a summary of any applicable (municipal, provincial, federal, or other) regulations, guidelines, or policies that Trans Mountain will comply with in order to limit the amount of obtrusive light being emitted at Westridge Marine Terminal and to reduce nuisance light disturbance for land-based residents and marine users. The response indicated Trans Mountain will design lighting at Westridge Marine Terminal to meet the Canada Occupational Health and Safety Regulations and the International Ship and Port Facility Security Code (for compliance) for worker safety and terminal security during construction. Although the proposed Westridge Marine Terminal dock expansion is not within the City of Burnaby jurisdiction, Trans Mountain did not identify any City of Burnaby bylaws related to nuisance light disturbance of an industrial use area (the only City of Burnaby requirement identified on lighting relates to an off-street loading and parking area). PMV does not have specific lighting regulations or policies but typically requires proponents, as part of its permitting process, to provide a lighting design stamped by a qualified engineer indicating that best practices are adhered to in order to eliminate and minimize lighting pollution.

Trans Mountain will conduct an area lighting study when the detailed design of Westridge Marine Terminal has progressed to the point where lighting can be selected. While the purpose of area lighting is operational safety, impact to the surrounding communities will be given due consideration. The results will be used to inform the locations and types of lighting selected. Trans Mountain will apply industry best practices in the selection of lighting types and fixtures at Westridge Marine Terminal that minimize extraneous light pollution, including the use of light-emitting diode technology. This will help achieve a fully Dark Sky compliant installation, with photometric qualities meeting or exceeding recommended qualities of the Illuminating Engineers Society and occupational health and safety requirements per Labour Canada.

District of North Vancouver IR No. 1.5.10d (Filing ID A3Y2J7) asked for details on the light impacts (light pollution) to district residents and parks users anticipated during construction and operation of the marine terminal. Trans Mountain's response was to refer to the response to Belcarra IR No. 1.8 (Filing ID A3X6W1) with respect to the design of lighting at the permanent facilities to be installed at Westridge Marine Terminal. Since comprehensive construction

planning has not been undertaken, it is not possible to provide details on the lighting impacts during construction. In general, however, lighting for construction will be used only to the extent necessary for the safety of construction workers, operational staff, and the users of Burrard Inlet in the vicinity of the construction area.

Belcarra IR No. 1.8 (Filing ID A3X6W1) asked for details on how Trans Mountain intends to minimize and / or mitigate the bright lights and noise from Westridge Marine Terminal and vessels. Trans Mountain indicated that information on the principles that will apply to lighting design is provided in Volume 4A, Section 3.4.4.10 of the Application (Filing ID A3S0Y9).

Information on the principles Trans Mountain will apply to noise mitigation at the expanded Westridge Marine Terminal is provided in Volume 4A, Section 3.4.4.6 of the Application (Filing ID A3S0Y9). When the detailed design of Westridge Marine Terminal has progressed to the point where mechanical equipment can be selected, an additional, predictive noise modelling study will be done. The results will be used to determine what, if any, noise reduction measures are required.

Belcarra IR No. 1.9 (Filing ID A3X6W1) asked for details regarding Trans Mountain's proposed "vessel acceptance criteria" for vessels calling at Westridge Marine Terminal that will reduce noise and light disturbances. Trans Mountain's response indicated that a copy of KMC's Tanker Acceptance Standard (the Standard) is included as Belcarra IR No. 1.9 - Attachment 1 (Filing ID A3X6W2). Section 4.8.1 of the Standard states, "All vessels shall conduct operations within Canada, specifically PMV, in accordance with any additional guidance provided by the Terminal, and shall always be respectful of the rights of the residents in surrounding neighbourhoods to not be unnecessarily disturbed by noise, odours, and health or other concerns from vessel operations. Such additional instructions may be verbal or written in nature and shall be issued by the Loading Master."

Trans Mountain has been actively working with PMV to develop guidance for the vessels to minimize the effects of light and noise on residents around the Port. Please refer to attached Belcarra IR No. 1.9 - Attachment 2 (Filing ID A3X6W3). Trans Mountain plans to operate Westridge Marine Terminal in a manner that will reduce the time vessels bound for the terminal would spend at the designated anchorages in Burrard Inlet and also help mitigate the effects of noise and light from vessels at anchor.

20.5 Preliminary Geotechnical Investigations

The Intervenor evidence submitted by the City of Burnaby included the "Geotechnical Review of Trans Mountain Expansion Project (TMEP), Burnaby Terminal Geotechnical Investigation" (Filing ID A4L8G0) and the "Geotechnical Review of Trans Mountain Expansion Project (TMEP), Westridge Marine Terminal Offshore Geotechnical Investigation" (Filing ID A4L8F9) reports that were prepared by MineIt Consulting Inc. The reports included various concerns related to the geotechnical investigations conducted at each location. Trans Mountain's replies to each MineIt Consulting Inc. report are provided below.

Burnaby Terminal

In response to the "Geotechnical Review of Trans Mountain Expansion Project (TMEP), Burnaby Terminal Geotechnical Investigation" report prepared by MineIt Consulting Inc., Trans Mountain believes the Preliminary Geotechnical Assessment Report for Burnaby Terminal (Filing ID A4I6K3) remains valid and complete for the stage of design for which it was prepared.

In general, the areas of concern noted in the MineIt Consulting Inc. report are not considered to be relevant or significant, for the following reasons:

1. The author of the MineIt Consulting Inc. report appears not to have fully read or understood the Preliminary Geotechnical Report, as several of the items listed as unknown or unaddressed were, in actuality, addressed. Examples include:
   - The statement "*It is unclear as whether the secondary containment dyke(s) are built for each tank or it is built surrounding the overall tank farm facility*" is not accurate. Secondary containment areas are shown on the Levelton site plan, and explicitly stated in the body of the Preliminary Report.
   - The claim that rock core testing was not completed is not accurate. In actuality, RQD and uniaxial compressive strength tests were completed, as stated in Findings Report Part 1.
   - The comment that there is no foundation design information is not accurate. Although it is still considered to be preliminary, the report listed anticipated foundation types and expected bearing pressures.
2. Some of the requested geotechnical information / recommendations, included in the General Conclusion and Recommendations of the MineIt Consulting Inc. report, are not applicable to the nature of the soils / ground conditions summarized for the site, including:
   - Preloading: Trans Mountain anticipates preloading will not be required for the proposed foundation areas at Burnaby Terminal.
   - Settlement monitoring: Structures will generally be founded on dense granular soils / bedrock, and settlements on such materials will generally be elastic and immediate; therefore, monitoring is expected to be irrelevant. In specific areas where settlement may be a possible concern, monitoring requirements will be evaluated during the detailed engineering and design phase of the Project.
   - The request for consolidated and unconsolidated shear strength information regarding saturated soils: Consolidated and unconsolidated shear strength tests have not been completed for the saturated soils at this preliminary stage. The saturated soils encountered during the investigation were generally limited to the surficial fills and loose native soils, which typically will be removed. Evaluation of consistency and density is based on index testing and is indicated on the test-hole logs.
3. Some of the requested geotechnical information / recommendations, included in the General Conclusion and Recommendations of the MineIt Consulting Inc. report, are not applicable to the current stage of design and cannot be completed until the civil, structural, and mechanical design has progressed further. These topics are ones which will be further addressed during the detailed engineering and design phase of the Project:
   - Differential settlement for tanks, pipe racks and manifolds: Design and analysis regarding differential settlement due to different stratigraphy has not been completed during the preliminary design. However, the nature of the underlying site geology implies that there will not be deep-seated differential settlement, and the design and construction will be such that variability in subsurface conditions will be addressed by

utilizing engineered fill to develop near-surface consistency beneath specific structures and over distances where differential settlement may have an impact on the design. Settlement prevention measures will be finalized during the detailed engineering and design phase of the Project.

- Seismic responses of foundations: Seismic response will depend on the types of foundation and the soils on / in which they are founded, which will be finalized during the detailed engineering and design phase of the Project.

4. A few of the requested items, included in the General Conclusion and Recommendations of the MineIt Consulting Inc. report, are not applicable to the scope of the Preliminary Geotechnical Report, which was prepared to assess conditions at key areas of the site as they apply to initial civil design concepts, including:

   - Review of historical geotechnical performance of the current terminal: The facility has operated for more than 60 years without any geotechnical-related issues.

   - Bedrock performance in seismic events: The site classification for seismic site response may be taken as Site Class C as per the 2012 BCBC, as provided in the Preliminary Geotechnical Report.

   - Overall slope hazard assessment: Slope stability assessment and geotechnical considerations, including the proposed new structures and affected portions of existing structures, will be completed during the detailed engineering and design phase of the Project. The general geology of Burnaby Terminal and the Burnaby Mountain area are relatively well-known, and there are no known detrimental underlying geological features. The geotechnical assessment with regards to the overall slope angle of the area generally relates to the stability of slopes and earthen structures on the slopes under seismic influences.

<u>Westridge Marine Terminal</u>

In response to the "Geotechnical Review of Trans Mountain Expansion Project (TMEP), Westridge Marine Terminal Offshore Geotechnical Investigation" report prepared by MineIt Consulting Inc., Trans Mountain believes the Preliminary Offshore Geotechnical Report for the Westridge Marine Terminal (Filing ID A4I6L5) remains valid and complete for the stage of design for which it was prepared. The preliminary geotechnical report provides adequate information as input to the siting considerations and screening level evaluation of various pile foundation design options for the proposed Westridge Marine Terminal expansion. In general, the areas of concern noted in the General Conclusion and Recommendations of the MineIt Consulting Inc. report, or other sections of the report as indicated, are not considered to be relevant or significant, for the following reasons:

1. Review of historical geotechnical performance: The collection and review of available historical data was carried out, but inclusion of results from the historical data review is not considered to be necessary or useful. The subsurface soil conditions in the existing marine terminal area, which is close to the shoreline and at shallow water depths, are significantly different from that at the proposed expanded terminal area, which is further away from the shoreline and at greater water depths. Furthermore, the facility has operated for more than 60 years without any geotechnical-related issues.

2. Detailed pile foundation design and seismic assessment of pile foundations: Geotechnical foundation performance, seismic related hazards, and other necessary geotechnical design issues and assessments will be addressed during the detailed engineering and design phase of the Project, which was also clearly stated in the preliminary geotechnical report. The preliminary report is primarily intended to be a data report for input to the selection of suitable systems for the marine structures. Trans Mountain does not believe there is any value in establishing the detailed recommendations that MineIt Consulting Inc. suggests are missing, until a feasible structural solution is identified.

3. Evaluation of the frequency and magnitude of a tsunami hazard: Trans Mountain has completed a screening level assessment of earthquake and landslide-induced tsunami hazards for the proposed Westridge Marine Terminal expansion, including impacts to vessels berthed at the facility, which will be used to inform detailed engineering and design.

   In the response to Doherty D IR No. 1.08b (Filing ID A3Y2K2), Trans Mountain indicated that the design principles that will apply to pipelines and storage terminals (tank farms) will also apply to Westridge Marine Terminal. With regard to tsunami, refer to the responses to GoC NRCan IR Nos. 1.01.0a, 1.01.0b, and 1.01.0c (Filing ID A4H6F9). The potential threat of both earthquake generated and landslide generated tsunami to the proposed Westridge Marine Terminal will be revisited during the detailed engineering and design phase of the Project and the results of the evaluation will be used to inform the design criteria. However, based on the information in the GoC NRCan IR responses and a preliminary design review, Trans Mountain believes that a tsunami wave is unlikely to cause significant damage to Westridge Marine Terminal, given that it will be designed and constructed in accordance with current design codes and standards and industry best practices.

   In the response to NDP IR No. 2.2.0a (Filing ID A4H8V7), Trans Mountain indicated that there is a possibility that a landslide in Burrard Inlet could be triggered by an earthquake. However, due to its sheltered location, there is an extremely low likelihood that a large tsunami created by an offshore earthquake could reach Westridge Marine Terminal. Emergency Management BC (http://www.embc.gov.bc.ca/em/hazard_preparedness/Tsunami_Preparedness_Information.html) has identified Burrard Inlet as being in Tsunami Notification Zone E (the lowest risk area). This is one of the reasons that the current location of Westridge Marine Terminal is desirable.

4. Erosion and sedimentation effects: Erosion and sedimentation are not part of the geotechnical scope of work. These issues have been taken into account in the preliminary design of the marine structures and will be evaluated further in the detailed engineering and design phase of the Project. Sedimentation is not expected to be an issue as there are no major sources of sediment nearby and this has not been an issue at the existing terminal. Based on Trans Mountain's experience at the existing terminal, maintenance dredging is not anticipated to be required. In addition, the proposed new facilities will not change the sedimentation patterns. The potential for erosion from waves, currents, or storm water discharge will be taken into account as part of the Westridge Marine Terminal structural design.

5. The General Conclusion and Recommendations of the MineIt Consulting Inc. report includes a number of suggested deficiencies that Trans Mountain believes are primarily related to structural engineering, as opposed to the Preliminary Offshore Geotechnical Report, including:

- Pile foundation design;
- Pile foundation differential settlement;
- Seismic assessment of pile foundations; and,
- Wind, wave, and other lateral dynamic loads on the pile foundations.

6. As referenced in the Project Description section of the MineIt Consulting Inc. report, the proposed development of the foreshore area at Westridge Marine Terminal, including the shoreline slope (*i.e.*, land side liquefaction and slope stability issues), is not included in Golder's work scope, which was clearly stated in the preliminary geotechnical report. The geotechnical evaluation of the proposed foreshore expansion will be completed by another geotechnical consultant.

7. Section 1a of the MineIt Consulting Inc. report states "In addition to Golder's recommendation in Section 5.1.1 more data should be collected and analyzed immediately." Trans Mountain notes that there is no Section 5.1.1 in the preliminary geotechnical report prepared by Golder. Section 5.2.1 in the preliminary geotechnical report recommended drilling additional boreholes at strategically selected locations to bridge the current data gap. However, Trans Mountain has also indicated in previous responses to IRs from the City of Burnaby that the currently completed tests are considered to be adequate for a screening level evaluation of various pile foundation design options. A preliminary foundation design evaluation is being developed by the marine structural engineer (Moffatt & Nichol) based on the geotechnical information provided by Golder. Once a preferred pile foundation design option is selected, Trans Mountain will consult with Golder and the marine structural engineer regarding what, if any, additional geotechnical work is needed to inform detailed design, including the need for any specialized testing. A key objective during the detailed engineering and design phase of the Project will be to minimize the risk of encountering geotechnical-related construction issues.

8. Section 1c of the MineIt Consulting Inc. report states "*Golder mentions that drilling 3-5m beyond the maximum depth of design pile tip is necessary but it was not performed*." A majority of the boreholes, and all Cone Penetration Testing, were terminated a short distance above or into the underlying competent soil. However, BH14-09 was advanced more than 17 m into the dense and strong till-like materials. Although bedrock was not encountered during the geotechnical investigation, it is not considered to be a limitation to the current screening level assessment considering pile foundations can be installed into the competent till-like deposits to develop the required structural support.

9. Section 2.1a of the MineIt Consulting Inc. report states "*Golder does not mention which test holes were eliminated and does not provide the initial drilling plan and also the reason for elimination*." Documenting the as-completed borehole investigation locations in the geotechnical report is considered to be good engineering practice. Including the borehole investigation locations that were initially planned, but not completed in the field, is not considered to be beneficial and could potentially cause confusion. The considerations made regarding adjustments to the field investigation program are included in Golder's preliminary geotechnical report.

With regards to the MineIt Consulting Inc. report commentary related to seismic and geohazard risk assessments, BROKE IR No. 1.1l (Filing ID A3Y2D3) asked about the likelihood of a seismic event, sufficient to cause a rupture, leak, spill, fire, or other associated hazard. As discussed in Volume 4A, Section 2.9.3 of the Facilities Application (Filing ID A3S0Y8) and following the guidance of the latest editions of the NBCC and the BCBC, the level of seismic activity proposed for design of the pipelines and facilities will have a 2% probability of exceedance in 50 years (or will occur once every 2,475 years). Therefore, the annual probability of exceedance will be approximately 0.04% and the probability of exceedance in 10 years will be approximately 0.4%. The potential for damage sufficient to cause a rupture, leak, spill, fire, or an associate hazard is not necessarily directly related to the probability of exceedance, given the safety factors included and inherent in codified design.

BROKE IR No. 2.1b.f (Filing ID A4H7Z4) also asked about the applicable Seismic Use Group (SUG) for the proposed new storage tanks. Trans Mountain has not yet begun the detailed design of the storage tanks proposed for Sumas Terminal or Burnaby Terminal and, as such, Trans Mountain has not yet selected the SUG for the tanks.

American Petroleum Institute (API) Standard 650, Welded Steel Tanks for Oil Storage, Annex E, defines the SUGs as follows:

> **E.3.1.1 Seismic Use Group III**
>
> SUG III tanks are those providing necessary service to facilities that are essential for post-earthquake recovery and essential to the life and health of the public; or, tanks containing substantial quantities of hazardous substances that do not have adequate control to prevent public exposure.
>
> **E.3.1.2 Seismic Use Group II**
>
> SUG II tanks are those storing material that may pose a substantial public hazard and lack secondary controls to prevent public exposure, or those tanks providing direct service to major facilities.
>
> **E.3.1.3 Seismic Use Group I**
>
> SUG I tanks are those not assigned to SUGs III or II.

In the commentary on Annex E, API 650 further qualifies the criteria for SUG I:

> “For example, tanks serving the following types of applications may be assigned SUG I….1) storage tanks in a terminal or industrial area isolated from public access that has secondary spill prevention and control….”

Trans Mountain believes that the new tanks proposed for Burnaby Terminal do not meet the API 650, Annex E criteria to be assigned SUG III or SUG II and do meet the criteria to be assigned SUG I, although this will be further considered during the detailed engineering and design phase.

City of Burnaby IR No. 1.08.13m (Filing ID A3Y2E6) asked about the extent of a spill and impacted locations in the event of multiple tank and containment area failures. Trans Mountain has not undertaken modelling of the scenario(s) suggested. Trans Mountain does not consider

the simultaneous failure of multiple tanks, secondary containment areas, and the tertiary containment area to be a credible scenario resulting in the release of oil outside of the Burnaby Terminal site. Similarly to the tanks, Trans Mountain intends to design the secondary containment areas to withstand the seismic event described in Volume 4A, Section 2.9.3 of the Facilities Application (Filing ID A3S0Y8) when filled to their design capacities. Similarly to the tanks, the new secondary containment berms will be founded on sandstone bedrock or other suitably strong material. Furthermore, the type of failure of the berms in an earthquake larger than the design seismic event, even with full static fluid pressure, is considered to be horizontal and vertical deformation leading to some reduction of freeboard, rather than complete collapse.

20.6 Proposed New Storage Tanks

Evidence submitted by various Intervenors included concerns related to risk mitigation measures for the proposed new storage tanks. Trans Mountain intends to implement a number of measures related to seismic design, Hazards and Operability (HazOp) reviews, inspection, testing, overfill protection, fire detection, leak detection, hydrocarbon detection, and fire protection systems. Additional information regarding specific measures is included in the responses to various IRs. Trans Mountain notes that NEB IR No. 3.093b (Filing ID A4H1V2) requested information on risk mitigation measures that will be implemented during design and operation. The risk mitigation measures that Trans Mountain intends to implement for the proposed new storage tanks during detailed engineering and design, construction, and operations, are generally outlined below:

- Design of the proposed new storage tanks will be in accordance with the latest edition of the API Standard 650, Welded Tanks for Oil Storage, as per the legislative requirements. API 650 identifies specific design provisions for seismic stability and seismic design parameters will be in accordance with the Alberta and British Columbia Building Codes, as applicable. Seismic design, including consideration of sloshing and other effects, will be in accordance with API 650, Annex E. All designs, including seismic considerations, will be undertaken by experienced and competent registered professional engineers. Geotechnical programs, which will include borehole and other investigative methods to obtain subsurface data, will be conducted, and the results and recommendations of registered professional engineers and geologists will be used to inform the seismic designs. Trans Mountain will also consider applicable topography and soil conditions in the design of tanks, tank foundations, and containments systems. Please refer to the response to NEB IR No. 2.114 (Filing ID A3Z4T9).

- Fabrication of components, construction, and installation will be rigorously inspected to ensure that the prescribed designs are followed and structural integrity will be verified by testing, as applicable. General information on design and quality verification principles is included in Volume 4A, Sections 2.1 through 2.7 (Filing ID A3S0Y8) and Volume 4B, Sections 3.4.8 through 3.4.13 (Filing ID A3S1K5) of the Facilities Application. Numerous other references to design principles and features and quality assurance (QA) methods exist throughout Volume 4A and 4B of the Facilities Application. Please refer to the response to NEB IR No. 2.114 (Filing ID A3Z4T9).

- Following construction, each storage tank will be hydrostatically tested (with water) which is more dense (heavier) than crude oil.

- Trans Mountain is highly confident that the proposed new storage tanks at Burnaby Terminal can be safely constructed in the vicinity of existing operational tanks, based on the recent successful experience, over a three year period, with constructing 16 new large diameter storage tanks immediately adjacent to the existing operating tanks at Edmonton Terminal. Site-specific safe work procedures and mitigation measures for the Burnaby Terminal will be developed during detailed construction planning in early / mid-2016, assuming the current Project schedule is maintained. Please refer to the response to NEB IR No. 2.119a (Filing ID A3Z4T9).

- Storage tank protective device design will generally include radar gauging, overfill protection, fire detection, leak detection, hydrocarbon detection in secondary containment areas, and terminal fire protection systems as outlined in Volume 4A, Section 3.4 of the Facilities Application (Filing ID A3S0Y8).

- Trans Mountain will provide overfill protection in accordance with API 2350. All proposed tanks will be equipped with a radar gauging system for liquid level measurement and overfill protection. Redundant instrumentation for overfill protection will also be provided. For tanks not designated as mainline relief tanks, the overfill protection system will automatically cause the tank valve to close if the liquid reaches a predetermined level. The overfill protection arrangement will be finalized during the detailed engineering and design phase. Please refer to the response to NEB IR No. 2.118c (Filing ID A3Z4T9).

- The under-tank leak detection system proposed for each new storage tank will consist of perforated pipes which will drain to a sump adjacent to the tank. The leak detection system design will be in accordance with API 650, Annex I. Please refer to the response to NEB IR No. 2.118c (Filing ID A3Z4T9).

- Several types of fire detection technologies are available for tanks, including linear wire heat detector technology, linear fiber heat detector technology, and triple infrared detector technology. The most suitable technology for the proposed tanks will be selected during the detailed engineering and design phase. When the design basis for the proposed fire protection systems is finalized, during the detailed engineering and design phase, specifications and drawings will be developed under the supervision of experienced and competent professional engineers, specializing in fire protection. Trans Mountain also retains the services of an industrial fire-fighting specialist to provide advice on conceptual and detailed design. Please refer to the response to NEB IR No. 2.125b (Filing ID A3Z4T9).

- Risk mitigation measures are also a subject of ongoing HazOp reviews. The first of a series of HazOp reviews was completed in Q2, 2014. This HazOp review focused on the primary elements of the crude oil process piping at Burnaby Terminal. Other HazOp reviews are scheduled in Q2, 2015 to complete the process piping at Burnaby Terminal. Additional reviews will be required to assess the fire-water/foam systems, and the non-process elements of the terminal design (*i.e.*, such as emergency response) at Burnaby Terminal. These will likely occur in Q3 or Q4, 2015. The timing of these HazOp reviews is related to the design cycles for each terminal. The risk assessment for Burnaby will be considered in coordination with the HazOp reviews and the implementation of any recommendations arising from the HazOp reviews.

- Trans Mountain intends to install fire protection systems on or nearby the proposed new tanks, as applicable, that will be designed to address the following fire scenarios at Burnaby Terminal:
  - Tank floating roof rim seal fire (fixed to tank, automated foam application);
  - Tank full-surface fire (fixed to tank, automated foam application);
  - Tank full-surface fire (application by portable foam monitors);
  - Adjacent tank cooling (application by portable water / foam monitors); and,
  - Release to secondary containment (application by portable foam monitors for odorous and combustible vapour suppression).

  Please refer to the response to NEB IR No. 2.125b (Filing ID A3Z4T9).

  Trans Mountain notes that the fixed, automated, full-surface fire protection feature proposed for the new tanks at Burnaby Terminal was not included in the Facilities Application and has been added to further enhance the robustness of the fire protection systems at these sites.

- Operating and maintenance procedures, routine inspection and maintenance activities, and facility integrity management, which will generally safeguard the proposed storage tanks, are described in Volume 4C, Sections 5.0, 6.0, and 8.0 of the Facilities Application (Filing ID A3S1L1).

As indicated in the response to NEB IR No. 2.118c.6 (Filing ID A3Z4T9), all proposed tanks will be located within secondary containment designed in accordance with CSA Standard Z662 and the National Fire Protection Association (NFPA) Code 30. Although not a statutory requirement, secondary containment volume will meet the additional requirements of the Alberta Fire Code (AFC) or the BC Fire Code (BCFC), whichever is applicable to the location.

NEB IR No. 4.24a (Filing ID A4K4W3) provided information on predicted total volumes, along with percentage of time, for Burnaby Terminal. Given the variability of the parameters and constraints that will determine the operational reality of the expanded TMPL system, the volume that will be at Burnaby Terminal at any given time is difficult to predict through simple speculative calculations. With this understanding, Trans Mountain has completed extensive simulation modelling of the expanded pipeline system, including tanker loading. Attachment 1 (NEB IR No. 4.24a – Attachment 1, Filing ID A4K4X3) provides histograms of tank utilization for all of the tanks at Burnaby Terminal, for various commodity types, and for the tanks within shared secondary containment areas. The simulation modelling predicts an average total volume of 233,870 m^3 (1,471,000 barrels; bbl) at Burnaby Terminal, a total volume of less than 476,960 m^3 (3,000,000 bbl) 98.2% of the time, and a total volume of less than 556,460 m^3 (3,500,000 bbl) 99.5% of the time.

Trans Mountain also notes that detailed discussion regarding the likelihood of two or more tanks failing as a result of a large seismic or other geotechnical-related event is included in Section 65: Facility Risk Assessment of this Reply Evidence.

20.7 Reference

Thomson R.E., Bornhold B.D., and S. Mazzottii. 2008. An examination of the factors affecting relative and absolute sea level in British Columbia. Canadian Technical Report of Hydrography and Ocean Sciences 260. Fisheries and Oceans Canada. Ottawa, ON.

21.0 FACILITY SITING

This section of Reply Evidence addresses various concerns expressed by intervenors regarding siting of the facilities for the TMEP.

21.1 Proximity to Residents

The Intervenor Evidence submitted by Geoffrey Senichenko (Filing ID A4L6Q9) included concerns regarding the proximity of storage tanks with respect to residents of Forest Grove. Section 2.3 (page 3) states "Now referring to attached Map 2 (Appendix B), the nearest proposed new tank #75 will be approximately 234m and uphill from the nearest home, while the nearest existing tank #73 is approximately 178m away." The preliminary location of the proposed new Tank 79 will result in a setback that is further than the residence is from existing Tank 73. Additional information regarding the proximity of storage tanks with respect to residents is included in the responses to various IRs.

Trans Mountain notes that City of Vancouver IR No. 2.09.3p (Filing ID A4H8I9) also asked about the safe siting of Burnaby Terminal. Trans Mountain's response was that expanding existing facilities reduces new disturbance, uses existing infrastructure, and minimizes environmental effects. This is consistent with good project planning and best environmental practices. While good planning and best practices favour using existing facilities, this does not reduce the rigour of conducting an assessment of the potential impacts associated with the expansion. Early in project planning Trans Mountain tested the basic premise that expanding existing facilities is the most responsible approach to the development.

City of Burnaby IR Nos. 1.14.01a and 1.14.01b (Filing ID A3Y2E6) asked if Trans Mountain will exceed the setback regulations stipulated in the Burnaby Zoning Bylaw with respect to adjacent residential properties and also asked about the proximity of the proposed new storage tanks with respect to Forest Grove Elementary School. Although the design of the proposed Burnaby Terminal expansion has not been finalized, the preliminary location of the new storage tanks to be situated in the existing open space on the east side of the terminal property will result in the closest tank (Tank 79) to the Forest Grove Community R or RM districts (located to the south) exceeding the M7a Marine District 2 setback requirement for the storage of petroleum products of 61 m (200 ft.). The preliminary location of Tank 79 will result in a setback of approximately 105 m (345 ft.) from the north boundary of the Forest Grove Community. The closest residence in the Forest Grove Community (in Wembley Estates) will be approximately 225 m (740 ft.) from the edge of the closest new tank (Tank 75), which is further than the residence is from existing Tank 73, approximately 170 m (560 ft.). There are no storage tanks proposed to be added to the west side of the Burnaby Terminal property, adjacent to the A2 District.

Trans Mountain believes it is relevant to note that both the City of Burnaby bylaw setback and the preliminary setback for proposed Tank 79 exceed the maximum setback requirement of 53 m (175 ft.) for any size tank in Table 22.4.1.1(a), NFPA Standard 30, even when there is no protection for exposures.

SFU IR No. 2.7.07.1 (Filing ID AH49C9) asked about the appropriateness of expanding Burnaby Terminal. The proposed expansion of Burnaby Terminal was conceptually designed to meet the applicable legislative requirements, which have been established and tested over time to provide for an appropriate balance of efficient land use, various types of development, and protection of the public. Trans Mountain also believes that the City of Burnaby community

planning principles, including the zoning of neighbourhoods with respect to industrial and residential uses and the setbacks established in the City of Burnaby bylaws, are primarily intended to protect the safety of the residents. The location of the proposed new tanks will result in setbacks greater than those established in the City of Burnaby bylaws for the M7a Marine District 2. Trans Mountain is not aware of any plans for additional community development south and west of Burnaby Terminal and understands that the areas to the north and east of Burnaby Terminal are part of the Burnaby Mountain Conservation Area, with the exception of the southwest corner of the Simon Fraser University (SFU) Enclave.

As described generally in Volume 4A, Section 3.4.3 of the Facilities Application (Filing ID A3S0Y8), Trans Mountain will incorporate numerous safety features into the design of the proposed additional facilities at Burnaby Terminal, some of which exceed the requirements of the applicable legislation. Furthermore, as discussed in Volume 4C and Volume 7 of the Facilities Application (Filing ID A56004 and A56025), Trans Mountain has, and will continue to develop and enhance, robust operations, maintenance, and emergency preparedness and response programs and procedures, all of which are intended to ensure the safety of operations.

21.2 Protection of Adjacencies

As indicated in Section 21.1: Proximity to Residents, the Intervenor Evidence submitted by Geoffrey Senichenko included concerns regarding the proximity of storage tanks with respect to residents of Forest Grove. Additional information regarding the protection of adjacencies at Burnaby Terminal, safe fire resource access and deployment positions is included in the responses to various IRs.

Trans Mountain notes that City of Burnaby IR No. 2.027l (Filing ID A4H8A1) also asked about protection of the fenceline forest area at Burnaby Terminal. Trans Mountain believes that protection of adjacencies at Burnaby Terminal would not be precluded for the various scenarios indicated in IRs received from the City of Burnaby, due to a lack of safe fire resource access or deployment positions due to outfall heat impact. The scenarios identified are:

- protection of forest area from full-surface tank fire (deployment);
- protection of forest area from secondary containment fire (access);
- protection of forest area from secondary containment fire (deployment);
- protection of adjacent tank from secondary containment fire (access);
- protection of adjacent tank from secondary containment fire (deployment).

First responders will have the benefit of protective measures and will generally be able to use strategic and tactical approaches for safe deployment. The proposed primary access routes at Burnaby Terminal will be designed and constructed so that emergency response access is available from a minimum of two independent directions. For additional information on emergency responder heat exposure and emergency access please refer to the responses to City of Burnaby IR No. 2.016d and City of Burnaby IR No. 2.030e (Filing ID A4H8A1).

For a discussion of the risk of fire extension to forested areas and adjacent tanks, with and without protection by first responders, please refer to the responses to City of Burnaby IR Nos. 2.016e, 2.016g, and 2.027k (Filing ID A4H8A1).

Strategic and tactical access and deployment plans for various tank fire and secondary containment spill / fire scenarios will be considered during the detailed engineering and design phase of the Project, and fully developed once the detailed designs are complete.

Trans Mountain acknowledges that the protection of an adjacent tank within a shared secondary containment area from a pool fire extending across the full secondary containment area, a subset of the scenario identified in City of Burnaby IR No. 2.027p (Filing ID A4H8A1), could be challenging for first responders. However, in such a scenario, Trans Mountain anticipates that damage to an adjacent tank would take some time and there are other mitigation measures (such as draining the adjacent tank or draining the secondary containment area to the intermediate retention area), that may be employed if considered appropriate. Trans Mountain's focus in design, operations, and spill response planning is to minimize the risk of a full-surface secondary containment area fire.

City of Burnaby IR No. 2.016d (Filing ID A4H8A1) requested the identification of areas in which the radiant heat exposure cannot be safely occupied by emergency responders. Trans Mountain has not completed detailed analyses to identify which outfall heat exposure areas may not be able to be safely occupied by emergency responders in the case of secondary containment fires or full-surface tank fires at Burnaby Terminal. The purpose of the generation of the 4.0 kW/m^2 radiant heat contour map for secondary containment areas was to identify potential risk to the public, rather than to emergency responders, in the case of an unmitigated fire. Emergency responders will have the benefit of personal protective equipment (PPE), fire suppression systems, and tactical fire-fighting expertise. Should such safe occupancy analyses be required for emergency response planning purposes, assuming they can be framed and conducted to yield meaningful results, they will be completed commensurate with the updating of the ERP.

In the event of any fire at Burnaby Terminal, emergency response will be conducted on a case-by-case basis, using philosophies, principles, and procedures identified in the ERP. A hazard assessment and risk evaluation will be used to determine the scope and magnitude of the incident, resource requirements, and response options.

Emergency responders will have rapid access to high-capacity water and foam concentrate supplies and various forms of fire-fighting equipment, both fixed and portable. Emergency responders will use PPE and clothing for the specific hazards present, including fire-fighting protective clothing and positive-pressure self-contained breathing apparatuses (SCBA). Continuous air monitoring will be conducted to detect Lower Explosive Limit (LEL) and hydrogen sulfide (H_2S) gas values. Cooling water screens may be applied to facilitate close approach and to protect any exposures impacted by flame encroachment. Emergency responders will be trained to effectively implement and sustain fire suppression for various fire scenarios.

Trans Mountain notes that the fire protection systems that will be installed on or nearby the proposed new tanks at Burnaby Terminal will be designed to address the following fire or fire-related scenarios:

- Tank floating roof rim seal fire (fixed to tank, automated foam application).

- Tank full-surface fire (fixed to tank, automated foam application).
- Tank full-surface fire (application by portable foam monitor).
- Adjacent tank cooling (application by portable water / foam monitors).
- Release to secondary containment (application by portable foam monitors to suppress combustible vapours and odours).

The fixed, automated, full-surface system proposed for the new tanks at Burnaby Terminal was not included in the Facilities Application and has been added (and discussed in various IR responses) to further enhance the fire protection system.

NEB IR No. 3.065c (Filing ID A4H1V2) asked about measures being considered to protect Westridge Marine Terminal infrastructure in case of a fire. Trans Mountain anticipates that the proposed Westridge Marine Terminal fire protection system will be designed to address the fire scenarios listed below.

- Aboveground process piping system fire (*i.e.*, manifold, metering, and trap areas).
- Vapour recovery and combustion system fire.
- Dock complex fire (*i.e.*, loading platform process areas).
- Grass fire.

The Westridge Marine Terminal fire protection system will not be designed to fight fires on tankers, which have their own fire protection systems. The specific capabilities and design of the fire protection systems will be finalized during the detailed engineering and design phase of the Project.

21.3 Fire Extension Risk

As indicated in Section 21.1, Proximity to Residents, and Section 21.2, Protection of Adjacencies, the Intervenor Evidence submitted by Geoffrey Senichenko included concerns regarding the proximity of storage tanks with respect to residents of Forest Grove. Additional information regarding radiant heat and fire extension is included in the responses to various IRs.

Trans Mountain notes that City of Burnaby IR No. 2.016e (Filing ID A4H8A1) requested identification of areas where the radiant heat level could create a risk of fire extension. Trans Mountain anticipates that in the highly unlikely event of a storage tank release (which extends to the entire surface of a secondary containment area or partial remote impoundment area), combined with a secondary containment area pool fire, the risk of fire extension at Burnaby Terminal is very limited, for the reasons indicated below.

- Trans Mountain considers that a radiant heat level of 25.0 kW/m^2 could create risk of fire extension to forested areas. Based on the risk assessment calculations, this radiant heat level may theoretically extend approximately 40 m (130 ft.) from the edges of the secondary containment areas. In the proposed Burnaby Terminal layout, the distances to the current edges of the forested areas from the edges of the secondary containment areas are much

greater than 40 m, except for very short sections at the closest approaches, which are just less than 40 m:

- northwest of proposed Tank 74;
- northeast of proposed Tank 78;
- northwest of proposed Tank 91;
- northeast of proposed Tank 98; and,
- northeast of the proposed partial remote impoundment.

In all of these locations, the forested areas extend somewhat within the property lines. However, none of the approaches listed above border Forest Grove or any other residential area. In the first three of these locations, the distances to the property lines from the proposed edges of the secondary containment areas, at the closest approaches, are approximately 50 m (165 ft.). Trans Mountain will consider removing small areas of trees inside the property lines to fully utilize the available separation distances. For the last two locations, there is also an opportunity to remove small areas of trees from the road allowance outside and adjacent to the property line.

Trans Mountain notes that the radiant heat distances are conservative as they assume flat terrain and no shielding from the tanks. In reality, the closest approaches to the forested areas are sheltered by the large terrace cuts in the northeast and northwest sectors of the secondary containment areas and there would be very little pool surface areas adjacent to the tanks in those sectors to generate high levels of radiant heat. This may factor into considerations to remove trees.

· As indicated in Section 21.2, Protection of Adjacencies, emergency responders will have rapid access to high-capacity water and foam supplies and water and foam monitors / cannons to allow them to implement and sustain fire suppression and guard against fire extension.

21.4 Proposed Terminal Drainage

The Intervenor Evidence submitted by Geoffrey Senichenko also included concerns regarding spills and leaks from the tanks during operation, accidents, or natural disasters impacting residential areas and ecosystems outside the Burnaby Terminal property. Section 3 (page 5) states "… *spills and leaks from the tanks during operation, accidents or natural disasters (ex. earthquakes) would flow downstream along those creeks impacting residential areas and ecosystems through Forest Grove Park, Burnaby 200 Conservation Area, Squint Lake park, Eagle Creek Ravine Trail System, Charles Rummel Park, Warner Loat Park, and then all the way into Burnaby Lake and affecting Burnaby Lake Regional Nature Park. Furthermore, the diluted bitumen and/or crude oil would then travel downstream along the Brunette River and eventually into the Fraser River and out to the Salish Sea*." Additional information regarding the terminal drainage systems is included in the responses to various IRs.

Trans Mountain notes that Living Oceans IR No. 1.28a (Filing ID A3Y2T4) asked how Trans Mountain will ensure compliance with waste water discharge standards. Trans Mountain currently complies with British Columbia Ministry of Environment (BC MOE; formerly Ministry of

Water, Land and Air Protection) water discharge permits at Burnaby Terminal and Westridge Marine Terminal. Copies of these permits are provided in Living Oceans IR No. 1.28a - Attachment 2 (Filing ID A3Y2T7) and Living Oceans IR No. 1.28a - Attachment 3 (Filing ID A3Y2T8), respectively. Trans Mountain anticipates that these permits will be amended or new permits will be issued for the expanded terminals and that the parameters and conditions will be the same or similar.

The proposed storm water management systems at Burnaby Terminal and Westridge Marine Terminal are described in Volume 4A, Section 3.4.3.2.1 (Filing ID A3S0Y8) and Section 3.4.4.2.1 (Filing ID A3S0Y9) of the Facilities Application. During normal operations, Trans Mountain anticipates that there will be no measurable hydrocarbons in the storm water flows leading to the oil / water separators. This will be assured by the design, maintenance, and operational procedures and practices that are described in Volume 4A and Volume 4C (Filing ID A56004) of the Facilities Application. In addition, and notwithstanding that the permits allow for short-term suspension of the normal discharge parameters under certain circumstances (*i.e*., emergencies) and conditions, there are a number of additional controls that physically exist or are prescribed in operational procedures, and will be extended to the expanded terminals, or that will be installed or prescribed as part of the proposed expansions. These controls provide layers of protection that are intended to control or prevent storm water discharge during rare upset conditions so that high levels of hydrocarbon do not reach the oil/water separators or the environment from the storm water systems. These will include, as applicable to the various terminals:

- Observation by operations personnel (Burnaby Terminal) before and during storm water draining from secondary containment areas.
- Hydrocarbon detectors within secondary containments areas (Burnaby Terminal) that, if triggered, will cause the automatic closure of the drain valve(s) (refer to the response to City of Burnaby IR No. 1.13.05u, Filing ID A3Y2E6).
- An intermediate retention area (Burnaby Terminal), with hydrocarbon detectors that, if triggered, will cause the automatic closure of the drain valve(s) (refer to the response to City of Burnaby IR No. 1.08.15a, Filing ID A3Y2E6).
- A tertiary containment area (Burnaby Terminal).
- Storm water collection tank(s) (Westridge Marine Terminal), with hydrocarbon detectors that, if triggered, will cause the automatic closure of the drain valve(s). Multiple tanks with weirs or high / low connections to provide bulk separation of crude oil and water, in an upset condition, are also being considered.

In this context, the oil / water separators are the last elements of a multi-faceted system for protecting the environment during storm water discharge. The final configurations and features of the storm water management systems will be determined in the detailed engineering and design phase of the Project. In addition, simple cross-sectional schematics showing the proposed secondary containment components for Burnaby Terminal and Westridge Marine Terminal are provided in NEB IR No. 3.081b (Filing ID A4H1V2) and NEB IR No. 3.081b - Attachment 1 (Filing ID A4H2E5).

City of Burnaby IR No. 2.056a (Filing ID A4H8A1) requested site drainage information for terminals in Burnaby. A general description of the existing drainage systems at Burnaby Terminal and Westridge Marine Terminal is provided below.

Burnaby Terminal

Secondary containment areas are drained through underground piping, to an oil-water separator, which is monitored by instrumentation capable of detecting hydrocarbons. Clean water from the separator is directed to the tertiary containment area. A motor operated valve (MOV) is located on the secondary containment area drain system outlet for each storage tank. The MOV is normally closed and is only opened to release collected storm water. In the extremely unlikely event of a spill into the secondary containment area while storm water is being drained, a hydrocarbon detector located in the secondary containment area will automatically cause the MOV to close. Subsurface drains under the secondary containment areas are also directed to the tertiary containment area. The drainage system for the proposed new storage tanks will be the same, except for an intermediate retention area that will be located upstream of the oil-water separator.

Westridge Marine Terminal

Secondary containment areas are drained through a storm water siphon system. Clean water from the siphon system is directed to Burrard Inlet. In the extremely unlikely event of a spill into a secondary containment area while storm water is being drained, a hydrocarbon detector will automatically cause a valve to open and re-introduce air into the system to stop flow in the siphon. Storm water runoff, from locations other than the secondary containment areas, is directed into open ditches that flow to a catch basin. Underground piping directs the water from the catch basin, under the Canadian Pacific Railway right-of-way, and into Burrard Inlet.

City of Burnaby IR No. 1.08.05d (Filing ID A3Y2E6) requested information on how open ditches at Burnaby Terminal will handle storm water and not convey product spills. Storm water runoff, from areas at Burnaby Terminal other than the proposed secondary containment areas, will be directed into open ditches. Secondary containment areas will be drained through underground culverts, via the intermediate retention area, to the tertiary containment area. The storm water ditches, therefore, will not convey oil in the event of a tank failure. Secondary containment design features are discussed in Volume 4A, Section 3.4.3.2.1 of the Facilities Application (Filing ID A3S0Y8). The robustness of the secondary containment berms is discussed in the response to City Burnaby IR No. 1.08.13m (Filing ID A3Y2E6). In the extremely unlikely event of a secondary containment area failure, coincident with a tank failure, oil may be conveyed in the storm water ditches. However, since the storm water ditches will be directed to the tertiary containment area, such an event will not result in oil leaving the Burnaby Terminal site.

City of Burnaby IR No. 1.15.01g (Filing ID A3Y2E6) asked about the tertiary containment outlet at Burnaby Terminal. The outlet of the existing tertiary containment area consists of an adjustable weir that allows for a small adjustment in water level. A valve, that can be closed to stop water from flowing out of the tertiary containment area, is located downstream of the adjustable weir. The maximum discharge rate is 17,500 m^3/d (110,070 bbl/d) in accordance with the BC MOE permit. In 2013, the discharge rate ranged between 440 m^3/d (2,770 bbl/d) in July to 6,300 m^3/d (39,630 bbl/d) in November. The tertiary containment area discharges to Eagle

Creek. An Eagle Creek tributary also flows through the main portion of the terminal. The creek flow is through underground piping to prevent water contamination. The overall volume of the tertiary containment area is estimated to be 95,000 m^3 (597,530 bbl). The estimated water volume in the tertiary containment area at any given time ranges from about 10,300 m^3 (64,790 bbl) to about 15,400 m^3 (96,860 bbl) depending on the position of the adjustable weir. When the adjustable weir is in the highest position, the remaining capacity is about 79,600 m^3 (500,670 bbl). Based on the preliminary design work completed to date, there are no changes proposed for the existing tertiary containment area.

City of Burnaby 1.08.05c indicates Volume 4A, Sections 3.4.3.2.1 and 3.4.3.2.2 of the Facilities Application (Filing ID A3S0Y8) describe the overall drainage scheme for the proposed expansion at Burnaby Terminal and make some references to the existing drainage scheme. There are no storm water sewers under any of the existing storage tanks. There are subsurface ground water drains under the existing secondary containment areas which are directed to the tertiary containment. Trans Mountain has no plans to remove and redirect any existing subsurface drainage system unless they obstruct proposed new tanks or other infrastructure. In the event of removal or redirection, Trans Mountain will ensure proper flow to the tertiary containment is achieved.

Based on the proposed terminal drainage system described above, Trans Mountain believes the possibility of oil leaving the Burnaby Terminal site and entering watercourses is extremely low.

City of Burnaby IR No. 1.20.02a and 1.20.02b asked about changes to the storm water discharge permit at Westridge Marine Terminal. Trans Mountain will review the status of the current storm water discharge permit with the BC Ministry of Environment to determine if the existing permit will remain in effect, if the existing permit will require an amendment, or if a new permit will be required. Changes to the existing storm water discharge permit for Westridge Marine Terminal are expected to define one or more new discharge location(s), increases in discharge volumes, and water discharge quality parameters (if different from those currently in effect). Trans Mountain intends to consult with the BC MOE and other stakeholders, as appropriate, during the detailed engineering and design phase of the Project and then refine the design of the storm water treatment systems to ensure that compliance with the terms of the future water discharge permit, and any other legislative requirements, will be achievable.

22.0 SYSTEMS OPERATIONS, CONTROL, AND LEAK DETECTION

22.1 System Operation and Hydraulic Modelling

The Intervenor Evidence submitted by Mr. Alfred James (Written Evidence of Shxw'ōwhámel First Nation) includes the following:

- Section 53 (page 10) states "… *Trans Mountain has indicated that at least one of the pipelines will be operated by slack line flow, which is a type of operation that can limit the effectiveness of leak detection systems*."
- Section 60 (page 11) states "… *the worst case scenario outlined in the Trans Mountain application materials could be easily exceeded if leak detection systems are not operating correctly* …"

Similarly, the report, *Groundwater Issues Associated with Ohamil I.R. 1 and Peters I.R. 1 and 2*, prepared by Piteau Associates Engineering Ltd., Section 4.1 (page 15) states "The Trans Mountain response to Shxw'ōwhámel FN IR No. 2 (Exhibit B317-30, Filing ID A4H9C8) indicated that at least one of the pipelines would be operated with slack line flow at least part of the time. This type of pipeline operation can limit the effectiveness of leak detection systems." Trans Mountain intends to implement a number of measures to address the issue of slack flow in the expanded pipeline system. Additional information regarding the issue of slack flow and mitigation measures are included in the responses to various IRs.

NEB IR No. 2.090a (Filing ID A3Z4T9) asked about measures that would be implemented to eliminate slack flow. Trans Mountain responded that the most recent steady-state hydraulic study, completed after the Application was filed (an excerpt from which is included in the response to NEB IR No. 1.94f [Filing ID A3W9H9]) indicates that proposed Line 1 will not be in slack flow downstream of the Coquihalla summit at the design flow rate and with the selected discharge pressure at Kingsvale Pump Station and the selected suction pressure at Sumas Pump Station. However, Trans Mountain is continuing to assess the feasibility of sustained operations in this flow regime. It is likely, as is the case today, that slack flow will continue to be a feature of operations in this segment (refer to the response to NEB IR No. 2.090b below). Trans Mountain will consider the application of back-pressure control, but it may not be feasible due to the existing pipe configuration and specifications in the area. The most recent hydraulic study for proposed Line 2, an excerpt from which is included in the response to NEB IR No. 1.94f (Filing ID A3W9H9), indicates that there will be the potential for slack flow downstream of the Coquihalla summit at the design flow rate and that back-pressure control is appropriate. Increased pipe wall thickness for several kilometres upstream (the exact length to be determined) and for approximately two kilometres downstream of Hope Relief Station will be included in the design, along with back-pressure control at Hope Relief Station. The back-pressure control facility (station) will have one or more control valves actuated by a proportional, integral, and derivative controller. The pressure set point of the controller will be adjustable to allow effective operation during transitional flow scenarios (*i.e.*, pipeline start-up and shut-down). The Control Centre will determine the set points as required, within a limited range, based on procedures, to be developed, and calculations done by the Computational Pipeline Monitoring (CPM) system. The Hope Relief Station currently protects the existing pipeline downstream of the Coquihalla summit and will protect Line 1 in the future. A pressure relief valve will be installed upstream of the back-pressure control valve(s) on Line 2. The design basis for both the pressure control and pressure relief systems will be determined during

the detailed design and engineering phase of the Project. At all other locations in the pipeline system, slack flow will not occur at the design flow rates on Line 1 or Line 2. Further study is required to assess atypical flow rate scenarios and shut-down and start-up conditions for both Line 1 and Line 2. It may be necessary and / or desirable to allow slack flow to develop in these transitional flow scenarios. Where it is possible and / or desirable to avoid slack flow during pipeline shut-down scenarios, mainline valves will be selectively closed to maintain line pack.

NEB IR No. 2.090b (Filing ID A3Z4T9) asked about measures currently taken to eliminate slack flow in Line 1. Trans Mountain responded that the existing pipeline is in slack flow downstream of the Coquihalla summit during normal operations. The existing pipeline has operated this way since it was constructed and was designed accordingly. The slack flow section of line has been inspected multiple times with state of the art ILI technology in recent years, and a hydrostatic test was performed successfully on the section in late 2013. In the event that the CPM system calculates that slack flow may occur elsewhere in the existing pipeline, a warning message is sent to the CCO who will take appropriate measures to adjust pressure set points to prevent the pipeline from reaching slack conditions. The CCO will continue to monitor the pipeline to ensure that it is properly packed.

Farquhar E IR No. 1.01d (Filing ID A3X6F0) asked about operating protocol when slack line flow or column separation occurs. Trans Mountain responded that if slack flow or column separation occurs in the existing pipeline or in Line 1 or Line 2 in the expanded pipeline system, the CCO will take appropriate measures to adjust pressure set points to eliminate the condition. The CCO will then continue to monitor the pipeline to ensure that the line has packed. If at any time the CCO feels further operation is unsafe or suspects that there may be a leak, the CCO has the authority and the responsibility to shut down the pipeline. The shut-down protocol for leak alarms and other abnormal conditions is generally described in Volume 4C, Sections 7.1.5 and 7.1.11.5 of the Facilities Application (Filing ID A56004). Notifications will also be made according to the applicable legislative requirements. The CCO will not be faulted for shutting down under these circumstances. The pipeline restart protocol is generally described in Volume 4C, Section 7.1.11.6 of the Facilities Application (Filing ID A56004).

Farquhar E IR No. 1.01e (Filing ID A3X6F0) asked about methods used to differentiate slack line flow and column separations caused by normal operation versus slack line flow caused by a leak. Trans Mountain responded that, as it can be difficult to distinguish the possible causes of slack line flow or column separation, it does not consider these conditions to be normal. To reduce the number of potential slack line flow or column separation events, the CPM system calculates the pressures along the pipeline between the pressure transmitters. If a calculated pressure approaches the low operating pressure of the pipeline, a warning message is sent to the CCO who will take appropriate measures to increase the pressure.

Farquhar E IR No. 1.01i (Filing ID A3X6F0) asked about how effective the leak detection system is when column separation or slack line flow are present. Trans Mountain responded that the CPM system that is currently in use on the existing pipeline and that will be extended to the expanded pipeline system, is able to model column separation. However, because column separation is difficult to model, leak detection sensitivity decreases during separation conditions. To ensure the integrity of leak detection, the CCOs endeavour to ensure packed line conditions. It is not normal practice to operate under slack line flow or column separation conditions.

The responses to Edward (Ted) Farquhar in Intervenor IR No. 1 were further clarified by responses to Farquhar in Intervenor IR No. 2.

Farquhar T IR No. 2.1a (Filing ID A4H8R2) asked about slack line flow under typical operating conditions. Trans Mountain responded that it has identified in the responses to NEB IR No. 2.090b (Filing ID A3Z4T9) and NEB IR No. 3.051a (Filing ID A4H1V2) that slack flow will continue to be a feature of operations of the existing pipeline segment (that will form part of Line 1) downstream of the Coquihalla summit after completion of the Project. Hydraulic modelling using Stoner Pipeline Simulator SPS, Version 9.9, has been completed at 50%, 75%, and 100% of the design flow rate for Line 1 and 50%, 60%, 80%, and 100% of the design flow rate for Line 2. The hydraulic modelling indicates that in the segment downstream of the Coquihalla summit, Line 1 will not be in slack flow at 100% of the design flow rate but will be in slack flow at 50% and 75% of the design flow rate. Trans Mountain notes, as discussed in the response to NEB IR No. 3.051d (Filing ID A4H1V2), that the existing pipeline was designed to operate in slack flow in this segment. In the 50% and 75% flow regimes, the pressures necessary to ensure operation without slack flow would exceed the allowable maximum operating pressures in this segment. As such, mitigation measures such as back-pressure control will not be possible. Similar to Line 1, the hydraulic modelling indicates that the only segment of Line 2 that could be in slack flow during typical operating conditions (*i.e.*, 50% to 100% of the design flow rate), without mitigation measures, is the segment downstream of the Coquihalla summit. The hydraulic modelling has confirmed that with the addition of a back-pressure control station (rated to ANSI 900# class) at Hope and heavy-wall pipe upstream of the back-pressure control station, Line 2 will not operate in slack flow at any of the modelled flow rates. These features are being incorporated into the design of the Project.

Farquhar T IR No. 2.1e (Filing ID A4H8R2) asked about procedures for collapsing a column separation on start-up to avoid pumping into a leak. Trans Mountain responded that pressure and temperature transmitters will be located both upstream and downstream of all pump stations and automated remote mainline block valve (RMLBV) sites on the proposed new pipeline segments. All locations where column separation is possible will be equipped with absolute pressure transmitters to aid in column separation detection. A pressure of less than one atmosphere will be alarmed in the SCADA system. The SCADA pressure alarm feature, coupled with the ability of the CPM system to recognize column separation, will alert the CCO. Column separation will normally be prevented during shut-downs by closing RMLBVs in specific areas to maintain packed conditions. Pressure will be maintained sufficiently above the vapour pressure of the fluid in the line to avoid temperature effects. Prevention of column separation, including during start-up and shut-down, will be addressed by operating procedures and executed by CCOs when required. Start-up procedures and training provide CCOs with the ability to recognize the difference between a collapsing vapour space and pumping into a rupture.

SFN IR No. 2.4.1b (Filing ID A4H9C8) asked for studies pertaining to Trans Mountain's leak detection and control room response timing if the proposed Project intends to operate in slack line in the area of Shxw'ōwhámel First Nation Traditional Territory. Trans Mountain responded that it will design the proposed new Line 2 to ensure that it will not operate in slack line conditions in the area of Shxw'ōwhámel First Nation Traditional Territory. Trans Mountain has identified that slack line conditions exist today and will continue to be a feature of operations in the existing pipeline segment that will form part of Line 1, downstream of the Coquihalla summit. With regard to leak detection, slack line conditions are difficult for CPM systems to model. The CPM system currently being used will decrease sensitivity levels for segments with column separation in order to model line conditions to the best of its abilities. As such, decreased CPM leak detection sensitivity is recognized as a feature of normal operations downstream of the

Coquihalla summit. However, as part of its systematic approach to leak detection, Trans Mountain does not rely on only one method and the CPM system is used in combination with other monitoring methods, such as CCO monitoring using the SCADA system, scheduled line balance calculations, aerial and ground surveillance patrols, and ILI using intelligent defect detection tools and acoustical leak detection technology, to maintain safe operations. Anytime the Control Centre suspects a leak, based on information received from one or more of the systematic leak detection sources, the CCO will follow established procedures to immediately shut down pipeline operations in a controlled manner.

22.2 Computational Pipeline Monitoring System

The Intervenor Evidence submitted by Shxw'ōwhámel First Nation, *Groundwater Issues Associated with Ohamil I.R. 1 and Peters I.R. 1 and 2*, prepared by Piteau Associates Engineering Ltd., Section 4.1 (page 12) states "*A leak detection system that can effectively detect small leaks and provide timely identification of larger leaks will minimize the potential volume of a PHC spill.*"

Similarly, the Intervenor Written Evidence to Support the City of New Westminster's Technical Review of Trans Mountain Expansion (TMX) Pipeline Project, Section 2.1.3 Suggested Mitigation (page 12) states "*The sensor programming threshold values and anticipated variation in natural dilbit pressure should be available for statistical review by third party interveners to ensure they are adequately sensitive (i.e., will not allow a small leak to occur and falsely categorize it as a natural drop in pressure)*." Trans Mountain intends to implement a number of technology advancements and improvements in the expanded pipeline system, including a second CPM system that will operate in parallel with the existing system. In addition, a number of instrumentation enhancements in the application of existing technology will result in Trans Mountain implementing significantly advanced leak detection for the new Line 2 pipeline segments. Additional information regarding the issue of technology advancements and improvements is included in the responses to various IRs.

Province of BC IR No. 2.15e (Filing ID A4H8W6) asked how leaks are identified by the leak detection system if the thresholds for alarm setoff are dynamic over time and location. Trans Mountain responded that it uses real-time transient modelling (RTTM) in the CPM system. RTTM is complex, but provides one of the most sensitive leak detection methods available. Detailed computer models of the pipeline system are developed using engineering data, including pipeline lengths, diameters, elevation profiles, fluid properties, and instrumentation accuracy/repeatability. The models are used to simulate pipeline conditions using advanced fluid mechanics and hydraulic modelling. The RTTM method automatically adjusts sensitivity based on SCADA data quality, operational events such as pump starts/stops, valve movements, shut-in conditions, and batch changes along the pipeline, so that the best balance of leak detection performance and minimum false alarms can be achieved. The RTTM calculations are driven by fluid parameters, such as flow, pressure, temperature, and physical characteristics (*i.e*., density and viscosity), collected from instruments along the pipeline. RTTM software can estimate the size and location of leaks as follows:

1. A complete theoretical hydraulic state of the pipeline is calculated by the RTTM, assuming no leaks are present.
2. The RTTM checks for variations, between calculated values and process measurements, which cannot be explained by instrument error. If variations are identified, the RTTM attempts to remove them by simulating leaks at different locations.

3. When the RTTM has successfully removed the variations, the size and location of the simulated leak is reported.

Based on the process described, if the simulated leak is larger than the dynamic threshold, an alarm is triggered and the CCO will respond, beginning with the Procedure for SCADA System Leak Alarms in the KMC Control Centre General Procedures, an excerpt of which is included in the response to Province of BC IR No. 2.15h (Filing ID A4H8W6).

Province of BC IR No. 2.15g (Filing ID A4H8W6) asked what additional leak detection systems Trans Mountain will implement to complement SCADA and ensure all spills are detected. Trans Mountain responded that, as stated in the response to Province of BC IR No. 2.16d (Filing ID A4H8W6), it has investigated and continues to review complementary leak detection systems. Trans Mountain uses a CPM system for leak detection. While current regulations in Canada require only a single leak detection system, regulations in Germany require two systems running in parallel on a single pipeline. In recognition of this higher standard and in an effort to continuously improve leak detection, Trans Mountain will, in 2015, be installing a second complementary CPM system that will operate in parallel with the existing system. The new CPM system will use a different technology to recognize leaks. If the application on the existing TMPL system proves successful, the new CPM system will also be implemented for the Project, ensuring that Trans Mountain not only meets, but exceeds regulatory requirements and maximizes CPM leak detection capability. In addition, Trans Mountain is currently participating in two joint industry projects, using large-scale testing, to investigate the viability of commercially available external leak detection systems and aerial surveillance systems for detection of oil spills. The testing is being completed using a test apparatus that is the first of its kind and enables testing of commercially available products under real-world conditions in a laboratory environment. The testing will help Trans Mountain and the pipeline industry determine which technology is optimal for external leak detection on liquids pipelines. The first project is testing four external leak detection technologies: vapour-sensing tubes, fibre-optic distributed temperature sensing systems, hydrocarbon-sensing cables, and distributed acoustic sensing systems. The second project is testing aerial surveillance systems that provide the ability to sense oil spills from a helicopter or fixed-wing aircraft flying over a pipeline. Two different technologies, volatile organic compound (VOC) sensing and temperature sensing, are being studied. As described in Province of BC IR No. 2.15i (Filing ID A4H8W6), Trans Mountain will seek to appropriately apply the above technologies, within the framework of continuous improvement, as the results of these projects (and other future projects, not yet identified) become known.

Province of BC IR No. 2.15i (Filing ID A4H8W6) asked about technological advancements that will be used to reduce detection thresholds. Trans Mountain responded that the KMC QA program, the Integrated Safety and Loss Management System (ISLMS), follows API, Recommended Practice 1130, Computational Pipeline Monitoring for Liquids. The ISLMS has a fundamental philosophy of continuous improvement and requires program managers in all areas of operations, including system control, monitoring, and leak detection, to set specific goals each year commensurate with the philosophy. Any physical or technological issues that are identified through periodic inspection or testing of the equipment and systems are addressed and the lessons learned are applied to locations across the system. The ISLMS, therefore, ensures that technology advancements and improvements to existing technology are constantly evaluated and adopted, where practical and applicable to the TMPL system. For the new Line 2 pipeline segments Trans Mountain intends to employ:

- Custody transfer quality ultrasonic flow meters at all pump stations and at all injection and delivery locations, to improve leak detection sensitivity;
- Pressure and temperature measurement at all RMLBV sites, to improve leak detection sensitivity;
- Pipeline fluid and ground temperature measurements below grade, to improve modelling of temperature for both steady-state operations and pipeline shut-down / start-up events;
- Online density and viscosity measurement at all injection locations, to improve fluid property modelling;
- Density measurement at all pumps stations, to improve batch alignment modelling; and,
- The latest version of CPM software, which includes all of the most recent enhancements developed by the CPM vendor.

All of these technology advancements and improvements in the application of existing technology will result in Trans Mountain implementing significantly advanced leak detection for the Project.

NEB IR No. 4.38b (Filing ID A4K4W3) asked how Trans Mountain has considered HCAs in the design of its leak detection system. Trans Mountain responded that, with respect to the design of the CPM system for Line 2, it does not intend to differentiate between HCAs and areas of lower consequence. The sophisticated real-time transient model used in the CPM system and the high standard of quality for field instrumentation will be applied to the entire pipeline, regardless of the location. KMC has developed and implemented a systematic approach to leak detection. In addition to the CPM system, there are complementary leak detection approaches, including:

- Monitoring by the CCO using the SCADA system;
- Scheduled line balance calculations;
- Surveillance patrols, both aerial and ground;
- ILI tools, which can identify small defects; and,
- ILI tools with acoustical microphones, which have the ability to detect small leaks.

Government of Canada Parks IR No. 1.1.06 (Filing ID A3X6G6) asked what quantity of spill can be detected by the CPM and how it shuts down the system. Trans Mountain responded that it has developed and implemented a systematic approach to leak detection. A CPM system is used in combination with other monitoring methods, such as surveillance patrols, regular ILI using smart pigs and smart ball tools (acoustical leak detection technology), CCO monitoring using the SCADA system, and scheduled line balance calculations. Within the CPM system, the alarm thresholds are dynamic over time and location, constantly changing due to flow dynamics and various factors which affect the uncertainty of instrumentation readings. For this reason,

there is no single defined threshold that will generate alarms identifying potential leaks. While not a legislative requirement, Trans Mountain generally follows the API Recommended Practice 1130, Computational Pipeline Monitoring for Liquids. This includes testing on an annual basis to confirm the effectiveness of the leak detection CPM system. The testing verifies the sensitivity and accuracy of the leak detection system. Weekly checks of the CPM system are also performed and documented to ensure the system is operating within design specifications. As described in Volume 4C, Section 7.1.11.2 of the Facilities Application (Filing ID A3S1L1), the existing CPM system will be extended to the proposed Line 1 and Line 2 and will be in accordance with CSA Standard Z662, Oil and Gas Pipeline Systems, Annex E. The latest technological advancements will be used to reduce detection thresholds to the extent practical. The CPM system will not automatically shut down a pipeline but will generate an alarm that notifies the CCO of a possible leak. As described in Volume 4C, Section 7.1.11.5 of the Facilities Application (Filing ID A3S1L1), the CCO will use prescribed procedures to determine the cause of the leak alarm. A Simulation Specialist will be on call 24 hours a day, 365 days a year to assist the CCO in the analysis of the leak alarm. CCOs receive training in hydraulics, leak detection, and emergency procedures. CCOs are trained to immediately assess and respond to any type of emergency or abnormal operating condition. A CCO has the authority and the responsibility to shut down a pipeline during an emergency or as a precaution when, in his or her judgment, further operation of the pipeline is unsafe. The CCO will not be faulted for shutting down a pipeline under these circumstances.

22.3 Computational Pipeline Monitoring System Sensitivity and Performance Testing

The Intervenor Evidence submitted by Shxw'ōwhámel First Nation, *Groundwater Issues Associated with Ohamil I.R. 1 and Peters I.R. 1 and 2*, prepared by Piteau Associates Engineering Ltd., Section 4.1 (page 14) states "*The efficacy of leak detection systems in pipelines is not clear in the submission or in the response to Information Requests (IRs), including its ability to detect small leaks that may be significant in terms of potential for groundwater contamination*."

Similarly, the Intervenor Written Evidence to Support the City of New Westminster's Technical Review of Trans Mountain Expansion (TMX) Pipeline Project, Section 2.6.3 Suggested Mitigation (page 21) states the following:

- "Commit to monitoring to meet a minimum level of statistical power (*e.g.*, 0.8) for all monitoring studies that utilize a before-after-control-impact (BACI), or a before-after (BA), or control-impact (CI) study design; and
- Commit to providing evidence for decisions about sensitivity levels to use for monitoring aspects such as dilbit pressure through the pipeline, and how data on pressure will be used to determine when a leak is likely occurring. Sensor thresholds for detecting a likely leak will require decisions about acceptability of type 1 versus type 2 statistical errors (false negative and false positive detections), which necessarily trade off against one another, and providing such information for review is a matter of public safety and transparency."

Trans Mountain notes that the current and proposed leak detection system is not implemented as described in the Intervenor Evidence from the City of New Westminster. As described in Section 22.2, Computational Pipeline Monitoring System, the leak detection system does not

utilize low pressure alarms, which are used for operational boundaries and safety systems other than leak detection. Low pressure alarms can only be used to indicate a leak when a major pipeline failure, which causes a significant pressure drop, occurs. The CPM system is significantly more sophisticated than the type of leak detection system described in the Intervenor Evidence from the City of New Westminster. Additional information regarding the efficacy of the leak detection system is included in the responses to various IRs.

Upper Nicola Band IR No. 2.11c (Filing ID A4H9I4) asked about sensitivity thresholds. Trans Mountain responded that during the detailed engineering and design phase, it will follow the accepted industry approach for estimating sensitivity thresholds by performing the calculations described in API, Publication 1149, Pipeline Variable Uncertainties and Their Effects on Leak Detectability. The API 1149 calculations have not yet been performed, as they rely on pipeline and facility design details which are currently under development. Trans Mountain conducts annual tests of the threshold sensitivity of the CPM system. Tests are performed by manipulating variables in a pipeline simulator, which exactly replicates the hydraulic operation of the pipeline. In the 2013 tests, the CPM system declared leaks from 3% to 7% of the pipeline flow rate. In the 2014 tests, the CPM system declared leaks from 4% to 5% of the pipeline flow rate. A sensitivity range is provided because multiple locations were tested and the range represents the highest and lowest sensitivities established. Based on the configuration of proposed Line 2, threshold sensitivities in the range of 2% to 5% are anticipated from both the API 1149 calculations and the in-service testing. The planned application of the latest technology at closely spaced intervals as well as the ongoing advancement of technology may reduce the upper end of the sensitivity range. When the expanded pipeline system is in service, the field data from the pipeline will be used to test the accuracy and sensitivity of the CPM system. The final thresholds will be determined after tuning for maximum sensitivity and minimal false alarms. Trans Mountain is committed to continuous improvement of its leak detection system.

Province of BC IR No. 2.15a (Filing ID A4H8W6) asked how testing is conducted to verify sensitivity and accuracy of the leak detection system. Trans Mountain responded that it conducts performance tests of the CPM system by loading SCADA system data, from recent steady-state historical pipeline operational periods, into a pipeline simulator. Process variables are manipulated to simulate a leak. The tests are performed annually using various pipeline locations in the simulator. CPM sensitivity is a measure of the size of a leak that a CPM system is capable of detecting. Sensitivity verification includes comparison of the most recent test results to previous results. If there are material deviations between results, an investigation is initiated to determine the cause of the deviation. CPM accuracy is a measure of the CPM system's ability to estimate parameters such as leak flow rate, total volume lost, type of fluid lost, and leak location. Accuracy verification assesses the CPM system's ability to calculate theses parameters. The test results are compared to the known test values.

Province of BC IR No. 2.15c (Filing ID A4H8W6) asked for test results for the past five years. Trans Mountain responded that although the information requested may not be within the scope of this proceeding, it offers the following:

- The annual leak testing has only been in place for two years; therefore, information is only available for 2013 and 2014. The accuracy and sensitivity testing was performed with the pipeline simulator replicating steady-state operation for two hours before the start of the tests and for the duration of the tests. All of the simulation data was collected when the

pipeline instrumentation was functioning normally and the pipeline was operating at close to its design flow rate.

- The CPM system is an element of the KMC ISLMS, and follows API, Recommended Practice 1130, Computational Pipeline Monitoring for Liquids.
- The CPM system testing is done, in part, to verify the effectiveness of the CPM continuous improvement program. It also provides information to establish focus areas to improve the CPM system for the following year.

Province of BC IR No. 2.16a (Filing ID A4H8W6) asked how Trans Mountain would detect small leaks in areas that may be under snow cover. Trans Mountain responded that small leaks in areas that experience prolonged snow cover would present challenges for visual detection during aerial surveillance. Trans Mountain is investigating the potential to improve leak detection capabilities through participation in joint industry projects to test and evaluate, among other things, aerial leak detection technologies as described in Trans Mountain's response to Province of BC IR No. 2.15g (Filing ID A4H8W6). The projects are advanced to the point to understand how the technology may perform in snow covered conditions. Trans Mountain notes that while it is committed to pursue the application of these technologies to further enhance leak detection, over its operating history it has no record that snow cover was the cause for a small leak not being detected. Also, the Trans Mountain mainline has been inspected for small leaks using an acoustic leak detection ILI tool with a stated capability to detect leaks as small as 0.1 L/min. No leaks have been identified using this tool.

Province of BC IR No. 2.16a (Filing ID A4H8W6) asked if Trans Mountain will commit to the use of best available technology for leak detection throughout the life of the Project. Trans Mountain responded that its responses to Province of BC IR No. 2.15c and 2.15g (Filing ID A4H8W6) demonstrate its continued commitment to deploy leading CPM systems that meet and exceed regulatory requirements in this area. KMC's ISLMS (refer to Province of BC IR No. 2.15c [Filing ID A4H8W6]) has a philosophy of continuous improvement. Trans Mountain notes that "proven to be effective, as demonstrated by its adoption by other industry members" is not a best available technology test that can be applied when it comes to the acceptance of leak detection technologies and, in particular, CPM systems. The reason is that different pipelines vary significantly in length, diameter, topography, and the types of liquids transported. Simply stated, what works for one pipeline may not work for another. Trans Mountain cannot commit to deploy technology that could have the unintended consequence of reducing the effectiveness and reliability of its leak detection. Trans Mountain will commit, however, to evaluate available technologies as they develop with a goal of continually improving leak detection, including non-CPM based systems, and will implement technologies that it determines to be viable and effective for its operations.

22.4 Estimated Potential Release Volumes (Before Computational Pipeline Monitoring System Detection)

The Intervenor Evidence submitted by Shxw'ōwhámel First Nation, *Groundwater Issues Associated with Ohamil I.R. 1 and Peters I.R. 1 and 2*, prepared by Piteau Associates Engineering Ltd., Section 4.1 (page 15) states "Further clarification on the resolution of the leak detection system and estimates of potential volumes that could leak without detection, and/or in the interval between detection and intervention, is required." Information regarding estimated

maximum volumes of product that could be released before detection is included in the response to an IR received from the NEB.

NEB IR No. 4.38d (Filing ID A4K4W3) asked for the estimated maximum volume of product that could be released before a leak is detected. Trans Mountain responded that, based on the configuration of proposed Line 2 and the Westridge Marine Terminal delivery lines, threshold sensitivities in the range of 2% to 5% are anticipated. The planned application of the latest technology at closely spaced intervals as well as the ongoing advancement of technology may reduce the upper end of the sensitivity range. When the expanded pipeline system is in service, the field data from the pipeline will be used to test the accuracy and sensitivity of the CPM system. The final thresholds will be determined after tuning for maximum sensitivity and minimal false alarms. Trans Mountain is committed to continuous improvement of its leak detection system. The planned peak design flow rates for the proposed pipelines are:

- Line 1: 2,440 m^3/hr (40.67 m^3/min)
- Line 2: 3,765 m^3/hr (62.75 m^3/min)
- Delivery Lines: 4,637 m^3/hr (77.28 m^3/min)

The anticipated CPM-based detectable leak thresholds for the proposed pipelines are:

- Line 1: 1.22 m^3/min to 2.85 m^3/min (based on 3% to 7% of design flow)
- Line 2: 1.26 m^3/min to 3.14 m^3/min (based on 2% to 5% of design flow)
- Delivery Lines: 1.55 m^3/min to 3.86 m^3/min (based on 2% to 5% of design flow)

The amount that could be released before detection by the CPM system will depend on the nature of the leak or rupture. The CPM system uses typical averaging periods of 5 minutes, 15 minutes, 1 hour, and 2 hours. A full-bore rupture is expected to be detected by the CPM system very quickly, within the 5 minute averaging period, and there should be little uncertainty in the evaluation of the leak alarm by the CCO, given that the SCADA system will likely present other data corroborating a large leak. A small leak, within the minimum detectable threshold range, may require the 2 hour averaging period to be detected. As such, conservative probable ranges for the released volume before detection, based on 5 minutes at full flow and 2 hours at the high end of the minimum detectable threshold ranges, are estimated to be:

- Line 1: 203 m^3 to 342 m^3
- Line 2: 314 m^3 to 377 m^3
- Delivery Lines: 386 m^3 to 463 m^3

Trans Mountain anticipates that in a populated area or along a multi-use transportation corridor, a full-bore rupture, or a threshold leak that continued for a period of time, would be quickly discovered and reported by external parties, possibly before the leak would be identified by the CPM system or by the CCO using available SCADA information.

23.0 PIPELINE OIL SPILL RISK ASSESSMENT

A number of common themes related to pipeline risk assessment have been included in evidence submitted by intervenors. For organizational purposes, these themes are provided below under the following topic areas:

- Purpose of the Pipeline Risk Assessment;
- Effect of Time on Pipeline Material Properties;
- Influence of Diluted Bitumen on Pipeline Reliability; and
- Risks Related to Aquifer Contamination.

23.1 Purpose of the Pipeline Risk Assessment

Perhaps the most common theme in the evidence submitted is the misperception and mischaracterization of the purpose of the pipeline risk assessment. Many intervenors are of the opinion that the risk assessment described in the Pipeline Risk Assessment Report (Filing ID A3Z8G1) represents the risk associated with the final design of Line 2 and the new delivery lines, and that furthermore, it should serve as the basis for some form of evaluation of risk acceptability. Many intervenors contend that to facilitate such a risk evaluation, the expected frequency of full-bore ruptures along the entire length of the pipeline should be reported as a "return period."

By way of example, Section 6.3 of the City of New Westminster's evidence (Filing ID A4Q0L5, pages 34-35) contains the following statements:

> "Failure frequencies provided by KMC are sub-divided into smaller risks by considering the risk of rupture due to separate causes, rather than the overall risk of rupture due to all causes combined. Risks are also presented at scales that are difficult for most readers to understand. Local governments should be provided with a better understanding of the number of full-bore rupture events expected over the life of the project over each main segment of pipeline for all causes of ruptures combined."

Annex B of the CSA Z662 Standard "Oil and Gas Pipeline Systems" provides guidance for the performance of risk assessments on pipelines. As noted in that Annex, risk assessment supports the decision-making process to facilitate activities such as design, operations, and maintenance, and the risk assessment process should begin with a definition of objectives. As indicated in the introduction of the Pipeline Risk Assessment Report (Filing ID A3Z8G1), the purpose of that risk assessment is to support the risk-based design of Line 2 and the new delivery lines.

As part of Trans Mountain's commitment to eliminate failures, it is implementing a risk-based design process on Line 2 and the new delivery lines. Risk-based design is a rigorous design approach that goes beyond the minimum requirements of the CSA Z662 code. It is an industry-leading, world class design approach that will enable the design team to identify potential risks along Line 2 and the new delivery lines, and to pre-emptively adopt mitigation measures at the design phase to address these risks. Working in order of risk priority, mitigation measures that are appropriate to the factor that is responsible for driving risk at each specific location are

developed and incorporated into final design. The mitigation measures, once incorporated into the final design, will reduce failure likelihood and/or consequence (and hence risk) by targeting risk mitigation strategies directed at the principal drivers of risk that have been identified in the risk assessment.

The preliminary results of the risk analysis that has been performed on Line 2 and the new delivery lines were provided in tabular format, showing risk at 1 km spacing in Filing IDs A3Z8G5 (pages 11-37), A4F5G8 and A4F5F9. These results are characterized as 'preliminary' because they represent the results of a risk analysis of a baseline design (*i.e.,* prior to the implementation of all the risk mitigation measures that will ultimately be incorporated into the final design). These risk results serve as a "starting point" for the risk-based design process, which as is discussed in Section 5 of the Line 2 Risk Report (Filing ID A3Z8G1) is an iterative process of Risk Assessment/Identify and Prioritize Risk/Develop Mitigation Plans/Re-evaluate Risk.

The Preliminary Risk Results are therefore in no way representative of the rupture frequency and risk numbers that will be characteristic of the final design of Line 2 and the new delivery lines. The high failure likelihood associated with the preliminary baseline design is primarily driven by geohazard threats that are known to exist and that are associated with the preliminary (un-vetted) pipeline configuration (*e.g.,* valves located in avalanche slopes). These threats and their associated failure likelihood values will undergo significant levels of mitigation through simple reconfiguration during detailed design and engineering.

While several commentators have advocated that the preliminary (baseline) risk results that are currently guiding the risk-based design process described above should be recast to provide a "combined, system-wide failure frequency," or a "system-wide failure return period," such reporting is not meaningful, since it in no way represents the failure frequency estimates that would be associated with a final design, following the completion of the risk-based design process. Furthermore, such an assessment would not be particularly useful or provide meaningful statistics with respect to facilitating the risk-based design of a new pipeline. Within the context of risk-based design of a pipeline, in order to identify potential risks and to pre-emptively adopt mitigation measures at the design phase to address those risks, risk results must be reported at a sufficiently high enough resolution. A high resolution is necessary to enable discrete high-risk locations to be identified, and to identify the primary factors that are driving risk at those locations, with the ultimate goal being to provide direction as to the location and type of risk mitigation measures that should be incorporated into the final design.

Therefore, as was noted in the response to NEB IR No. 3.050a, (Filing ID A4H1V2), risk results have been calculated on a dynamic segment basis. A dynamic segment is defined as a contiguous section of pipeline over which all attributes used in the calculation of risk are held constant. By way of illustrating the level of resolution available at the dynamic segment level, there are over 91,000 dynamic segments between Edmonton and Burnaby. The 1 km resolution that was presented in the risk results was adopted for reporting purposes only. Aggregating results over the entire length of the pipeline, for the purposes of reporting a return period would involve removing all resolution from the analysis to the point where the results would do nothing to facilitate the risk-based design process that the risk assessment is intended for.

Furthermore, when calculating failure rates for linear infrastructure, such as pipelines, return period varies as a function of pipeline length, such that all other factors being equal, the return period increases as the length of pipeline that is being evaluated decreases. Aggregating failure

likelihood over the length of a pipeline in order to report it in terms of a return period is contrary to and inconsistent with how the consequences of failure manifest themselves, which is location-specific. Failure likelihood or risk results reported as “return periods” for linear infrastructure are therefore misleading and make it difficult to interpret results, especially when attempting to compare pipeline performance against industry benchmarks or incident statistics, which are reported on a per-unit-length per-year basis.

Another misleading aspect of the “return period” concept is that it is predicated on an assumption of static threat levels. In reality, pipelines operate in a changing environment that includes time-dependent threat mechanisms for which regular assessments (such as ILI) are made. Maintenance and repair operations are regularly undertaken to prevent failure from those time-dependent threats. The “return period” concept does not account for that changing environment, nor does it take into consideration the fact that future maintenance and repair will be undertaken to prevent failure.

23.2 Effect of Time on Pipeline Material Properties

Section 6.3 of the City of New Westminster’s evidence (Filing ID A4Q0L5, pages 34-35) contains the following statements:

> “KMC also states in its response that, as properties of steel do not change appreciably with time, steel pipelines are normally designed with an indefinite design life, and it is common for pipeline operators to manage their assets as such by implementing integrity programs to address time-dependent degradation mechanisms such as corrosion. We have seen that, in many older structures, steel does age prematurely, particularly with exposure to ground water. The potential long-term impacts of the new types of chemicals proposed to be transported in the pipeline are also not well understood and, as a result, the long term risk is not well understood.”

> “A more detailed analysis of the long-term risk resulting from the deterioration of steel pipes, particularly to the new types of chemical to be transported, namely dilbit, should be provided.”

Steel has been in use for thousands of years, dating back to the beginning of the Iron Age. It is in active use in structures that are well over 100 years old, such as the Brooklyn Bridge (commissioned in 1883) and the Flatiron Building (built in 1902). The material properties of steel and their behaviour over time are well understood and well documented. With respect to the use of steel in pipelines, as summarized in a paper by Kiefner and Trench (2001):

> “Line-pipe steels, that is, low-carbon or low-alloy steels, are durable. Over the ranges of temperatures in which they are commonly used (-20F to +250F), these materials are stable: their properties do not change with the passage of time. Tensile tests or toughness tests conducted today on a low-carbon-steel material manufactured in 1910 will yield the similar results as tests that might have been conducted on the same material back in 1910.”

If properties of steel were to change appreciably with time, codes and standards governing design of bridges, buildings, and pipelines would identify the need to account for this phenomenon. They do not - nor do they mandate that steel structures must be retired after a

fixed period of time. In fact, steel structures can be operated indefinitely, given proper inspection and maintenance.

Degradation, such as corrosion, is not the same as material property change with time. Highly reliable methods of inspection and assessment are available to address degradation mechanisms such as corrosion, and these are in active use on the existing TMPL.

23.3 Influence of Diluted Bitumen on Pipeline Reliability

A great deal of study has been directed at the issue of dilbit corrosivity in recent years, resulting in the publication of a number of independent reports. Three such reports provide a detailed description of the pipeline industry's operating experience in the transmission of dilbit. These reports are "Comparison of the Corrosivity of Dilbit and Conventional Crude" (Been 2011), "State of the Art Report, Dilbit Corrosivity" (CEPA 2013), and "Effects of Diluted Bitumen on Crude Oil Transmission Pipelines" (Transportation Research Board 2013).

Although completely independent of one another, each of the above reports came to similar conclusions:

- Alberta Innovates – Technology Futures "Comparison of the Corrosivity of Dilbit and Conventional Crude":
    - This review has indicated that the characteristics of dilbit are not unique and are comparable to conventional crude oils.
    - Adjustment of the Alberta and U.S. pipeline failure statistics to compare similar crude oil pipeline systems on an equivalent basis indicated that the Alberta systems (with a large percentage of dilbit lines) experienced comparable internal corrosion failure rates than the U.S. systems (predominantly conventional crude lines).
- Canadian Energy Pipelines Association "State of the Art Report, Dilbit Corrosivity":
    - A substantial amount of work has been carried out recently to demonstrate that Dilbit and Synbit are no more corrosive than conventional crudes.
    - There are no significant additional implications for corrosion control in a pipeline carrying Dilbit and Synbit as part of pipeline integrity management over and above what is already standard practice.
- Transportation Research Board National Research Council of the National Academies "Effects of Diluted Bitumen on Crude Oil Transmission Pipelines" :
    - The committee does not find any causes of pipeline failure unique to the transportation of dilbit. Furthermore, the committee does not find evidence of chemical or physical properties of dilbit that are outside the range of other crude oils or any other aspect of its transportation by transmission pipeline that would make dilbit more likely than other crude oils to cause releases.

- Dilbit does not have unique or extreme properties that make it more likely than other crude oils to cause internal damage to transmission pipelines from corrosion or erosion.
- Dilbit does not have properties that make it more likely than other crude oils to cause damage to transmission pipelines from external corrosion and cracking or from mechanical forces.
- Pipeline operations and maintenance practices are the same for shipments of dilbit as for shipments of other crude oils.

In addition to the above, a great deal of information regarding the industry's operating experience with the transportation of dilbit was put on the public record during the Northern Gateway hearing (Hearing Order OH-4-2011). A semi-quantitative risk assessment was submitted in response to the Joint Review Panel Information Request No. 8.1(b) and is available in the hearing record as Document Number B75-2 (Filing ID A2T9V7). As indicated on PDF page 120 of 172 of that report:

> "Through this process, it was determined that the ILI data obtained from Enbridge's NPS 36 Line 4 would be most representative of the corrosivity conditions expected on the Northern Gateway crude oil pipeline. Approximately 10,000 km-years' (distance of pipeline inspected times the number of years of operation) worth of ILI data from the NPS 36 Line 4 was reviewed. No evidence of active internal corrosion was found."

From the perspective of internal corrosion susceptibility, there are significant similarities between Enbridge NPS 36 Line 4 and TMEP Line 2. Both are NPS 36 pipelines whose principal product stream is dilbit, having maximum sediment and water specifications of 0.5% as defined in the Tariff, and both would transport this product in a fully-turbulent mode. Operating experience dictates that given these operating parameters, what little water is present will be fully entrained, resulting in oil-wet pipe wall conditions. This experience is further supported by the operating history of the TMPL, which has transported dilbit for greater than 30 years, with no related increase in susceptibility to internal corrosion, and which has been substantiated through repeated ILI inspections throughout this period.

Therefore, no significant internal corrosion is expected on this pipeline. Given the planned ILI reassessment interval of 5 years on the TMEP Line 2 pipeline, it is reasonable to expect that any internal corrosion features that may initiate will be detected before they can reach a critical flaw size so that plans for any maintenance that is required can be developed and implemented as a pre-emptive measure. Given this situation, the failure probability for this threat is assessed as being negligible.

As was noted by Northern Gateway in its exhibit B75-2, this conclusion is consistent with an API Publication "Pipeline Transportation of Diluted Bitumen from the Canadian Oil Sands," which states among its findings:

· Although oil sands dilbit has been transported through Canadian and U.S. pipelines for more than a decade, there have been no instances of crude oil releases caused by internal corrosion from pipelines carrying Canadian dilbit.

- Corrosivity of dilbit is largely similar to crude oil, which is considered to be low. In addition, the threat of corrosion from dilbit can be managed by conventional engineering practice in the same way as crude oil.

Northern Gateway also cited independent corroboration of the above findings in a presentation given by Cheryl Trench to the 6th Annual Pipeline Safety Conference in November, 2011:

> "The issue of crude oil sourced from Canadian oil sands was included in that presentation and the results of an investigation into the internal corrosion history of pipelines carrying that product were provided. The study investigated PHMSA accident data for pipelines that have interconnections to Canadian crude sources. It also investigated data from the U.S. Energy Information Administration Form 814; shipment-by-shipment crude imports to determine which refineries were sourcing Canadian oil sands crude. Finally, it investigated pipeline industry information to determine all interconnections, including storage hubs to determine which part of the pipeline infrastructure could have transported Canadian oil sands crude. The results of this analysis established that **there has not been one** failure in any of this infrastructure that is attributed to internal corrosion resulting from the transportation of Canadian oil sands crude."

With the similarities in the operating conditions proposed for both the TMEP Line 2 pipeline and the Northern Gateway pipeline, Trans Mountain has arrived at a similar conclusion to that arrived at for Northern Gateway; that it is not possible to arrive at a finite value of expected failure frequency for internal corrosion.

With respect to external corrosion, as described in Attachment A to the Preliminary Risk Results (Filing ID A3Z8G1), a reliability analysis was conducted, which concluded the following:

> "The unmitigated analysis demonstrates the relative lack of sensitivity of external corrosion failure frequency over time, relative to the planned 5-year in-line inspection (ILI) reassessment interval (i.e., the first measureable onset of a non-zero failure probability occurs after the pipeline will have received two in-line inspections). Given this lack of time-sensitivity to failure, relative to the planned ILI interval, it is reasonable to expect that any external corrosion features that may initiate will be detected before they can reach a critical size so that plans for any maintenance that is required can be developed and implemented as a pre-emptive measure. Given this circumstance, it is not possible to arrive at a finite value of expected failure frequency over the long term."

It should be noted that the regular in-line-inspection that is referenced with respect to external corrosion detection is equally effective on all forms of volumetric wall loss, including internal corrosion and its capacity to pre-emptively detect corrosion prior to failure applies to both internal and external corrosion.

23.4 Risks Related to Aquifer Contamination

In the affidavits of Asher Rizvi (Filing ID A4L7R8) and Kevin Larsen (Filing ID A4L7S0) of the Township of Langley, they each make note of the fact that the proposed alignment passes through a number of aquifers that the Township relies upon for drinking water. For the identified aquifers that are assessed as vulnerable, they lack a protective layer making them susceptible to surface contaminants. In their affidavits, Asher Rizvi and Kevin Larsen each express concern

regarding the impact that a potential pipeline crude oil spill would have on the Township's aquifer resources. Section 39.2.1 of this Reply Evidence provides information on potential infiltration of spill materials into the groundwater.

As with any human endeavour, pipelines represent an associated risk, with a corresponding suite of tools employed to mitigate this risk. The best way to minimize the risk to aquifers is through the pursuit of zero incidents – particularly in those segments of pipeline that could adversely impact HCAs such as aquifers and other water resources. Just as airlines strive to eliminate plane crashes, it is Trans Mountain's goal to eliminate pipeline failures.

On its existing pipeline infrastructure Trans Mountain strives to eliminate pipeline failures through its pipeline integrity management program that leverages the availability of rapidly advancing ILI technology to inspect its pipelines on a regular basis, and to pre-emptively identify threats and perform maintenance by undertaking regular risk assessments to prioritize and direct its integrity management program.

On the new facilities that are part of this application, and as is outlined in the Risk Report for Line 2 and the new delivery lines (Filing ID A3Z8G1), Trans Mountain is undertaking a risk-based design of Line 2 and the new delivery lines.

As part of Trans Mountain's commitment to eliminate failures, it is implementing a risk-based design process on Line 2 and the new delivery lines. Risk-based design is a rigorous design approach that goes beyond the minimum requirements of the CSA Z662 code. It is an industry-leading, world class design approach that will enable the design team to identify potential risks along Line 2 and the new delivery lines and to pre-emptively adopt mitigation measures at the design phase to address those risks. These mitigation measures, (which for example, may include increased depth of burial or increased wall thickness to guard against the threat of third-party damage), will reduce failure likelihood and/or consequence (and hence risk) by targeting risk mitigation strategies directed at the principal drivers of risk that have been identified in the risk assessment.

The philosophy behind risk-based design is that areas of higher risk are identified and given additional priority for the implementation of additional risk mitigation measures. These risk mitigation measures act to mitigate risk by targeting the primary threats (thereby lowering failure likelihood) and/or consequences (*e.g.*, through the optimization of valve placement design).

As is described in the Line 2 Consequence Report (Filing ID A3Z8G5), for the purposes of the risk assessment that guides the risk-based design process, watercourses, including aquifers, are treated by a special consequence scoring approach (known as the 'watercourse intersect' approach) that assigns higher consequence scores. This is consistent with the fact that these locations have greater potential to be adversely impacted by an oil spill.

In accordance with a commitment made to the Province of BC in response to their IR No. (Filing ID A4H8W6), Trans Mountain has committed that for the purpose of the risk-based design process through which additional risk mitigation measures are prescribed, higher levels of priority will be given to all moderate and high vulnerability aquifers. Section 39.2.2 provides further information on the risk-based design process and potential mitigation measures. Section 39.2.3 outlines Trans Mountain's commitments to apply an appropriate response to a release from the pipeline or facility resulting from construction-related or operational activities on the pipeline and to replace or maintain any water supply impacted by their activities.

23.5 References

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24.0 FACILITY RISK ASSESSMENT

This section of Reply Evidence responds to intervenor evidence that identifies concerns regarding the TMEP's Facility Risk Assessment.

24.1 Fire Code Requirements

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Executive Summary (page 3) and Conclusions (page 80) states, "Additionally, the TMEP lacks appropriate consideration for original facility fire protection premises and industry best practices in petroleum storage and fire protection, as the proposal only seeks to comply with minimum federal and provincial code requirements." The report Conclusions (page 85) also states, "The time prior to life and environmental impact will be significantly reduced by the TMEP, as has many of the engineered in facility configuration countermeasures responsible for the minimization of event growth and corresponding impact escalation have been greatly reduced from original facility premises which fundamentally adhered to the intent of best practices, to the reduced performance of minimum code requirements."

Based on the evidence provided throughout this Section 24, Facility Risk Assessment, Trans Mountain has established that the proposed design for Burnaby Terminal includes a robust fire protection system, which exceeds the statutory requirements. Specific examples include:

- All of the property line setbacks will meet or exceed the requirements of NFPA Code 30 and City of Burnaby bylaws.
- The uphill tank to tank spacing will exceed the requirements of NFPA Code 30 and the British Columbia Fire Code (BCFC).
- Trans Mountain will comply with the additional secondary containment volume requirements of the BCFC.
- CSA Standard Z662, NFPA Code 30, and BCFC do not set limits on the number of tanks that can share a common secondary containment area. Trans Mountain has limited the maximum number of tanks to three per shared secondary containment area.
- The fire protection system for the proposed new storage tanks will be designed to extinguish a full-surface fire, utilizing fixed foam chamber / nozzle arrangement and automated foam application.

24.2 Burnaby Terminal Location

The intervenor evidence submitted by Dorothy Doherty, Section 5, The Future of the Burnaby Mountain Tank Farm (Burnaby Terminal), page 8, states, "I believe the Burnaby Mountain Tank Farm (Burnaby Terminal) should be decommissioned and moved to a site away from heavily populated areas, where an accident would not be so devastating to human life" (Filing ID A4L8U3).

Trans Mountain has no intent to decommission and move Burnaby Terminal and this is outside the scope of issues to be considered by the NEB with respect to the Application. Trans Mountain notes that the development around Burnaby Terminal, including the residential neighbourhoods and SFU, occurred after the terminal was constructed. With respect to the

proposed location of new tanks and infrastructure at Burnaby Terminal, as indicated in the responses to various IRs, expanding existing facilities reduces new disturbance, uses existing infrastructure and minimizes environmental effects, which is consistent with good project planning and best environmental practices. Trans Mountain acknowledges Ms. Doherty's concern regarding the effects of an accident or malfunction, but is confident that an expanded Burnaby Terminal will continue to operate successfully and safely at its current location.

Trans Mountain notes that Taylor IR No. 1.04a (Filing ID A3Y3T2) raised a concern with increasing storage tank capacity on a hill versus a flat area that is not surrounded by neighbourhoods. Trans Mountain responded that it is not uncommon to locate storage (tank) terminals on hills or slopes. There are numerous examples of terminals safely operating on hills or slopes around the world. As the response to NEB IR No. 1.93c.2 (Filing ID A3W9H9) indicates, Burnaby Terminal was originally designed to provide gravity feed (without pumps) to Westridge Marine Terminal. Although pumps are used today to supplement the effects of gravity and will be used in the proposed expansion, the location of Burnaby Terminal continues to provide technical advantages for the delivery of crude oil to Westridge Marine Terminal. The proximity to Westridge Marine Terminal is also important to minimize the length of the delivery lines and there are no alternative flat areas located between Burnaby Terminal and Westridge Marine Terminal. With respect to safety, all new tanks at Burnaby Terminal will be designed and constructed in accordance with the latest edition of the API Standard 650, the recognized North American standard. All new tanks at Burnaby Terminal will be located within secondary containment designed in accordance with CSA Z662 and NFPA 30. Seismic design of the tanks and secondary containment will be in accordance with API 650, Annex E and the British Columbia Building Code (BCBC). There is also a tertiary containment area at Burnaby Terminal, which provides an extra level of safety. Trans Mountain is confident that Burnaby Terminal will continue to operate successfully and safely at its current hillside location.

City of Burnaby IR No. 1.08.01b (Filing ID A3Y2E6) asked about criteria used and options considered to locate the required storage tanks in other locations along the proposed pipeline route which could enhance public safety. Trans Mountain responded that the proposed additional storage tanks are required to support the expanded operation at Westridge Marine Terminal. Location of the tanks close to Westridge Marine Terminal (as Burnaby Terminal is) reduces the length of the Burnaby to Westridge Marine Terminal delivery pipelines. There is no undeveloped land suitable for locating storage tanks between Burnaby Terminal and Westridge Marine Terminal. Locating the storage tanks east of Burnaby, if a suitable site were available, would increase the incremental number of pipelines required to be constructed through Burnaby (east of Burnaby Terminal) from one to three.

City of Burnaby IR No. 1.14.01b (Filing ID A3Y2E6) asked about the safety criteria used to evaluate and support the proposed location of the new storage tanks. Trans Mountain responded that it believes that the City of Burnaby community planning principles, including the zoning of neighbourhoods with respect to industrial and residential uses and the setbacks established in the City of Burnaby bylaws, are primarily intended to protect the safety of the residents. As discussed in the response to City Burnaby IR No. 1.14.01a (Filing ID A3Y2E6), the location of the proposed new tanks will result in setbacks greater than those established in the City of Burnaby bylaws for the M7a Marine District 2. In addition, as described generally in Volume 4A, Section 3.4.3 of the Facilities Application (Filing ID A3S0Y8), Trans Mountain will incorporate numerous safety features into the design of the proposed additional facilities at Burnaby Terminal, some of which exceed the requirements of the applicable legislation. As

discussed in Volume 4C and Volume 7 of the Facilities Application (Filing IDs A3S1L1 and A3S4V5), Trans Mountain has, and will continue to develop and enhance, robust operations, maintenance, and emergency preparedness and response programs and procedures, all of which are intended to ensure the safety of operations.

City of Vancouver IR No. 2.09.3p (Filing ID A4H8I9) asked about a risk assessment related to safe siting and interaction between the proposed Project and existing facilities. Trans Mountain responded that it has not completed risk assessments specifically for the purposes of evaluating the siting of expanded infrastructure at Burnaby Terminal and Westridge Marine Terminal. The risk assessments that have been completed to date are described in the response to City of Vancouver IR No. 2.09.3c (Filing ID A4H8I9) and have been used to evaluate the designs on the existing sites. Expanding existing facilities reduces new disturbance, uses existing infrastructure and minimizes environmental effects. This is consistent with good project planning and best environmental practices. While good planning and best practices favour using existing facilities, this does not reduce the rigour of conducting an assessment of the potential impacts associated with the Project. Early in project planning, Trans Mountain tested the basic premise that expanding existing facilities is the most responsible approach to the proposed development. Potential alternative marine terminal locations were considered, based on the feasibility of coincident marine and pipeline access, and screened based on technical, economic, and environmental considerations. These alternative locations included Kitimat, BC and Roberts Bank in Delta, BC. Trans Mountain ultimately concluded that constructing and operating a new marine terminal and new supporting infrastructure would result in significantly greater cost, larger footprint, and additional environmental effects, as compared to expanding existing facilities. Accordingly, Trans Mountain did not continue with a further assessment of alternative terminal locations.

24.3 Proximity to Residents

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Distance to Fenceline (page 40) states, “The TMEP creates emergency control scenarios risking the residential areas in proximity, SFU, UniverCity village, and the Burnaby Mountain Conservation Area, related to:

- Fenceline exposure to heat, including subsequent fire extension to the proximity treeline and high potential for treetop driven wildfire
- Smoke exposure to the community
- Sulphur based gas exposure to the community
- Ignition of flammable gas releases within community”

Aside from other considerations, Trans Mountain has addressed the concept of community risk from a municipal planning perspective. Trans Mountain believes that the City of Burnaby planning principles, including the zoning of neighbourhoods with respect to industrial and residential uses and the setbacks established in the City of Burnaby bylaws, are intended to ensure the compatibility of industrial and residential uses. Discussion regarding setback regulations and protection of adjacent residential uses, SFU and Burnaby Mountain Conservation Area, as well as risk assessment, is included in the following responses to various IRs.

City of Burnaby IR No. 1.14.01a (Filing ID A3Y2E6) asked if Trans Mountain will exceed the setback regulations stipulated in the M7a District of the Burnaby Zoning Bylaw 1965 with respect to the adjacent residential (A2, R2, and RM) properties. Trans Mountain responded that, although the design has not been finalized, the preliminary location of the proposed new tanks, to be situated in the existing open space on the east side of the Burnaby Terminal property, will result in the closest tank (Tank 79) to the Forest Grove Community R or RM districts (located to the south) exceeding the M7a Marine District 2 setback requirement for the storage of petroleum products of 61 m (200 ft.). The preliminary location of Tank 79 will result in a setback of approximately 105 m (345 ft.) from the north boundary of the Forest Grove Community. The closest residence in the Forest Grove Community (in Wembley Estates) will be approximately 225 m (740 ft.) from the edge of the closest new tank (Tank 75), which is further than the residence is from existing Tank 73, approximately 170 m (560 ft.). There are no tanks proposed to be added to the west side of the Burnaby Terminal property, adjacent to the A2 District. Trans Mountain believes it is relevant to note that both the City of Burnaby bylaw setback and the preliminary setback for proposed Tank 79, exceed the maximum setback requirement in Table 22.4.1.1(a), NFPA 30, for any size tank of 53 m (175 ft.) when there is no protection for exposures.

SFU IR No. 2.7.08.1 (Filing ID A4H9C9) asked if the design and tank location criteria included maximizing the protection of adjacent residential uses and SFU. Trans Mountain responded that the proposed expansion of Burnaby Terminal was conceptually designed to meet the applicable legislative requirements, which have been established and tested over time to provide for an appropriate balance of efficient land use, various types of development, and protection of the public. Trans Mountain believes that the City of Burnaby community planning principles, including the zoning of neighbourhoods with respect to industrial, residential, and institutional land uses, and the setbacks established in the City of Burnaby bylaws, are primarily intended to protect the safety of the public. As discussed in the response to City Burnaby IR No. 1.14.01a (Filing ID A3Y2E6), the location of the proposed new tanks will result in setbacks greater than those established in the City of Burnaby bylaws for the M7a Marine District 2. In addition, setbacks will meet or exceed the requirements of NFPA 30. As discussed in the response to SFU IR No. 2.3.07.1 (Filing ID A4H9C9), Trans Mountain has completed a fire risk assessment using the Major Industrial Accidents Council of Canada (MIACC), Risk-based Land Use Planning Guidelines criteria. The assessment presents fire scenarios for the expanded Burnaby Terminal, without consideration of the activation of mitigation measures, such as fire-fighting foam deployment. The risk assessment indicates acceptability under the MIACC criteria, even without mitigation measures. In addition, as described in Volume 4A, Section 3.4.3 of the Facilities Application (Filing ID A3S0Y8), SFU IR No. 2.3.12.1 (Filing ID A4H9C9), and NEB IR No. 3.093b (Filing ID A4H1V2), Trans Mountain will incorporate numerous safety features into the design of the proposed additional facilities at Burnaby Terminal, some of which exceed the requirements of the applicable legislation. As discussed in Volume 4C (Filing ID A3S1L1) and Volume 7 of the Facilities Application (Filing IDs A3S4V5 and A3S4V6), and SFU IR No. 2.3.12.1 (Filing ID A4H9C9), Trans Mountain has, and will continue to develop and enhance, robust operations, maintenance, and emergency preparedness and response programs and procedures, which are intended to ensure the safety of operations.

The “Opinion on Potential Off-Site Risks of the Proposed Expansion of Burnaby Tank Farm” report, prepared by Dr. Ivan Vince, Section 3.2.5 (page 6) states, “Note that the MIACC guidelines are for development near a major hazard - and not for the converse situation: the construction or expansion of a major hazard near existing residential areas.” In fact, there is

nothing within the MIACC Risk-based Land Use Planning Guidelines which suggests that Dr. Vince's statement is true. There are numerous references to new projects throughout the MIACC Risk-based Land Use Planning Guidelines, including, on page 3, a reference to "impact assessment procedures for major projects," and, on page 24, a section entitled "5.2 Land use planning and control for new industrial activities." Trans Mountain's view is that the MIACC criteria can be used for any risk analysis as a means of determining acceptability, including the expansion of an existing terminal adjacent to other existing land uses.

SFU IR No. 2.7.07.1 (Filing ID A4H9C9) asked why the proposal to expand heavy industrial use in the proposed locations is appropriate. Trans Mountain responded that the proposed expansion of Burnaby Terminal and Westridge Marine Terminal are expansions of existing industrial facilities. The expansion of Burnaby Terminal will be entirely within the footprint of the existing site and the expansion of Westridge Marine Terminal will be entirely within the east-west (shoreline) extent of the existing site. Furthermore, the expansion of Westridge Marine Terminal is compatible with the existing industrial uses within PMV. As discussed in the responses to City of Burnaby IR No. 1.14.01b (Filing ID A3Y2E6), Trans Mountain believes that the City of Burnaby planning principles, including the zoning of neighbourhoods with respect to industrial and residential uses and the setbacks established in the City of Burnaby bylaws, are intended to ensure the compatibility of industrial and residential uses. This belief is consistent with the conclusions of the risk assessments referred to in the responses to SFU IR No. 2.3.07 and SFU IR No. 2.4.01.3 (Filing ID A4H9C9). Trans Mountain is not aware of any plans for additional community development south and west of Burnaby Terminal and understands that the areas to the north and east of Burnaby Terminal are part of the Burnaby Mountain Conservation Area, with the exception of the southwest corner of the SFU Enclave. Trans Mountain is not aware of any plans for additional community development to the east and west of Westridge Marine Terminal.

Trans Mountain concluded the response to SFU IR No. 2.7.07.1 (Filing ID A4H9C9) by stating that it recognizes that working in an urban environment requires greater attention to the potential effects on people due to construction, including consideration of traffic and access management, noise management, and preventing, minimizing, or mitigating impacts to existing residential, commercial, and recreational/community use areas. Volume 5B of the Application, in particular Sections 7.2.3, 7.2.4, 7.2.5, 7.2.7, and 7.2.8 (Filing ID A3S1S7), describes and characterizes the potential effects of the Project on people in proximity to Project activity, including key mitigation measures. The Socio-Economic Management Plan in Appendix C of Volume 6B (Filing ID A3S2S3) summarizes the socio-economic mitigation measures that will reduce effects on the human environment, many of which are focused on managing and reducing effects in an urban environment. Further, and as described in the Socio-Economic Management Plan in Appendix C of Volume 6B, Trans Mountain will develop and implement an issues tracking process to monitor and respond to Project-related socio-economic issues and opportunities that emerge during construction and reclamation. This is a unique construction-phase measure, and is a direct reflection of the many urbanized environments crossed by or in proximity to the Project. As suggested in NEB Draft Condition 11 as outlined in the NEB's Letter – Draft Conditions and Regulatory Oversight (April 16, 2014) (Filing ID A3V8Z8), this will be called a Socio-Economic Effects Monitoring Program. Please refer to the response to NEB IR No. 1.17d.6 (Filing ID A3W9H8).

24.4 Burnaby Terminal Design

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, includes the following:

- Conclusions (page 6) states, "Weaknesses in the design of a facility can create fire event situations that cannot be safely or effectively mitigated without allowing a storage tank or several tanks to burnout."
- Conclusions (page 8) states, "The TMEP does not provide the basic engineered safety provisions standard in high-impact potential facility design."
- Appendix I (page 9) states, "No commitment has been made to comply with local government bylaws, regulations and approvals processes, or industry best practices and standards."
- Appendix I (page 12) states, "More significantly, from a fire and safety perspective, the design and proposed densification of the Burnaby Mountain Terminal on a mountain slope surrounded by residential neighbourhoods and environmentally sensitive lands has made no consideration for public safety and mitigation/elimination of fire risks."

Trans Mountain does not agree with the various City of Burnaby Fire Department statements listed above. Trans Mountain follows the legislative requirements that are applicable to the design, construction, and operation of NEB-regulated pipeline systems (including storage tank terminals and marine terminals) and applies provincial, national, and international guidelines, codes, standards, and approaches, where appropriate. In addition, the KMC ISLMS outlines a commitment to establishing, implementing, monitoring, and continuously improving processes and controls to ensure that business is conducted in a safe, environmentally responsible, and sustainable manner. Additional information is included in the following responses to various IRs.

SFU IR No. 2.3.12.1 (Filing ID A4H9C9) requested information on prevention, response, and mitigation measures that Trans Mountain will undertake in order to protect adjacent property, members of the public, and businesses from the impacts and effects of a release. Trans Mountain responded that it and KMC integrate safety and spill prevention into design and operations. Volume 4A, Section 3.4.3 of the Facilities Application (Filing ID A3S0Y8), in particular Sections 3.4.3.2.1, 3.4.3.7, 3.4.3.10, and 3.4.3.11, describe numerous spill prevention, detection, and mitigation measures that will be included in the design of Burnaby Terminal. Volume 4A, Section 3.4.4 of the Facilities Application (Filing IDs A3S0Y8, A3S0Z1, A3S0Z0, and A3S0Y9), in particular Sections 3.4.4.2.1, 3.4.4.7, 3.4.4.8.1, 3.4.4.11, and 3.4.4.12, describe numerous spill prevention, detection, and mitigation measures that will be included in the design of Westridge Marine Terminal. Westridge Marine Terminal will also be designed, constructed, and operated in accordance with Oil Companies International Marine Forum (OCIMF) recommendations and operated according to the International Oil Tanker and Terminal Safety Guide. Trans Mountain deploys a containment boom around each tanker during loading to mitigate consequences in the extremely unlikely event of a spill. Trans Mountain does not own or operate the marine vessels calling at Westridge Marine Terminal; however, the vessels are operated in accordance with Canadian regulations and international regulations and standards, which are described in Volume 8A, Section 1.4 of the Facilities Application (Filing IDs A3S4X3 and A3S4X4).

Trans Mountain continued the response to SFU IR No. 2.3.12.1 (Filing ID A4H9C9) by stating that, with respect to the prevention of releases to tank secondary containment areas at Burnaby Terminal, the following approaches, as described in Volume 4A, Section 3.4 of the Facilities Application (Filing ID A3S0Y8), will be applied. Storage tanks and their associated infrastructure will be designed to meet 1) CSA Z662, 2) API 650, and 3) Canadian Council of the Ministers of the Environment (CCME) Standard 1326. Tank foundation designs will be based on BCFC requirements and local geotechnical conditions. Each tank will be equipped with a radar gauging system, for liquid level measurement, and redundant overfill protection systems. In addition, piping and equipment within process system secondary containment areas will be designed and protected from overpressure in accordance with CSA Z662. Seismic design of earthen, concrete, and steel structures, including foundations and marine piles, containment berms, tanks, pipe racks, other support systems, and piping, will be in accordance with the latest editions of the NBCC, the BCFC, API 650 (Annex E), and other recognized standards and practices, as applicable to the structures and locations.

Trans Mountain continued the response to SFU IR No. 2.3.12.1 (Filing ID A4H9C9) by stating that spill prevention, detection, and mitigation measures are also the subject of ongoing formalized HazOp reviews, which are utilized world-wide for risk control in the development of energy infrastructure. The first of a series of HazOp reviews for Burnaby Terminal and Westridge Marine Terminal were completed in Q2 and Q4, 2014. These reviews focused on the primary elements of the crude oil process piping. Other HazOp reviews are scheduled for Q2, 2015 to complete the process piping. Additional reviews will be required to assess the fire-protection systems, vapour recovery systems, and other elements, such as emergency response. These will likely occur in Q3 or Q4, 2015. Recommendations from the HazOp reviews will be incorporated into the detailed designs and operating procedures, as appropriate. Volume 4C, Section 8.2 (Filing ID A3S1L1) and Volume 7, Section 2.2 (Filing ID A3S4V5) of the Facilities Application describe the Facility Integrity Management Plan (FIMP) and control measures for terminals. Volume 7, Section 2.2.1 is specific to Westridge Marine Terminal.

Trans Mountain concluded the response to SFU IR No. 2.3.12.1 (Filing ID A4H9C9) by stating that, for the operation of the existing pipeline system, KMC has established and implemented the ISLMS as the basis for ensuring a strong safety culture with an emphasis on continuous improvement. The ISLMS will also apply to the expanded system. Refer to the response to NEB IR Nos. 3.002a-k (Filing ID A4H1V2) for a more detailed description of the ISLMS. The ISLMS outlines a commitment to establishing, implementing, monitoring, and continuously improving processes and controls to ensure that business is conducted in a safe, environmentally responsible, and sustainable manner. The ISLMS outlines the requirements that will apply to the following protection programs:

- Safety, Security, Environmental Protection, and Emergency Response;
- Pipeline and Facility Integrity;
- Damage Prevention and Public Awareness;
- Control Centre Operations and Leak Detection;
- Engineering and Major Projects; and
- Operations and Maintenance.

Spill prevention activities during operations are not stand-alone; rather, they are one focus of the preceding programs. In the unlikely event of a spill at Burnaby Terminal or Westridge Marine Terminal, KMC has a robust emergency response program in place to respond. Volume 7, Section 4 of the Facilities Application (Filing ID A3S4V5), outlines emergency management. KMC has a mature EMP, which is based on a combination of regulatory compliance, operational need, industry best practices, and lessons learned through regular exercises and actual incidents. The EMP is embedded within the framework provided by the ISLMS and the EHS Management System. Key elements of the EMP include long-standing and regularly reviewed Emergency Response Plans (ERPs), response equipment, and regular desktop training and field deployment exercises, which contribute to a highly trained response staff and response readiness within KMC. Volume 7, Section 4.8 outlines the process to enhance the existing EMP for the Project. The final EMP will be developed in a manner consistent with the NEB draft conditions related to emergency response (Filing ID A3V8Z8).

NEB IR No. 2.120a (Filing ID A3Z4T9) asked how sharing containment between tanks containing different types of products would be feasible in the event of a leak or spill. Trans Mountain responded that all proposed storage tanks will be located within secondary containment designed in accordance with CSA Z662 and the NFPA 30. Although not a statutory requirement, Trans Mountain has committed to comply with the additional secondary containment volume requirements of the AFC and the BCFC, as applicable for the location. Given that it is a feature of all relevant codes and a very common practice in North America and internationally, Trans Mountain believes that using shared secondary containment for tanks is a reasonable approach. Trans Mountain is not aware of any reason why tanks containing different types of crude oil (or crude oil and refined products) should not share containment areas.

SFU IR No. 2.3.11.2 (Filing ID A4H9C9) asked if Trans Mountain investigated and compared its planned containment design with similar facilities globally. Trans Mountain responded that it has not investigated and compared the secondary containment design for the proposed expansion of Burnaby Terminal with similar facilities globally. Trans Mountain has a statutory obligation to comply with CSA Z662, which requires that the capacity of a shared secondary containment area be 110% of the volume of the largest tank within the area. Trans Mountain has voluntarily committed to comply with the BCFC, which requires that the capacity of a shared containment area be 100% of the volume of the largest tank plus 10% of the volume of the other tanks within the area. Both of these requirements exceed the requirements of NFPA 30, which is typically the governing code in the United States. In addition, the available volume within the existing tertiary containment area at Burnaby Terminal, which will be retained in the proposed expansion, is approximately 80,000 m^3 (500,000 bbl), increasing the overall containment capacity at Burnaby Terminal. Tertiary containment is not a feature of most pipeline terminal facilities.

Trans Mountain notes that in the unlikely event of an accidental release to secondary containment, a pipe connection failure (*i.e.*, flange connection) is anticipated to be the most probable cause. Features that will generally be incorporated into the design of secondary containment areas to minimize the impact from an accidental release will include the following:

- A curbed concrete pad or a liner system will be installed under process piping areas (*i.e.*, areas containing flanged connections - manifolds, pumps, meters, sending and receiving traps).

- Most containment areas (*i.e.*, tank secondary containment areas) will be designed to hold storm water until it can be examined by operations personnel and observed to be acceptable for release. In certain cases (*i.e.*, process secondary containment areas), where the retention of storm water is not desirable, oil-water separators may be employed to allow continuous drainage to subsequent secondary or tertiary containment areas.
- Where the intention is to hold water for observation, secondary containment area drain valves will be normally closed.
- Hydrocarbon detectors will be installed in secondary containment areas.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Appendix I (page 6) states, “The engineering design specifications (dimensions, materiality, construction method, etc.) for the new tanks are currently undisclosed by Kinder Morgan, and there is no clarity regarding the proposed separation distance between tanks.” Trans Mountain notes that the tank dimensions were available to the City of Burnaby in the response to NEB IR No. 2.118c.4 (Filing ID A3Z4T9) and in Technical Update No. 2, Part 2, Facilities Update (Filing ID A4A4D5). Design and tank spacing information is also included in Section 24.7, Burnaby Terminal Risk Assessment and Section 24.5, Burnaby Terminal Storage Tank Spacing.

City of Burnaby IR No. 2.009n (Filing ID A4H8A1) asked when Trans Mountain will provide the final seismic design for the storage tanks and pipeline. Trans Mountain responded that it anticipates that the seismic design basis for the proposed new storage tanks at Burnaby Terminal will be finalized in Q4, 2015. Detailed storage tank design, following the seismic design basis, will be completed by one or more tank design / build contractors after the contract(s) are awarded. Detailed storage tank design is expected to be completed by Q4, 2016. Trans Mountain anticipates that the final seismic design for the pipeline(s) will be available after detailed engineering and design is complete, currently scheduled for Q2, 2016. All of the milestones indicated assume the current overall Project schedule is maintained. Trans Mountain does not intend to make the final seismic designs for the proposed storage tanks and pipeline(s) generally available to the public. However, Trans Mountain remains open to opportunities to discuss the seismic design of the proposed new storage tanks and the pipeline(s) with the City of Burnaby.

NEB IR No. 2.118c.4 (Filing ID A3Z4T9) requested dimensions for each proposed storage tank. Trans Mountain responded that the anticipated tank dimensions are summarized in Table 2.118c.4-1. Subsequently, the diameters of three tanks at Burnaby Terminal were altered, with the changes identified in the Technical Update No. 2, Part 2, Facilities Update (Filing ID A4A4D5). The diameters were shown in Attachment 1.0-1 Proposed Plot Plan Burnaby Terminal (Filing ID A4A4D6). For clarity, the dimensions in Table 24.4-1 below are provided to reflect the Facilities Update.

TABLE 24.4-1

PROPOSED STORAGE TANK DIMENSIONS

Location	Tank No.	Nominal Shell Capacity		Diameter (m)	Height (m)
		(m^3)	(bbl)		
Burnaby Terminal	74	53,260	335,000	61.0	18.3
	75	45,310	285,000	56.1	18.3
	76	53,260	335,000	61.0	18.3
	77	45,310	285,000	56.1	18.3
	78	53,260	335,000	61.0	18.3
	79	26,230	165,000	42.7	18.3
	80	45,310	285,000	56.1	18.3
	89	45,310	285,000	56.1	18.3
	91	45,310	285,000	56.1	18.3
	93	45,310	285,000	56.1	18.3
	95	45,310	285,000	56.1	18.3
	96	39,750	250,000	52.7	18.3
	97	45,310	285,000	56.1	18.3
	98	39,750	250,000	52.7	18.3

Doherty D IR No. 1.08a (Filing ID A3Y2K2) asked if Trans Mountain addressed the structural integrity of pipelines and tank farms in relation to the possibility of earthquakes. Trans Mountain responded that Volume 4A, Section 2.9.3 of the Facilities Application (Filing ID A3S0Y8) briefly describes the principles to be used in the seismic design of the new pipelines and facilities (including pump stations and terminals) proposed as part of the Project. Seismic design of earthen, concrete, and steel structures, including foundations and marine piles, containment berms, pipe racks, other support systems, and piping, will be in accordance with the latest editions of the NBCC, the Alberta Building Code, the BCBC, and other recognized standards and practices, as applicable to the structures and locations. Seismic design of storage tanks, including consideration of sloshing and other effects, will be in accordance with the latest edition of the API 650, Annex E, the recognized North American standard. Seismic design will be undertaken by experienced and competent professional engineers, registered in the province where the pipeline segment or facility is to be located. Geotechnical programs, which will include borehole and other investigative methods to obtain subsurface data, will be conducted, and the results and recommendations of registered professional engineers and geologists will be used to inform the seismic designs. Fabrication of components, construction, and installation will be rigorously inspected to ensure that the prescribed designs are followed and structural integrity will be verified by testing, as applicable. General information on design and quality verification principles is included in Volume 4A, Sections 2.1 through 2.7 (Filing ID A3S0Y8) and Volume 4B, Sections 3.4.8 through 3.4.13 of the Facilities Application (Filing ID A3S1K5). Numerous other references to design principles and features and QA methods exist throughout Volume 4A and 4B of the Facilities Application. Trans Mountain is highly confident that these approaches will ensure that the new pipelines and facilities will be able to withstand large earthquake scenarios with minimal damage or loss of integrity.

BROKE IR No. 2.1b.f (Filing ID A4H7Z4) asked about selection of the API 650, Annex E, Seismic Use Groups and the appropriateness of the tank sizes in that context. Trans Mountain responded with the following:

Seismic Use Group

Trans Mountain has not yet begun the detailed design of the storage tanks proposed for Sumas Terminal or Burnaby Terminal and, as such, Trans Mountain has not yet selected the SUG for the tanks. API 650, Annex E, defines the SUGs as follows:

- E.3.1.1 Seismic Use Group III
  - SUG III tanks are those providing necessary service to facilities that are essential for post-earthquake recovery and essential to the life and health of the public; or, tanks containing substantial quantities of hazardous substances that do not have adequate control to prevent public exposure.
- E.3.1.2 Seismic Use Group II
  - SUG II tanks are those storing material that may pose a substantial public hazard and lack secondary controls to prevent public exposure, or those tanks providing direct service to major facilities.
- E.3.1.3 Seismic Use Group I
  - SUG I tanks are those not assigned to SUGs III or II.

In the commentary on Annex E, API 650 further qualifies the criteria for SUG I:

> "For example, tanks serving the following types of applications may be assigned SUG I….1) storage tanks in a terminal or industrial area isolated from public access that has secondary spill prevention and control…."

Trans Mountain believes that the new tanks proposed for Burnaby Terminal do not meet the API 650, Annex E criteria to be assigned SUG III or SUG II and do meet the criteria to be assigned SUG I, although this will be further considered during the detailed engineering and design phase.

Tank Sizes

The diameters of the tanks proposed for Burnaby Terminal are identified in Technical Update No. 2, Part 2, Facilities Update, Attachment 1.0-1 (Filing ID A4A4D6). The diameter of the tank proposed for Sumas Terminal is 45.7 m (150 ft.). It is anticipated that all of the tanks will have shells 18.3 m (60 ft.) high.

Suitability of Tank Sizes

API 650 does not provide guidance on the allowable fixed sizes of tanks because the purpose of API 650 is to provide a formulaic approach to the design of tanks of any theoretical diameter or height. The size of a tank designed according to API 650 is limited by the practicality of manufacturing thick enough plates and by various construction considerations. The tank diameters that Trans Mountain is proposing are well within the range of sizes that are being constructed world-wide, including in seismic zones. Trans Mountain has not done the detailed design calculations to determine the impulsive natural period and convective (sloshing) period of the tanks. Trans Mountain will ensure that the structural design of the tanks is in accordance

with API 650 and is appropriate for the impulsive and convective periods and the other design parameters that are calculated.

City of Burnaby IR No. 2.012c (Filing ID A4H8A1) asked how tank design and spacing impacts the degree of spills, fire, and seismic events. Trans Mountain responded by referring to the response to City of Burnaby IR No. 2.027a (Filing ID A4H8A1), which addresses the relationship between tank design and spacing and fire and spill risk. Trans Mountain also referred to the NEB Ruling 33 follow-up response to City of Burnaby IR No. 1.08.12a (Filing ID A4D3G2), which provides a detailed discussion of seismic risk. In summary, Trans Mountain believes that robust tank designs, in accordance with statutory requirements, reduce the risk (probabilities and consequences) of spills and fires, associated with seismic activity or otherwise, and that tank spacing, provided that the statutory requirements are met, has no material impact on the risk of spills or fires.

24.5 Burnaby Terminal Storage Tank Spacing

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, includes the following:

- Conclusions (page 6) states, "The TMEP massively deviates from the original safety premise and approval basis of providing storage tank isolation for proposed tanks at a proximity distance of 0.5 tank diameters."
- Tank Spacing (page 25) states, "Of specific concern are storage tanks located uphill. Tanks located uphill of a tank fire (at the same tank spacing) receive significantly greater heat exposure than a tank located at the same elevation."
- Tank Spacing (page 28) states, "In the event that an extinguishing stream can't be applied to the surface of a tank fire, it is likely that defensive strategy would need to be employed to protect adjacent tanks while allowing the original tank fire to burnout over several days."
- Consequences (page 63) states, "The distance between storage tanks is a key design and engineering feature provided to allow firefighters to effectively isolate an active tank fire, preventing a multiple tank fire event. The TMEP proposal effectively increases the risk associated with a multiple tank fire event due to the reduction in storage tank spacing."
- Appendix I (page 9) states, "In general, the distance between storage tanks, as well as construction details, are regulated through a number of federal and provincial regulations, including but not limited to the NFPA Standard 30, and the BC Fire Code. These regulations provide a minimum standard in terminal developments. Where public safety and mitigation of fire risks are the primary objective, the application of the highest industry standards and best practices (using international baseline) should be applied to terminal developments."

Hazards to Simon Fraser University Associated with the Trans Mountain Expansion Project: A Gap Analysis, prepared by David Etkin *et al*., Executive Summary (page 3) states, "The proposed expansion of the Kinder Morgan pipeline and tank farms in the Burnaby area create increased risk for SFU. In part this is because more product will be flowing through the pipelines and stored at the Burnaby Tank Farm, but it is also because previous levels of safety will be decreased by densification of the tank farm, tanks being positioned closer to fences and roads, and the reduced ability of the Burnaby Fire Department to effectively respond to an accident."

In addition, the intervenor evidence submitted by Dorothy Doherty, Section 4. Public Safety (page 6) states "The new tanks will be very close to each other, creating hazards for anyone who responds to a tank farm fire" (Filing ID A4L8U3).

Trans Mountain does not agree with the various Intervenor statements above. The minimum spacing of the proposed storage tanks will be in accordance with the requirements of NFPA 30, which is consistent with the spacing required by the BCFC, specifically $(D_1 + D_2)/4$ or 0.5 times diameter, also known as "half diameter" spacing. In addition, Trans Mountain notes that the topography of the Burnaby Terminal will make the minimum spacing relevant only for adjacent tanks within each terrace and within the two-tank or three-tank groupings proposed. The spacing between tanks on different terraces and in different groupings will be not less than "one diameter" and in most cases substantially greater. Discussion on storage tank spacing is included in the following comments and responses to various IRs.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Consequences (page 63) states "*Because of the tight facility footprint, in order to provide containment diking as many as four (4) storage tanks will share a common containment dike*." Trans Mountain notes that this statement is incorrect. The current Burnaby Terminal plot plan, included in Technical Update No. 2, Part 2, Facilities Update, Attachment 1.0-1, Proposed Plot Plan Burnaby Terminal (Filing ID A4A4D6), shows a maximum of three storage tanks within a shared secondary containment area.

City of Burnaby IR No. 1.08.03a (Filing ID A3Y2E6) requested the requirements for tank spacing. Trans Mountain responded that the NEB *Onshore Pipeline Regulations* require that pipeline systems be designed in accordance with CSA Z662, Oil and Gas Pipeline Systems. CSA Z662, Clause 4.15.1.2 requires that the location and spacing of storage tanks be in accordance with NFPA 30, Flammable and Combustible Liquids Code. NFPA 30, Clause 22.4.2.1 requires that floating roof storage tanks have a spacing of 0.25 times the sum of adjacent tank diameters, where open diking is provided (as is the case at Burnaby Terminal). This is consistent with the spacing of 0.25 times the sum of adjacent tank diameters required by the BCFC, Division B, Part 4, Clause 4.3.2.2. Trans Mountain notes that the topography of the Burnaby Terminal site will make the minimum spacing defined by NFPA 30 relevant only for adjacent tanks within each terrace and within the two-tank or three-tank groupings proposed (nine adjacencies in total). The spacing between tanks on different terraces and in different groupings will be not less than one diameter and in most cases substantially greater.

SFU IR No. 2.3.11.3 (Filing ID A4H9C9) asked for an explanation of the assumptions and basis upon which Trans Mountain determined its planned containment sizing and capacity. Trans Mountain responded that it had selected initial tank diameters and laid out the tanks to optimize the use of the available space at Burnaby Terminal, respecting the NFPA 30 and BCFC tank spacing and property line setback requirements. Tank numbers and capacities were tested through simulation modelling to ensure that the proposed expanded operation of Westridge Marine Terminal could be effectively supported. Trans Mountain assessed the containment capacity requirements of the BCFC, including consideration of shared containment. Three-dimensional topographical and civil design models were used to determine if the required containment capacities could be practically achieved. The process was repeated iteratively, resulting in the currently proposed design. Consideration was also given to the potential extent of secondary containment pool fire radiant heat contours and small adjustments were made to the surface areas and locations of the secondary containment areas.

City of Burnaby IR No. 2.027k (Filing ID A4H8A1) asked why three-dimensional (3D) heat outfall modelling was not used. Trans Mountain responded that it believes that 3D heat outfall analysis for Burnaby Terminal is not necessary and provided a reference to City of Burnaby IR No. 1.08.03a (Filing ID A3Y2E6) for a discussion of tank to tank spacing between tanks on different terraces. Due to the topography, the tank to tank spacing in the south to north (uphill) direction is much greater than that required by the NFPA 30. The following are a few illustrative examples:

- Tank 75 to Tank 74
  - NFPA 30 spacing: 29.3 m
  - Proposed spacing: 77.7 m
  - Proposed / NFPA 30 ratio: 2.65
- Tank 89 to Tank 86
  - NFPA 30 spacing: 25.5 m
  - Proposed spacing: 64.3 m
  - Proposed / NFPA 30 ratio: 2.52
- Tank 97 to Tank 98
  - NFPA 30 spacing: 27.4 m
  - Proposed spacing: 55.5 m
  - Proposed / NFPA 30 ratio: 2.02

Trans Mountain also notes that the distances identified in the Burnaby Terminal Risk Assessment, NEB IR No. 1.98a - Attachment 3 (Filing ID A3W9S5), for a radiant heat level of 37.5 kW/m^2 (sufficient to cause damage to process equipment), do not extend beyond the secondary containment areas. Based on the uphill tank to tank spacing, which exceeds the NFPA 30 requirement, and the limited extent of the radiant heat that may be sufficient to cause damage to adjacent tanks, Trans Mountain believes that three-dimensional modelling would not have provided any additional value to the analyses that had been completed.

City of Burnaby IR No. 2.027a (Filing ID A4H8A1) asked about increases in risks associated with the planned reduction in tank spacing. Trans Mountain responded that it has not completed a comparative assessment to determine if there is a change in risk associated with the proposed tank spacing compared with the current tank spacing. There is no evidence to suggest that the existing tank spacing was based on an assessment of risk. The statutory requirement for tank spacing for Burnaby Terminal is discussed in the response to City of Burnaby IR No. 1.08.03a (Filing ID A3Y2E6). The statutory requirement, in NFPA 30, is identical to the requirement in the National Fire Code of Canada and the BCFC, reflecting broad acceptance of its appropriateness. Trans Mountain believes the statutory requirement was developed to achieve a reasonable balance between risk and the efficient use of space. Risk is defined as the product of the probability of an event and the consequences of an event. Trans Mountain does not believe that a comparative risk assessment would show any material difference in the

probability of a fire or spill related to tank spacing. The probability of a fire or a spill is more likely to be correlated to the number of tanks, the tank design features, and the presence of protective devices to prevent a fire or spill, all of which are independent of spacing. Trans Mountain also does not believe that a comparative risk assessment would show any material difference in the consequences of a fire or spill related to tank spacing.

Trans Mountain concluded the response to City of Burnaby IR No. 2.027a (Filing ID A4H8A1) by stating that the consequences of a fire or spill are more likely to be correlated to fire or spill detection measures, mitigation measures, including the capacity of the secondary and tertiary containment areas and the capability of fire suppression and emergency response systems, and proximity to residential or other public areas. In fact by utilizing the tank spacing allowed by the statutory requirements, Trans Mountain is able to maximize the distances to residential areas for the same number of tanks, thus reducing the potential consequences from what they might otherwise be if a greater spacing were to be used. Trans Mountain has filed a fire risk assessment for Burnaby Terminal as part of the response to NEB IR No. 1.98a (Filing ID A3W9H9). The risk assessment itself is Attachment 3 (NEB IR No. 1.98a - Attachment 3), TMEP Burnaby Terminal Portion Risk Assessment (Filing ID A3W9S5). The risk assessment indicates that the proposed expansion meets the MIACC criteria for acceptability, even without mitigation measures, such as fire-protection. Nevertheless, Trans Mountain has chosen to include a robust fire protection system, which exceeds the statutory requirement for fire protection, and is further discussed in the response to City of Burnaby IR No. 2.027c (Filing ID A4H8A1).

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Consequences (page 63) states "*The TMEP proposal effectively increases the risk associated with a multiple tank fire event due to the reduction in storage tank spacing*." Based on the discussion in the IR responses provided above, Trans Mountain believes the Project does not increase the risk associated with a multiple-tank fire event due to storage tank spacing.

24.6 Number of Storage Tanks at Burnaby Terminal

Assessment of the Trans Mountain Pipeline and Tanker Expansion Proposal, prepared by Tsleil-Waututh Nation, Section 6, Trans Mountain Pipeline and Tanker Expansion Proposal (page 44) states, "Additional infrastructure inside the Consultation Area includes more storage at the Burnaby Tank Farm: there will be 27 large tanks instead of 13." Trans Mountain notes that this statement is incorrect. A total of 14 new storage tanks are proposed for the Burnaby Terminal; however, one existing storage tank will be replaced, which will result in a total of 26 storage tanks at the terminal.

24.7 Burnaby Terminal Risk Mitigation Measures

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, includes the following:

- Concepts of Risk (pages 3 and 10) states, "This process of risk assessment is based on an arguable premise: that sufficiently low frequency risks can remain unmanaged regardless of the severity of the consequence."
- Concepts of Risk (page 10) also states, "The potential for a release of crude oil at the TMEP may occur by several specific means including tank overfill, the physical failure of

containment provisions and human error damage associated with improperly controlled industrial work in proximity to tankage or piping."

Trans Mountain does not agree with the City of Burnaby that its risk assessment premise is to leave low frequency risks unmanaged, regardless of the severity of the consequences. Trans Mountain uses a risk matrix approach to review facility integrity hazards and to qualitatively assess the risk of hazards. A Qualitative Risk Assessment Matrix is used by Trans Mountain to review facility integrity hazards and to qualitatively assess the risk of hazards. The matrix also considers the prevention, detection, and protection measures applied to control hazards at facilities. In general, each preventive control measure reduces the likelihood of a hazard, while each detective and / or protective control measure reduces the consequence. Further information on Trans Mountain's Qualitative Risk Assessment Matrix has been provided in the response to NEB IR No. 3.093f (Filing ID A4H1V2).

City of Burnaby IR No. 2.028c (Filing ID A4H8A1) asked for the percentage increase in risk to the surrounding population for each additional storage tank at the Burnaby Terminal. Trans Mountain responded that a risk assessment for Burnaby Terminal has been provided as part of the response to NEB IR No. 1.98a (Filing ID A3W9H9). The risk assessment itself is Attachment 3 (NEB IR No. 1.98a - Attachment 3, TMEP Burnaby Terminal Portion Risk Assessment (Filing ID A3W9S5). The risk assessment indicates that the proposed expansion meets the MIACC criteria for acceptability, even without mitigation measures, such as fire protection.

Trans Mountain notes that the purpose of risk assessment is to identify credible events, to evaluate their risks in the context of the probabilities of their occurrence and their estimated consequences, and to apply controls to reduce either the probabilities or consequences, where appropriate and as informed by accepted risk assessment criteria. Trans Mountain is of the view that the risk analysis report prepared by the City of Burnaby Fire Department is not a risk assessment. The report does not follow commonly accepted methodologies and it does not include calculations to quantify the nature or probability of the hazards raised or their consequences. The result is an unclear and repetitive report that focuses on incredible scenarios and creates an inappropriate analysis for the NEB and the general public to consider.

City of Burnaby IR No. 2.027c (Filing ID A4H8A1) asked about the proposed increases in facility fire protection capabilities, with respect to increases in risk related to a reduction in storage tank spacing. Trans Mountain responded that, as discussed in the response to City of Burnaby IR No. 2.027a (Filing ID A4H8A1), it does not believe that a comparative risk assessment, which evaluated the risks related specifically to tank spacing, would result in a conclusion of increase risk. However, in the interest of providing a comprehensive response, Trans Mountain also provided information on a number of risk control measures, which were also identified in the response to NEB IR No. 3.093b (Filing ID A4H1V2) and which, directly or indirectly, reduce the probabilities and / or consequences of fires or spills. The risk mitigation measures that Trans Mountain intends to implement for the proposed new storage tanks during detailed engineering and design, construction, and operations, are generally outlined below:

- Design of the proposed new storage tanks at Burnaby Terminal will be in accordance with the latest edition of the API 650, Welded Tanks for Oil Storage, as per the legislative requirements. API 650 identifies specific design provisions for seismic stability and seismic design parameters will be in accordance with the BCBC, as applicable. Seismic design, including consideration of sloshing and other effects, will be in accordance with API 650,

Annex E. All designs, including seismic considerations, will be undertaken by experienced and competent registered professional engineers. Geotechnical programs, which will include borehole and other investigative methods to obtain subsurface data, will be conducted, and the results and recommendations of registered professional engineers and geologists will be used to inform the seismic designs. Trans Mountain will also consider applicable topography and soil conditions in the design of tanks, tank foundations, and containments systems. Please refer to the response to NEB IR No. 2.114 (Filing ID A3Z4T9).

- Fabrication of components, construction, and installation will be rigorously inspected to ensure that the prescribed designs are followed and structural integrity will be verified by testing, as applicable. General information on design and quality verification principles is included in Volume 4A, Sections 2.1 through 2.7 (Filing ID A3S0Y8) and Volume 4B, Sections 3.4.8 through 3.4.13 (Filing ID A3S1K5) of the Facilities Application. Numerous other references to design principles and features and QA methods exist throughout Volume 4A and 4B of the Facilities Application. Please refer to the response to NEB IR No. 2.114 (Filing ID A3Z4T9).
- Following construction, each storage tank will be hydrostatically tested (with water) which is more dense (heavier) than crude oil.
- Trans Mountain is highly confident that the proposed new storage tanks at Burnaby Terminal can be safely constructed in the vicinity of existing operational tanks, based on the recent successful experience, over a three year period, with constructing 16 new large diameter storage tanks immediately adjacent to the existing operating tanks at Edmonton Terminal. Site-specific safe work procedures and mitigation measures will be developed during detailed construction planning in early / mid-2016, assuming the current Project schedule is maintained. Please refer to the response to NEB IR No. 2.119a (Filing ID A3Z4T9).
- Storage tank protective device design will generally include radar gauging, overfill protection, fire detection, leak detection, hydrocarbon detection in secondary containment areas, and terminal fire protection systems as outlined in Volume 4A, Section 3.4 of the Facilities Application (Filing ID A3S0Y8).
- Trans Mountain will provide overfill protection in accordance with API Standard 2350. All proposed tanks will be equipped with a radar gauging system for liquid level measurement and overfill protection. Redundant instrumentation for overfill protection will also be provided. For tanks not designated as mainline relief tanks, the overfill protection system will automatically cause the tank valve to close if the liquid reaches a predetermined level. The overfill protection arrangement will be finalized during the detailed engineering and design phase. Please refer to the response to NEB IR No. 2.118c (Filing ID A3Z4T9).
- The under-tank leak detection system proposed for each new storage tank will consist of perforated pipes which will drain to a sump adjacent to the tank. The leak detection system design will be in accordance with API 650, Annex I. Please refer to the response to NEB IR No. 2.118c (Filing ID A3Z4T9).
- Several types of fire detection technologies are available for tanks, including linear wire heat detector technology, linear fibre heat detector technology, and triple infrared detector technology. The most suitable technology for the proposed tanks will be selected during the

detailed engineering and design phase. When the design basis for the proposed fire protection systems is finalized, during the detailed engineering and design phase, specifications and drawings will be developed under the supervision of experienced and competent professional engineers, specializing in fire protection. Trans Mountain also retains the services of an industrial fire-fighting specialist to provide advice on conceptual and detailed design. Please refer to the response to NEB IR No. 2.125b (Filing ID A3Z4T9).

- Risk mitigation measures are also a subject of ongoing Hazards and Operability (HazOp) reviews. The first of a series of HazOp reviews was completed in Q2, 2014. This HazOp review focused on the primary elements of the crude oil process piping at Burnaby Terminal. Other HazOp reviews are scheduled in Q2, 2015 to complete the process piping at Burnaby Terminal. Additional reviews will be required to assess the fire-water/foam systems, and the non-process elements of the terminal design (*i.e.*, such as emergency response) at Burnaby Terminal. These will likely occur in Q3 or Q4, 2015. The risk assessment for Burnaby Terminal will be considered in coordination with the HazOp reviews and the implementation of any recommendations arising from the HazOp reviews.
- Trans Mountain intends to install fire protection systems on or nearby the proposed new tanks, as applicable, that will be designed to address the following fire or spill scenarios:
  - tank floating roof rim seal fire (fixed to tank, automated foam application);
  - tank full-surface fire (fixed to tank, automated foam application);
  - tank full-surface fire (application by portable foam monitors);
  - adjacent tank cooling (application by portable water / foam monitors); and,
  - release to secondary containment (application by portable foam monitors for odorous and combustible vapour suppression).

Please refer to the response to NEB IR No. 2.125b (Filing ID A3Z4T9).

Trans Mountain notes that the fixed, automated, full-surface fire protection feature proposed for the new tanks at Burnaby Terminal was not included in the Facilities Application and has been added to further enhance the robustness of the fire protection systems at these sites.

Operating and maintenance procedures, routine inspection and maintenance activities, and facility integrity management, which will generally safeguard the proposed storage tanks, are described in Volume 4C, Sections 5.0, 6.0, and 8.0 of the Facilities Application (Filing ID A3S1L1).

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Tank Spacing (page 33) states, “In essence, the TMEP shifts the control of hazard from an engineered approach of tank isolation, to an emergency response approach.” Given the inclusion of the numerous mitigation measures indicated above, Trans Mountain is of the view that the control of hazards will not be shifted from an engineered approach to emergency response. However, it is not practically possible to entirely eliminate all hazards through engineered approaches, hence the important role of emergency response.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Consequences (page 64) also states, "The TMEP proposal presents many conditions that provide no legitimate and safe strategies for extinguishment, other than allowing tank fire burnout." Based on the discussion included in the IR responses provided above, Trans Mountain believes that the Project provides robust measures for fire extinguishment, specifically intended to avoid a scenario where the contents of a storage tank are allowed to burn out.

Doherty D IR No. 2.5a (Filing ID A4H8R0) noted the Valdez, Alaska tank farm fire and asked about measures to prevent a long fire duration. Trans Mountain responded that a direct comparison with the 1964 Alaska earthquake that affected Valdez is somewhat difficult given the differences in design, commodities, location, geology, and other factors. As discussed in the response to Doherty D IR No. 1.08a (Filing ID A3Y2K2), Trans Mountain intends to design the storage tank foundations, the tanks themselves, the secondary containment systems, and other infrastructure at Burnaby Terminal to withstand large earthquakes with minimal damage or loss of integrity. According to information on the USGS website, http://earthquake.usgs.gov/earthquakes/events/alaska1964/, the 1964 event in Alaska was a subduction earthquake of magnitude 9.2, with its epicenter 56 miles west of Valdez, and was the second largest earthquake ever recorded world-wide. For comparison, the response to Wembley Estates IR No. 1.8b (Filing ID A3Y3W9) refers to a similar event, specifically "…..*it is anticipated that design ground motion will be equivalent to that resulting from a M7.1 shallow crustal event close to Vancouver and to an M9 subduction event off Vancouver Island.*" Aside from appropriate seismic design, Trans Mountain intends to install fire protection systems on or nearby the proposed new tanks. Trans Mountain anticipates that the Burnaby Terminal fire protection system will include the following elements:

- Fire Water System
  - Make-up water connection from the City of Burnaby;
  - Expanded fire water reservoir;
  - Two fire water pumps (one diesel-powered and one electric-powered);
  - Fire water distribution system;
  - Hydrants located throughout the expanded areas of the terminal; and,
  - Portable water monitors.
- Fire Foam System
  - Foam storage tank and injection system;
  - Foam distribution system;
  - Fire detection equipment on the new storage tanks;
  - Foam distribution and application systems on the new storage tanks;
  - Foam manifolds located throughout the expanded areas of the terminal; and

- Portable foam monitors.

Trans Mountain has seismic monitoring instruments at Burnaby Terminal today and will add additional seismic monitors as part of the Project. There will also be a standby generator to ensure that power supply is available to critical control systems and valve actuators in case of utility power failure.

24.8 Risk Assessment Probability Analysis

The "Opinion on Potential Off-Site Risks of the Proposed Expansion of Burnaby Tank Farm" report, prepared by Dr. Ivan Vince, Section 3.3.11 states, "A 2011 presentation in Sweden[13] included statistics on various types of fire, according to which the predicted frequency of full-surface fire - the usual precursor of boil-over - had risen from 3.0×10^{-5} (3 in 100,000) per tank per year in 1997 to 4.21×10^{-5} (4.21 in 100,000) in 2011."

Trans Mountain notes that the mentioned presentation does not provide any reference to data supporting the supposed "predicted" increase in frequency of storage tank full-surface fire events. Trans Mountain also notes that the MARSH Risk Engineering Position Paper - 01, Atmospheric Storage Tanks, suggests the frequency of a storage tank full-surface fire is 3.0×10^{-5} per year, which is within the range indicated in the Burnaby Terminal Risk Assessment, which was prepared by Doug McCutcheon and Associates.

The probability analysis in the Burnaby Terminal Risk Assessment used the values from the Rijnmond Report, shown in Table 14, which are specific to liquid hydrocarbon tanks. In addition, information contained in Item FR 1.1.1.1, Large Vessels (Page 8) of Failure Rate and Event Data for Use Within Risk Assessments, UK Health and Safety Executive (HSE), 2012, identifies catastrophic atmospheric storage tank releases as having a probability of 5×10^{-6} per year and major atmospheric storage tank releases as having a probability of 1×10^{-4} per year, which corroborate the Rijnmond data. These are both valid and respected sources for failure probability data. The other probability information included in Table 15 and Table 16 of the Burnaby Terminal Risk Assessment was used for the general discussion of human factors and is applicable in that context.

The "Opinion on Potential Off-Site Risks of the Proposed Expansion of Burnaby Tank Farm" report, prepared by Dr. Ivan Vince, Section 3.2.4 states *"… the final result should be multiplied by 13 for the current situation and by 26 for the situation after the proposed expansion i.e. to 1.3×10^{-4} (1.3 in 10,000) and 2.6×10^{-4} (2.6 in 10,000) per year, respectively, thus putting a question mark over whether the risk would exceed MIACC guidelines for the nearby residential area.*"

With regard to aggregated risk from multiple tanks, NEB IR No. 3.093d (Filing ID A4H1V2) asked for justification should Trans Mountain deem it unnecessary to revise the Burnaby Terminal risk analysis to include consideration of the total number of tanks. Trans Mountain responded that, as discussed in the response to NEB IR No. 3.093a (Filing ID A4H1V2), Trans Mountain believes it is unnecessary to revise the risk analysis sections requested. Trans Mountain acknowledges the concept that the overall probability of failure of a system of components is the sum of the probabilities of failure of each component. However, Trans Mountain believes that the risk assessments provided are already conservative for the following reasons:

- The risk assessments extend a risk (4.0 kW/m^2 radiant heat) contour around each terminal, which is derived from assessing each tank and shared containment area in their respective locations. Rather than considering the centre of the each terminal as a point source, this effectively considers the worst-case consequence scenario for every possible receptor.

- Preventive measures, such as robust design, fabrication, and testing, protective devices, electrical classification, operating procedures, and maintenance practices are not specifically considered in the probabilities. Mitigation measures, such as fire protection, are also not considered. As such the release probability used (1×10^{-4}), which is at the high end of a probability range extending to 6×10^{-6}, and the ignition probability used (1×10^{-1}) are very conservative. In its operational history, Trans Mountain has not experienced ignition of released oil.

- As identified in the risk assessments, the 1×10^{-1} probability of ignition is for extremely large releases (*i.e.*, 150 kg/s, 574.5 m^3/hr, 3,613 bbl/hr), essentially massive catastrophic failures, for which the probability of occurrence is expected to be much less than 1×10^{-4} (refer to the response to NEB IR No. 3.091a, (Filing ID A4H1V2) for a further discussion of tank failure probabilities). Smaller releases (*i.e.*, 20 kg/s, 76.6 m^3/hr, 482 bbl/hr), still very large releases to Trans Mountain, are expected to have a probability of ignition of 3×10^{-2}. The risk assessments conservatively calculate the probability of a fire as:

  - 1×10^{-4} (release) × 1×10^{-1} (ignition) = 1×10^{-5}

  More realistic probabilities for fire are likely to be:

  - 5×10^{-6} (extremely large release) × 1×10^{-1} (ignition) = 5×10^{-7}

  - 1×10^{-4} (large release) × 3×10^{-2} (ignition) = 3×10^{-6}

- The MIACC, Risk-Based Land Use Planning Guidelines criteria for acceptable annual individual risk for manufacturing, warehouse, and open space areas (parkland, golf courses, etc.) is a range of 1×10^{-4} to 1×10^{-5}. Using the more realistic fire risk range of 5×10^{-7} to 3×10^{-6}, the probabilities for a single tank fall well beyond the MIACC “manufacturing” land use acceptability zone to straddle the “commercial” and “all other uses” land use acceptability zones. To get back to into the “manufacturing” zone, 4 to 20 tanks would need to be considered, all concentrated at the exact same location. To get out of the manufacturing zone into the “no land use” zone, 34 to 200 tanks would need to be considered, all concentrated at the exact same location.

Trans Mountain continued the response to NEB IR No. 3.093d (Filing ID A4H1V2) by stating that more detailed risk analyses for each site, considering individual tanks and containment areas as well as summed probabilities and / or summed risks to receptors, would be an extensive undertaking, representing many months of detailed work. To ensure that the approach did not inappropriately overstate the risks, Trans Mountain would likely endeavour to further define the probabilities of different types of tank failures, include preventive, protective, and mitigation measures, and look at some detail at the geometry of the secondary containment areas, including the Remote Impound and the Remote Impound Annex in Edmonton and the partial remote impoundment proposed for Burnaby, to better assess consequences. For Burnaby and Sumas Terminals, the aggregate number of tank failures impacting given receptors is expected to rise only slightly, given the distribution of the secondary containment

areas around the site, while the failure probabilities and the consequences, for some scenarios, are expected to decrease, with a net offsetting result of similar conclusions to those reached in the risk assessments already provided. The location of the 4.0 kW/m^2 radiant heat contour will be unchanged. Based on all of these considerations, Trans Mountain believes that revised risk analyses, assessing the total number of tanks, will provide little additional value to the Board in its determination of public safety.

The evidence provided by Dorothy Doherty, Fire Hazards and other emergencies (page 4) states, "Judging from scientific reports, a significant spill and / or fire means an explosion is imminent" (Filing ID A4L8U3). Trans Mountain does not believe that an explosion is imminent following a significant spill and / or fire. As indicated in the response to NEB IR No. 3.093d (Filing ID A4H1V2), above, the probability of ignition is anticipated to be between 1×10^{-1} for an extremely large release, essentially a massive catastrophic failure, to a probability of 3×10^{-2} for a smaller release.

Wright K IR No. 1.2.4 (Filing ID A3X6W5) raised concern with pipeline proximity to an elementary school. Trans Mountain responded that the pipeline that is referenced in the Preamble is currently in operation, and, as was indicated in Trans Mountain's response to NEB IR No. 1.93e (Filing ID A3W9H9), has seen historical flow rates as high as 60,400 m^3/d (380,000 bbl/d). Pipeline capacity is highly dependent on the density and viscosity of the commodities being transported because heavier, more viscous commodities will not flow as easily when the same amount of pressure is applied. As proposed for the Project, Line 1 is intended to primarily transport light crude oil and refined products. The existing pipeline transports heavy crude oil as well, which currently restricts its capacity to about 47,700 m^3/d (300,000 bbl/d). The heavy crude oil currently being transported in the existing pipeline will flow in Line 2 in the proposed expanded system, which will allow an increased capacity in the existing pipeline segments that will become part of Line 1, without the need to increase the maximum operating pressure of these segments. Trans Mountain's pipelines are managed through a Pipeline Integrity Management Program that utilizes regular re-evaluations of risk as the basis for identifying and prioritizing assessment and risk mitigation actions. The continual re-evaluation of geohazard threats, such as the seismic threat that is referenced in the IR, is an integral part of Trans Mountain's Pipeline Integrity Management Program. An example of seismic risk mitigation was the HDD replacement of the existing pipeline crossing [of the Fraser River] in 2003. In this regular re-evaluation of risk, and as further explained in Trans Mountain's response to NEB IR No. 1.92c (Filing ID A3W9H9), populated areas, such as those typically found in the vicinity of schools, are characterized as HCAs. As such, they receive an enhanced weighting in the risk assessment, and a higher priority for any consideration of assessment and mitigation. Finally, it is important to bear in mind that the product being transported in the existing pipeline is crude oil. Industry experience has shown that crude oil does not readily ignite in consideration of a potential pipeline release, even in contemplation of a CWCS full-bore rupture. Therefore, Trans Mountain feels that the scenario depicted in the IR is highly unrealistic. By way of illustration, in a report by Dr. F. Jeglic, of the NEB (Jeglic 2004), it was observed that no ignition of spilled product occurred in any of the pipeline ruptures involving low vapour pressure liquid products (the class of product that crude oil falls in) over the 20-year analysis period reviewed. Please refer to Wright K IR No. 1.2.4 – Attachment 1 (Filing ID A3X6W5). Therefore, from a risk perspective, Trans Mountain asserts the following with respect to its existing operating pipeline:

- the integrity of the existing pipeline will not be adversely affected by the proposed project;
- the integrity of the existing pipeline will be managed through Trans Mountain's ongoing Pipeline Integrity Management Program, which is applied to all of Trans Mountain's operating pipeline infrastructure; and,
- the scenario depicted in the IR is not supported by industry operating experience in the transportation of crude oil by pipelines.

24.9 Radiant Heat Distances

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Heat Discharge Against the Fenceline (page 73) states, *"Serious impact is felt up to 86 - 224m from the dike walls*."

Hazards to Simon Fraser University Associated with the Trans Mountain Expansion Project: A Gap Analysis, prepared by David Etkin *et al*., includes the following:

- Section 5, Risks Related to Tank Farm (page 23) states, "Scenario 1: Tank Fire Caused by a Major Oil Tank release (heavy smoke)
  i. Maximum distance of radiant heat impact from a pool fire = 733m (Table 9 of TM / McCutcheon and Associates report)
  ii. Maximum distance of radiant heat impact from a tank top pool fire = 216 m (Table 9 of TM / McCutcheon and Associates report)"
- Section 5, Risks Related to Tank Farm (page 25) states, "The presence of a wind will greatly change the nature of the hazard, decreasing it upwind and magnifying it enormously downwind. There is no evidence that TM has sufficiently considered local meteorological conditions in the vicinity of SFU, and this gap needs to be addressed."

Trans Mountain is of the view that the City of Burnaby and SFU (Etkin *et al*.) have attempted to overstate the effect on people and public lands from the 1.0 kW/m^2 and 4.0 kW/m^2 radiant heat intensity distances described in the report prepared by Doug McCutcheon and Associates, Consulting and included in the response to NEB IR No. 1.98a (Filing ID A3W9H9) as Attachment 3 (NEB IR No. 1.98a - Attachment 3, TMEP Burnaby Terminal Portion Risk Assessment (Filing ID A3W9S5)). A crude oil fire will generate heavy smoke, which will have reduced heat intensity distances in comparison to a smokeless fire (*i.e.*, 4.0 kW/m^2 radiant heat intensity distances will be less). In addition, the effect of the 4.0 kW/m^2 radiant heat intensity level is defined as significant injury to people (further defined as second degree burns to exposed skin) after approximately 100 seconds of exposure. Damage to public lands would require a much higher level of radiant heat, perhaps as high as 25.0 kW/m^2, which would occur much closer to the tanks and secondary containment areas than the 4.0 kW/m^2 radiant heat level. Further discussion on radiant heat is included below and in the responses to various IRs.

The radiant heat distances indicated in the Etkin *et al*. report, "Maximum distance of radiant heat impact from a pool fire = 733 m" and "Maximum distance of radiant heat impact from a tank top pool fire = 216 m," were based on a 1.0 kW/m^2 radiant heat intensity distance as indicated in the report prepared by Doug McCutcheon and Associates, Consulting. However, the values

referenced are based on a smokeless fire, which will not be the case for crude oil. A crude oil fire will generate heavy smoke, which will reduce the 1.0 kW/m^2 heat intensity maximum distances to 536 m for a secondary containment pool fire and to184 m for a full-surface tank fire. Furthermore, based on the additional information provided below, Trans Mountain is of the view that, in the highly unlikely event of a secondary containment pool fire or a full-surface tank fire, the 4.0 kW/m^2 radiant heat intensity maximum distance of 224 m for a secondary containment pool fire and 71 m for a full-surface tank fire are far more representative of the conditions that could be expected to cause significant injuries (*i.e.*, second degree burns). An updated figure showing the 4.0 kW/m^2 radiant heat intensity contour for tank secondary containment pool fires for Burnaby Terminal, is provided in NEB IR No. 4.33a - Attachment 3 (Filing ID A4K4X7). Trans Mountain also notes that the radiant heat intensity level of 1.0 kW/m^2 is anticipated to be equivalent to injury received from a sunburn (*i.e.*, a first degree burn). With regards to the presence of a wind, the radiant heat distance calculations in the Burnaby Terminal Risk Assessment assume there is no wind present and the fire is essentially vertical. Wind will affect the flame slightly, which in turn could affect the radiant heat impact distance. However, the difference in the radiant heat impact distance caused by wind is expected to be small in comparison to the somewhat large distances related to the radiant heat intensity values of 1.0 kW/m^2 and 4.0 kW/m^2.

NEB IR No. 4.31 (Filing ID A4K4W3) requested an explanation of the effect of 4.0 kW/m^2 radiant heat intensity level used in the risk assessments. Trans Mountain responded that the effect of the 4.0 kW/m^2 radiant heat intensity level used in the risk assessments is defined as significant injury to people after approximately 100 seconds of exposure and no significant damage to equipment. Significant injury could include second degree burns if it is not possible for those impacted to obtain protection or to move to a safe distance from the fire within the specified time period. With second degree burns, there is a risk of fatalities. For a radiant heat intensity level below 4.0 kW/m^2, the risk of fatalities is essentially zero.

City of Burnaby IR No. 2.027g (Filing ID A4H8A1) asked how a reduction in the distance between storage tanks and the fenceline would change heat impacts to public lands. Trans Mountain responded that in the areas at Burnaby Terminal where there are currently no tanks, the level of radiant heat projected on some adjacent public lands, if there were a fire in the proposed new tanks or secondary containment areas, would increase compared to what it would be if there were a fire in the existing tanks or secondary containment areas. As discussed in the response to City of Burnaby 2.027a (Filing ID A4H8A1), a risk assessment is included in the response to NEB IR No. 1.98a, Attachment 3, TMEP Burnaby Terminal Portion Risk Assessment (Filing ID A3W9S5). In the risk assessment, Figure 4a, Figure 5, and Figure 6 (mislabelled as Figure 5) on pages 36, 37, and 38, respectively, show 4.0 kW/m^2 radiant heat ellipses for the existing and expanded tank arrangements. An updated and more refined 4.0 kW/m^2 radiant heat contour (*i.e.*, not an ellipse) for secondary containment fires is discussed in Technical Update No. 2, Part 2, Facilities Update, Conceptual Design and Layout of Burnaby Terminal and Westridge Marine Terminal (Filing ID A4A4D5). The refined 4.0 kW/m^2 radiant heat contour is included in Technical Update No. 2, Part 2, Facilities Update, Attachment 1.0-3, Secondary Containment Fire Radiant Heat Contour Burnaby Terminal (Filing ID A4A4D8). Trans Mountain notes that the 4.0 kW/m^2 contour was chosen, for risk assessment purposes, as the threshold for potential injury to the public and is not intended to imply damage to public lands. Damage to public lands would require a much higher level of radiant heat, perhaps as high as 25.0 kW/m^2, which would occur much closer to the tanks and secondary containment areas than the 4.0 kW/m^2 radiant heat level.

NEB IR No. 4.21 (Filing ID A4K4W3) requested an update on tank information and updated risk assessments. Trans Mountain responded that a revised proposed tank layout for Burnaby Terminal in Technical Update No. 2, Part 2, Conceptual Design of Burnaby Terminal and Westridge Marine Terminal (Filing ID A4A4D5) and in Part 2, Attachment 1.0-1, Proposed Plot Plan - Burnaby Terminal (Filing ID A4A4D6). The update indicated changes to the diameters of three of the 14 tanks from those that were identified in the Facilities Application. The rational for the changes was to allow a minor reconfiguration of two shared secondary containment areas to draw the 4.0 kW/m^2 contour further away from a neighbouring residential area to the south. Trans Mountain also provided a revised radiant heat intensity contour, in Part 2, Attachment 1.0-3, Secondary Containment Fire 4.0 kW/m^2 Radiant Heat Intensity Contour - Burnaby Terminal (Filing ID A4A4D8). Since the changes were specifically made for the purpose of slightly reducing the radiant heat risk, the overall conclusions of the risk assessment provided in Attachment 3 of the response to NEB IR No. 1.98a (Filing ID A3W9S5) were unchanged. Trans Mountain has not changed the number or sizes of the tanks since Technical Update No. 2 was filed. Accordingly, an updated risk assessment is not required. Additional drawings, showing the 4.0 kW/m^2 and 1.0 kW/m^2 radiant heat intensity contours for Edmonton Terminal, Sumas Terminal, and Burnaby Terminal, are included in the response to NEB IR No. 4.33a (Filing ID A4K4W3). These drawings more accurately show the radiant heat intensity contours and the sensitive elements within the contours but do not change the conclusions of the risk assessments. As discussed above, the tank number and size changes identified do not change the conclusions of the risk assessments. Therefore, the only purpose of providing updated risk assessments would be to formally incorporate the more accurate representations of the radiant heat intensity contours. As such, Trans Mountain believes that providing updated risk assessments is not necessary and would not provide any additional information that would be helpful to the Board in its review of the Application.

24.10 Protection of Adjacencies at Burnaby Terminal

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, includes the following:

- Conclusions (page 8) states, "*Additionally, the close proximity of storage tanks to the fenceline dramatically increases the risk of wildland fire to the Burnaby Mountain Conservation Area.*"
- Tank Spacing (page 28) states, "*In the event that an extinguishing stream can't be applied to the surface of a tank fire, it is likely that defensive strategy would need to be employed to protect adjacent tanks while allowing the original tank fire to burnout over several days.*"
- Distance to Fenceline (page 44) states, "*The decreased tank to fenceline distance and consequential impact potentials to the community presents the higher requirement and increased priority of evacuation operations conducted simultaneously with fire control activities*."
- Distance to Fenceline (page 44) states, "*The close proximity of storage tanks to the fenceline dramatically increases the risk of wildland fire to the Burnaby Mountain Conservation Area.*"
- Heat Discharge Against the Fenceline (page 73) states, "*The proposed TMEP massively decreases the distance the TMTF sits directly adjacent to the Burnaby residential*

communities of Lochdale, Sperling-Duthie, Meadowood, Forest Grove (the nearest residential property being 20 m away), as well as in proximity to Simon Fraser University and UniverCity."

- Heat Discharge Against the Fenceline (page 73) states, "*Serious impact is felt up to 86 - 224m from the dike walls.*"
- Heat Discharge Against the Fenceline (page 75) states, "*The TMEP will create potential heat impacts to exterior fenceline sensitivities from 15 tanks. Additionally, as illustrated in Diagrams 8 & Diagram 9, the depth at which the heat impacts from a tank fire event in the proposed TMEP Configuration will penetrate the forested area is extensive*."
- Heat Discharge Against the Fenceline (page 77) states, "*An uncooled heat exposure to the trees surrounding the TMTF, would create conditions consistent with ignition and development of a rapidly advancing 'High Tree Top' Wildfire event*."
- Heat Discharge Against the Fenceline (page 78) states, "*Potential impacts to the Suncor Burrard Products Refined Hydrocarbon Storage Tanks in the Glennayre neighborhood of Port Moody.*"

Trans Mountain does not agree with the various City of Burnaby Fire Department statements above. The fire protection systems that will be installed on or nearby the proposed new tanks at Burnaby Terminal will be designed to address a number of fire or fire-related scenarios. Trans Mountain is proposing to install a robust fire protection system to significantly reduce the inherently very low risk of fires associated with the proposed new tanks and therefore is of the view that the scenario of a tank fire burning for several days is extremely unlikely. In the event of any fire at Burnaby Terminal, emergency response will be conducted on a case-by-case basis, using philosophies, principles, and procedures identified in the ERP. Discussion regarding the protection of adjacencies is included in the following comments and responses to various IRs.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Appendix I (page 5) also states, "The existing fire protection system for the Burnaby Mountain Terminal is a water-based system, which draws from a southwest detention pond." Trans Mountain notes that this statement is partially incorrect. Fire-water is obtained from the existing fire-water reservoir located at the north (upper) end of the terminal, not the tertiary containment located at the southwest (lower) corner of the terminal.

City of Burnaby IR No. 2.027l (Filing ID A4H8A1) asked if there any full liquid surface tank fire events that would preclude protection of the fenceline forest area due to a lack of safe fire resource deployment. Trans Mountain responded that it believes that protection of adjacencies at Burnaby Terminal would not be precluded for the various scenarios indicated in City of Burnaby IR No. 2.027l, 2.027m, 2.027n, 2.027o, and 2.027p (Filing ID A4H8A1), due to a lack of safe fire resource access or deployment positions due to outfall heat impact. The scenarios identified are:

- 2.027l: protection of forest area from full-surface tank fire (deployment);
- 2.027m: protection of forest area from secondary containment fire (access);
- 2.027n: protection of forest area from secondary containment fire (deployment);

- 2.027o: protection of adjacent tank from secondary containment fire (access);
- 2.027p: protection of adjacent tank from secondary containment fire (deployment).

First responders will have the benefit of protective measures and will generally be able to use strategic and tactical approaches for safe deployment. The proposed primary access routes at Burnaby Terminal will be designed and constructed so that emergency response access is available from a minimum of two independent directions. For additional information on emergency responder heat exposure and emergency access please refer to responses to City of Burnaby IR No. 2.016d and City of Burnaby IR No. 2.030e (Filing ID A4H8A1). For a discussion of the risk of fire extension to forested areas and adjacent tanks, with and without protection by first responders, please refer to responses to City of Burnaby IR Nos. 2.016e, 2.016g, and 2.027k (Filing ID A4H8A1). Strategic and tactical access and deployment plans for various tank fire and secondary containment spill / fire scenarios will be considered during the detailed engineering and design phase and fully developed once the detailed designs are complete. Trans Mountain acknowledges that protection of an adjacent tank within a shared secondary containment area from a pool fire extending across the full secondary containment area, a subset of the scenario identified in City of Burnaby IR No. 2.027p (Filing ID A4H8A1), could be challenging for first responders. However, in such a scenario, Trans Mountain anticipates that damage to an adjacent tank would take some time and there are other mitigation measures (such as draining the adjacent tank or draining the secondary containment area to the intermediate retention area), that may be employed if considered appropriate. Trans Mountain's focus in design, operations, and spill response planning is to minimize the risk of a full-surface secondary containment area fire.

City of Burnaby IR No. 2.016d (Filing ID A4H8A1) requested the identification of areas where the outfall heat exposure cannot safely be occupied by emergency responders. Trans Mountain responded that it has not completed detailed analyses to identify which outfall heat exposure areas may not be able to be safely occupied by emergency responders in the case of secondary containment fires or full-surface tank fires at Burnaby Terminal. The purpose of the generation of the 4.0 kW/m^2 radiant heat contour map for secondary containment areas was to identify potential risk to the public, rather than to emergency responders, in the case of an unmitigated fire. Emergency responders will have the benefit of PPE, fire suppression systems, and tactical fire-fighting expertise. Should such safe occupancy analyses be required for emergency response planning purposes, assuming they can be framed and conducted to yield meaningful results, they will be completed commensurate with the updating of the ERP. In the event of any fire at Burnaby Terminal, emergency response will be conducted on a case-by-case basis, using philosophies, principles, and procedures identified in the ERP. A hazard assessment and risk evaluation will be used to determine the scope and magnitude of the incident, resource requirements, and response options. Emergency responders will have rapid access to high-capacity water and foam concentrate supplies and various forms of fire-fighting equipment, both fixed and portable. Emergency responders will use PPE and clothing for the specific hazards present, including fire-fighting protective clothing and positive-pressure SCBA. Continuous air monitoring will be conducted to detect LEL and H_2S gas values. Cooling water screens may be applied to facilitate close approach and to protect any exposures impacted by flame encroachment. Emergency responders will be trained to effectively implement and sustain fire suppression for various fire scenarios. Trans Mountain notes that the fire protection systems

that will be installed on or nearby the proposed new tanks at Burnaby Terminal will be designed to address the following fire or fire-related scenarios:

- Tank floating roof rim seal fire (fixed to tank, automated foam application).
- Tank full-surface fire (fixed to tank, automated foam application).
- Tank full-surface fire (application by portable foam monitor).
- Adjacent tank cooling (application by portable water / foam monitors).
- Release to secondary containment (application by portable foam monitors to suppress combustible vapours and odours).

The fixed, automated, full-surface system proposed for the new tanks at Burnaby Terminal was not included in the Facilities Application and has been added to further enhance the robustness of the fire protection system.

With respect to a high tree top wildfire event that could cause "*Potential impacts to the Suncor Burrard Products Refined Hydrocarbon Storage Tanks in the Glennayre neighborhood of Port Moody*," Trans Mountain has conducted an additional review. Based on measurements obtained using Google Earth, Trans Mountain has identified the distance from the Burnaby Terminal property line to the nearest Suncor storage tank as approximately 2.3 km. Trans Mountain notes that there are a number of existing fire breaks between Burnaby Terminal and the Suncor facility that include Gaglardi Way, the Powerline Trail clearing and the setback distance to the nearest storage tank at the Suncor facility. Again, based on measurements obtained using Google Earth, the width of Gaglardi Way is approximately 20 m (65 ft.) and the width of the Powerline Trail clearing and the Suncor storage tank setback distance are approximately 45 m (150 ft.). Therefore, Trans Mountain is of the view that the scenario of a wildfire, initiated from Burnaby Terminal, extending a significant distance to the Suncor facility, is also highly unlikely.

24.11 Releases from Storage Tanks

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, includes the following:

- Concepts of Risk (page 10) states, "*The potential for a release of crude oil at the TMEP may occur by several specific means including tank overfill, the physical failure of containment provisions and human error damage associated with improperly controlled industrial work in proximity to tankage or piping.*"
- Tank Overfill to Secondary Containment (page 14) states, "*Tank overfill is a common loss of containment for stored crude oil.*"
- Watercourse Outfall of Liquid Crude Oil Release (page 52) states, "*The release to areas outside of lined secondary containment diking creates the potential of a crude oil introduction into watercourses exiting the TMTF facility*."
- Watercourse Outfall of Liquid Crude Oil Release (repeated on page 82) states, "*The release of Crude Oil to areas outside of lined secondary containment diking creates the potential of a crude oil introduction into watercourses exiting the TMTF facility*."

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Flammable Gas Outfall Against the Fenceline (page 67) also states, "*Of note, during the TMTF 2009 storage tank overfill event, KM failed to notify the community in any manner during the release of flammable gas from a crude oil loss of containment*." Similarly, in the SFU written evidence Section 3.2 Impact on SFU of Expanded Tank Farm (page 23), Dr. Terry Waterhouse states "*Bowcock refers to an overfilling event in 2009 that caused a spill*…." Trans Mountain notes that both statements are incorrect. The release to secondary containment was caused by a contractor's pump connection failure that occurred during tank cleaning work. At the time of the release, the storage tank contained a minimal amount of product. It was not an overfill event nor was it caused by a failure of tank components.

Operating and maintenance procedures, routine inspections, maintenance activities, and facility integrity management, are utilized to prevent a release of oil by tank overfilling, failure of containment systems, human error, etc. Trans Mountain is of the view that a tank overfill scenario is highly unlikely based on the number of mitigation measures that are utilized, which include overfill protection in accordance with API Standard 2350, a radar gauge to monitor oil level, overfill protection instrumentation that will automatically cause the tank valve to close if the oil reaches a predetermined level, equipment maintenance programs, oil level monitoring by the CCO, monitoring by local operations, etc. Overfill protection is also discussed in Section 24.7, Burnaby Terminal Risk Mitigation Measures.

Furthermore, based on the drainage system described in Section 27.4, Proposed Terminal Drainage, Trans Mountain believes the possibility of oil leaving the Burnaby Terminal site and entering watercourses is extremely low.

24.12 Multiple-Tank Failures

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Consequences (page 62) states, "*The potential liquid product release scenario stemming from an expected regional area seismic event would be catastrophic in nature, and has potential to release the contents of several if not all of the storage tanks simultaneously, overwhelming the facilities retention provisions and flowing unrestricted to highly populated residential areas and sensitive environmental habitats*."

Trans Mountain does not agree with the City of Burnaby Fire Department statement. Trans Mountain is of the view that the probability of simultaneous multiple-tank failures within shared secondary containment areas is extremely low (near zero). Further, Trans Mountain does not consider the release of oil outside Burnaby Terminal to be a credible scenario. Such an event would require the simultaneous failure of multiple tanks within the same shared secondary containment areas, with the tanks at close to full capacity, combined with the failure of the tertiary containment area. Discussion regarding the sufficiency of containment, multiple-tank failures scenarios, and their associated probabilities is included in the following IR responses.

To properly consider the likelihood of simultaneous multiple-tank failures and uncontained releases of oil, it is important to first consider the intended purpose of the Burnaby Terminal tanks and their levels of utilization.

NEB IR No. 4.24a (Filing ID A4K4W3) asked for the anticipated typical total capacities at Burnaby Terminal just before loading two Aframax class tankers. Trans Mountain responded that it cannot precisely predict the volume of crude oil that could be at Burnaby Terminal just

before loading two Aframax class tankers at Westridge Marine Terminal. There is some variability in the size of the Aframax class tankers that call at Westridge Marine Terminal. The capacity of the tankers is also affected by the density of the crude oil and the available tide height at Second Narrows. Hypothetically, if both tankers were of 44 m beam (the largest typical), if the crude oil was light conventional or light synthetic (having a density of approximately 870 kg/m^3), and the tide height was such that the maximum allowable draft of 13.5 m could be achieved, each tanker could carry approximately 111,290 m^3 (700,000 bbl). In this extreme case, if the crude oil was all at Burnaby Terminal awaiting the arrival of the tankers, the volume would be 222,580 m^3 (1,400,000 bbl). More realistically, given the constraints at Second Narrows, Trans Mountain anticipates that tankers will be limited, on average, to 87,440 m^3 (550,000 bbl) of heavy crude oil and 92,210 m^3 (580,000 bbl) of light crude oil. As such, a more realistic value for the crude oil awaiting two Aframax class tankers is 179,650 m^3 (1,130,000 bbl). In addition to the crude oil awaiting tankers, Trans Mountain anticipates that some crude oil and refined product volumes might also be awaiting delivery to Chevron Refinery. Tanks currently in this service have a capacity, at high working level, of approximately 79,490 m^3 (500,000 bbl); however, since deliveries are more or less rateable, the typical volume in the tanks is expected to be about half of the capacity. Combining the tanker destined volumes and the Chevron Refinery destined volumes, Trans Mountain anticipates that approximately 219,400 m^3 (1,380,000 bbl) of crude oil and a small amount of refined product could be at Burnaby Terminal just before the loading of two Aframax class tankers. Trans Mountain notes that it is not necessary for all of the crude oil destined for a tanker to be at Burnaby Terminal just before loading. It is possible and likely that some crude oil will arrive at Burnaby Terminal during the loading, given that the loading duration for an Aframax class tanker will be approximately 20 hours.

Trans Mountain concluded the response to NEB IR No. 4.24a (Filing ID A4K4W3) by stating that, given the variability of the parameters and constraints that will determine the operational reality of the expanded TMPL system, the volume that will be at Burnaby Terminal at any given time is difficult to predict through simple speculative calculations. With this understanding, Trans Mountain has completed extensive simulation modelling of the expanded pipeline system, including tanker loading. Attachment 1 (NEB IR No. 4.24a – Attachment 1, Filing ID A4K4X3) provides histograms of tank utilization for all of the tanks at Burnaby Terminal, for various commodity types, and for the tanks within shared secondary containment areas. The simulation modelling predicts an average total volume of 233,870 m^3 (1,471,000 bbl) at Burnaby Terminal, a total volume of less than 476,960 m^3 (3,000,000 bbl) 98.2% of the time, and a total volume of less than 556,460 m^3 (3,500,000 bbl) 99.5% of the time.

With the predicted volumes of oil at Burnaby Terminal established, it is then important to consider the available secondary and tertiary containment capacities. The following response identifies that the combined total secondary and tertiary containment capacity at Burnaby Terminal, approximately 610,000 m^3 (3,850,000 bbl), is approximately 10% more than the amount of oil that will be at the terminal 99.5% of the time.

City of Burnaby IR No. 1.08.05h (Filing ID A3Y2E6) asked for information on impacts, both onsite and offsite in the event of an earthquake exceeding the standards, as well as the size of primary, secondary, and tertiary containment onsite. Trans Mountain responded that, based on the preliminary design work completed to date, it is estimated that, after the proposed expansion at Burnaby Terminal is complete, the total secondary containment volume will be approximately 530,000 m^3 (3,350,000 bbl), which is more than 60% of the total proposed storage tank capacity

(at high working levels) and more than 10 times the capacity (at high working level) of the largest tank. Further, the volume of the existing tertiary containment, which will be retained in the expansion (refer to City Burnaby IR No. 1.15.01g, Filing ID A3Y2E6), is approximately 80,000 m^3 (500,000 bbl), increasing the total containment volume to more than 70% of the total proposed product storage volume and nearly 12 times the capacity of the largest tank. Given the extreme unlikelihood of the circumstance necessary to cause a volume equivalent to the total proposed storage volume at Burnaby Terminal to be released (*i.e.*, all tanks at high working level, an earthquake producing seismic forces exceeding the tank design criteria, and all tanks failing), Trans Mountain believes that the containment volume proposed for the expansion at Burnaby Terminal is sufficient.

With respect to simultaneous multiple-tank failures within shared secondary containment areas, Trans Mountain noted in the response to NEB IR No. 4.29b (Filing ID A4K4W3) that the tank utilization histograms, provided in the Attachments to the responses to NEB IR No. 4.24a and NEB IR No. 4.24b (Filing ID A4K4W3), provide evidence that the total volumes within tanks in shared secondary containment areas are rarely greater than the containment capacities available. For example the total volume in Tanks 74, 76, and 78 is not expected to exceed 95,390 m^3 (600,000 bbl) more than 6.3% of the time. In the response to NEB IR No. 3.069a (Filing ID A4H1V2), Trans Mountain identified that, in the case of a multiple-tank failure, the effective volume of the shared secondary containment area will be approximately 96,000 m^3 (604,000 bbl). The full text of the response to NEB IR No. 4.29b appears in Section 24.14, Radiant Heat Knock-On Effect and Fire Extension.

Trans Mountain notes that Tanks 74, 76, and 78 will be the largest tanks onsite, with a combined volume at high working level of approximately 155,800 m^3 (980,000 bbl). In the rare instances when where the combined volume in Tanks 74, 76, and 78 exceeds the available secondary containment capacity of approximately 96,000 m^3 (604,000 bbl), the tertiary containment capacity of 80,000 m^3 (500,000 bbl) will be available as a contingency.

Aside from the demonstration of sufficient secondary containment capacity, Trans Mountain considered the risk of simultaneous multiple-tank failures as well as secondary containment failures.

NEB IR No. 4.26 (Filing ID A4K4W3) requested a detailed discussion on the likelihood of two or more tanks failing as a result of a large seismic or other geotechnical-related event. Trans Mountain responded that, as detailed in the Application, the design earthquake for pipelines and facilities, including storage tanks, will have a probability of exceedance of 2% in 50 years (1 exceedance in 2,475 years or 4.0×10^{-4} per year). This is consistent with the design requirements of API 650, Welded Tanks for Oil Storage, Annex E, the NBCC, and the BCBC. A probability of 4.0×10^{-4} per year can be considered very low. In Trans Mountain's view, the probability of a tank failing during a design (or greater) earthquake will reduce in proportion to the oil level in the tank. Trans Mountain cannot quantify the magnitude of the reduction, as seismic design is conducted assuming that the oil level is at the maximum design level. Given that Burnaby Terminal will operate as a dynamic facility to support the operation of Westridge Marine Terminal (*i.e.*, not a long-term storage facility), with tank levels rising and falling on a regular basis, the probability of failure of a single tank during a design earthquake is inherently much lower than 4.0×10^{-4}. Stated another way, during a design earthquake, it is reasonable to assume that only tanks operating at or close to their maximum capacities are at risk of failure. It is also not necessarily the case that a full tank would fail, given the inherent conservatism in codified design. With respect to simultaneous multiple-tank failures, Trans Mountain has

provided tank utilization histograms for Burnaby Terminal, in NEB IR No. 4.24a - Attachment 1 (Filing ID A4K4X3), and for Sumas Terminal, in NEB IR No. 4.24b - Attachment 1 (Filing ID A4K4X4). The following provides a summary of some of the information in the histograms.

Sumas Terminal:

- Two-tank shared secondary containment area (Tank 100 and Tank 103):
  - 51,670 m^3 (325,000 bbl) combined shell volume;
  - Approximately 47,720 m^3 (300,160 bbl) capacity at high working level; and,
  - 0.2% of the time above 31,800 m^3 (200,000 bbl) or about 67% of capacity.

Burnaby Terminal:

- Two-tank shared secondary containment area (Tank 96 and Tank 98):
  - 79,490 m^3 (500,000 bbl) combined shell volume;
  - Approximately 77,510 m^3 (487,500 bbl) capacity at high working level; and,
  - 12.4% of the time above 63,600 m^3 (400,000 bbl) or about 82% of capacity.
- Three-tank shared secondary containment area (Tank 74, Tank 76, and Tank 78):
  - 159,780 m^3 (1,005,000 bbl) combined shell volume;
  - Approximately 155,790 m^3 (979,880 bbl) capacity at high working level;
  - 3.8% of the time above 127,190 m^3 (800,000 bbl) or about 82% of capacity; and,
  - 6.3% of the time above 95,390 m^3 (600,000 bbl) or about 63% of capacity (*i.e.*, one tank at 10% of capacity and two tanks at 87% of capacity).

Based on the probability of a design earthquake and using the histogram data above, Trans Mountain believes that it is reasonable to use the approach identified below to calculate the maximum probabilities of simultaneous multiple-tank failures.

Sumas Terminal:

- Two-tank shared containment area (Tank 100 and Tank 103):
  - $4.0 \times 10^{-4} \times 0.2\% \ (2.0 \times 10^{-3}) = 8.0 \times 10^{-7}$ per year.

Burnaby Terminal:

- Two-tank shared containment area (Tank 96 and Tank 98):
  - $4.0 \times 10^{-4} \times 12.4\% \ (1.2 \times 10^{-1}) = 4.8 \times 10^{-5}$ per year.

- Three-tank shared containment area (Tank 74, Tank 76, and Tank 78):
  - $4.0 \times 10^{-4} \times 3.8\%$ (3.8×10^{-2}) = 1.5×10^{-5} per year (three-tank failure).
  - $4.0 \times 10^{-4} \times 6.3\%$ (6.3×10^{-2}) = 2.5×10^{-5} per year (two-tank failure).

Trans Mountain believes that this analysis reinforces the assertion that the probability of simultaneous multiple-tank failures within shared secondary containment areas is extremely low (near zero) and provides an indication as to why none of the codes and standards that set out requirements (statutory for Trans Mountain or otherwise) for shared secondary containment contemplate simultaneous multiple-tank failures.

Trans Mountain concluded the response to NEB IR No. 4.26 (Filing ID A4K4W3) by stating that, given the use of the design earthquake probability, the inherent conservatism in codified design, the selection of utilization probabilities for somewhat less than maximum oil levels, and the conservative distribution of oil between tanks (in the three-tank case), Trans Mountain is also of the view that the analysis provided is conservative. It is likely that a more sophisticated analysis would yield probabilities even lower than those calculated, perhaps as much as one order of magnitude lower. A more sophisticated analysis might attempt to establish the lower probabilities of failure associated with various oil levels combined with the probabilities of the oil being at those levels. However, Trans Mountain believes that a more sophisticated analysis of this kind would require complex numerical and statistical modelling and would be difficult and costly to undertake. Given that the basic and conservative analysis provided establishes extremely low probabilities, a more sophisticated analysis, expected to yield even lower probabilities, would not provide value commensurate with the effort. Trans Mountain is not aware of any other geotechnical-related events that could occur at Burnaby Terminal and cause a simultaneous multiple-tank failure. The tanks and secondary containment berms will be founded on sandstone bedrock. The terrace back-walls will be stabilized and reinforced with shot-crete and the tanks will be far enough apart, in observance of the required $(D_1+D_2)/4$ minimum spacing, that, in the extremely unlikely event of a localized failure within a terrace wall, only one tank would potentially be at risk of impact. The failure probabilities associated with non-seismic multiple-tank failure event scenarios, if such scenarios exist, would likely also be reduced by the tank utilization considerations discussed above.

City of Burnaby IR No. 1.08.13m (Filing ID A3Y2E6) asked if modelling had been performed to determine the extent of a potential spill in the event of multiple-tank and secondary containment failures. Trans Mountain responded that it has not undertaken modelling of the scenario(s) suggested. Trans Mountain does not consider the simultaneous failure of multiple tanks, secondary containment areas, and the tertiary containment area to be a credible scenario resulting in the release of oil outside of the Burnaby Terminal site. Similarly to the tanks, Trans Mountain intends to design the secondary containment areas to withstand the seismic event described in Volume 4A, Section 2.9.3 of the Facilities Application (Filing ID A3S0Y8) when filled to their design capacities. Similarly to the tanks, the new secondary containment berms will be founded on sandstone bedrock or other suitably strong material. Furthermore, the type of failure of the berms in an earthquake larger than the design seismic event, even with full static fluid pressure, is considered to be horizontal and vertical deformation leading to some reduction of freeboard, rather than complete collapse.

24.13 Boil-Over

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, includes the following:

- Tank Fire Boilover (page 59) states, "*As many gallons of water are potentially present within storage tanks the size currently present in the TMTF and proposed by the TMEP, a mass and sudden increase in the volume of the tank content occurs*."

- Tank Fire Boilover (page 59) states, "*As many gallons of water are potentially present within storage tanks the size currently present in the TMTF and proposed by the TMEP, a mass and sudden increase in the volume of the tank content occurs. The steam rapidly expanding in the bottom portion of the tank, will suddenly force the heated crude oil contents above out the top of the tank, discharging heated and molten crude oil over the area 10 times the tanks diameter.*"

The Opinion on Potential Off-Site Risks of the Proposed Expansion of Burnaby Tank Farm report, prepared by Dr. Ivan Vince, includes the following:

- 3.2.2 (page 4) states, "*The risk assessment by Doug McCutcheon and Associates contains several shortcomings and errors, of which the most important is the gross underestimate of the risk of boil-over.*"

- 3.2.6 (page 5) states, "*For the Burnaby tank farm, in my opinion, the risk is dominated by tank boil-over, since this scenario has by far the most severe and most extensive potential consequences and, though relatively infrequent, is wholly credible (has a far from negligible likelihood of realisation).*"

- 3.3.3 (page 7) states, "*A number of prevention and mitigation measures have been tried, with varying results but to date always short of full success. In particular, it has not been feasible to ensure the removal of water from crude oil tanks*."

- 3.3.11 (page 7) states, "*A 2011 presentation in Sweden13 included statistics on various types of fire, according to which the predicted frequency of full-surface fire - the usual precursor of boil-over - had risen from 3.0×10^{-5} (3 in 100,000) per tank per year in 1997 to 4.21×10^{-5} (4.21 in 100,000) in 2011*."

- 3.3.12 (page 7) states, "*A review of incidents world wide by the Swedish National Testing and Research Institute supports the LASTFIRE finding that full surface fires are likely to escalate: of 22 full surface fires (out of a total of 104 fires recorded), 16 went on to produce boil-over.*"

- 4.3 (page 8) states, "*The risk assessment carried out on behalf of the applicant contains several serious deficiencies, the most important of which is that it fails to give due regard to the CWCS of tank boil-over and incorrectly states that the worst case is a pool fire*."

Trans Mountain does not agree with the various Intervenor statements above. Trans Mountain is of the view that the City of Burnaby and their consultant, Dr. Ivan Vince, have attempted to overstate the risk of boil-over at Burnaby Terminal. All of the proposed new storage tanks will have numerous features, combined with anticipated high utilization to support Westridge Marine Terminal operations, which will minimize the potential for water to accumulate in the tanks. All of

the tanks will have automated fire detection and suppression systems to prevent and/or extinguish full-surface fires. As such, Trans Mountain believes that a boil-over event is hypothetical and not a credible scenario for Burnaby Terminal. In addition, boil-over can only occur after a lengthy burn period of many hours, allowing emergency management measures in the case of a tank fire, including evacuations, if appropriate, to be highly effective in reducing consequences to the public. Discussion on boil-over is included in the following responses to various IRs.

City of Burnaby IR No. 2.038a (Filing ID A4H8A1) asked if the Burnaby Terminal had the ability to remove water from incoming crude oil to ensure water content within the storage tanks does not support a boil-over event. Trans Mountain responded that there is no system which will provide the ability to remove water from the crude oil receipt streams at the point where the pipelines enter Burnaby Terminal. However, all of the proposed new storage tanks will have water-draw piping, which may be used to remove water if it is deemed necessary as part of the tank water management program. In addition, the proposed new storage tanks will have fixed roofs, which will provide an added barrier (to the floating roof and seals) to prevent rain-water from getting inside the tank. Trans Mountain believes, however, that active water management for the new tanks (using the water-draw piping) will not be necessary, given the tank bottom design and the anticipated high utilization of the tanks to support Westridge Marine Terminal operations. Each of the new tanks will have a cone shaped bottom, sloped down toward a centre sump, where the tank inlet / outlet line(s) will terminate. If a small amount of water settles out of the oil, during the relatively brief periods when the tank is inactive, it will be flushed out during the next delivery, preventing accumulation. Active water management is more typically necessary for open top tanks with “cone-up” bottoms, which may allow water to accumulate around the inside perimeter, particularly if they are in long-term storage service and idle for weeks or months. Also refer to response to City of Burnaby IR No. 2.038e (Filing ID A4H8A1).

NEB IR No. 6.23 (Filing ID A4R6I4) asked why Trans Mountain did not consider boil-over as the CWCS in the risk assessments. The full text of that response follows, presented in multiple paragraphs. In the response, Reference iv) is the report entitled Opinion on Potential Off-Site Risks of the Proposed Expansion of Burnaby Tank Farm, prepared by Dr. Ivan Vince.

Trans Mountain has the following comments on the evidence presented by the City of Burnaby in Reference iv), which also generally apply to the evidence in Reference v).

In Reference iv), the source for the probability of 3×10^{-7} per year as the threshold for determining if an event is credible is identified as the “UK Health and Safety Executive (HSE) Evidence at the Public Inquiry re Oval Cricket Ground, Lambeth, London” (London Borough of Lambeth 2008). The probability seems to coincide with the HSE’s Land Use Planning Methodology which defines risk contours around hazardous installations, specifically an Inner Zone with a level of risk of a “dangerous dose” of 1×10^{-5} per year, a Middle Zone with a level of risk of 1×10^{-6} per year, and an Outer Zone with a level of risk of 3×10^{-7} per year (UK Health and Safety Executive, Year Unknown; UK Health and Safety Executive 2011). However, the HSE’s Land Use Planning Methodology does not provide the rationale for the selection of these probabilities.

Reference iv) suggests that the “in practice” test for the use of 3×10^{-7} per year as the threshold for determining if an event is credible is also the HSE’s Evidence at the Public Inquiry. Trans Mountain has not yet been able to obtain a transcript of the Lambeth Cricket Ground Public Inquiry. However, although not specifically referring to the probability of 3×10^{-7} per year, a

series of excerpts from the Lambeth Planning Report on the Kennington Oval Cricket Ground provide insight into the controversy over the applicability of HSE's planning methodology.

> "10. The HSE considers that a catastrophic failure of the gasholder, resulting in 50% release of maximum potential capacity combined with instant ignition could create a massive fireball and that this incident is both foreseeable and credible."

> "12. The applicant commissioned Hyder BT&P to conduct its own assessment of the risks involved. Based on a review of past incidents at gasholders and a technical evaluation of the likelihood of a particular event to occur and of the effects of any particular event, Hyder BT&P concludes that the combination of worst case scenarios to produce a massive fireball are so unlikely as to be not a sufficient reason as to warrant withholding planning permission."

> "13. Lambeth Council commissioned its own consultant, Renaissance Risk, to review Hyder BT&P's work. This concludes that the report is 'substantially accurate and truthful'."

> "14. Although it is not usual practice to do so the HSE has commented on Hyder BT&P's report. These comments cover a number of points, but in particular the HSE notes that Hyder BT&P has not included any quantified support for its claim that the Council should consider a major fire as an 'incredible [i.e. too implausible to be credible] event'."

> "15. Hyder BT&P has responded to the HSE comments noting that it stated a fireball was incredible rather than a major fire. A major fire would produce a smaller range of consultation distances. Hyder BT&P accepts that quantified support for its view that a fireball is incredible has not been given, although detailed qualitative reasons with some quantification have been given."

> "19. The London Development Agency commissioned a review of the HSE policy. A key finding of this review was that the HSE does not take the specific details of sites into account and the contours produced can, at best, be regarded as indicative of risk levels produced by the worst possible event, not the worst credible event. The study notes that there has never been a recorded major incident involving gasholders in London, even during the blitz."

> "22. Having reviewed all the information and having regard to the LDA's report, the approach taken by the Council is sound. Specifically in relation to London Plan policy regard has been had to the HSE's advice. The likelihood of a combination of events occurring that would give rise to the type of catastrophic event that has led to the HSE's advice is so unlikely that they can be ruled out and thus refusal of planning permission is not justified…."

> "43. The HSE has advised against granting planning permission because of the risk posed by the adjacent Kennington Gasholders. However, independent advice questions the level of risk and on this basis a recommendation of refusal is not warranted."

While the HSE may apply the threshold probability of 3×10^{-7} per year to determine the credibility of an event, at least in the case identified in Reference iv), the record suggests that

others in the risk assessment profession and in other branches of UK government do not necessarily agree with the HSE.

In Reference iv), the source for a full-surface fire probability of 4.21×10^{-5} per year and a boil-over probability of 1.0, given a full-surface fire, is identified as the 2011 Resource Protection International presentation of LASTFIRE data. While the LASTFIRE data presumably indicates an increase in the frequency of full-surface fires, it shows a corresponding decrease in the frequency of rim seal fires. The presentation provides no evidence to corroborate the frequencies and, in fact, the data table shows "Note [1]" for the current boil-over frequency without identifying what Note [1] is. The study does not identify the types of tanks (*i.e.*, external floating roof, internal floating roof, etc.), the types of products (*i.e.*, crude oil, refined products, etc.), the water management practices that were employed, the nature of the fire incidents (*i.e.*, tank failure, ignition source, etc.), the fire prevention, detection, and suppression systems that were installed or employed, if any, nor does it provide an explanation for the reported increase in full-surface fires.

In Reference iv), the source for corroboration of the LASTFIRE frequency range for boil-over event of 0.5 (as adjusted by Dr. Vince) to 1.0, assuming an unextinguished, sustained full-surface fire, is identified as the Review of Tank Fire Incidents 1951-2003 (Lonnermark). Trans Mountain could only find 14 boil-over incidents among the fire incidents listed, rather than the 16 suggested in Reference iv). Of these 14 boil-over incidents, one occurred in the 1960s, four occurred in the 1970s, seven occurred in the 1980s and one occurred in the 1990s and one in the 2000s. In the last 14 years of the review period there were only two boil-over incidents world-wide, highlighting their extreme rarity. For these boil-over incidents, there is also very limited information on the types of tanks (*i.e.*, external floating roof, internal floating roof, etc.), the types of products (*i.e.*, crude oil, refined products, etc.), the water management practices employed, the nature of the fire incidents (*i.e.*, tank failure, ignition source, etc.), the fire prevention, detection, and suppression systems that were installed or employed if any.

The 2011 Resource Protection International presentation of LASTFIRE data goes on to identify fixed roofs, fire detection, and foam as risk reduction measures. For Sumas Terminal and Burnaby Terminal, Trans Mountain has identified fixed roofs above internal floating roofs as elements of the proposed tank designs. For all terminals, Trans Mountain has identified robust tank fire prevention, detection, and suppression systems, including fixed automated rim seal and full-surface foam-based fire suppression systems. In the response to NEB IR No. 3.093b (Filing ID A4H1V2), Trans Mountain summarizes all of the fire prevention, detection, suppression, and mitigation measures.

Trans Mountain provided the following information in the response to City of Burnaby IR No. 2.038a (Filing ID A4H8A1). All of the proposed new storage tanks will have water-draw piping, which may be used to remove water if it is deemed necessary as part of the tank water management program. In addition, the proposed new storage tanks will have fixed roofs, which will provide an added barrier (to the floating roof and seals) to prevent rain-water from getting inside the tank. Trans Mountain believes, however, that active water management for the new tanks (using the water-draw piping) will not be necessary, given the tank bottom design and the anticipated high utilization of the tanks to support Westridge Marine Terminal operations. Each of the new tanks will have a cone shaped bottom, sloped down toward a centre sump, where the tank inlet / outlet line(s) will terminate. If a small amount of water settles out of the oil, during the relatively brief periods when the tank is inactive, it will be flushed out during the next delivery, preventing accumulation.

In the response to NEB IR No. 4.32a (Filing ID A4K4W3), Trans Mountain describes how it is too simplistic to calculate aggregate incident probabilities at a terminal by considering all the tanks simultaneously. Given the geographical expanse of the terminals, an individual member of the public is only exposed to the consequences of events originating at some tanks, not all tanks, specifically the tanks closest to them. As such, the simplistic approach taken for Burnaby Terminal in Reference iv), multiplying the calculated boil-over probability by 26, based on all 26 tanks at the terminal, is inappropriately conservative for risk assessment purposes. The same principle is applicable to Edmonton Terminal and Sumas Terminal.

In Trans Mountain's view, Reference iv) fails to present persuasive evidence that the probabilities of boil-over events for the tanks proposed for the Edmonton, Sumas, and Burnaby terminals correlate to the boil-over event frequencies postulated. Trans Mountain has not completed detailed risk assessment work to be able to determine quantitatively the reduction in theoretical boil-over probability for the specific tanks, given all of the incident frequency reduction measures proposed, assuming such quantitative risk assessment work is practically feasible. However, in Trans Mountain's opinion, for all of the reasons provided, the probabilities of unextinguished full-surface fires resulting in boil-over events, specific to the proposed tanks, will be much less than the frequencies suggested in Reference iv).

A semi-quantitative approach can be used to approximate the probability of the exposure of an individual to a boil-over event for a single tank in Burnaby (the specific location of interest in Reference iv)). The starting point is an initial frequency range of 3×10^{-5} per year to 4.2×10^{-5} per year as taken from Reference iv). Trans Mountain is of the view that a factor of 0.1 can be applied, given that the design, construction, inspection, and maintenance measures that Trans Mountain will employ, as well as the location (*i.e.*, infrequent lightning), will reduce the probability of a full-surface fire as compared with storage tanks in service world-wide. Trans Mountain is also of the view that an additional factor of 0.1 can be applied, given that the inclusion of full-surface fire suppression systems will reduce the probability of an unextinguished, sustained full-surface fire. The result is a range of 3×10^{-7} per year to 4.2×10^{-7} per year for the probability of a full-surface fire with the potential for boil-over. Trans Mountain believes that the boil-over frequency of 0.5 (as adjusted by Dr. Vince), assuming an unextinguished, sustained full-surface fire, is conservative for the Burnaby tanks, given the proposed fixed roof design, which will prevent water ingress, the tank bottom design, which will concentrate any water brought in with the crude oil streams to the area near the tank line, and the anticipated frequency of tank use, which will prevent water accumulation. Using this value, however, the resulting boil-over probability range can be calculated as 1.5×10^{-7} per year to 2.1×10^{-7} per year. For a given individual in the vicinity of Burnaby Terminal, the final probability range will vary, depending on the number of tanks that have a boil-over radius that extends to their specific location. However, even assuming the 10 times diameter radius of effect, which is hypothetical at best, it is unlikely that the number will be more than 10 tanks and for most individuals it will be fewer. Assuming exposure to 10 tanks, the probability range will be 1.5×10^{-6} per year to 2.1×10^{-6} per year. While these probabilities are somewhat higher than 3×10^{-7} per year, they remain extremely low and, as discussed previously, 3×10^{-7} per year is by no means universally accepted as an appropriate credibility threshold.

With respect to boil-over consequences, of the 14 boil-over incidents identified in Review of Tank Fire Incidents 1951-2003 (Lonnermark), only one, the 1982 Tacoa, Venezuela incident, appears to have resulted in public fatalities. A lengthy account in Industrial Fire World http://www.fireworld.com/Archives/tabid/93/articleType/ArticleView/articleId/86994/Inferno-at-

Tacoa.aspx, describes the incident in great detail (Industrial Fire World, Year Unknown). The article states: “On December 19, 1982, a large crowd of power plant workers and local residents in Tacoa, Venezuela, gathered to watch a burning crude oil storage tank. Nearly eight hours had passed since the tank first caught fire.” The account of the incident identifies two factors that prevent danger to the public from tank boil-over events, however extremely unlikely these events may be. The first is emergency management, including consideration of evacuation, which was not employed in any way in the Tacoa incident, but which likely would have prevented any fatalities if effectively employed. The second is that boil-over events take significant time to occur from the start of a fire, in the case of Tacoa, almost eight hours. This significant reaction time allows emergency management to organize, plan, and execute the appropriate response. Trans Mountain has acknowledged that emergency response planning should consider a boil-over event; however, that does not imply that a boil-over event should be evaluated as the CWCS from a quantitative risk assessment land-use planning perspective.

Trans Mountain notes that the significant time required for a boil-over event to develop has the effect of reducing the probability of exposure to a boil-over event for an individual in the vicinity of one of the terminals. The debate over the Lambeth Cricket Ground involved a hypothetical, but very rapidly developing gas-fed fireball from which there was likely to be no escape. In contrast, there is a very high probability that in the case of an unextinguished, full-surface tank fire, an individual in the vicinity of one of the terminals, with the assistance of emergency responders, will have more than adequate time to be able to recognize the potential danger of a tank full-surface fire and to evacuate the danger zone.

In conclusion, the extremely low probabilities of boil-over events (based on the extremely low probabilities of tanks fires, and given the prevention, detection, suppression, and other mitigation measures) combined with the mitigated consequences (given the time to boil-over and effective emergency planning) is the reason that Trans Mountain did not consider boil-over scenarios to be the CWCS’s for the terminal risk assessments.

SFU IR No. 2.3.13.1 (Filing ID A4H9C9) asked about the circumstances where Trans Mountain would be unable to prevent a boil-over event from occurring. Trans Mountain responded that the reference to boil-over risk in Volume 7 of the Application (Filing ID A3S4V5), quoted in the Preamble, is in the context of hazard identification, prior to control measures being applied. Technically, the circumstances which may result in a boil-over are a large amount of water inside a tank combined with a fire in the tank which burns for a sufficient length of time to heat the water to its boiling point. However, numerous control measures, the primary ones which are discussed below, will be included in the design of the proposed new storage tanks at Burnaby Terminal. As such, Trans Mountain believes that a boil-over event is hypothetical and not a credible risk. All of the proposed new storage tanks at Burnaby Terminal will have water-draw piping, which may be used to remove water if it is deemed necessary as part of the tank water management program. However, the need for active water management (using the water-draw piping) will be diminished for the following reasons:

- All of the tanks will have fixed roofs, which will provide an added barrier (to the floating roof and seals) to prevent rain-water from getting inside the tank.
- All of the tanks will have cone shaped bottoms, sloped down toward a centre sump, where the tank inlet / outlet line(s) will terminate. The tanks will also be highly utilized to support Westridge Marine Terminal operations. If a small amount of water settles out of the oil,

during the relatively brief period when the tank is inactive, it will be flushed out during the next delivery, preventing further accumulation.

Trans Mountain will employ a number of other prevention, detection, and mitigation control measures to reduce the risk of fires at Burnaby Terminal and their potential impacts. Trans Mountain has outlined many of these measures in the response to NEB IR No. 3.093b (Filing ID A4H1V2). Trans Mountain has also identified that fixed, automated, full-surface fire protection, which was not included in the Facilities Application, has been added to the proposed suite of fire-protection measures for the new tanks at Burnaby Terminal, to further enhance the overall robustness of the design.

SFU IR No. 2.3.13.2 (Filing ID A4H9C9) asked about the impacts from a boil-over tank fire to SFU, and to SFU access (*i.e*., Gaglardi Drive and Burnaby Mountain Parkway). Trans Mountain responded that it anticipates that in the hypothetical case of a tank fire boil-over, SFU will not be impacted due to the distance between the proposed new storage tanks at Burnaby Terminal and SFU. Trans Mountain anticipates that in the hypothetical case of a tank fire boil-over, depending on which tank is considered, it is possible that access to Gaglardi Drive or Burnaby Mountain Parkway could be temporarily impacted. However, a tank fire boil-over is expected to take a significant amount of time to develop, which should provide ample time for the Burnaby Terminal ERP measures to be implemented. Emergency response procedures in such a case may include temporary closure of Gaglardi Drive and / or Burnaby Mountain Parkway. Also refer to responses to SFU IR No. 2.3.13.1 and SFU IR No. 2.4.08.2 (Filing ID A4H9C9).

SFU IR No. 2.4.08.2 (Filing ID A4H9C9) asked what areas will be at risk during a tank fire boil-over scenario. Trans Mountain responded that the areas that are within 10 tank diameters of the proposed new storage tanks at Burnaby Terminal are the forested areas to the west, north, and east of the terminal and northern parts of the residential communities to the south of the terminal. The level of risk from a hypothetical tank fire boil-over is not defined solely by proximity and must take into account the likelihood of occurrence, considering the prevention, detection, and mitigation measures, as well as the reduction in potential consequences, considering the time available to enact emergency response.

SFU IR No. 2.4.03.2 (Filing ID A4H9C9) asked under what emergency circumstances continued operation of facility functions would not be allowed. Trans Mountain responded that during any emergency situation, including the hypothetical case of a tank boil-over, the safety of response personnel and the public would be the number one priority. Any incident would be assessed by response and incident command personnel to determine the safe limits of approach and the zones to be established to restrict access. In keeping with this approach, any facility function that required personnel to access isolation zones would be discontinued. If any other pipeline or facility operation were to be deemed potentially unsafe due to the emergency situation, it would also be discontinued. Isolation and / or removal of oil from piping or tanks might also be considered by emergency response personnel.

24.14 Radiant Heat Knock-On Effect and Fire Extension

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, includes the following:

- Conclusions (page 7) states, "*The TMEP presents a significantly larger fire control risk within the TMTF. The identified increase in events with potential to escalate and extend to adjacent*

storage tank exposures due to insufficient fire-fighting deployment positions increases the likelihood of a multiple tank fire (including the potential of having to allow one or several storage tanks to burnout over 2-4 days), toxic smoke plume discharge (including long term chemical exposure to adjacent communities), and heat discharge to areas outside the facility (including high probability of fire extension to the forest areas of the Burnaby Mountain Conservation Area."

- Application Positions (page 34) states, "*The primary concerns created by the TMEP related to deployment positions are:*
  - *Insufficient deployment positions to cool adjacent tanks to prevent event heat exposures from escalating into fire extension."*
- Distance to Fenceline (page 40) states, "*The TMEP creates emergency control scenarios risking the residential areas in proximity, Simon Fraser University, UniverCity village and the Burnaby Mountain Conservation Area, related to:*
  - *Fenceline exposure to heat, including subsequent fire extension to the proximity treeline and high potential for treetop driven wildfire.*"
- Heat Discharge Against the Fenceline (page 75) states, "*The TMEP increases the potential of exterior fenceline heat impact scenarios by a magnitude of 7.5 times*."
- Hazard Events (page 82) states "*TMEP degrades the original fire protection premise of the facility and increases the likelihood of spill or fire extension* …"

Trans Mountain does not agree with the various City of Burnaby Fire Department statements above. Trans Mountain anticipates that in the highly unlikely event of a storage tank or secondary containment fire scenario, the risk of radiant heat knock-on effects and fire extension at Burnaby Terminal is limited, for the reasons discussed in the following responses to various IRs.

NDP IR No. 2.2.1f (Filing ID A4H8V7) mentioned that the nearest residential properties are an estimated 20 m away, and asked what is the risk that a fire at the tank facility could escalate to the point that it cannot be contained by onsite fire suppression resources. Trans Mountain responded that it would like to correct the misconception of proximity stated in the IR. While the nearest residences in the closest townhouse complex in Forest Grove are approximately 25 m (80 ft.) from the terminal property, the closet secondary containment area is approximately 145 m (475 ft.) from these residences and the closest tank is approximately 170 m (560 ft.) from the these residences. The closest tank was constructed in 1953, before the construction of the townhouse complex. The comparative distances for the closest proposed new secondary containment area and tank are approximately 185 m (605 ft.) and 215 m (705 ft.), respectively. The next closest residences in Forest Grove will be approximately 275 m (900 ft.) and 305 m (1,000 ft.), respectively, from the closest proposed new secondary containment area and tank. All of the property line setbacks will meet or exceed the requirements of NFPA 30 and City of Burnaby bylaws. Trans Mountain anticipates that in the highly unlikely event of a storage tank or secondary containment fire scenario, the risk of fire extension at Burnaby Terminal is very limited, for the reasons indicated below.

- Trans Mountain considers that a radiant heat level of 25.0 kW/m^2 could create risk of fire extension to forested areas. Based on risk assessment calculations, this radiant heat level may theoretically extend approximately 40 m (130 ft.) from the edges of the secondary containment areas. In the proposed Burnaby Terminal layout, the distances to the current edges of the forested areas from the edges of the secondary containment areas are much greater than 40 m, except for very short sections at the closest approaches, which are just less than 40 m:
    - northwest of proposed Tank 74;
    - northeast of proposed Tank 78;
    - northwest of proposed Tank 91;
    - northeast of proposed Tank 98; and,
    - northeast of the proposed partial remote impoundment.

None of these approaches border Forest Grove or any other residential area.

In all of these locations, the forested areas extend somewhat within the property lines. In the first three of these locations, the distances to the property lines from the proposed edges of the secondary containment areas, at the closest approaches, are approximately 50 m (160 ft.). Trans Mountain will consider removing small areas of trees inside the property lines to fully utilize the available separation distances. For the last two locations, there is also an opportunity to remove small areas of trees from the road allowance outside and adjacent to the property line.

Trans Mountain notes that the radiant heat distances are conservative as they assume flat terrain and no shielding from the tanks. In reality, the closest approaches to the forested areas are sheltered by the large terrace cuts in the northeast and northwest sectors of the secondary containment areas and there would be very little pool surface areas adjacent to the tanks in those sectors to generate high levels of radiant heat. This may factor into considerations to remove trees.

- Emergency responders will have rapid access to high-capacity water and foam supplies and water and foam monitors / cannons to allow them to implement and sustain fire suppression and guard against fire extension. Trans Mountain notes that the fire protection systems that will be installed on or nearby the proposed new tanks at Burnaby Terminal will be designed to address the following fire or fire-related scenarios:
    - tank floating roof rim seal fire (fixed to tank, automated foam application);
    - tank full-surface fire (fixed to tank, automated foam application);
    - tank full-surface fire (application by portable foam monitor);
    - adjacent tank cooling (application by portable water / foam monitors); and,
    - release to secondary containment (application by portable foam monitors to suppress combustible vapours and odours).

NEB IR No. 4.29a (Filing ID A4K4W3) asked whether the radiant heat levels caused by a major dike fire, including at levels less than 37.5 kW/m^2, could affect the surrounding tanks in a way that these tanks could fail and contribute to fire propagation. Trans Mountain responded that radiant heat intensity levels approaching 37.5 kW/m^2 could have an impact on the steel shells of adjacent tanks, assuming cooling streams from portable water / foam monitors are not applied. The effect would be an increase in the steel temperature and weakening of the steel, eventually resulting in bending or buckling and the potential loss of oil. The effect on the tank shell above the oil level in the tank is likely to be different than the effect on the tank shell below the oil level. Below the oil level, the tank shell will heat much more slowly as the heat energy is transferred to the oil. This is important given that the load on the shell is proportionate to the oil level and only the shell below the oil level is under load. The mitigating effect of the slower tank shell heating will provide additional time for emergency response personnel to attempt to address the fire and to apply tank cooling by portable water / foam monitors.

NEB IR No. 4.29b (Filing ID A4K4W3) asked why Trans Mountain considers the probability of the “knock- on” effect to be very low. Trans Mountain responded that the risk assessments consider cases where the spills are large enough to create pools covering the entire surface areas of the shared secondary containments. In these cases, there is a higher probability of the “knock-on” effect, should a fire occur that cannot be controlled. Due to the unlikeliness of these cases, the probability of the types of spill / fire events significant enough to cause the possibility of the “knock-on” effect is very low. There are very few recorded incidents where the “knock-on” effect has materialized. With respect to Sumas Terminal and Burnaby Terminal, Trans Mountain anticipates that should spills occur, they will, in most cases, be small enough to be contained within the intermediate berms. Tank level creep alarms and hydrocarbon detection will ensure that a spill will be detected quickly and an emergency response will be initiated to control the spill, apply foam to the spill pool surface (to significantly reduce the risk of fire), and / or drain the spilled oil to another location, away from adjacent tanks (such as the intermediate retention area at Burnaby Terminal), if deemed appropriate. As an additional precautionary measure, the oil volume in adjacent tanks could be reduced by pumping the contents to other tanks, away from the risk area, in order to reduce the volume of oil that could be spilled in a “knock-on” incident. The benefit of this action would have to be weighed against the loss of the protective effect of the oil within the tank. In cases where there is a fire, the probability of the “knock-on” effect may be inherently reduced by the configuration of the shared secondary containment area (*i.e.*, the tendency for oil to pool unevenly due to the grading for drainage), the surface area of adjacent tank(s) exposed to the radiant heat, and the protective benefit of the oil in the tank(s). Trans Mountain also intends to install fire protection systems on or nearby the proposed new tanks, designed to address adjacent tank cooling by portable water / foam monitors.

Trans Mountain continued the response to NEB IR No. 4.29b (Filing ID A4K4W3) by stating that, with respect to the consequences of the “knock-on” effect, for the reasons identified in the response to NEB IR No. 4.29a, there is a greater risk of the failure of an adjacent tank the lower the oil level is, but the size of the potential additional spill is lower. In addition, the tank utilization histograms, provided in the attachments to the responses to NEB IR No. 4.24a and NEB IR No. 4.24b (Filing ID A4K4W3), provide evidence that the total volumes within tanks in shared secondary containment areas are rarely greater than the containment capacities available. For example, the total volume in Tanks 74, 76, and 78 is not expected to exceed 95,390 m^3 (600,000 bbl) more than 6.3% of the time. In the response to NEB IR No. 3.069a (Filing ID A4H1V2), Trans Mountain identified that, in the case of a multiple-tank failure, the effective

volume of the shared secondary containment area will be approximately 96,000 m^3 (604,000 bbl).

Trans Mountain concluded the response to NEB IR No. 4.29b (Filing ID A4K4W3) by stating that the risk assessments were intended to identify the potential for incidents that could occur with little warning and potentially impact the public. "Knock-on" incidents that result from the radiant heat impact to adjacent tanks are very unlikely to develop quickly and, given that they can only arise from an initial significant incident, emergency response measures such as fire-fighting, evacuation, sheltering in place, etc. should be well engaged by the time a "knock-on" incident occurs.

Trans Mountain also notes that the City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report Appendix D (page 31) states "Generally tank fire escalation is unlikely if tank spacing >0.5 diameter." As discussed in Section 24.5, Burnaby Terminal Storage Tank Spacing, Trans Mountain notes that the topography of the Burnaby Terminal will make the minimum spacing of 0.5 diameter, or $(D_1 + D_2)/4$, relevant only for adjacent tanks within each terrace and within the two-tank or three-tank groupings proposed. The spacing between tanks on different terraces and in different groupings will be not less than one diameter and in most cases substantially greater.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Heat Discharge against the Fenceline (page 75) states "The TMEP increases the potential of exterior fenceline heat impact scenarios by a magnitude of 7.5 times." Trans Mountain notes that Diagram 9 on page 77 of the report appears to depict the extent of the 4.0 kW/m^2 heat intensity level, which will not create any risk of fire extension.

24.15 Lightning

The intervenor evidence submitted by Dorothy Doherty, Section 4, Public safety (page 7) states, "Lightning is the suspected cause of a tank farm fire in Leavenworth, Kansas. This is significant because of the large number of electrical storms on Burnaby Mountain" (Filing ID A4L8U3).

Trans Mountain does not agree with the intervenor statement above. Thousands of API 650 storage tanks are used safely all over North America in areas with lightning intensity orders of magnitude greater than at Burnaby Terminal. In addition, Trans Mountain will implement measures included in API Recommended Practice 545, Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids, in the design and construction of all new storage tanks. Discussion on lightning protection is included in the following responses to various IRs.

Taylor IR No. 1.05a (Filing ID A3Y3T2) asked about the potential for an explosion from a lighting strike and the impact on adjacent storage tanks. Trans Mountain responded, in part, that the proposed storage tanks will be designed in accordance with API 650, as per the legislative requirements. The floating roofs, seals, and venting provisions (for tanks with fixed roofs), prescribed by API 650, prevent the development of conditions that could lead to a build-up of explosive gases. The nature of storage tanks (steel construction), and the grounding that is used, make them particularly resistant to the effects of lightning. Thousands of API 650 storage tanks are used safely all over North America in areas with lightning intensity orders of magnitude greater than at Burnaby Terminal. In addition, as described in Volume 4A, Section 3.4.3.8.2, of the Facilities Application (Filing ID A3S0Y8), Trans Mountain is proposing

to include substantial fire protection at Burnaby Terminal, which will exceed the statutory requirements and the requirements of the BCFC. Security measures are described in Volume 4C, Section 11.0 (Filing ID A3S1L1). Operations, maintenance, and control procedures and practices intended to prevent human error are described in Volume 4C, Section 4.0 through Section 7.0 (Filing ID A3S1L1).

NDP IR No. 2.2.1e (Filing ID A4H8V7) asked if any of the current oil tank storage facilities been struck by lightning. Trans Mountain responded that it is of the opinion that one tank at Edson Pump Station, in Alberta, was hit by lightning in the mid-1970s. The only evidence to suggest a lightning strike was damage to the grounding conductors connecting the tank to the ground grid surrounding the tank. No damage, other than to the tank grounding conductors, was sustained to the tank or to the tank contents. Trans Mountain acknowledges that other companies have reported lightning strikes to storage tanks. Trans Mountain will implement measures included in API Recommended Practice 545, Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids, in the design and construction of all new storage tanks proposed as part of the Project.

24.16 Flash Fire or Vapour Cloud Explosion

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Consequences (page 5) includes the statement, “Flammable Gas Outfall against the Fenceline. The potential for flammable gas ignition outside the fenceline is based upon the use of the land areas in proximity to the fenceline. The highly populated areas around the TMEP present a high likelihood of ignition by the natural community activities.”

The intervenor evidence submitted by Dorothy Doherty, Section 2, Fire hazards and other emergencies (page 5) states, “Released vapours may form flammable / explosive mixtures. Vapours may travel considerable distances to ignition sources and cause a flash fire” (Filing ID A4L8U3).

Trans Mountain does not agree with the intervenor statements above. If a spill were to occur, foam can be applied to the spill to protect personnel from the potential ignition of flammable vapours when vapour emissions present a potential hazard. If a flash fire were to occur, it is expected to be localized and not extend outside the terminal. Information regarding flash fires and vapour cloud explosions is included in the following responses to various IRs.

NEB IR No. 3.085 (Filing ID A4H1V2) asked about the potential for a flash fire or vapour cloud explosion in the case of a spill. Trans Mountain responded that crude oil is classified as a flammable liquid, with a NFPA rating of 3, flashpoint of -7^{o}C to +32^{o}C and boiling point over +37.8^{o}C. A flammable vapour (*i.e.*, gas) at atmospheric pressure is classified as a flammable gas with a NFPA rating of 4, flashpoint below +22.8^{o}C and boiling point below +37.8^{o}C. Crude oil is made up of several components, usually starting with butane. However, some crude oil products may also contain methane, ethane, and propane. Methane to pentane are considered flammable gases, while hexane to decane are considered flammable liquids. The definition of a flash fire from the Center for Chemical Process Safety (CCPS), Guidelines for Chemical Process Quantitative Risk Analysis (Second Edition), page 730, is: “The combustion of a flammable vapour and air mixture in which flame passes through that mixture at less than sonic velocity, such that negligible damaging overpressure is generated.” The definition of a vapour cloud explosion from the Guidelines for Chemical Process Quantitative Risk Analysis (Second Edition), page 736, is: “When a flammable vapour is released, its mixture with air will form a

flammable vapour cloud. If ignited, the flame speed may accelerate to high velocities and produce a significant blast overpressure." A quote from Guidelines for Chemical Process Quantitative Risk Analysis (Second Edition), page 180, states:

> *"A flash fire is a non-explosive combustion of a vapour cloud resulting from the release of flammable material into open air. Experiments have shown (AIChE, 1994) that vapour clouds only explode in areas where intensely turbulent combustion develops and only if certain conditions are met. Major hazards from flash fires are from thermal radiation and direct flame contact. The literature provides little information on the effect of thermal radiation from flash fires, probably because thermal radiation hazards burning vapour clouds are considered less significant than possible blast effects. Furthermore, flash combustion of a vapour cloud normally lasts no more than tenths of a second. Therefore the total intercepted radiation by an object near a flash fire is substantially less than in the case of a pool fire."*

A quote from Guidelines for Chemical Process Quantitative Risk Analysis (Second Edition), page 157, states: "When <u>a large amount of flammable</u> vapourizing liquid or gas <u>is rapidly released</u>, a vapour cloud forms and disperses with the surrounding air. The release can occur from a storage tank, process, transport vessel, or pipeline. …If this cloud is ignited before the cloud is diluted below its LEL, a Vapour Cloud Explosion (VCE) or flash fire will occur. The main consequence of a VCE is an overpressure that results while the main consequence of a flash fire is direct flame contact and thermal radiation…." (CCPS 2000). As a crude oil spill will have the potential to be flammable, the risk assessment recognizes that for all Trans Mountain terminals there is a possibility for a fire after a spill. The composition of the crude oil generally has about 20% flammable vapours and liquids, with the remainder considered a combustible liquid. However, the type of spill will not be rapid or large enough (in the author of the risk assessment's opinion) to create enough of a flammable cloud to produce a VCE. If a flash fire were to occur, it is expected to be localized and not extend outside the terminal.

Trans Mountain notes that if a spill were to occur, foam can be applied to the spill, using systems and equipment provided onsite, to protect personnel from potential ignition of flammable vapours when vapour emissions present a potential hazard.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Tank Vent Fire (page 17) states, "*Internal Floating Roof Tanks have potential to experience ignition and fire conditions at the vents located on the perimeter of the tank roof*." Based on the design work completed to date, the proposed new storage tanks at the Burnaby Terminal are not intended to utilize vents located along the perimeter of the tank roof. Venting of the tank will occur through the vapour treatment (odour abatement) systems. The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report Appendix D (page 5) also states, "*Vent fires are commonly extinguished with minimal damage and low risk to personnel*." As indicated in Section 24.7, Burnaby Terminal Risk Mitigation Measures, Trans Mountain intends to install a fire protection system on the storage tanks that will be designed to address a full-surface tank fire, is fixed to the tank, and will utilize automated foam application. Back-up systems will include high-volume hydrants combined with a portable foam cannon.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Rim Seal Tank Fire (page 18) states, "*Ignitable mixtures of light end components and air may occur at the rim seal during the initial fill of the tank and for up to 25 hours*." Trans Mountain

notes that the “initial” filling of storage tanks occurs very infrequently. Under normal operating conditions, oil is not entirely drained from a storage tank and a minimum level is maintained in the tank to ensure the floating roof remains floating (*i.e.*, a vapour space is not created between the oil and floating roof). The initial filling of a storage tank occurs when the tank goes into service for the first time, very occasionally if there is a change of service to a different commodity (not required in every case), and after a tank is cleaned and internally inspected, which can occur at intervals of 10 years or more.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Rim Seal Tank Fire (page 18) also states:

- “*If left uncontrolled, heating of proximity roof components cause warping and damage that may allow product or fire-fighting agents to flood the floating roof.*”
- “*Application of foam solution via ground monitors presents a real risk of being applied to the hard roof portion with the potential to partially sinking the floating roof and escalating the fire to a full surface fire event*.”

Trans Mountain notes that the City of Burnaby has misunderstood the design of the proposed fire suppression system. Foam application to a rim seal area is by fixed foam pourers mounted on the tank shell, and a foam dam located on the floating roof adjacent to the rim seal. Mobile foam deployment equipment (*i.e.*, foam cannon) is not intended to be used for a rim seal area fire. Trans Mountain performs regular maintenance and testing on fire protection systems to ensure the systems are operational in the event of a fire. Floating roof pontoons are inspected on a regular basis for the presence of product vapour or leaks. Trans Mountain believes that the likelihood of a floating roof sinking during a rim seal fire event is extremely low because the small amount of foam that would be deployed is not expected to be sufficient enough to create buoyancy issues for a floating roof.

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Rim Seal Tank Fire (page 19 and page 20) also states:

- “*Rim seal foam pourers are highly susceptible to a lack of maintenance*.”
- “*Water supply systems and foam lateral piping is highly susceptible to corrosion and scale build-up if not properly maintained*.”
- “*A pontoon explosion during ignition has legitimate potential to damage the floating roof*….”

As indicated above, Trans Mountain performs regular maintenance and testing on fire protection systems to ensure the systems are operational in the event of a fire. In addition, water supply systems (fire-water/foam mains) are intended to be made from high-density polyethylene, or similar, and will not be subject to corrosion. Foam lateral piping will be made from galvanized steel or stainless steel and will be resistant to corrosion. Floating roof pontoons will be inspected on a regular basis for the presence of product vapour or leaks.

24.17 Sulphur Dioxide and Smoke

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, includes the following:

- Consequences (page 5) states, "*Release of Sulphur Based Gases against the Fenceline. Highly toxic Hydrogen Sulfide will very quickly, upon facility release, expose residential areas to conditions that are immediately dangerous to life. Smoke outfalls from fire event may contain Sulphur Dioxide (SO_2), in which KMC analysis shows a potential health concern could be felt up to 5.2 km. downwind*."
- Regional Seismic Event (page 24) states, "*The resulting damage, loss of containment and fire potentials associated with an expected regional seismic event would likely encompass the following impacts:*
  - *sulphur based gas outfalls*"
- Distance to Fenceline (page 40) states, "*The TMEP creates emergency control scenarios risking the residential areas in proximity, Simon Fraser University, UniverCity village and the Burnaby Mountain Conservation Area, related to:*
  - *Smoke exposure to the community*
  - *Sulphur based gas exposure to the community*"
- Tank Fire Burnout (page 55) states, "*Therefore the use of a Tank Burnout tactic exposes the community to the full potential impact and duration of toxic smoke and heat discharge based upon the volume of crude oil present at the time of ignition*."
- Hazard Events (page 82) states, "*TMEP degrades the original fire protection premise of the facility and increases the likelihood of spill or fire extension exposing the community to the following hazard events.*
  - *Release of Sulphur based Gases*"

The Written Evidence of SFU, prepared by Dr. Terry Waterhouse, includes the following:

- Section 3.2.1, Plume, Smoke and Gas Released in a Tank Farm Fire (page 23) states, "*Etkin et al also indicate that TM analysis used weather data from the Vancouver Airport and that it is uncertain how representative the wind data from the Vancouver airport is to Burnaby Mountain*."
- Section 3.2.1, Plume, Smoke and Gas Released in a Tank Farm Fire (page 24) states, "*The significance of this finding is that winds from a southerly direction pose a greater threat to SFU since they would carry a plume or toxic cloud towards SFU.*"

While Trans Mountain acknowledges that a tank or secondary containment fire will produce smoke, Trans Mountain does not agree with the magnitude of the consequences described in the Intervenor statements. As described in many IR responses, tanks fires are inherently very low probability events and Trans Mountain will employ a number of prevention, detection, and mitigation measures to reduce the probability of fires at Burnaby Terminal and their potential impacts. The suggested 5.2 km emergency response planning radius is conservative as it does not take into account the smoke plume rise, the dilution of SO_2 within the smoke plume, and the lower concentrations of SO_2 anticipated at ground level in comparison to the concentrations within the smoke plume. Discussion on SO_2 and smoke is included in the following responses to various IRs.

City of Burnaby IR No. 2.039a (Filing ID A4H8A1) asked about the possible scenario of a toxic smoke plume. Trans Mountain responded that the reference to toxic smoke plume risk in Volume 7 of the Application (Filing ID A3S4V5), is in the context of hazard identification, prior to control measures being applied. As described in the response to City Burnaby IR No. 1.12.06 and numerous other responses to the City of Burnaby (Filing ID A3Y2E6), Trans Mountain will employ a number of prevention, detection, and mitigation control measures to reduce the risk of fires at Burnaby Terminal and their potential impacts. In the response to NEB IR No. 3.093b (Filing ID A4H1V2), Trans Mountain has also identified that fixed, automated, full-surface fire protection, which was not included in the Facilities Application, has been added to the proposed suite of fire-protection measures for the proposed new tanks at Burnaby Terminal to further enhance the overall robustness of the design. ERPs have been developed for the existing pipeline system, including specific facilities, and the plans will be enhanced and implemented in relation to the proposed expansion of Burnaby Terminal and considering the possibility of a smoke plume. Trans Mountain does not agree that the response to City Burnaby IR No. 1.12.06 (Filing ID A3Y2E6) denies the possibility of a toxic smoke plume scenario. The response indicates that in the highly unlikely event of a fire, mitigation measures are expected to prevent prolonged fire duration.

SFU IR No. 2.5.13.1 (Filing ID A4H9C9) also asked if it is possible for a toxic smoke plume to discharge from the facility. Trans Mountain again responded that the reference to toxic smoke plume risk in Volume 7 of the Application (Filing ID A3S4V5), is in the context of hazard identification, prior to control measures being applied. A smoke plume is also discussed in the Burnaby Terminal fire risk assessment referred to in the response to SFU IR No. 2.3.07.1 (Filing ID A4H9C9), also without control measures being applied. Trans Mountain will employ a number of prevention, detection, and mitigation control measures to reduce the risk of fires at Burnaby Terminal and their potential impacts. Trans Mountain has outlined many of these measures in the response to NEB IR No. 3.093b (Filing ID A4H1V2). Trans Mountain has also identified that fixed, automated, full-surface fire protection, which was not included in the Facilities Application, has been added to the proposed suite of fire-protection measures for the new tanks at Burnaby Terminal, to further enhance the overall robustness of the design. Significant conservatism is discussed in the Burnaby Terminal risk assessment. The suggested 5.2 km emergency response planning radius determined using the ERPG-2 level does not take into account the smoke plume rise, the dilution of SO_2 within the smoke plume, and the concentrations of SO_2 at ground level compared to the concentrations within the smoke plume. The purpose of the smoke assessment was to inform emergency response planning. ERPs have been developed for the existing pipeline system, including specific facilities, and the plans will be enhanced and implemented in relation to the proposed expansion of Burnaby Terminal and considering the possibility of a smoke plume. In the highly unlikely event of a fire, mitigation measures are expected to prevent a prolonged duration.

Wembley Estates IR No. 2.2a (Filing ID A4H9K1) asked about the rate of dispersal for Immediately Dangerous to Life and Health (IDLH) levels of SO_2 smoke as it relates to the Burnaby Terminal. Trans Mountain responded that it has not calculated dispersion rates for SO_2 for the storage tank and secondary containment fire cases assessed for the proposed expansion of Burnaby Terminal. As such, Trans Mountain cannot confirm how quickly, if at all, IDLH levels of SO_2 could occur in the area of Wembley Estates or Forest Grove Elementary School. However, Trans Mountain can clarify that the risk assessment analysis utilized a calculation tool that assumes a release of SO_2 at ground level and dispersion without the effect of a fire. In reality the heat generated by the fire will drive the smoke plume, and the SO_2 within

it, high into the air. The dispersion of the SO_2 will depend on many factors, including the rate of the smoke plume rise and how quickly the smoke plume is moved around by the wind. Since SO_2 is heavier than air, it may eventually fall back to earth, but that will take some time and the smoke will likely travel downwind for some distance before that happens. The conservative calculations in the risk assessment also do not take into account the mitigating effects of the dilution of SO_2 caused by turbulent mixing within the smoke plume. The analysis of combustion products from tank and secondary containment fires was conducted specifically to emphasize that emergency response planning needs to consider that a smoke plume could contain SO_2. KMC has a mature ERP for Burnaby Terminal, which will be updated to reflect the tanks and infrastructure to be added for the Project. Trans Mountain will include numerous prevention, detection, and mitigation control measures in the design of Burnaby Terminal to ensure that risk of fires is extremely low. Please refer to the response to NEB IR No. 3.093b (Filing ID A4H1V2).

24.18 Smoke and Toxic Fumes from Westridge Marine Terminal

The Written Evidence of SFU, prepared by Dr. Terry Waterhouse, Section 3.2.1 Plume, Smoke and Gas Released in a Tank Farm Fire (page 24) states, "The Westridge Terminal is northeast of SFU at the foot of Burnaby Mountain." Trans Mountain notes that this statement is incorrect. Westridge Marine Terminal is located approximately 1.5 km northwest of SFU.

24.19 Burnaby Terminal Access and Egress

Hazards to Simon Fraser University Associated with the Trans Mountain Expansion Project: A Gap Analysis, prepared by David Etkin *et al*., Section 5. Risks Related to Tank Farm (page 26) states, "Therefore, emergency planning at SFU needs to include the scenario of an ERPG-2 event, at a minimum. Specifically, the TM/McCutcheon and Associates report suggest having an emergency plan in place with the ability for foam addition, and good road access from at least two directions is imperative."

SFU IR No. 2.3.07.3 (Filing ID A4H9C9) asked if Trans Mountain considered and prepared plans to identify the need for and to facilitate the construction of a secondary emergency egress road to and from the Burnaby Terminal, and to and from SFU. Trans Mountain responded that it has two operational access / egress roads at Burnaby Terminal and a third egress could easily be created by minor improvements to a former road. Trans Mountain has not considered or prepared plans to identify the need for or to facilitate the construction of a secondary emergency egress road to or from SFU for the following reasons:

- Municipal infrastructure is in the City of Burnaby's jurisdiction.
- Trans Mountain is proposing to install a robust fire protection system to significantly reduce the risk of fires associated with the proposed new tanks.
- Burnaby Terminal existed before the construction of SFU. Presumably, SFU and City of Burnaby planners assessed the potential risks to the campus at the time of site selection, have done so in the intervening years, and have concluded that the current egress is acceptable.

Trans Mountain looks forward to engaging with SFU and the City of Burnaby during the update of the Burnaby Terminal ERP associated with the Project.

24.20 Access Within Burnaby Terminal

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Application Positions (page 34) states, "The primary concerns created by the TMEP related to deployment positions are:

- Insufficient roadway option to allow for safe access and egress of deployment positions to provide all necessary fire stream applications in all potential wind conditions."

Trans Mountain does not agree with the City of Burnaby Fire Department statement above. City of Burnaby IR No. 2.030e (Filing ID A4H8A1) asked if access routes will be built to withstand the weight of emergency equipment, accommodate the width and turning radius, and provide safe access to emergency operations. Trans Mountain responded that the proposed primary and secondary access routes at Burnaby Terminal will be designed and constructed to accommodate wheel loads from emergency apparatus or equipment, as given in the International Association of Fire Chiefs (IAFC) Emergency Vehicle Size and Weight Regulation Guideline. The geometric design of the proposed primary access routes at Burnaby Terminal will be designed with alignment, sag, crest, and horizontal curves and clearances to accommodate the movement of emergency apparatus or equipment. As indicated in the response to City of Burnaby IR No. 1.08.05r (Filing ID A3Y2E6), secondary access routes will be primarily intended for routine inspection and maintenance activities, but may also be used for emergency response, if appropriate. Access routes will also be verified by a swept path analysis. Overhead piping or cable crossings at proposed roads will be designed and constructed with clearances to enable the passage of emergency apparatus or equipment. Drainage crossings at proposed access roads will consist of culverts designed and constructed to support wheel loads from emergency apparatus or equipment. The proposed primary access routes at Burnaby Terminal will be designed and constructed so that emergency response access is available from a minimum of two independent directions. Since secondary access routes will be primarily intended for routine inspection and maintenance activities, in most cases there will only be a single access route into each secondary containment area.

24.21 Traffic Control Plans

The Written Evidence of SFU, prepared by Dr. Terry Waterhouse, Section 3.3.3, Impact of Construction (page 28) states, "SFU is concerned that traffic along these routes (Burnaby Mountain Parkway, Gaglardi Way) will be blocked or severely restricted during the construction period." Trans Mountain notes that construction access routes are described in Section 28.2, Traffic Control and Access Plans.

24.22 History of Kinder Morgan Pipeline Accidents

Hazards to Simon Fraser University Associated with the Trans Mountain Expansion Project: A Gap Analysis, prepared by David Etkin *et al.*, Section 4.2.2, History of Kinder Morgan Pipeline Accidents (item c, page 22) states, "*Burnaby 2009: 200,000 litres seeped from a storage tank into a surrounding containment bay at the Burnaby Mountain tank farm*." This statement is incorrect as it implies that a storage tank leak occurred. The release of oil to the secondary containment area was caused by a contractor's pump connection failure during tank cleaning work. Oil did not seep from the storage tank nor was the release caused by a failure of tank components.

24.23 History of Full-surface Tank Fires

The City of Burnaby Fire Department, Trans Mountain Tank Farm Tactical Risk Analysis report, Full Surface Tank Fire (page 21) lists 12 events that are presented as full-surface tank fire incidents. In general, Trans Mountain is of the view that the events listed by the City of Burnaby Fire Department are not applicable to the proposed expansion of the Burnaby Terminal for the reasons provided below.

<u>Vopak Terminal Diesel Storage Tank Fire, Essex, England, April 29, 2013</u>

According to the Essex County Fire and Rescue Service website, the fire occurred in an empty diesel storage tank (Essex County Fire and Rescue Service 2015). Trans Mountain notes that none of the proposed new storage tanks at Burnaby Terminal are intended to contain diesel fuel.

<u>Indian Oil Corporation Terminal Fire, Surat, India, January 5, 2013</u>

According to an article on the Reuters website, the storage tank that caught fire contained gasoline (Reuters 2015a). Trans Mountain notes that none of the proposed new storage tanks at Burnaby Terminal are intended to contain gasoline.

<u>Chevron Refinery Fire, Richmond, California, August 6, 2012</u>

According to a U.S. Chemical Safety and Hazard Investigation Board report, the fire was the result of a pipe failure in a crude oil process unit (U.S. Chemical Safety and Hazard Investigation Board 2015). Trans Mountain notes that the incident was not a full-surface tank fire as indicated by the City of Burnaby Fire Department.

<u>Merit Energy Tank Fire, Near Anson, Texas, May 6, 2012</u>

According to an article on the KTXS News website, the storage tank that caught fire, after an apparent lightning strike, was a very small 300 barrel tank (KTXS News 2015). Trans Mountain notes that 300 barrel oil-field tanks do not have an internal floating roof, which would result in flammable vapour being present inside the tank, above the liquid level. The proposed new storage tanks at Burnaby Terminal will include a floating roof and seals, which are very effective at controlling emissions, and will significantly reduce the potential for flammable vapours to collect above the floating roof. Trans Mountain also notes that the frequency and intensity of lightning in the south-central United States is significantly higher than in Burnaby.

<u>Petro China Diesel Tank Fire, Dalian, China, August 30, 2011</u>

According to an article on the Taipei Times website, the fire occurred in a diesel storage tank (Taipei Times 2015). Trans Mountain notes that none of the proposed new storage tanks at Burnaby Terminal are intended to contain diesel fuel.

<u>Chevron Refinery Fire, Pembroke, Wales, June 2, 2011</u>

Trans Mountain understands that information on the cause of the incident is not available as the investigation is ongoing.

<u>Petroleos de Venezuela Tank Fire, Bonaire Dutch Caribbean, September 10, 2010</u>

According to an article on the Reuters website, the storage tank that caught fire, after an apparent lightning strike, contained the refined product (chemical) naphthalene (Reuters 2015b). Trans Mountain notes that none of the proposed new storage tanks at the Burnaby Terminal are intended to contain naphthalene. Trans Mountain also notes that the frequency and intensity of lightning in the tropics is significantly higher than in Burnaby.

Colonial Pipeline Tank Fire, Greensboro, North Carolina, June 13, 2010

According to an article on the CNN website, the storage tank that caught fire, after an apparent lightning strike, contained gasoline (CNN 2015). Trans Mountain notes that none of the proposed new storage tanks at the Burnaby Terminal are intended to contain gasoline. Trans Mountain also notes that the frequency and intensity of lightning in the southeastern United States is significantly higher than in Burnaby.

Indian Oil Corporation Terminal Fire, Jaipur, India, October 29, 2009

According to an Indian Oil Corporation Fire Accident Investigation report, the fire occurred after a product release that was caused by improper valve operation on a delivery line (Indian Oil Corporation 2009). The product transfer included “Kerosene” and “Motor Spirit,” not crude oil. Trans Mountain notes that the incident was not a full-surface tank fire as indicated by the City of Burnaby Fire Department.

Caribbean Petroleum Corporation Tank Farm Fire, San Juan, Puerto Rico, October 23, 2009

According to a draft U.S. Chemical Safety Board report, the fire occurred after a gasoline storage tank overfilling incident that was caused by an outdated and poorly maintained liquid level measuring device (*i.e.*, float and measuring tape system) (U.S. Chemical Safety Board 2015). Trans Mountain notes that none of the proposed new storage tanks at the Burnaby Terminal are intended to contain gasoline. In addition, all of the proposed tanks will be equipped with a modern radar gauging system for liquid level measurement and overfill protection. Redundant instrumentation for overfill protection will also be provided.

Magellan Midstream Partners Tank Fire, Kansas City, Kansas, June 3, 2008

Trans Mountain was unable to find any information on the Magellan gasoline storage tank fire in Fairfax, California on June 7, 2008 that was referenced by the City of Burnaby Fire Department. However, Trans Mountain was able to find information on a Magellan gasoline storage tank fire that occurred in Kansas City, Kansas on June 3, 2008. According to a U.S. EPA presentation, the storage tank that caught fire, after an apparent lightning strike, contained gasoline (U.S. EPA 2015). Trans Mountain notes that none of the proposed new storage tanks at Burnaby Terminal are intended to contain gasoline. Trans Mountain also notes that the frequency and intensity of lightning in the central United States is significantly higher than in Burnaby.

Hertfordshire Oil Storage Depot Fire, Buncefield, England, December 11, 2005

According to the final report of the Buncefield Major Incident Investigation Board, the fire occurred after a gasoline storage tank overfilling incident (Buncefield Major Incident Investigation Board 2008). Trans Mountain notes that none of the proposed new storage tanks at the Burnaby Terminal are intended to contain gasoline. In addition, all proposed tanks will be equipped with a modern radar gauging system for liquid level measurement and overfill protection. Redundant instrumentation for overfill protection will also be provided.

In conclusion, the City of Burnaby Fire Department has failed to establish a compelling link between the incidents listed and the risk of storage tank fires at Burnaby Terminal.

24.24 The UK Approach

The Opinion on Potential Off-Site Risks of the Proposed Expansion of Burnaby Tank Farm report, prepared by Dr. Ivan Vince, Section 1.5 (page 1) states, “I shall first present a simplified summary in Section 2 of the framework of regulation and assessment within which the risks at the Burnaby facility would be approached in the UK.” Trans Mountain is of the view that, while interesting, the framework of regulation and assessment, within which the risks related to the proposed Burnaby Terminal expansion would be approached in the United Kingdom, is not relevant to the Project. Refer to the discussion in Section 24.13, Boil-Over.

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25.0 FATE AND BEHAVIOUR OF OIL

25.1 Introduction

A number of intervenors and commenters have addressed issues associated with oil weathering, behaviour on water (marine and freshwater), and potential for submergence or sinking. This section of Reply Evidence addresses evidence submitted by the City of New Westminster, City of Vancouver, District of North Vancouver, Environment Canada, David Farmer, Living Oceans Society, Lyackson First Nation, Elizabeth May, Maa-nulth Nations, Makah Tribal Council, Matsqui First Nation, Musqueam Indian Band, Natural Resources Canada, Pacheedaht First Nation, Shxw'owhamel First Nation, Squamish Nation, Tsleil-Waututh Nation, and Unifor.

Oil sands products are not a new commodity and have been safely transported via the TMPL for many decades. Throughout the IR process, Trans Mountain has seen intervenors use the terms “bitumen,” “diluted bitumen,” and “weathered bitumen” interchangeably, all in reference to the same pipeline substance (*e.g.*, City of Vancouver, Executive Summary section [Filing ID A4L7V8, no. 33]). The conflation of multiple definitions is confusing, particularly when these references become candidates for misapplication of API gravity, specific gravity, density values, and associated assumptions about fate and behaviour. As discussed extensively by Trans Mountain during the course of the hearing, NEB tariffs specify that the density of petroleum product shipments is to never exceed 940 kg/m^3 at a reference temperature of 15°C, and that viscosity is not to exceed 350 cSt when measured at the posted pipeline operating temperature. As shown in the Gainford study (Volume 8C, TERMPOL reports, TR 8-C-12, S7 A – Study of Fate and Behavior of Diluted Bitumen Oils on Marine Waters; Filing ID A3S5G2), Government of Canada study (2013), and the SLRoss study (2012), the initial density of the two most commonly transported dilbits, Cold Lake Blend (CLB) and Access Winter Blend (AWB), are both less than the tariff specification.

As an aside, a discussion of nomenclature should include reference to the catchall term “oil”; Trans Mountain Tariff No. 92, Section 1.19 states: “‘Crude Petroleum’ means ‘oil’ as defined in the *National Energy Board Act* (“Oil”).” According to the *Canada Oil and Gas Operations Act*, Definitions 2, “oil” refers to:

- Crude petroleum regardless of gravity produced at a well-head in liquid form.
- Any other hydrocarbons, except coal and gas, including hydrocarbons that may be extracted or recovered from surface or subsurface deposits, including deposits of oil sand, bitumen, bituminous sand, oil shale and other types of deposits.”

In short, “oil” is an acceptable general term for any energy hydrocarbon that is neither coal nor gas.

Spill prevention is paramount for Trans Mountain and will remain a priority for all operations indefinitely. Prudent planning and awareness are important; however, should a spill occur, plans, equipment, and training have been and continue to be focal points for the protection of human, environmental, and cultural sensitivities. In the unlikely event of a spill, the response from the Project would entail the same procedures and approaches used for conventional crude oil spills. To that end, Trans Mountain disagrees with the assertion made by the City of Vancouver (Written Evidence, page 45, Section 5.6.1; Filing ID A4L7V8), “….two unique risks

associated with a spill of dilbit. The first is the potential for dilbit to submerge when spilled and the second is the risk posed to air quality and human health by the toxic plume created by evaporating diluents."

The potential for oil submergence or sinking is not unique to dilbit and has been documented for a number of spills (HDR 2015). The human health risk from inhalation of light-end hydrocarbons is also not unique to dilbit (refer to Section 62, Human Health Risk Assessment, of this Reply Evidence).

25.2 Oil Toxicity

Several intervenors question the relative toxicity of dilbit to other crude oils. Recognizing that there is a range of oil sands products and an even wider range of crude oils, this simplifying statement needs to consider the oils referenced. The subject of relative toxicity also was commented on during the IR process (refer for example to the toxicity assessment of hydrocarbon components that was provided in Section 3.4 of the Detailed Quantitative Ecological Risk Assessment [DQERA], which was submitted to the NEB on May 14, 2014, as an Attachment 1 to Response to NEB IR No. 1.62d; Filing ID A3W9K1). In Application Volume 8C, *A Comparison of the Properties of Diluted Bitumen Crudes with Other Oils* (Filing ID A3S5G7), Polaris provided summaries of the benzene, toluene, ethylbenzene, and xylenes (BTEX) components in a range of oils, including CLB and A1B dilbits. Table 25-1, extracted from that report, shows concentrations of the acutely toxic BTEX compounds are greatest in the Mixed Sweet Blend (MSB) conventional crude.

TABLE 25-1

RANGES OF BTEX CONCENTRATIONS (VOLUME PERCENT) FOR EXAMPLE ALBERTA CRUDE OIL BLENDS

Component	Mixed Sweet Blend	Husky Synthetic Blend	Premium Albian Synthetic	Lloyd Kerrobert	Wabasca Heavy	Western Canadian Blend	Access Western Blend	Cold Lake Blend	Western Canadian Select	Albian Heavy Synthetic
Benzene	0.27 ± 0.05	0.04 ± 0.01	0.03 ± 0.01	0.14 ± 0.05	0.12 ± 0.02	0.10 ± 0.03	0.29 ± 0.03	0.23 ± 0.03	0.16 ± 0.03	0.15 ± 0.03
Toluene	0.81 ± 0.13	0.15 ± 0.03	0.21 ± 0.07	0.21 ± 0.08	0.29 ± 0.07	0.18 ± 0.04	0.50 ± 0.08	0.39 ± 0.07	0.30 ± 0.06	0.37 ± 0.09
Ethyl Benzene	0.24 ± 0.03	0.10 ± 0.02	0.16 ± 0.03	0.04 ± 0.01	0.13 ± 0.02	0.06 ± 0.01	0.06 ± 0.01	0.06 ± 0.01	0.06 ± 0.01	0.12 ± 0.03
Xylenes	1.06 ± 0.13	0.33 ± 0.05	0.54 ± 0.16	0.19 ± 0.06	0.47 ± 0.10	0.25 ± 0.04	0.39 ± 0.08	0.33 ± 0.07	0.29 ± 0.06	0.43 ± 0.12

Source: CrudeMonitor (2013) - 5-year average and range

Zhou *et al.* (2015) (Appendix 25A) described tests comparing the toxicity and sublethal effects of CLB with a MSB conventional crude on zebrafish larvae. Zhou *et al*. note "*The survivorship values (7 day LC50) indicated that MSB crude was more toxic than dilbit, demonstrating that the risks associated with dilbit are less or no different from those of conventional crude (CC).*"

Polyaromatic hydrocarbons (PAHs) are another component of oil with environmental concerns, particularly for more chronic effects. In general, PAH content is low in dilbits compared to many other crude oils. A typical crude oil may contain 0.2 percent to more than 7 percent total PAH.

The National Research Council (2003) reports an average PAH content of 1.39 for 25 crude oils (heavy and light) using data from numerous sources. Heavy distillates, such as a bunker fuel and light distillates, for example diesel, averaged 2.42 and 3.44 percent, respectively. Fresh oil samples of Cold Lake Winter Blend (CLWB) and AWB dilbits contained 1.1 and 0.45 percent PAH by weight in the Gainford Study. Yang *et al*. (2011) and Zhou *et al*. (2015) discuss PAH content in oil sand products and compare those with conventional oils. Yang *et al*. (2011) results indicate that total alkylated PAHs in dilbit are 25% lower than in conventional crude. The Government of Canada (2013) found that total alkyl PAHs in heavy fuel oil (HFO) and intermediate fuel oil (IFO) 180 (heavy distillates) are more than 10 times higher than found in any of the dilbit samples tested. The conclusions from the multiple chemical analyses indicate that dilbits should not be considered more toxic than other crude oils.

25.3 Oil Weathering

Several intervenors argue that in the case of a spill, there is insufficient information provided for authorities and responders to fully understand the risks and undertake necessary response. Therefore, they recommend undertaking of more effects analysis of dilbit properties and potential behaviour (Elizabeth May Written Evidence [Filing ID A4L8Q9]; Mark West Spill Risk Assessment Report [Filing ID A4Q1A2]; Affidavit of Julie Pavey [Filing ID A4Q0E9]; Affidavit of Ken Bennet [Filing ID A4Q0I1]). Trans Mountain contends that there is more than sufficient information to support the Application and findings presented. Multiple studies, including the Gainford study done for Trans Mountain (Filing IDs A3S5G2, A3S5G4, A3S5G5) have examined dilbit weathering and behaviour with an emphasis on possible spills to water, including referenced reports and new reports added to this reply (refer to Section 66.4; CRREL & SLRoss 2015; Government of Canada 2013; King *et al*. 2015; SLRoss 2012; Zhou *et al*. 2015).

Evidence submitted by Environment Canada (EC; written evidence [Filing ID A4L8Y6, page 121]) states:

> "The Proponent has provided significant information on oil properties in section 5.1 of Volume 7 of their Application (Exhibit B18-1, PDF page 75), summarizing a report by Polaris Applied Sciences Inc., 2013, "A Comparison of the Properties of Diluted Bitumen Crudes with other Oils" (Exhibit B21-8). This provides a range of properties and oil composition data based on a review of existing literature, for select crude oils, fuels and diluted bitumen products. Extensive data sets for Cold Lake Blend (CLB) and Access Western Blend (AWB), winter-season, high-condensate diluted bitumen blends, are provided in section 5.2.8 of volume 7 of the submission (Exhibits B18-1 and B18-2), based on the Witt O'Briens et al., 2013 report entitled "A Study of Fate and Behavior of Diluted Bitumen Oils on Marine Waters" (Exhibits B21-5, B21-6, and B21-7).

Page 123 of the same EC written evidence notes:

> "A comparison of a substantial study on the weathering for two types of diluted bitumen, *A Study of Fate and Behavior of Diluted Bitumen Oils on Marine Waters* (Exhibits B21-5, B21-6, and B21-7), includes examinations of: evaporation, dissolution, sinking and adherence to substrates. This study also includes information on the use of surface washing agents and a wide variety of skimmers for use in cleaning spills. **Where there is overlap, EC notes that these results are, in general, in good agreement with the GoC technical report of 2014 (FGTR 2014), as well as subsequent testing by the**

Department of Fisheries and Oceans (King et al 2014, and King et al 2015)." (Filing ID A4L8Y6, page123)" [emphasis added]

A topic emphasized by the Short Reports (Filing IDs A4L9R7 and A4L9R8), and repeated in multiple lines of intervenor Reply Evidence, concerns evaporation rates and potential effects on dilbit weathering and density changes, arguing that dilbits may become prone to submergence and sinking within 24 hours of being spilled on water. Short states "Moreover, the thick oil layers (~1.14 mm–20 mm) used in the five experimental studies would rarely occur during the initial discharge phase of a real oil spill unless the spill occurred in a confined area that prevented the oil layer from spreading to its fullest natural extent" (Filing ID A4L9R7, page 27). The premise of the author's discussion is then based on an assumed 0.4 mm thick layer on water.

Yarranton *et.al* (2014) studied the evaporation rates of dilbit (CLWB) and light crude oil (Alberta Sweet Blend; ASB) films on glass over time (up to 30 days). The parameters of the testing included different air flow rates and temperatures of 5, 15, and 25°C. In addition to testing the oils on glass, the oils were also tested on fresh water at 15°C. The evaporation rates, density, and viscosity of CLWB and ASB films weathered over still water were identical to the corresponding films weathered on glass, within the error of the measurements. The authors note "evaporation rate depends on the diffusion rate of the lighter components through the film and convective mass transfer to the air above [Note: This same formulation was used in the modelling conducted for the TMEP Application]. As expected, the mass transfer rate increased with increasing temperature and decreasing film thickness in all cases. The evaporation rate from CLWB films was insensitive to the air flow rate suggesting that the mass transfer is limited by the diffusion of the diluent through the film." These findings, similar to other results, indicated: "*The density of the CLWB films reached 998 kg/m³ after 30 days of weathering. The viscosity of the film approached 70,000 mPa.s at this point and mass transfer limitations may hinder further evaporation and density increase. It is possible that dilbit films will not sink in water for a very long time*."

Trans Mountain notes that tests on flumes (CRREL/SLRoss 2015; SLRoss 2012) and tests in the Gainford tanks with wave and wind effects (Filing ID A3S5G2) produced a range of oil on water thicknesses, dependent on the water surface circulation. The performed meso-scale tests (Gainford [Filing IDs A3S5G2, A3S5G4, and A3S5G5], CRREL/SLRoss [2015], and SLRoss [2012]) are close approximations of natural conditions. Results from the tests are valuable for modelling and provide empirical information on actual (not modelled) behaviour. Regardless of the evaporation rates assumed, the weathered dilbits tested remained floating at least for the duration of each of the study periods: 13 days (SLRoss 2012) and 5 days (CRREL/SLRoss 2015) on freshwater flume studies and for 10 days on brackish water (Filing IDs A3S5G2, A3S5G4, and A3S5G5).

25.4 Sediment and Shoreline Interaction

During the IR process and in Intervenor Evidence (*e.g.*, Affidavit of Julie Pavey [Filing ID A4Q0E9, page 15, Item 8.2]; Prelim Report MIB Evidence for TMEP [Filing ID A4Q2F9, page 18]; Unifor Evidence TMX [Filing ID A4L6C6, page 13]), intervenors expressed concerns regarding possible oil submergence and sinking, particularly when related to potential sediment interaction.

The subject has been discussed extensively in replies to IRs and was the subject of substantial discussion during the Northern Gateway hearings as well. As was noted in both the Application

and in IR responses, weathered oil interaction with suspended sediment may contribute to a portion of weathered oil submerging and/or sinking given specific conditions, including density of receiving water, agitation, sediment type, size and suspended load, and turbulence. Short (Item 98) asserts that "*other mechanisms such as contact with shoreline sediments or accumulation of small amounts of suspended inorganic material in the water column would increase the likelihood that spilled diluted bitumen could submerge in brackish receiving waters*." Trans Mountain notes, however, that oil-sediment interaction is not simply a function of sediment availability for oil-mineral aggregate (OMA) formation, but that the natural dispersion of oil droplets, oil viscosity, and other factors contribute to the process. A high level of energy is required to form stable OMA, as discussed below. Tests conducted at NRCan (NRCan Written Evidence ANNEX I-J 27May15; Filing ID A4Q0V3, page 25-26), for example, showed that a weathered conventional crude floating on fresh water and then in contact with a sediment beach ended up sinking, whereas dilbit, under the same conditions, did not.

In addition to laboratory (*e.g.*, SL Ross 2012) and meso-scale testing of dilbit (*e.g.,* Technical Report 8C-12-S7; Filing IDs A3S5G2, A3S5G4, A3S5G5), recent studies (Zhou *et al.* 2015; Fingas 2015) emphasize the following key points with respect to the effect of weathering on density:

- Weathering alone is not likely to cause bitumen diluted with condensate to achieve a density greater than that of fresh water in less than 8 to 10 days, and it is unlikely that dilbit would achieve a density greater than that of brackish or salt water even after extended weathering.

- Other forms of dilbit (*e.g.*, bitumen diluted with another light oil or synthetic oil) will have slower initial weathering than bitumen diluted with condensate, and are even less likely to achieve a density greater than that of fresh water in a short time.

A second mechanism that could cause dilbit to sink, as with other crude oils, involves interactions between the spilled crude oil and suspended sediments forming OMAs. It should be noted that the overall sediment load to Indian Arm is not the main factor driving the formation of OMA. First, only suspended sediment concentration should be taken into account in the formation of OMA, not the total sediment load. Grain size of 8 microns or less would be characteristic in the OMA formation process. Coarser grain sizes would not be suspended, hence not available for interaction with oil on the surface. In addition, the interaction between oil and suspended sediment leading to submergence depends primarily on three parameters: the concentration of oil, the concentration of suspended sediment, and the level of agitation characterized by the energy dissipation rate. For OMA formation to be a significant process requires all three factors to be present: high concentration of fine sediments, sufficient concentration of oil, and high energy levels. These criteria were not met in Burrard Inlet or Indian Arm. If one of these criteria is not met, the formation of stable OMA would be negligible to non-existent.

In summary, the oil must first become dispersed into the water column; this implies that a sufficient level of energy is being provided by wind and waves. Then, after dispersion has occurred, there must be a sufficient concentration of suspended sediment (typically greater than 100 mg/L) already in the water in order for these interactions to take place. Finally, the relatively high viscosity of dilbit, and the tendency for the viscosity of spilled dilbit to rapidly increase after release (Fingas 2015), mitigates the formation and dispersion of small droplets into the water

column making interactions between dilbit and suspended sediment less likely to occur than may be the case for conventional crude oils (Zhou *et al.* 2015).

Wave data were extracted from the wave model Simulating Waves Nearshore (SWAN) that provided wave information to the oil spill model SPILLCALC, as part of the Application. The model grid size is 125 m and covers the entire Burrard Inlet and Indian Arm. Data were extracted over the simulated period (October 2011 to September 2012). Maximum wave height over Burrard Inlet was extracted on an hourly basis and was used to compute the average maximum wave height. This parameter allowed computation of the energy dissipation rate (*i.e.*, quantification of the energy level) and compare it with literature values from other rivers, ocean, and lab data.

As one can see on Figure 25-1, lab experiments showed that energy levels have to reach a certain threshold to start forming stable OMA. This threshold is much greater than energy levels observed in natural habitats such as Juan de Fuca Strait, tidal rivers, and Burrard Inlet. This includes Indian Arm, since wave conditions in Indian Arm are much calmer than in Burrard Inlet. In other words, the energy level is not sufficient to create OMA in Indian Arm.

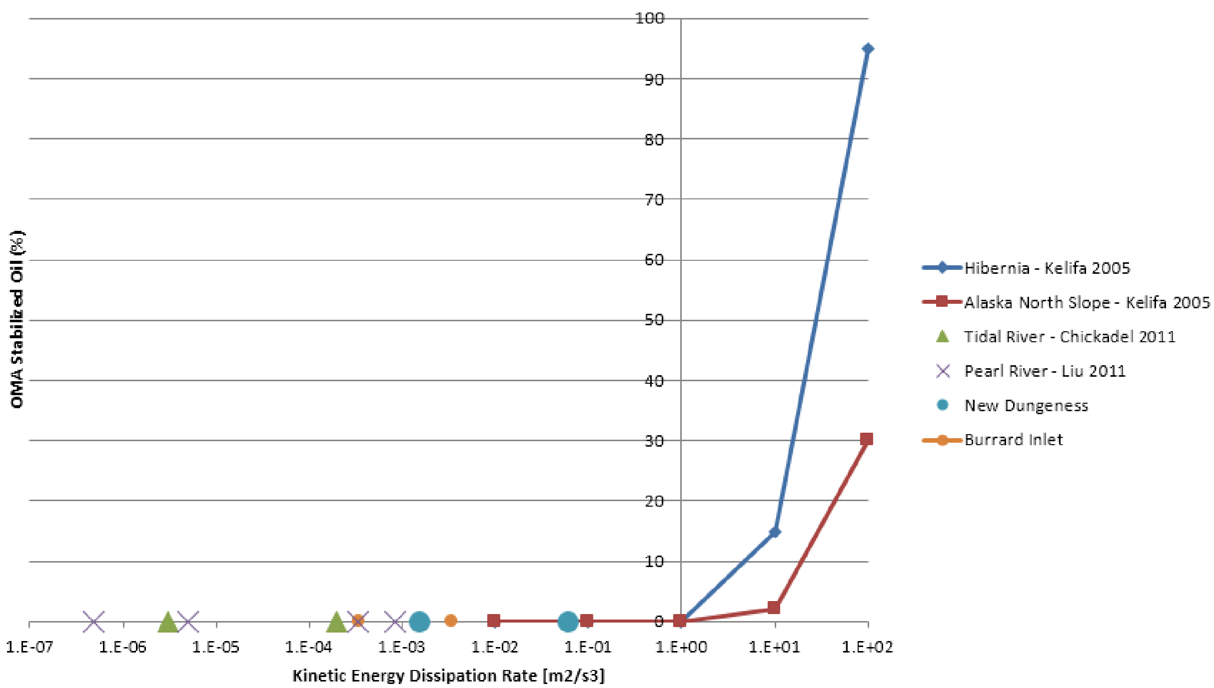

Figure 25-1 OMA Formation based on Energy Dissipation Rate

In the unlikely event of a significant spill to water, dilbit (relatively fresh to weathered) may contact the shoreline. Oil retention along shorelines, river banks, or in soils is a function of pore space and effective permeability. Effective permeability, in turn, is a function of pore geometry and of the fluid (stranded oil) characteristics. Coastal and Ocean Resources (2013; refer to Volume 8B; Filing ID A3S5I8) reported that the highest oil retention is expected in sand and cobble-pebble mix, with more potential penetration into the latter. The Coastal and Ocean Resources study notes that the high level of oil retention is for fresh dilbit only; once dilbit begins

to weather and viscosity increases, the potential for penetration decreases substantially. Harper *et al* (2015) concluded with the hypothesis that the majority of armoured, low-energy shorelines (a predominant type in BC) have limited penetration potential. Very little penetration would be expected in sand and mud flats except for what gets into sufficiently large burrows.

Intervenors also expressed concerns regarding the interaction between sediment, shore, and oil for the mudflats of the Maplewood Conservation Area and other environmentally sensitive areas in the District of North Vancouver (*e.g.*, Affidavit of Julie Pavey [Filing ID A4Q0E9, page 15, Item 8.2]; Prelim Report MIB Evidence for TMEP [Filing ID A4Q2F9, page 18]; Unifor Evidence TMX [Filing ID A4L6C6, page 13]).

It should be noted that the east, southeast and south-southeast winds that would direct a marine spill from the Westridge Marine Terminal towards the Maplewood Mud Flats are a relatively rare occurrence in Burrard Inlet. Based on wind data collected in 2013 by Tetra Tech EBA at Westridge Terminal, winds spanning east to south-southeast represent less than 2% of the total recorded winds. Tidal currents plus wind are a far more important factor for determining the trajectory of a marine spill that could be transported towards the Maplewood Mud Flats. Table 25-2 presents the typical seasonal probability of a hypothetical spill from Westridge Terminal reaching the Westwood Mud Flats. The contents of the table are derived from modelling results presented in Tetra Tech EBA's report, "Modelling the Fate and Behaviour of Marine Oil Spills for the Trans Mountain Expansion Project" (Filing ID A3S5G9).

TABLE 25-2

PROBABILITY OF OIL CONTACT AND ESTIMATED FIRST SHORELINE CONTACT TIMES AT MAPLEWOOD MUD FLATS FOLLOWING A HYPOTHETICAL SPILL AT WESTRIDGE TERMINAL

Season	Probability of Oiled Shoreline	Time to First Shoreline Contact
Winter	20%	4 hours
Spring	40%	6 hours
Summer	60%	6 hours
Fall	40%	4 hours

As stated in the Application and IR responses, shoreline (and even riverbed) treatment is to be done in consideration of net environmental benefit analysis (NEBA) and with Unified Command (UC) approval. Cleanup would be done as appropriate and to the degree recommended for habitat recovery.

25.5 New Research and Reports

As with many studies related to oils, spill response, effects, and countermeasures, ongoing research continues to add to our knowledge base for considering effects assessments, risk minimization, and contingency planning. Industry and government research on oil sands products and their properties continue, as evident in presentations made in 2014 and 2015 to the two national panels tasked to provide perspectives on these oils: the Royal Society of Canada (RSC) and the National Academy of Science (NAS) in the United States. NRCan Written Evidence ANNEX I-J 27May15 (Filing ID A4Q0V3) provides presentations by H. Dettman to RSC and NAS. HDR (2015) compiled a review and summary characterization of oil sands products compared to other transported crude oils. Both Zhou *et al*., (2015) and

CRREL/SLRoss (2015), performed tank tests to compare the behaviours of conventional crudes and oil sands products, both of which are extensively discussed below. A common feature of all cited reports is that they confirm and complement the information provided in the Application and in Trans Mountain's IR responses.

25.5.1 NRCan and Alberta Innovates

Zhou *et al*. (2015) and NRCan Written Evidence ANNEX I-J 27May15 (Filing ID A4Q0V3) describe tests conducted to observe, analyze, and compare the fate and behaviour of dilbit (CLWB) with conventional crude oil (MSB). Fresh oils were introduced into a wave tank and allowed to weather over an 8-day period. The weathering in the tanks alternated between two (2) days of high energy (breaking waves) and two (2) days of still conditions (Table 25-3). The receiving water was fresh water in which natural (Saskatchewan River bank) sediments (clay to silt sizes) had been introduced to achieve a 2,000 ppm concentration.

TABLE 25-3

SUMMARY OF DILBIT AND CONVENTIONAL OIL BEHAVIOURS ON FRESHWATER WITH SEDIMENT WAVE TANK TESTS

	Time Periods			
Oil	2 Days High Energy	2 Days Still	2 Days High Energy	2 Days Still
CLB-W	Most of oil floating at beach	Thick layer of oil covering water surface	Most of oil floating at beach	Thick layer of bubbly oil covering water surface
	Oil stuck on beach	Oil stuck on beach	Oil stuck on beach	Oil stuck on beach
	Oil line on window, otherwise clear	Oil line on window, otherwise clear	Oil line on window, otherwise clear	Oil line on window, otherwise clear
ALO-1	Oil dispersed (none floating)	Thin layer of bubbly oil covering water surface	Oil dispersed (none floating)	All oil submerged
	Oil stuck on beach	Oil stuck on beach	Oil removed from beach	Oil removed from beach
	Window covered with oil	Top 25% of Window cleared of oil	Window covered with oil	Top 25% of Window cleared of oil

Source: From NRCan Written Evidence ANNEX I-J 27May15; Filing ID A4Q0V3

Dilbit remained floating through the duration of the test, either at the edge of the tank beach during the two breaking-wave weathering intervals or spread out over the water surface during the still water intervals. In contrast, the conventional crude immediately dispersed into the water column upon spillage in front of the breaking wave. A portion of the conventional crude rose to the surface during the first still period; however, the conventional crude dispersed again when the waves were restarted and did not resurface again when the water was still the second time.

Observations for oil on the beach indicated a portion of the conventional crude adhered to the beach during the initial breaking-wave weathering interval and remained there during the first still water interval. However, upon starting the second high-energy interval, the conventional crude was removed from the beach by the wave action. This washing effect was not observed on dilbit as the portion of oil stuck to the beach was not removed by wave action.

As tanks were emptied, there was no obvious dilbit either stuck to the tank bottom or on the sediment.

In terms of OMA formation, the authors noted:

> "Low viscosity oils that readily disperse form OMAs; higher viscosity oils do not disperse easily and so forms less OMAs. The results from these tank tests support their (Stoffyn-Egli and Lee (2002) conclusions. Consequently, the increased interaction of the conventional crude with the sediment is expected due to its low viscosity. Similarly, that the dilbit had higher viscosity and did not disperse into the water column agrees with low quantity of OMAs formed as indicated by the high recovery of dilbit obtained."

25.5.2 CRREL/SLRoss Study

In a study performed for the API (CRREL/SLRoss 2015), researchers studied five (5) oils:

- three [3] dilbit oil sands products (OS1, OS2, and OS3) consisting of:
  - two [2] dilbits (OS1 and OS3) and
  - one [1] dilsynbit (OS2); and,
- two [2] conventional heavy crude oils (CH1 and CH2)

It is important to note that the fresh oil characteristics for the OS2 oil tested exceeded the NEB tariff specifications for pipeline transport by Trans Mountain (*i.e.*, as tested, the OS2 oil would not have met pipeline transport conditions).

The study's objective was to investigate the behavioural similarities or differences between the products spilled under various environmental conditions. Evaporation and standardized analyses were performed to generate quantitative data for modelling purposes recognizing that the pan-evaporation tests do not necessarily simulate realistic spill conditions. As commented by the authors: "One of the primary concerns regarding dilbit products is whether or not the oil will sink if spilled in a fresh or salt water environment."

Flume Tests

Each oil was tested in a flume and circulated around the tank via surface wind shear and water currents. Flume tests included freshwater and saltwater (35 parts per thousand) runs for each oil, with two (2) controlled temperature settings: 20°C for the warm water tests and 2°C for the cold water tests.

The tested dilbits never sank in any of the tests. No oil was found on the tank bottom at the end of the testing for two (2) of the oil sands products (OS1 and OS3). The OS1 (dilbit) did not sink in the tests but the oil density did reach 1.000 g/cc after five days of weathering. The OS3 (dilbit) density remained below 1.000 g/cc over the five day test period and also did not sink. In the meso-scale flume tests conducted in this study a portion of the weathered OS2 dilsynbit sank in the fresh water tests but not in the salt water tests.

Thus, of the three (3) oil sands products tested, only the dilsynbit (OS2) showed partial submergence and sinking behaviour and then only in the freshwater tests. However, the fresh oil characteristics for the OS2 oil tested exceeded the NEB tariff specifications for pipeline transport by Trans Mountain (*i.e.*, as tested, the OS2 oil would not have met pipeline transport conditions). As such, the OS2 results are inconclusive as far as they pertain to TMEP.

The oils with the highest evaporative losses in both the cold and warm water tests over the 5 days were OS1, OS3 and the CH1 conventional heavy crude oil. As would be expected, the evaporative loss of the oils occurred more quickly in the warm water tests and was slightly higher at the end of testing. The oil densities and evaporative losses were very similar for the cold fresh and salt water tests.

The meso-stable emulsions that formed during the tests generally did not achieve high water contents. Water contents peaked at about 24 hours (reaching maximums of about 45% water content) and then decreased over time (dropping to 20 to 25% water content).

The authors noted that: "*the surface behavior of all of the oils on the recirculating flume was quite similar. In the early stages of the test the oils flowed freely around the flume on the water surface. As the oil weathered and became more viscous the flow was reduced and attachment of oil to the tank side walls resulted in a build-up of oil in calmer areas with oil streamers and then smaller pieces eventually stripping away from the down-wind and down-current end of the slick and returning to the backside of the stationary oil patch. Good mobility of the surface oil was observed up to the point where the oil viscosity reached approximately 20,000 cP. For all except one conventional heavy crude, oil mobility decreased significantly with about 24 hours of exposure in the warm water tests and between 6 and 12 hours in the cold water tests*."

In none of the experiments was there any evidence of phase separation with the dilbits, contrary to the statement made by Musqueum Indian Band: *"Over a matter of a few hours weathering would cause spilled dilbit to lose the condensate diluent by evaporation becoming non-buoyant and potentially sinking*" (Section 3.5, page 20, Prelim Report MIB Evidence for TMEP; Filing ID A4Q2F9). The fresh and evaporated oils remained as homogeneous mixtures of soluble components.

The CRREL/SLRoss (2015) study corroborates many of the findings expressed in earlier studies. The authors include in their discussion the following:

> "The meso-scale flume testing results indicated that the diluted bitumen products may not form as stable emulsions as some heavy conventional oils. This could result in an improved window of opportunity to burn the diluted bitumen products insitu when compared to conventional crude oils. Both the heavy conventional crude oils and diluted bitumen products achieved high viscosities when they weathered. These high viscosities will require that specialized heavy oil skimmers and oil handling systems be used in a spill response. These heavy oil response packages will be effective on both oil types but may be needed somewhat earlier in the response operation in the case of diluted bitumen spills. Chemical dispersants are likely to be a viable option for both the heavy conventional and diluted bitumen crudes only when the oils are relatively fresh and have not weathered and increased in viscosity to the point where the dispersant no longer mixes well with the oil. The window of opportunity for dispersant use will be short for both of these oil types."

Streambed Tests

A series of twenty-four (24) experiments were conducted in a tilting flume at CRREL to investigate the behaviour of spills in rivers of three [3] of the five [5] different crude oil types: CH2, OS2, and OS3.

The flume was prepared with four (4) sediment types: sand, gravel, cobble, and sand separated by rock weirs spaced 7 m apart. The flume was configured with a weir at the upstream end to provide a small waterfall into the downstream riverbed. Oil was introduced onto the water surface above the weir and subjected to the significant turbulence at the base of the fall to provide the most likely effective mechanism for incorporation of oil into the streambed sediments. The entire streambed was examined after each test to identify the extent of oiling (surface coverage estimates and extent of downstream oiling).

The results showed that there was no noticeable difference in the behaviour and amount of sediment oiling among the fresh oils (*i.e.*, un-evaporated). All oils dispersed somewhat as they passed over the initial weir at the head of the flume and then reformed a slick that floated down the length of the flume without causing more than light oiling of the streambed, regardless of sediment type.

Differences in behaviour and sediment oiling were noted with the evaporated test oils (note: oils were evaporated artificially through air sparging and, where required, limited heating). The degree of streambed oiling by the evaporated crudes appears to be a function of both crude oil type and sediment type. The degree of streambed oiling increased with increasing evaporated oil density and increasing bottom roughness (the oiling of the sand streambed was minimal while the oiling of the gravel and cobble streambeds ranged from light to heavy). Of the three products tested, OS2 caused the higher amount of streambed oiling (CH2 < OS3 < OS2). As noted earlier, the fresh oil density of OS2 as tested would not have met pipeline transport conditions.

25.6 Further Research in Oil Properties

A number of intervenors have voiced concerns about possible lack of information regarding the properties and behaviour of dilbit. As acknowledged in the NEB Review for Enbridge Northern Gateway:

> "Although there is some uncertainty regarding behaviour of dilbit spilled in water, the Panel finds that the weight of evidence indicates that dilbit is no more likely to sink to the bottom than other heavier oils with similar physical and chemical properties. The Panel finds that dilbit is unlikely to sink due to natural weathering processes alone, within the timeframe in which initial, on-water response may occur, or in the absence of sediment or other particulate matter interactions. The Panel finds that a dilbit spill is not likely to sink as a continuous layer that coats the seabed or riverbed." (NEB 2013, page 99)

In addition to industry, Environment Canada, DFO, and Natural Resources Canada have conducted scientific research on non-conventional petroleum products, such as dilbit, to enhance the understanding of these substances and how they behave when spilled in the marine environment. Their results have helped to corroborate the findings from the Gainford study (Filing IDs A3S5G2, A3S5G4, A3S5G5). The government research also provides a better understanding of the effect of products, such as dilbit, on marine ecosystems. Trans Mountain and other experts believe enough is known about dilbit properties to allow for effective response in the unlikely event of a spill.

Evidence submitted by Environment Canada (Filing ID A4L8Y6, page 121) notes:

> "EC recognizes the extent of data already provided and accepts it as useful for understanding possible spills of these products. However, data needs for emergency

> preparedness and effective response requires consistent data on key chemical constituents and certain physical properties for all products to be transported by the proposed project, and secondly, routine, periodic re-measurement to ensure that the data adequately represent the hydrocarbon products transported in the future."

The emphasis placed in this Environment Canada comment pertains to common protocols for the range of oil sands products that are, or will be proposed, for transport via TMEP, knowing that each product must still meet the NEB tariff specifications for pipeline transport. Trans Mountain recognizes that ongoing characterization of oil sands products are provided through crudemonitor.ca and that additional properties tested can add to improved knowledge regarding potential risks.

25.6.1 Royal Society of Canada

Additional studies and information to be gained from further investigation on oil sands products are the subject of several prior IRs and the focal point of the two national review panels: the RSC and the NAS (USA; refer to NEB IR No. 1.63a; Filing ID A3W9H8). Continued integration of scientific research on dilbits or other oil sands products, as with any oil, is expected to lead to improved decision-making in the areas of spill-response technologies and countermeasures, enabling identification of additional best practices with regard to the selection of the best response tools in a given situation. For example, Natural Resources Canada is launching the Oil Spill Response Science (OSRS) Program. The OSRS Program is a conditionally repayable contribution program that will provide $5 million over three years (2016 to 2019) for research, development, and demonstration (RD&D) projects focused on improving current mechanical recovery technologies and processes for the cleanup of heavy oil products spilled in marine environments.

25.6.2 Environment Canada Recommendations

In Evidence submitted by EC (Filing ID A4L8Y6), EC provides several recommendations, two of which pertain to further oil research.

Recommendation 2-17

Recommendation that the Responsible Authority require that the Proponent undertake studies on the effects of oil on biofilm, given the limited understanding of oil spill effects on biofilm and the importance of biofilm in supporting shorebird populations.

Trans Mountain notes that this relatively limited understanding pertains to any oil that could affect the marine biofilms of area mud flats.

Trans Mountain recognized in its Application that biofilms are a component considered in potential effects of a spill (Application, Technical Report 8B-7, Marine Spills, Section 6.2; Filing ID A3S4K7). In Technical Report 7-1, Pipeline Spills, Section 6.2.2.10 (Filing ID A3S4W9), Trans Mountain referenced the Proposed Vancouver Airport Fuel Delivery Project and work done for that Application, which were reported by the proponents (VAFFC 2012a,b) and underwent regulatory review (Environment Canada 2012). One of the biofilms described in the VAFFC report is an extracellular polysaccharide material, typical of bacterial and fungal assemblages, which also are related to oil biodegradation. In its review of the Vancouver Airport Fuel Delivery Project, Environment Canada agreed that the potential effects of a Jet A fuel spill

on biofilm were unlikely to be high-magnitude and irreversible (Environment Canada 2012), which also would be the case in the unlikely event of a spill from the Project.

The Environment Canada Recommendation 2-17 is not specific to the Application and, although of interest, should be a subject for consideration in future research and not as a pre-requisite before operations. Trans Mountain does not agree that this recommendation should be a condition for approval.

Recommendation 4-3

Recommendation that Trans Mountain commit to provide spill responders and regulators a specific suite of test data for all types of hydrocarbon products to be shipped, before shipping, to facilitate appropriate spill response preparedness.

Trans Mountain is supportive of regulators having appropriate level of information on the properties of oil carried in pipelines but believes this is a matter that requires industry-wide development and consultation between regulators and industry. Many tests are already in the public domain on key oils and Environment Canada typically has maintained an extensive database on oils and properties (Environmental Science Technology Centre, Ottawa). Trans Mountain also collects and maintains comprehensive data related to the physical and chemical characteristics of all oils transported in the TMPL system and provides those to regulators and responders, as appropriate or upon request. The sources of that information include the Commodity Approval Process, Routine Testing Requirements described in the Service Standards, valid Material Data Safety Sheets (MSDS), and the Canadian Association of Petroleum Producers (CAPP) sponsored crudemonitor.ca.

As noted in Trans Mountain Response to Province of BC IR No. 2.31a (Filing ID A4H8W6), all Trans Mountain field personnel who are expected to respond to an incident on the TMPL system are trained in Incident Safe Approach. Trans Mountain is able to quickly identify the product in a storage tank and/or specific pipeline location and almost immediately provides MSDS, including the product name, to incoming first responders. As part of its ongoing public awareness program, Trans Mountain provides training to first responders that includes considerations for safest approach to a release. Trans Mountain also has an ongoing program to provide Community Awareness Emergency Response (CAER) sessions to first responders along the pipeline system. These sessions provide information with regard to the type and properties of petroleum transported through the pipeline and how to respond safely.

In the unlikely event of a release, Trans Mountain provides MSDS and the product name to incoming first responders and communities as soon as possible to determine selection of appropriate recovery equipment, and assess immediate health and safety risks for both responders and the general public. In the event of a pipeline-related release, the Trans Mountain Control Centre communicates the MSDS information as part of the Emergency Condition Report, along with pertinent information about location, estimated volume, and related information. If an event were to occur after a tanker has loaded and been released from the Westridge Dock, the MSDS and representative samples would be onboard, as they are supplied to the vessel before departure.

As mentioned earlier, the MSDS carries details of chemicals in the oil that could be potentially harmful to first responders and others in the immediate aftermath of an oil spill. The chemical

properties requested in Environment Canada Recommendation 4.3 that are not typically included in the Trans Mountain analyses and oil characterization testing, or MSDS, are:

- PAH and alkylated PAHs;
- Hopane and sterane “biomarker” compounds, and,
- Hydrocarbon group constituents (“SARA”).

Trans Mountain disagrees that these additional tests should be pre-requisites for Application approval or for shipments. These analyses have not been required for shipments of oils. The information gained from these additional analyses are of interest scientifically but are not expected to drive first response. Given that representative samples of both pipeline batches and ship cargoes are collected and retained, these types of analysis can be performed post-event.

- PAH and alkylated PAHs

  While PAH includes compounds that have some of the more serious environmental effects of the compounds in crude oil, exact prior knowledge of the PAH concentrations does not impact strategies or actions of first responders. PAH analyses assist in characterizing the originating dilbit for assessment of hydrocarbon content and degradation patterns.

- Hopane and sterane “biomarker” compounds

  Biomarkers such as hopane and sterane can be detected in low quantities (ppm and sub-ppm level) in the presence of other types of petroleum hydrocarbons by the use of the gas chromatography/mass spectrometry (GC/MS). Relative to other hydrocarbon groups, biomarkers are more degradation-resistant in the environment. Chemical analysis of biomarkers generates information to assist in environmental forensic investigations in terms of determining the source of spilled oil, differentiating and correlating oils, and monitoring the degradation process and weathering state of oils under a wide variety of conditions.

- Hydrocarbon group constituents (“SARA”)

  Oils can be categorized into different hydrocarbon groups on the basis of solubility and adsorption characteristics. A common methodology is to separate these fractions by a sequence of solvent extraction and adsorption columns into four groups: saturates, aromatics, resins, and asphaltenes, collectively referred to by the acronym SARA. The determination of hydrocarbon groups in crude oils can contribute to our understanding of both physical and behavioural oil properties. The concentration and relative ratios of these compounds can impact dissolution, photo-oxidation, bio-degradation, emulsion formation, and weathering characteristics. This information is useful as a spill matures, but like PAHs and biomarkers, SARA data is not a governing factor during initial spill response and can be determined as required.

Recommendation 4-4

EC recommends that the Proponent commit to provide, upon request, representative samples of any hydrocarbon products to be shipped for the purposes of verification and validation of the standard physical properties and chemical composition data they provide in Table 4-2.

Trans Mountain is not the owner of oil shipped through the pipeline. As such, representative samples can only be provided after the requesting party has obtained permission from the shipper. Trans Mountain has always provided a facilitation role by liaising in sample procurement, ensuring samples are drawn safely, and arranging to transport oil samples to the requesting party. A separate commitment is not necessary.

Recommendation 4-5

EC recommends that the Proponent commit to supporting research on the development of standardized methods and research protocols for characterizing hydrocarbon behaviours in the environment, and to applying the new knowledge to the specific hydrocarbon products to be shipped. The resulting enhanced data and information on compositions, evaporation, emulsification, sediment mixing and other behaviours for the specific hydrocarbon products being shipped should be readily accessible to spill responders and regulators before transport.

As discussed earlier, Trans Mountain is aware of various research initiatives on hydrocarbon properties and behaviours in the environment. Trans Mountain supports having well-considered and practical standardized methods and research protocols for characterizing hydrocarbon behaviours in the environment. However, this should not be done on a pipeline by pipeline basis and needs to be a joint initiative between the regulator, industry, and other government agencies. Instead, like the work currently being undertaken by the RSC (described above in Section 66.6.1) industry representation is best provided through organizations like the Canadian Energy Pipeline Association and CAPP. The products transported by Trans Mountain are not unique to Trans Mountain, rather they are representative of oils produced in the Western Canadian Sedimentary basin and moved to market by all other pipelines emanating from this basin. As such, Trans Mountain does not support this item as a condition on the Project.

25.7 References

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26.0 COSTS OF AN OIL SPILL

Several intervenors (*e.g.*, Lyackson First Nation [Filing ID A4Q0H9; Filing ID A4Q0I4, pages 20-21, 31], Maa-nulth Nations [Filing ID A4L6D5, Section 4.3], Matsqui First Nation, Pacheedaht First Nation [Filing ID A4L5K2, paragraphs 124, 132-137], Tsleil-Waututh Nation [Affidavit of Ernie George, Filing ID A4L5Z8, paragraphs 18-24, pages 6-9], US Tribes [Filing ID A4L7G7, paragraph 17; Filing ID A4L7G8, paragraph 9], A. Olsen [Written Evidence, Filing ID A4L6V3, Section 8], and Unifor [Filing ID A4L6C6, paragraphs 46, 47, 49, 52]) expressed concern that tanker spills would have long-term to permanent effects on their resource-based economy, commercial and traditional harvest activities, culture, and community well-being. Trans Mountain acknowledges the high level of First Nation, government, and public concern about spills, and the Application confirmed that evidence from past spills demonstrates that Aboriginal peoples who rely on subsistence foods and natural resources are at greatest risk of adverse socio-economic effects (Filing ID A3S5Q3, Volume 8A, Section 5.6.1). Matsqui First Nation (Matsqui First Nation Impact Assessment, Filing ID A4L8J3, Sections 7.1.3, 7.1.4, 7.1.5, pages 77-118) constructed a narrative about potential effects of hypothetical spills and cleanup activities at two locations in the lower Fraser River valley and one location along the marine shipping route. The estimates of impact magnitude and duration for hypothetical spills provided by intervenors in their evidence appear to reflect worst-case assumptions.

Other intervenors (*e.g.*, City of Port Moody [Filing ID A4L7Q4, pages 3-5; Filing ID A4L7Q6], City of Victoria [Filing ID A4L8Y1, Section 5], and NS NOPE [Filing ID A4L5Y9]) expressed concern that tanker spills would affect city parks and public spaces, recreational marine use, human health, cultural and historic resources, municipal services, and community well-being. These intervenors provided estimates of some potential spill-related damages. These potential effects were also identified in the Application (Filing ID A3S5Q3, Volume 8A, Section 5.6.1), but Trans Mountain concluded that there is no credible way to predict or quantify socio-economic impacts of hypothetical future events, and the estimates of magnitude and duration provided by intervenors appear to reflect worst-case assumptions. As stated in responses to a number of requests for additional information, actual socio-economic effects would depend on the unique circumstances of a spill, were one to occur (*e.g.*, response to City of Port Moody IR No. 2.3.15b, 2.3.24c, Filing ID A4H8G7).

While in no way diminishing understandable concerns about spills, Trans Mountain notes that the risk of significant adverse spill effects already exists from current developments and activities in Burrard Inlet and along the marine shipping route, and that the probability of such events is demonstrated to be low, both by analyses included in the Application (Filing IDs A3S4Y3 and A3S4Y4, Volume 8A, Sections 5.2.1, 5.2.2, 5.2.3, and 5.2.5,) and Trans Mountain's 60 year operating history with no tanker-related spills. Proper design and emergency preparedness planning was identified both by Trans Mountain and intervenors as the most practical and cost effective approach to minimize spill risks. In addition, the most appropriate mitigation for socio-economic effects in the event of a spill was described in the independent review commissioned by Vancouver Coastal Health (Eykelbosh 2014, *e.g.*, response to City of Port Moody IR No. 2.3.24c, Filing ID A4H8G7): easing financial uncertainty through timely and satisfactory compensation; implementing mechanisms that encourage or utilize social support and public engagement; and risk communication about a spill and food safety in particular. Trans Mountain has committed to invite affected groups to participate in the UC established as part of the Incident Command System for those spills for which it is responsible. Participation in UC would allow affected groups to identify measures to mitigate potential socio-economic

effects based on the unique circumstances of a spill (*e.g.*, response to District of North Vancouver IR No. 2.02.3a, Filing ID A4H8L7).

26.1 References

Eykelbosh A. 2014. Short- and long-term health impacts of marine and terrestrial oil spills. Literature review prepared for the Regional Health Protection Program, Office of the Chief Medical Office, Vancouver Coastal Health by Institute for Resources, Environment and Environmental Sustainability.

27.0 ECONOMIC COSTS OF AN OIL SPILL

27.1 Introduction

A number of intervenors and commenters have addressed issues associated with the economic costs of a potential oil spill arising from Project operations of the pipeline, from activities at a facility, or from operations of Project-related tankers calling at the Westridge Marine Terminal. This section of the Reply Evidence addresses evidence contained in the following documents:

- Tofino-Long Beach Chamber of Commerce (TLBCC). "C350-3-1 TLBCC Intervenor Evidence May 27th submission." Prepared by Emery Hartley, Dave Mills & Jen Dart. Filing ID A4Q2G1.
- City of Vancouver. "C77-27-01 Written Evidence of the City of Vancouver." Filing ID A4L7V8.
- City of Vancouver. Appendix 81. "C77-30-06 Local Government Impacts of Oil Spills: A Study of Potential Costs for the City of Vancouver." Prepared by Jeremy Stone. Filing ID A4L8E9. Referred to here as the "Stone Report."
- City of Vancouver. Appendix 82. "C77-30-07 Brand Valuation." Prepared by Edgar Baum Brand Finance (Canada) Inc. Filing ID A4L8F0. Referred to here as the "Brand Finance Report."
- City of Vancouver. Appendix 83. "C77-31-08 Direct Written Evidence of Rashid Sumaila, May 19, 2015: Appendix B: Potential Economic Impact of a Tanker Spill on Ocean-dependent Activities in Vancouver, BC," Prepared by Sumaila R, Hotte N, Bjarnason H. Filing ID A4L9G4. Referred to here as the "Sumaila Report."
- City of Victoria. "C84-2-2 Written Evidence of the City of Victoria." Filing ID A4L8Y1.
- Upper Nicola Indian Band. "C363-21-22 An Assessment of Oil Spill Risks for the Trans Mountain Expansion Project," Prepared by Gunton T & Broadbent S. Filing ID A4Q1T7. (Also filed as Volume 5 of Tsleil-Waututh Nation's Record of Written Evidence Filing ID A4L6A6.) Referred to here as the "Gunton & Broadbent Report."
- Catherine Douglas. "C112-2-5 Economic Costs and Benefits of the Trans Mountain Expansion Project (TMX) for BC and Metro Vancouver, 2014." Prepared by Goodman I & Rowan B, The Goodman Group Ltd. In Collaboration with The Centre for Public Policy Research, Simon Fraser University. Filing ID A4Q0C1. Referred to here as the "Goodman Report."

Trans Mountain notes that the documents sometimes do not treat or specify whether the costs are associated with pipeline, facility, or tanker spills. Similarly, they do not specify whether the spills originate in the terrestrial or marine environment. For the purposes of this Section 27 (Economic Cost of an Oil Spill) of the Reply Evidence, therefore, costs from all sources (pipeline, facility, and tanker) into either the terrestrial or marine environments are addressed. Trans Mountain notes, however, that it is not the Responsible Party in the event of a tanker-based spill when the tanker is in transit to or from the Westridge Marine Terminal.

Trans Mountain further notes that the nature of the issues addressed by intervenor evidence include (i) evidence relating directly to magnitude of spill costs and the various components of these costs; (ii) evidence relating to the general adequacy or sufficiency of the compensation regimes; (iii) evidence relating to the eligibility of specific spill costs for compensation under the applicable liability and compensation regimes; and (iv) evidence associated with compensation related to emergency response preparation costs (as opposed to actual emergency response costs). The scope of this Section 27 focuses on issues associated with the *magnitude* of oil spill costs; the *compensation regimes* are also summarized here because the limits of the regimes are best represented and understood in the context of the spill magnitudes. Intervenors also addressed selected cost component issues which are addressed in this Section 27: including Ecosystem goods and services, brand value, extra-territorial costs, volunteer costs, research costs and costs associated with illegal activities. Detailed issues associated with compensation adequacy, eligibility, and timing are addressed in Section 61 (Marine Spill Liability Compensation).

Finally, Trans Mountain's experts have prepared specific stand-alone reports to address the contents and conclusions of selected intervenor documents. Specifically, Trans Mountain also adopts as its evidence the following:

- Attachment 1.02 by Glen Hodgson, The Conference Board of Canada; Steven N. Fekete, IHS; and, Dr. Jack Ruitenbeek, HJ Ruitenbeek Resource Consulting Limited. Reply to Catherine Douglas, "Economic Costs and Benefits of the Trans Mountain Expansion Project (TMX) for BC and Metro Vancouver, 2014." Prepared by Goodman I & Rowan B, The Goodman Group Ltd. In Collaboration with The Centre for Public Policy Research, Simon Fraser University. Referred to here as the "Reply to the Goodman Report."
- Attachment 1.06 by the Glen Hodgson, Conference Board of Canada; Jack Ruitenbeek, HJ Ruitenbeek Resource Consulting Limited.. Reply to City of Vancouver "Potential Economic Impact of a Tanker Spill on Ocean-dependent Activities in Vancouver;" Prepared by Sumaila R, Hotte N, Bjarnason H." August 2015. Referred to here as the "Reply to the Sumaila Report."
- Attachment 1.07 by DNV, Dynamic Risk, CH2M Hill Energy Canada, HJ Ruitenbeek Resource Consulting Limited, and the discipline experts on the Trans Mountain Expansion Project. Reply to Tsleil-Waututh Nation, Tsawout First Nation, Upper Nicola Indian Band: An Assessment of Oil Spill Risks for the Trans Mountain Expansion Project, prepared by Gunton and Broadbent. August 2015. Referred to here as the "Reply to the Gunton & Broadbent Report."

27.2 Summary of Trans Mountain Evidence

27.2.1 Pipeline and Facility Spills

The Application provides Trans Mountain's evidence relating to oil spills for which it is the Responsible Party. For an assessment of costs of hypothetical land-based spills, please refer to "Potential Cleanup and Damage Costs of a Hypothetical Oil Spill: Assessment of Trans Mountain Expansion Project" in Application Volume 7, Appendix G (Filing ID A3S4W8). Metro Vancouver can be regarded as a HCA within the context of that analysis. The assessment indicates that a credible worst-case spill would have a cost of the order of $100 million to $300 million. Additional sensitivity analyses are reflected in Trans Mountain's Response to NEB IR

No. 1.10b (Filing ID A3W9H8, Page 32 of 481); that response indicates that a large spill (4,000 m^3) affecting an HCA would have a cost of the order of \$340 million. A full description of the model with all assumptions and equations was provided as part of Follow-Up Response to NEB Ruling 33 Allan R F-IR No. 1.18c (Filing ID A4D3G4). This evidence has not been specifically refuted; the general approach that intervenors have taken to spill costs is to develop their own narratives around potential worst-case scenarios based on a small selection of spills.

Trans Mountain has also documented the resources available to address any such costs. Trans Mountain has access to \$750 million in insurance for a land-based spill. Compensation frameworks and insurance covering a land-based spill are described in responses to NEB IR No. 1.08b to 1.08h (Filing ID A3W9H8, Page 24 of 481). In the event that a liability occurs that is in excess of its insurance, Trans Mountain expects that any losses and claims would be paid out of cash reserves and cash flow from operations, which are illustrated in the response to NEB IR No. 1.09a and 1.09b (Filing ID A3W9H8, Page 24 of 481). Those responses illustrate that Trans Mountain expects that it would have cash available over the first 5 years of approximately \$2.1 billion and a cash reserve balance at the end of Year 5 of approximately \$150 million. To the extent there is insufficient cash available Trans Mountain would either draw on credit facilities, issue debt, or borrow from its parent depending on the extent of the loss and its immediacy.

Moreover, recent promulgation of the *2015 Pipeline Safety Act - An Act to amend the National Energy Board Act and the Canada Oil and Gas Operations Act* will see its various provisions in full force by June 2016. The Act reinforces the polluter pays principle, and confirms that the liability of companies that operate pipelines is unlimited if an unintended or uncontrolled release of oil, gas or any other commodity from a pipeline that they operate is the result of their fault or negligence. The Act also establishes the limit of liability without proof of fault or negligence at no less than one billion dollars for companies that operate pipelines that have the capacity to transport at least 250,000 barrels of oil per day. The provisions of the Act also affirm that pipeline operators will need to demonstrate that financial resources of \$1 billion are available in the event of a spill.

The Summary from the Act highlights the enhancements that will be in place by June 2016 (Website http://www.parl.gc.ca/HousePublications/Publication.aspx?Language=E&Mode=1&DocId=8057008; Accessed 25 June 2015):

> SUMMARY
> This enactment amends the *National Energy Board Act* and the *Canada Oil and Gas Operations Act* in order to strengthen the safety and security of pipelines regulated by those Acts.
> More specifically, the enactment, among other things,
> (*a*) reinforces the “polluter pays” principle;
> (*b*) confirms that the liability of companies that operate pipelines is unlimited if an unintended or uncontrolled release of oil, gas or any other commodity from a pipeline that they operate is the result of their fault or negligence;
> (*c*) establishes the limit of liability without proof of fault or negligence at no less than one billion dollars for companies that operate pipelines that have the capacity to transport at least 250,000 barrels of oil per day and at an amount prescribed by regulation for companies that operate any other pipelines;
> (*d*) requires that companies that operate pipelines maintain the financial

resources necessary to pay the amount of the limit of liability that applies to them;

(*e*) authorizes the National Energy Board to order any company that operates a pipeline from which an unintended or uncontrolled release of oil, gas or any other commodity occurs to reimburse any government institution the costs it incurred in taking any action or measure in relation to that release;

(*f*) requires that companies that operate pipelines remain responsible for their abandoned pipelines;

(*g*) authorizes the National Energy Board to order companies that operate pipelines to maintain funds to pay for the abandonment of their pipelines or for their abandoned pipelines;

(*h*) allows the Governor in Council to authorize the National Energy Board to take, in certain circumstances, any action or measure that the National Energy Board considers necessary in relation to an unintended or uncontrolled release of oil, gas or any other commodity from a pipeline;

(*i*) allows the Governor in Council to establish, in certain circumstances, a pipeline claims tribunal whose purpose is to examine and adjudicate the claims for compensation for compensable damage caused by an unintended or uncontrolled release of oil, gas or any other commodity from a pipeline;

(*j*) authorizes, in certain circumstances, that funds may be paid out of the Consolidated Revenue Fund to pay the costs of taking the actions or measures that the National Energy Board considers necessary in relation to an unintended or uncontrolled release of oil, gas or any other commodity from a pipeline, to pay the costs related to establishing a pipeline claims tribunal and to pay any amount of compensation that such a tribunal awards; and

(*k*) authorizes the National Energy Board to recover those funds from the company that operates the pipeline from which the release occurred and from companies that operate pipelines that transport a commodity of the same class as the one that was released

For further information, please refer to Section 4 - Corporate Liability of this Reply Evidence.

27.2.2 Tanker Spills

Trans Mountain is not liable for a tanker-based marine spill, and has not estimated any costs. Responsibility for such an event lies with the tanker owner. Trans Mountain also notes that, because each spill is different, it is not possible to provide breakdowns or aggregates of costs for a hypothetical event. The NEB articulated (September 2013) the filing requirements regarding environment and socio-economic effects for increased marine shipping activities and specified that "*The assessment of accidents and malfunctions must also provide a description of the liability and compensation regime that would apply in the case of a spill*." Such a description is found in Volume 8A, Section 1.4.1.6 (Filing ID A3S4X3) of the Application. Procedures in Canada are defined under the *Marine Liability Act* and guidance for claims is provided under the International Oil Pollution Compensation Fund (IOPCF) Claims Manual (Filing ID A3X5W1) and Canada's SOPF Claims Manual 2014 (Filing ID A4H8G6). Canada's SOPF considers claims as stipulated in Part 7 of the *Marine Liability Act*.

The existing regime comprising the IOPCF and Canada's SOPF together provide in excess of $1.44 billion of funding to compensate eligible spill costs in the event of an incident. Trans Mountain supports proposed measures that would increase this funding as outlined in the

Recommendations of the Tanker Safety Expert Panel; the measures effectively remove the caps to this funding through providing the SOPF with additional financing capacity. The TMEP TERMPOL Report describes these and other potential enhancements to the compensation regime being considered by the Government of Canada, including regulatory amendments to the SOPF (Filing ID A4F8Z4, PDF page 52 of 68):

> "Strengthening the polluter pay regime by introducing legislative and regulatory amendments that will enhance Canada's domestic Ship-Source Oil Pollution Fund (SOPF). These amendments will:
>
> - remove the fund's existing per-incident liability limit of $161 million to make available the full amount of the SOPF for a single incident, currently around $400 million;
> - ensure compensation is provided to eligible claimants and recover these costs from industry through a levy, in the unlikely event that all domestic and international pollution funds have been exhausted; and
> - compensate those who have lost earnings due to an oil spill even if their property has not been contaminated by a spill."

Trans Mountain notes that the potential amendments would serve to improve what is already a regime that is among the most robust in the world. The financial liability tiers (ship-owner insurance, Canada's SOPF and the IOPCF) provide funding that would be available in the event of any marine incident. No spill in Canadian waters has ever exceeded the caps available within this regime. Internationally, no spill within the jurisdiction of the IOPCF has exhausted the resources available through the funding tiers that include the 1992 Fund and the Supplementary Fund; Canada has access to both of these funds.

Trans Mountain notes that the regime itself can continue to evolve and improve even without enactments. For example, funds available through Canada's SOPF increase every year through indexing. Voluntary measures by industry (such as conducting a TERMPOL Review) help identify measures that continue to improve marine safety.

27.3 Summary of Stand-Alone Reviews

27.3.1 Summary of Review of Goodman Report

Trans Mountain does not regard the Goodman Report as providing credible costs that are applicable to the circumstances representative of the Application. To inform their conclusions, the authors rely on examples involving the Lac Mégantic (Québec) rail spill, the San Bruno (USA) natural gas pipeline explosion, and the fires from two explosions after an incident in Qingdao (China). These situations are not analogs for Trans Mountain's existing facilities or for the proposed expansion.

27.3.2 Summary of Review of Sumaila Report

The Sumaila Report provides a further example of spill cost estimation, in this instance using a hybrid approach that confuses economic costs with economic impacts. The mixture of the approaches makes it impossible to replicate or compare figures using accepted approaches such as cost-benefit analysis (which considers economic efficiency losses) and economic impact analysis (which tracks initial impacts through a series of subsequent indirect and induced impacts). The method used in the hybrid approach essentially considers rent losses

(*i.e.*, efficiency losses) from an oil spill in the Metro Vancouver area across five ocean-dependent economic segments (commercial fishing, shipping, cruises, seaplane transportation, and ocean side recreation by tourists and locals). These are then processed through multipliers, and subsequent results are discounted at a 3% discount rate. Most of the technical input assumptions are based on arbitrary assumptions, and many of the economic assumptions are selected without defensible rationales except that they serve to increase the final costs. For example, the literature referenced by the authors for cruise ship tourism suggests that tourism impacted by an oil spill typically recovers within 3 years, yet their modelling results assume a 5 to 8 year delay before tourism recovers. Also, the 3% discount rate is cited as being relevant for environmental projects, but this is not an environmental project: all the activities considered are normal commercial businesses. Environmental projects are investments that are intended to provide permanent improvements to environmental assets (such as the addition of treatment systems to a sewage outfall). The selection of the 3% rate serves only to increase the present value of the cost stream.

In addition to the methodological issues, a number of technical flaws are evident. First, the report does not realize or does not acknowledge that the economic impact conducted by the Conference Board of Canada (CBoC) to characterize project impacts did not include the marine (*i.e.*, port) operations in the analysis. Consequently, in the comparisons the Sumaila Report is including negative impacts of port operations from a spill but the positive impacts of the TMEP operation are not considered. It thus ignores the approximately $310,000 local benefit that every calling tanker brings to the local economy (refer to Trans Mountain Response to Allan R IR 1.15r, Filing ID A3X5V9, PDF page 154). Because the port operations are among the biggest component the authors measure, this creates a significant bias that overstates negative impacts from a spill in comparison to the positive impacts from ongoing operations. Second, the study incorrectly counts local tourism impacts by implicitly assuming that these expenditures would not occur elsewhere in the local economy either in the same period or with a slight delay. Third, the impacts of a 3 day port closure are grossly exaggerated; experience elsewhere suggests that not all business is interrupted and that some of the business is simply delayed and requires a busy catch-up period. Port closures from labour disruptions are much more common (and lengthier) than those from oil spills and such disruptions are managed on a routine basis and also involve some catch-up period. Fourth, some of the impacts are based on cost scenarios (*e.g.*, Deepwater Horizon spill), which are not credible analogs for Vancouver port operations.

Finally, the Sumaila Report authors admit to having not undertaken any risk assessment (Filing ID A4L9G4, PDF Page 133); they simply assume the probability of such an event is 100%. This approach directly over-estimates the recurrence frequency of such a catastrophic spill, and ignores that the project is incremental to existing operations that pose a variety of risks from tanker and non-tanker traffic. Remarkably, even with these consistent over-estimates of negative impacts and understatement of positive impacts, the assumptions lead to a GDP loss of $1.2 billion as compared to the $1.7 billion positive economic impact that the authors derive from the CBoC figures. The net impacts are still positive; if costs were not so exaggerated and positive impacts of port operations were included in the baseline, then more realistic assumptions would show that negative spill impacts are relatively small in comparison to the positive impacts of operations. Given that the positive impacts of Project operations are certain, and the negative impacts of a potential spill are not certain (but less than unity), then the major lesson to be taken from the Sumaila Report is one relating to distribution of impacts. The Sumaila Report simply highlights the obvious: while the benefits of the TMEP would be widely

spread, the costs of a (highly unlikely) major oil spill would be disproportionately borne by the area in which the spill occurs.

27.3.3 Summary of Review of Gunton & Broadbent Report

Dr. Gunton and Dr. Broadbent conclude that Trans Mountain has not presented an accurate estimate of upper bound spill costs for pipelines and terminals, and that it has not provided a comprehensive compensation plan in the event of a tanker spill. Using spill cost estimates presented in the report, the authors conclude that in the event of a worst-case pipeline spill or a tanker spill, adequate compensation is not assured.

Trans Mountain disagrees with the conclusions of the authors. Their cost analyses are fraught with methodological errors that bias estimates incorrectly to the high side. The literature that the Gunton & Broadbent Report refers to for other evidence (*e.g*., the Goodman Report) has neither gone through independent peer review, nor have the authors treated it with due diligence. The authors misinterpret evidence on the record of the Northern Gateway Project, and derive costs in excess of $4 billion of damages for a tanker spill when passive use values are excluded, noting that the damages would be higher if passive use values were included; the authors therefore conclude that available compensation resources are inadequate. In addition to the methodological flaws, Trans Mountain takes exception to the use of estimates relating to Northern Gateway Project (involving greenfield activities) as an analog for Trans Mountain's proposed expansion of an existing facility.

The authors also calculate a worst-case cost for a pipeline rupture based on a worst-case outflow of 25,160 bbls (4,000 m^3) and a worst-case unit cost of $60,177/bbl corresponding to that of the Enbridge Line 6B ("Marshall") rupture. The resultant cost of $1.5 billion is not credible because the result does not reflect the economies of scale noted consistently throughout Trans Mountain evidence that larger spills generally have lower unit costs (Volume 7, Appendix G, Filing ID A3S4W8, PDF page 13) and that, as noted below, the Marshall Spill unit costs cannot be transferred to any modern pipeline construction and operation.

Trans Mountain further notes that the methodological flaws in the Gunton & Broadbent Report are not isolated only to their assessment of costs. The full review (Attachment 1.07, Reply to Tsleil-Waututh Nation, Tsawout First Nation, Upper Nicola Indian Band "An Assessment of Oil Spill Risks for the Trans Mountain Expansion Project") also uncovered serious flaws relating to their treatment of the marine, facility, and pipeline risk assessments, as well as the environmental assessment methods. Given that a number of the factors arising from the risk analyses (such as outflow levels and rupture probabilities) are in turn used to inform their opinion, the resultant costs are further exaggerated. For example, the full review notes that "Given the misleading nature of Gunton & Broadbent's analysis, which appears to have been performed on data that includes leaks below the detection threshold of monitoring equipment, that evidence should be dismissed." Trans Mountain further notes that the outputs from the Gunton & Broadbent Report are also relied upon by the public interest work undertaken by Dr. Gunton *et al*. (Filing ID A4L9S2).

In brief, the entire cost analysis in this report is based upon speculative selection of high cost events that have no analogs to the existing Application. The cost estimates further rely partially on reports which are flawed and over which Gunton & Broadbent conducted no due diligence. Trans Mountain also notes that the current Gunton & Broadbent Report mirrors in some respect the evidence they put forward before the Northern Gateway Project Joint Review Panel in

January 2012 entitled "A Review of Potential Impacts to Coastal First Nations (CFN) from an Oil Tanker Spill associated with the Northern Gateway Project" (Gunton and Broadbent 2012). Yet that same Panel in its recommendations made two determinations that directly contradict the basis for the findings of their submission in this current Proceeding. Specifically, the Joint Review Panel concluded the following:

> The NEB Joint Review Panel for the Northern Gateway Project – after examining the evidence – concluded with the view that "The Panel accepts that the cleanup costs for the Marshall, Michigan spill were orders of magnitude higher because of the extended response time. For this reason the Panel did not use the Marshall Spill costs in its calculations." (refer to Response to NEB IR No. 1.10b, Filing ID A3W9H8)

> "Based on the hearing record, the Panel finds that the estimated costs for damages to ecosystem goods and services are neither well developed nor currently broadly accepted." (Government of Canada 2013, page 362).

The conclusions in the Gunton & Broadbent report are not credible and should not be relied on.

27.4 Oil Spill Costs in the Context of Risk Assessments

27.4.1 Intervenor Costs are Over-stated when Risk Analyses are Ignored

Trans Mountain has addressed the risk assessment of spills in other sections of this Reply Evidence (Section 23 [Pipeline Risk Assessment] and Section 24 [Facility Risk Assessment] for land-based spills, and Section 60 [Marine Risk Assessment] for marine based spills). Trans Mountain notes that many of the intervenor reports pay no attention to spill risks when considering spill costs. For example, the Sumaila Report states: "The likelihood of each potential release scenario has not been estimated within the scope of this analysis" (Filing ID A4L9G4, PDF Page 133). The Brand Finance Report states "*This study also did not evaluate the risk of an oil spill in the GVA [Metro Vancouver Area, sic. viz. PDF page 10] as such an evaluation is outside the scope of Brand Finance's expertise*" (Filing ID A4L8F0, PDF Page 11). Elsewhere on the record where the costs are discussed within a compensation framework, the Friends of Ecological Reserves asserts that the occurrence of a spill is a certainty: "Despite assurances to the contrary there is absolute certainty that an oil spill will occur with the projected massive increases of oil tankers going out of the Port of Vancouver and transiting the full length of the Strait of Juan de Fuca along the coast of Vancouver Island" (Filing ID A4Q2T7, PDF page 27). TLBCC in their evidence refer to the "inevitable damage caused by the project" in the context of a discussion of oil spills (Filing ID A4Q2G1, PDF page 7). Trans Mountain submits that the absence of any objective discussion of risks negates the credibility and usefulness of all of the above evidence. The costs estimated in these studies are purely speculative. Essentially, it removes any potential benchmark for determining whether the costs associated with an event or occurrence can be credibly likened to the activities contemplated in the Application. This leaves the intervenor evidence with an open field for hand-selecting high-cost improbable or impossible scenarios that are not relevant to the Application. As an extreme case, the Goodman Report (Filing ID A4Q0C1) draws its cost examples from a rail spill in Québec, a natural gas explosion in California, and a refinery feeder line fire in China; estimated costs of these events are put forward without any discussion of the risk profiles of such events. It is impossible to tie these either conceptually or analytically to the risks or costs associated with Project-related spills.

The lack of attention to any sort of risk analysis in the above studies also undermines the credibility of cost estimates on other grounds. This Application is not for a greenfield project. When considering hypothetical costs, one must therefore consider the incremental costs and incremental risks associated with a hypothetical event such as a spill. By ignoring this reality, analyses implicitly consider total costs of a certain event, or total costs of a hypothetical event with no existing threat. For spills, there is a small but finite existing threat. Vancouver is a working port with existing threats, and with existing programs and measures to address those threats. To ignore this reality makes it more likely that both risks and costs will be over-stated.

27.4.2 The Stone Report: A Misguided Focus on Extreme Costs

The Stone Report was contracted by City of Vancouver to address the following questions (Filing ID A4L8E9, PDF Page 5):

- What are the typical costs that local governments are likely to incur in responding to, and recovering from, an oil spill?
- What hidden costs for local governments, if any, are associated with oil spills but are rarely compensated?

In undertaking these tasks, Mr. Stone does not consider the issue of likelihood and concentrates only on high cost low probability events. Mr. Stone states: "*Studies that focus on data near the means of risk are in direct contrast to modern disaster management methodologies that prepare for 'low-chance, high-impact' events that present 'urgent threats to societal core values and life-sustaining systems' (Comfort et al. 2010)*." (Filing ID A4L8E9, PDF Page 6) Based on this, Mr. Stone asserts that the high cost historical events are the only events of relevance. He polls 12 events from around the world with high spill costs; these include the BP Deepwater Horizon spill in the Gulf of Mexico ($43.86 billion), the Kalamazoo pipeline spill ($1.33 billion), the Exxon Valdez release ($4.72 billion), and others. Interestingly, Mr. Stone also includes the Burnaby spill of 2007 ($16.86 million). Mr. Stone acknowledges that "*In terms of historical spills, there is very little data for cost analyses in Canada since there have been very few oil tanker spills here.*" (Filing ID A4L8E9, PDF page 7). Trans Mountain agrees. In a paper to which he is a contributor, and refers to in his evidence, there is a citation that *"First, the proximity to a densely populated urban area with over 2 million residents has many ramifications. No major oil tanker spills have occurred, to date, in similarly urban coastal settings*." (Chang *et al*. 2014, page 7). In short, having found that there were no high cost spills in Canada, Mr. Stone selected a methodology that, essentially, looked for only high cost scenarios. These high cost scenarios, are, however, largely irrelevant. They do not represent analogs for a tanker-based spill in Vancouver. One correct conclusion – expressed in both the peer-reviewed paper by Clark *et al.* (2014) and the Stone Report, which has not gone through independent peer review – that Trans Mountain agrees with was that tanker spills are rare events.

Mr. Stone selected a methodology which, Trans Mountain submits, misrepresents an important seminal work. His citation from Comfort *et al.* 2010 comes from a paragraph in the opening pages of a book entitled "Designing Resilience: Preparing for Extreme Events." The book is an edited volume of articles by various authors dealing with the relatively new science of resilience and, in this case, its role in public policy. But this book is not about oil spills; the book is about disasters orders of magnitude worse and more deadly than an oil spill. Within its pages one will not find reference to an "oil spill," a "leak," a "rupture," or any "spill" for that matter; even life-threatening events such as fires and hostage takings are regarded by the editors of the book

as “routine emergencies;” they are not extreme events. The case studies in the book include extreme events such as the terrorist bombings in London, the Avian flu pandemic, and Hurricane Katrina (which took almost 2,000 lives); the 2008 earthquake in China and the 2004 Asian tsunami also feature in the discussions. The complete citation from the book illustrates clearly the intended context of the methodology:

> Terrorist attacks, water shortages, critical infrastructure failures, a looming energy crisis, a continuing flow of illegal immigrants, the effects of climate change, the threat of a pandemic: societies face an array of potentially devastating threats. These are not “routine emergencies” such as fires, traffic accidents, and hostage takings. These are so-called *low-chance, high-impact* events: urgent threats to societal core values and life-sustaining systems that typically require governmental intervention under conditions of deep uncertainty.

The events specifically listed by the editors – terrorism, climate change effects, pandemics – are not of the same nature as an oil spill. Moreover, even if the prescript were valid for this type of event, it simply states that communities must “*prepare for … urgent threats*.” Concretely, the book’s cover abstract states:

> In the wake of severe climatic events and terrorist acts and the emergence of dangerous technologies, communities, nations, and global organizations have diligently sought to create strategies to prepare for such events. *Designing Resilience* presents case studies of extreme events and analyzes the ability of affected individuals, institutions, governments, and technological systems to cope with disaster. This volume defines resilience as it relates to disaster management at specific stages: **mitigation, prevention, preparation, and response and recovery [emphasis added]**.

The intent of the book is to promote the concept of resilience in public policy formulation; it does not state that any given extreme case is an inevitable outcome. Trans Mountain notes that the NEB process is already designed to address the elements of resilience prescribed in this volume: accordingly, Trans Mountain has addressed issues related to spill prevention, mitigation, preparedness, recovery, and restoration as part of this Application.

Finally, Trans Mountain questions Mr. Stone’s qualifications to give expert opinion evidence on how decision-making should be made within the context of this Application. His undergraduate work in anthropology and his master’s work in Public Finance provide him with skills to address the terms of reference he was tasked to fulfill: enumerating potential spill costs that may be borne by municipalities. He is qualified to research and enumerate such costs, and present the results of such in evidence. But neither this experience, nor his professional career, nor his unfinished doctoral work in “economic development, community disaster recovery, [and] social change” qualify him, in Trans Mountain’s view, to give opinion evidence on whether it is reasonable to transfer absolute gross costs from events such as Deepwater Horizon, Kalamazoo, Exxon Valdez, and other events to scenarios involving BC tanker spills. Indeed, his misinterpretation of recent literature suggests he is inappropriately using applied frameworks for drawing such conclusions. He also provides no evidence that he has the technical skills needed to judge the applicability of individual spills that he draws upon. Indeed, Mr. Stone’s lack of experience in such matters seems to influence his interpretation of what he cites as “modern disaster management methodologies;” while such methods exist, the one he relies upon is not relevant to an oil spill.

Mr. Stone and others have drawn attention to the cost of the Enbridge Line 6B ("Kalamazoo" or "Marshall") release in Michigan. This, however, is a case in point of a spill that is not relevant to the situation being considered within this Application. As Trans Mountain noted in response to Allan R IR No. 1.18(u) (Filing ID A3X5V9, PDF pages 183-184), the costs associated with the Kalamazoo spill were not regarded by the Joint Review Panel for the Northern Gateway Project as being relevant. The response states:

> "As described in the study in reference (ii) [Volume 7 Appendix G Filing ID A3S4W8], costs of an actual spill will depend on local conditions and can differ from spill to spill according to the circumstances of that spill. The analysis provides a methodology for determining a credible range of potential costs to determine if financial assurances are adequate. The analysis also selects spill sizes in a conservative manner to generate a representative range of spill scenarios of relevance to the Trans Mountain Application (see Response to NEB IR No. 1.10b – Filing ID A3W9H8). In the case of the Enbridge Line 6B ("Kalamazoo" or "Marshall") release, spill volumes and higher costs were related to extenuating circumstances associated with an exceptionally long response time (approximately 17 hours) before emergency procedures were started. Industry and regulators recognize that these circumstances make it an untypical spill. For example, the NEB Joint Review Panel for the Northern Gateway Project – after examining the evidence – concluded with the view that "The Panel accepts that the cleanup costs for the Marshall, Michigan spill were orders of magnitude higher because of the extended response time. For this reason the Panel did not use the Marshall Spill costs in its calculations." For similar reasons, Trans Mountain did not rely on the Marshall Spill costs to inform the hypothetical spill scenarios that would be relevant to this Application."

Mr. Stone (and others) also cite the Exxon Valdez oil spill as an important analog. As described in response to Allan R IR No. 1.18(n) (Filing ID A3X5V9, PDF page 181), the costs associated with the Exxon Valdez spill were not regarded as useful comparators to more recent or future spills. Etkin (2000, Filing ID A3W9I3, PDF page 4) states:

> "For example, the total cleanup costs associated with the 1989 Exxon Valdez spill which oiled over 1,200 km of shoreline in Prince William Sound, Alaska, USA, resulted in cleanup costs of over $93,568.74/tonne ($84.08/liter). This spill had extremely high unit costs associated with it due to the complexity of the cleanup operations, which were greatly influenced by the highly political nature of the entire incident." Her North American summaries in Etkin (1999) and elsewhere, therefore, generally exclude the Exxon Valdez incident."

In summary, the narrative approach of many intervenors that focuses on high cost spills in an ad hoc approach does not provide reliable information for predicting or planning for situations that are likely to arise under this Application.

27.5 Oil Spill Costs – Ecosystem Goods & Services/Passive Use Values

Various intervenors have attempted to include the value of ecosystem goods and services within the cost calculations. These are also sometimes called environmental externalities. Trans Mountain's evidence is that such potential environmental externalities are mitigated and prevented through risk-based design that internalizes many of the so-called environmental

costs. They are thus already internalized within routing and design considerations of the pipeline.

Specific treatment of some of these costs is provided in the stand-alone review of the Gunton & Broadbent Report. Specifically, Gunton & Broadbent assert that Passive Use values can add from $1.4 billion to $21.1 billion to the final spill cost. The derivation of this range of figures is fundamentally flawed: it relies originally on a benefit transfer approach in which the original questioning (in the United States for the Exxon Valdez spill and a hypothetical spill on the coast of California) asked individuals what amount they would be willing to pay to improve tanker safety through the use of escorts, double hulled tankers, and other safety features. At the time the surveys were done, these standards were not in place. These standards will, however, be in place for tankers calling on the Westridge Marine Terminal; hence if the same question were to be asked today then the passive use value would by definition be zero. Moreover, focusing on the passive use of "conservation or protection" neglects the fact that there may also be a "passive use value" or "option value" for development that may totally offset the passive use value of conservation. Option values inherently consider the irreversible loss of a future opportunity: if environmental assets are irreversibly blocked from development through, for example, a moratorium or a high level of protection that precludes development or exploitation, then there is also a loss of option value by those potentially deprived of the development option. If one is to measure the passive use values of conservation, one should also attempt to consider the lost option values associated with imposing such restrictions.

Finally, in the general area of ecosystem goods and services valuation, Trans Mountain relies also on its Response to Allan R IR No. 1.18(l) (Filing ID A3X5V9, PDF page 180-181):

> "Passive use values are explicitly excluded from the cost estimates. These represent a category of values associated with ecosystem goods and services (EGS) that are experienced by some parts of the population even though they do not directly use the EGS. Loss of such values is not explicitly separated and compensated in any jurisdiction; methodological issues do not permit their credible measurement and attribution." (Volume 7, Appendix G, page 2, Filing ID A3S4W8)
>
> Passive use can thus more generally be considered as an ecosystem good or service (EGS) experienced by some parts of the population, even though they do not directly use the EGS. Trans Mountain notes that the Northern Gateway Joint Review Panel reached a similar conclusion relating to EGS in general: "Based on the hearing record, the Panel finds that the estimated costs for damages to ecosystem goods and services are neither well developed nor currently broadly accepted." (Government of Canada 2013, page 362).

27.6 Oil Spill Costs – Brand Valuation

27.6.1 Introduction

Trans Mountain understands the role of brands in the promotional and management initiatives of some of the municipalities and civil society organizations along the pipeline route. Kamloops, Hope, Vancouver, and Victoria have all expressed some level of concern that facility construction, operation or malfunction might impact their brands in a negative manner. Pro Information Pro Environment United People (PIPEUP) asserted in a preamble to PIPEUP IR No. 2.10 (Filing ID A4H8W4, PDF page 74) that "the Southern Resident Killer Whales are part

of [the] West Coast commercial brand and in part drive our tourist trade." The City of Victoria states that "tourism is a $1.9 billion dollar industry in Greater Victoria with more than 21,700 people directly employed in the tourism sector. In addition to any long-term impacts on Victoria's tourist "brand" from an oil spill, tourism operators whose work is directly related to the health of the marine ecosystem would be immediately impacted…." (Filing ID A4L8Y1, PDF page 15). During IR Round 1, the City of Vancouver asked Trans Mountain if the effects on various brands (*e.g.*, "Super Natural BC" and "Greenest City") were considered in the economic impact assessment of spills. Trans Mountain provided the following response to City of Vancouver IR No. 1.02.05fg (Filing ID A3Y2G6, PDF pages 18-20):

> A monetization of an economic impact on the brands or reputation was not conducted. An analysis of spill costs (including damages) arising from hypothetical spills is provided in Application Volume 7, Appendix G. The approach undertaken in the spill cost analysis is to estimate total costs; conditions vary from spill to spill and it is not possible to provide damage estimates on individual specific items that may be of value, such as branding campaigns or reputation. That said, Trans Mountain considers the risks of a large spill are small and it has sufficient financial capacity to contain, remediate, and compensate for damages that might occur.

In its filed evidence, the City of Vancouver adopts as evidence the Brand Finance Report (Filing ID A4L8F0) prepared by Mr. Edgar Baum and "concludes that an oil spill would result in the impairment of the Vancouver brand and a reduction in Brand Value ranging between USD $1 billion for a small spill and USD $3 billion for a large spill" (Filing ID A4L7V8, PDF pages 91-92) The Brand Finance Report also concludes that the City of Vancouver Brand has a benchmark value of USD $31.475 billion.

Trans Mountain notes that Brand Finance (Canada) Inc. is part of the Brand Finance PLC organization headquartered in the UK, established in 1996 (Brand Finance website – refer to Appendix 27B; Brand Finance 2015). The website features brand valuations for companies on an annualized basis to as recent as 2015, including for example "Top Canadian Companies," as well as similar lists including most developed regions around the world. For example, the Kinder Morgan brand is ranked #237 in the United States in 2015 with a Brand Value of $2.557 billion. Brand Finance has also established brand values for entities other than corporations. For example, Santa Claus was valued at $1.6 trillion as a brand in 2013. Its clients, according to its documentation, include "international brand owners, tax authorities, Intellectual Property lawyers and investment banks."

27.6.2 Trans Mountain Summary of the Brand Finance Report

Trans Mountain notes the following points of disagreement and concerns with the Brand Finance Report:

(i) the author does not appear to follow accepted standards of brand valuation – these standards are defined by the International Standards Organisation (ISO) under ISO 10668:2010(E) (2015) *Brand Valuation – Requirements for monetary brand valuation* (refer to Appendix 27A) and consist of three key components: legal analysis, financial analysis, and behavioural analysis. A legal analysis is missing and the other two analyses are incomplete or flawed;

(ii) the author includes a document in Appendix D that is noted as being the accepted ISO 10668 standard but is in fact not the official document;

(iii) the author states that the brand valuation is being conducted for the City of Vancouver to establish a financial and behavioural benchmark. This is not one of the classes of use specifically listed in the ISO 10668 Requirements (Section 4.1) but coincides most closely to "*(a) management information*," or "*(b) strategic planning.*" If management information or strategic planning is the purpose then it is only of relevance for the City of Vancouver and is not relevant for the NEB's consideration of the TMEP. If City of Vancouver intends to rely on this for other specific purposes (*e.g*., litigation support or licensing, as listed in the ISO 10668 Requirements) then this particular piece is also not applicable and should not be relied on);

(iv) the analysis does not clearly link to one of the ISO 10668 valuation approaches recognized as appropriate to this purpose. The three recognized valuation methods are described as "*income, market or cost approach*." The analysis by Mr. Baum focuses on a hybrid style Royalty relief approach that is more appropriately applied to a public or private company rather than to a government entity;

(v) the analytical approach has relied on a questionnaire that is more accurately described as an "opinion poll" rather than a scientifically valid questionnaire that accurately and objectively communicates information;

(vi) the questionnaire refers to a hypothetical situation (a future spill) without communicating critically relevant risk information related to the spill. The author confirms that Brand Finance has no expertise to address risk-related information;

(vii) the questionnaire provides few control variables or questions against which the validity of the findings can be controlled. Such control variables in a properly designed survey might have asked respondents simple questions about their familiarity with spills or Vancouver, as well as what their judgments were of other events that may have impacted (negatively or positively) Vancouver's alleged Brand value (*e.g*., Stanley Cup riots, attitudes towards illegal drugs, performance as an Olympic host city). Absent such controls, the findings have little scientific basis;

(viii) of the five other "cities" in the control set described in the background information, not all are cities and the lack of clarity in the surveys creates potentially significant errors. In short, the set of "cities" was poorly selected. Singapore is a Nation State having potential values both as a city and as a state. Hong Kong is an Autonomous Territory with urban and rural elements;

(ix) the final conclusions rely on judgmental "adjustments" that are neither explained nor transparent, which is not in accordance with ISO 10668 standards which require transparency; and,

(x) Brand Finance has disclosed that it had insufficient data for some technical factors that would, presumably, have changed their conclusions.

The above points are supported by further elaboration below. Trans Mountain respectively suggests that the brand valuation is simply a speculative exercise with no merit and is not relevant.

27.6.3 ISO 10668 Requirements

27.6.3.1 Market Analysis, Behavioural Analysis, & Legal Analysis

ISO 10668:2010(E) (2015) *Brand Valuation – Requirements for monetary brand valuation* (refer to Appendix 27A – referred to here as ISO 10668 Requirements) specifies that a brand

valuation must consist of three key components: legal analysis, financial analysis, and behavioural analysis. A legal analysis must be undertaken that, following ISO 10668 Requirements §6.3, reflects the following: (i) assessment of legal protection, which includes identifying each of the legal rights that protect the brand, the legal owner of these legal rights, and the legal parameters influencing negatively or positively the value of the brand; (ii) legal rights to be valued (which generally include but are not limited to trademarks), ownership, relevant national and regional laws, registration status of legal rights, use status of legal rights; and (iii) other legal parameters (distinctiveness, scope of use and registration, extent of use, notoriety to which brand is well known, risk of cancellation, willingness and/or ability of the owner to enforce legal rights).

The Brand Finance study has not included a legal analysis consistent with these requirements.

27.6.3.2 Cost, Income, and Royalty Approaches

The ISO 10668 Requirements §5 “Valuation approaches” prescribe that “Brands shall be valued by applying the income, market or cost approach. The purpose of the valuation, the value concept and the characteristics of the brand being valued shall dictate which approach (or approaches) is (are) utilized to calculate the value of a brand.”

The Brand Finance Study refers to a Royalty relief approach. Strictly, however, as described in ISO 10668 Requirements §5.2.2.7, this entails the following:

> In order to determine the cash flow generated by the brand, the royalty relief method can be applied. This method shall measure the value of the brand as the present value of expected future royalty payments, assuming that the brand is not owned but licensed. The value calculated through the royalty relief method thus constitutes the present value of the royalty payments saved through the ownership of the brand.
>
> The royalty rate applied in the valuation shall be determined after an in-depth analysis of available data from licensing arrangements for comparable brands and an appropriate split of brand earnings between licensor and licensee, and shall be as close as possible to brands with the same characteristics and size as the brand subject to valuation.

According to the Brand Finance website, this approach is also most commonly used by Brand Finance in valuation of company brands. It states:

> Within the Income Approach the most common method used for finance and tax brand valuations is the Royalty relief method because it is transparent, based on commercial practice, and is more verifiable for audit and legal purposes. (see Appendix 27B, page 2)

Trans Mountain submits that this approach is better suited to a private or public company brand than a government brand. The “royalty rate” in particular is regarded as entirely speculative in this context. Vancouver neither pays nor receives royalties for the use of its name.

27.6.3.3 Purpose of Valuation

ISO 10668 Requirements §4.1 "Declaration of purpose" specifies:

> The declaration of purpose shall specify the intended use, the addressed audiences, the identified asset, the premise of value, the position of the appraiser (valuator), the valuation date and the value date.
> The value concept shall be specified in accordance with the purpose of valuation.
> NOTE The purposes of valuation are diverse. Common purposes are:
> a) management information;
> b) strategic planning;
> c) value reporting;
> d) accounting;
> e) liquidation;
> f) legal transaction;
> g) licensing;
> h) litigation support;
> i) dispute resolution;
> j) taxation planning and compliance;
> k) loan and equity financing.

The author of the Brand Finance Report states that "the brand valuation is being conducted for the City of Vancouver to establish a financial and behavioural benchmark" (Filing ID A4L8F0, PDF page 10). This is not one of the categories specifically listed in the ISO 10668 requirements listing, but may correspond most closely to (a) "management information" or (b) "strategic planning," both of which would be for internal management purposes specific to the City of Vancouver.

Trans Mountain submits that such internal management documents are not relevant to these Proceedings.

27.6.4 Incorrect Reference to ISO Documentation

The authors state that (Filing ID A4L8F0, PDF page 10):

> "The study was conducted in accordance with the ISO:10668 (2010) standards for Brand Valuation to establish a financial and behavioural benchmark for the City of Vancouver brand and overall GRDP value. The ISO:10668 standards for Brand Valuation are attached as Appendix D."

Appendix D (Filing ID A4L8F0, PDF page 33) does not contain the indicated document. Appendix D is a document entitled "Overview of Brand Valuation – Requirements for monetary brand valuation" and is authored by the Australian Marketing Institute and Brand Finance. The document in Appendix D includes an introduction from the Australian Marketing Institute, some extracts from the ISO 10668 Requirements, opinion pieces by an Australian academic and by the Australian managing director of Brand Finance PLC, a chapter describing the work of the Australia Marketing Institute, and a chapter profiling the work of Brand Finance PLC.

The reader consulting Appendix D is thus referred to a promotional brochure. While some of the ISO:10668 Requirements are reflected in this brochure, the details in the brochure are not

comprehensive. Trans Mountain has, for the convenience of the NEB and Participants, provided details on how to access the full ISO 10668 Requirements in Appendix 27A.

27.6.5 Flaws in Questionnaire

27.6.5.1 Questionnaire Lacks Scientific Rigour

The Brand Finance Report describes (Filing ID A4L8F0, PDF page 13) that Lutz Research – a San Diego based firm – polled "over 1000 individuals in countries with ready access to Vancouver (*i.e*., Canada, Western United States, mainland China, select metropolises in Asia and Europe)." Vancouver was one among six cities (the others being Hong Kong, San Francisco, Singapore, Sydney, Shanghai, and Hong Kong) on which respondents were asked to cast opinions. This was then transformed in due course to a benchmark valuation for each of the cities and applications of judgmentally applied royalty rates. This application itself lacks transparency and is inconsistent with ISO 10668 Requirements.

Such an exercise may be of interest in decision-making, but it does not compare to a scientific survey that also keeps track of and adjusts for other preferences or demographic attributes of respondents. This is simply an opinion poll. Opinions may be very unstable, and the poll is thus valid only for a brief period. It should not and cannot be compared to brand valuations that rely (for the financial analysis) on auditable financial statements and transactions. Most important, there is no manner for testing the stability of this result. Unlike company financial statements, which are audited and controlled yearly, this single valuation is not useful in the context of these proceedings. As it is also the benchmark against which a hypothetical event is judged (an oil spill), it is even less reliable.

27.6.5.2 Treatment of a Hypothetical Situation and Absence of Control Variables

The Brand Finance Report describes (Filing ID A4L8F0, PDF page 18) that "survey respondents were asked to rate how their overall score for each city would change in the event that there was a small, medium, or major oil spill in the general vicinity of the city." Posing such a hypothetical situation demands a great deal from the questioner and the respondent in such a survey. Most important, for such a question to be regarded as scientifically meaningful in social science, important information regarding the scenario and the risks must be clearly and comprehensibly communicated. The information communicated was limited essentially to: "The size of the spill (small, medium or large) was defined by how easy or difficult it would be to clean the spill and whether there would be a lasting environmental impact or not …." There were no controls in place that polled respondents with their familiarity with such events, their familiarity with other potential events that might influence a brand's value, or their personal levels of risk aversion. Trans Mountain also notes that the survey was conducted electronically; this requires even greater care in risk communication and would normally need to involve internal controls for probing and error-checking (such as asking similar questions in different ways to determine if they statistically generate similar results).

Moreover, Brand Finance itself has stated it has no expertise in assessing risk-based information. The Brand Finance Report states "*This study also did not evaluate the risk of an oil spill in the GVA [Metro Vancouver Area, sic. viz. PDF page 10] as such an evaluation is outside the scope of Brand Finance's expertise*." (Filing ID A4L8F0, PDF Page 11)

A more comprehensive valuation of any brand that better reflected the impacts of a hypothetical event associated with TMEP would have required evaluating three value propositions: (i) value

of brand with no spill event; (ii) change in value of brand with a spill event from any source in Vancouver harbour from existing operations and harbour traffic; and (iii) incremental change in value of brand arising from a spill event associated with expanded activity. Risk and likelihood information would need to be conveyed for each of these value propositions by a qualified researcher to an informed respondent. From the simplistic characterization of the with/without spill scenarios used in the Brand Finance Report, it is not possible to determine what portion, if any, of the asserted brand impairment is attributable to the proposed Application.

27.6.5.3 Unknown Biases

Of the five other "cities" in the control set described in the background information, not all are cities and the lack of clarity in the surveys creates potentially significant errors. In short, the set of "cities" was poorly selected. Singapore is a nation having potential values both as a city and as a nation. Hong Kong is an autonomous territory with urban and rural elements. Brand Finance describes that (Filing ID A4L8F0, PDF page 13) "*Specific responses were sought from business leaders, tourists and students (the 'Stakeholders') who expressed interest in conducting business in, traveling to, or studying in* ***at least two of the six cities***." [emphasis added]. This implies that many of the respondents would not have been familiar with one other true "city" (San Francisco, Shanghai, Sydney) in addition to Vancouver. It can be shown that *approximately* 40% of respondents should have been screened out of the survey, but were accepted; these are the respondents that would have selected Hong Kong or Singapore as the second city of familiarity shown on the screen "S3" indicated in the questionnaire (Appendix E, Filing ID A4L8F0, PDF page 54). This increases the potential sampling error of the survey, and increases the potential error in both the benchmark value and the value of the incremental impact of the hypothetical event. The retention of the invalid respondents is "approximately" 40% because no adequately detailed summary statistics were provided in the survey results to deduce this proportion. The table entitled "Quotas and Screening Criteria" specified in Appendix E of the Brand Finance Report showed 100 (out of 1,100) as a maximum number of permitted respondents from Vancouver, and a maximum of 200 each residing in the five other "cities," but a familiarity result is not provided for the final sample size (Filing ID A4L8F0, PDF page 52). This anomaly arising from the choice set invalidates the accuracy of this information as an opinion poll about cities. It also underscores the lack of scientific care in conducting the research expected in an ISO 10668 compliant document.

27.6.6 Other Deficiencies

The authors state the following limitations to their work (Filing ID A4L8F0, PDF page 23):

> "The financial impact demonstrated in these graphs indicates the financial impact in the event of an oil spill. It does not, in any way, reflect the likelihood of any of the three sizes of oil spill occurring in any of the six cities for which this exercise was conducted. Brand Finance was not provided any data to evaluate the likelihood of a spill happening.
>
> The Brand Value impact of the oil spill did not include any change in GRDP that may result in the event of an oil spill and Brand Finance had insufficient data to predict this. The Brand Value assessment also did not include the GRDP uplift of constructing and operating a new pipeline. Oxford Economics forecasts did not include this uplift, and Brand Finance had insufficient data to predict this."

These limitations simply underline the lack of credibility of the overall conclusions. The above statement implies that Brand Finance did not have this information; more critically, survey respondents also did not have it. Indeed, any relevant information regarding baseline conditions, baseline risks, incremental risks, and so on, were all unavailable to the respondents.

27.7 Other Issues

27.7.1 Impacts Outside of Canada

Several intervenors filed evidence highlighting regional issues and seeking further commitments by Trans Mountain. The issues called to attention by these intervenors are a result of the region's diverse activities and are not specific to the Project. Trans Mountain has made marine safety commitments on record that will protect the region from oil spill accidents during the transit or loading of Project tankers. Specific to marine transportation, these commitments closely follow the recommendations and findings of the TERMPOL Review Committee and details can be found in the TERMPOL Review Process Report on the Trans Mountain Expansion Project (Filing ID A4F8Z4), as well as in Trans Mountain's Response to NEB IR dated December 17, 2014 (Filing ID A4G3U4).

Trans Mountain is supportive of national and regional collaborative efforts aimed at continual improvements that that will help enhance marine safety and encourage environmental improvement initiatives. In Trans Mountain's opinion, the additional efforts suggested by intervenors would be better addressed through joint arrangements and actions by the region's industry, governments, regulators and other stakeholders and not as commitments by Trans Mountain alone as part of hearings for a single project. It should be noted that Trans Mountain traffic currently constitutes 1.1% of large vessels trading in the study area. Subject to TMEP reaching full operational status, this will increase to 6.6%, still only constituting a small portion of commercial vessel traffic in the study area.

27.7.2 Research Costs

A number of intervenors have noted the need to include research costs as part of any estimation of oil spill costs. Most of the research costs will be incurred during monitoring of recovery efforts.

Trans Mountain acknowledges that post-spill research is important. It also notes that such research is a global public good, and that costs of such research are covered proactively by many insurance schemes. Because an oil spill is an undesired accident throughout the global industry, post-spill research provides important insights into how best to mitigate and recover from a spill. This knowledge is of global interest. For example, the IOPCF funds have special provisions for financing post-spill research provided that it builds on existing knowledge, and that it will be made available to the global community. The IOPCF Claims Manual (Filing ID A3X5W1) indicates (pp 39-40):

> *3.6.10 The Fund should be invited at an early stage to participate in the determination of whether or not a particular incident should be subject to a post-spill environmental study. If it is agreed that such a study is justified, the Fund should then be given the opportunity of becoming involved in planning and establishing the terms of reference for the study. In this context the Fund can play an important role in helping to ensure that any post-spill environmental study does not unnecessarily repeat*

> *what has been done elsewhere. The Fund can also assist in ensuring that appropriate techniques and experts are employed. It is essential that progress with the studies is monitored, and that the results are clearly and impartially documented. This is not only important for the particular incident but also for the compilation of relevant data by the Fund for future cases.*

While some intervenors have noted that spill costs might be expected to go up in the future if regulatory standards are more strict, the influence of research is that overall spill costs could be expected to go down because of better mitigation and recovery efforts that might be identified from research findings.

27.7.3 Volunteer Costs

Some intervenors have noted that volunteers often play an important role in oil spill cleanup efforts. The intervenors assert that the volunteers are not properly valued in the accounting of spill costs and, even if their services are attributed a nil value, there are real costs incurred by spill response organizers to coordinate, equip, and supervise such volunteers.

Trans Mountain acknowledges that volunteers can have an important role to play provided that their efforts are consistent with the safety protocols, priorities, and cleanup endpoints established by the Incident Command Structure. The overhead costs incurred by non-governmental organizations (NGOs), informal interest groups, and others in accessing volunteers are normally reflected in compensable spill costs to the extent that the costs are reasonable and directly connected to the spill. Trans Mountain again asserts, however, that it is not possible to determine in advance either the amount of volunteer effort or the total costs of such effort; such costs will be spill-specific and cannot be known in advance.

27.7.4 Sabotage

Some intervenors have suggested that sabotage, civil disobedience, terrorism attacks, or other forms of illegal disruption or protest may or will escalate if the Application is approved. The intervenors submit that such activities will impose additional costs to society which should be considered as part of any Project costing.

Trans Mountain has not included such costs into any of its estimates. Trans Mountain assumes that the rule of law would apply and that everybody behaves legally; disruptions would be treated through normal policing and legal procedures. Moreover, Trans Mountain believes that it is methodologically incorrect to consider such costs or impacts in determining whether the Project is in the public interest. Such costs cannot and should not be included in a determination of the public interest because it implies that anybody with the resources to illegally stop a project would effectively have a way to veto any project simply by including all such costs; such costs should not be included.

27.8 References

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28.0 ENVIRONMENTAL ASSESSMENT METHODS

28.1 Accidents and Malfunctions

Several intervenors (Upper Nicola Band [Filing ID A4R4I4], Tsawout First Nation [Filing ID A4Q1G5, paragraph 18, page vii; Filing ID A4R4G4], Tsleil-Waututh Nation [Filing ID A4L6A8, paragraph 73, page 20; Filing ID A4L6A6, paragraph 18, page vii], Pacheedaht First Nation [Filing ID A4L7D1, Section 7.1, page 40], Cowichan Tribes [Filing ID A4Q0U9, Section 4.2.3, pages 38-39], Squamish Nation [Filing ID A4L7E6, Section 7.3, pages 22-23], City of New Westminster [Filing ID A4Q0L5, Sections 2.1.1, 2.1.2, 2.1.3, pages 3,11,12], BC Nature & Nature Canada [Filing ID A4L8K8, Section 2.5.6, page 14], and Metro Vancouver [Filing ID A4L8C2, Sections 5.1.3.1, 5.1.3.2, 11.3.3, pages 79, 83-87, 110]) questioned or disagreed with the methodology applied by Trans Mountain to evaluate the potential effects of accidents and malfunctions, particularly worst-case and smaller tanker spills, and less frequently pipeline and terminal spills. While Trans Mountain acknowledges the high level of First Nation, government, and public concern about spills, it is confident that its assessment of accidents and malfunctions follows the NEB's guidance on this issue and meets the requirements of the *Canadian Environmental Assessment Act,* 2012 (*CEA Act 2012*; see response to BC Nature and Nature Canada IR No. 2.30a.01; Filing ID A4H7Y8).

Trans Mountain does not agree with conclusions provided by the Pacheedaht First Nation (Filing ID A4L7D1, Section 5.1, pages 19-25, Section 7.1, page 38-39, Section 9.1, page 44), Tsawout First Nation (Filing ID A4Q1G5, paragraph 6, page i) and Tsleil-Waututh Nation (Filing ID A4L6A6, paragraph 6, page i) that the assessment of accidents and malfunctions provided in the Facilities Application does not comply with environmental assessment and risk assessment standards of practice. Using non-Canadian references, Pacheedaht First Nation narrowly defines a proper risk assessment (as opposed to environmental assessment) as one that allows the 'acceptability' of potential effects to be compared between different locations and times for specific resources of interest. They also state that the assessment should provide site-specific conclusions based on likelihood and consequence. Trans Mountain's approach to assessing accidents and malfunctions reflected the need to apply risk assessment methods to inform the environmental assessment. The selected approach was based on guidance from the NEB to assess effects for scenarios at representative locations along the shipping route (Filing ID A3V6I2) and evidence provided by Environment Canada (2011) during the Enbridge Northern Gateway Hearings process recommending the risk-based Aleutian Islands Risk Assessment (AIRA) approach to modelling the fate and transport of spilled oil. Trans Mountain concluded that a comprehensive approach combining stochastic and deterministic modelling, qualitative impact assessment, and quantitative ecological and human health risk assessments was most appropriate for the Project because this approach is based on a recent Canadian precedent for a similar project. Information on spill risk and consequences was used in the Facilities Application to reach conclusions on impact significance using well-established significance criteria. For environmental assessments, significance may be considered to be one indicator of 'acceptability' of predicted effects that can be used to inform the NEB's decision.

28.1.1 Significance Evaluation for Accidents and Malfunctions

The Tsawout First Nation (Filing ID A4Q1G5, Section 4.2.3, page 38-39), Tsleil-Waututh Nation (Filing ID A4L6A8, Section 4.2.3, page 38-39), Pacheedaht First Nation (Filing ID A4L7D1, Section 7.1.3, page 25), Squamish Nation (Filing ID A4L7E6, Section 7.3, pages 22-23), and Cheam and Chawathil First Nations (Filing ID A4Q2C6, paragraphs 99,100, page 25) incorrectly

suggest that potential effects of credible worst-case and smaller spills were not evaluated for significance. As noted in the responses to Nations IR No. F-1R 1.3.2 (Filing ID A4D3G2) and BC Nature Nature Cda IR No. 2.30a.01 (Filing ID A4H7Y8), accidents and malfunctions related to the pipeline and facilities, and increase in Project-related marine shipping activities are considered to have a low probability of occurrence (*i.e.*, the scenarios considered and formally evaluated are not likely to unfold). The central test in *CEA Act, 2012* is whether or not a project is likely to cause significant adverse environmental effects. Since the likelihood of a credible worst-case or smaller spill occurring is low, Trans Mountain concluded that effects of accidental spills were not significant in the context of the *CEA Act, 2012*, based on the significance framework and criteria provided in Volume 5A, Section 7.1 (Filing ID A3S1Q9), Volume 5B, Section 7.1 (Filing ID A3S1S7), and Volume 8A, Section 4.3.1 (Filing ID A3S4Y3). Because this likelihood criterion rating is applied in all cases, specific significance ratings were not provided for the residual effect of credible worst-case and smaller spills on each ESA indicator. This does not mean that residual effects and significance of credible worst-case and smaller spills were not evaluated in the Facilities Application. Specific methods applied for the risk-based spill evaluation approach do differ from those applied for evaluations of routine activities, but the differences are appropriate, and stem from the complexity and challenges associated with predicting and evaluating the effects of hypothetical events when compared to evaluation of effects associated with routine, predictable activities.

The Gunton and Broadbent report submitted by Tsawout First Nation and Tsleil-Waututh Nation (Filing ID A4Q1G5, Section 4.2.3, pages 38-39; Filing ID A4L6A6, Section 4.2.3, pages 38-39) and Squamish Nation (Filing ID A4L7E6, Section 7.3, pages 22-23) suggests that the approach adopted by Trans Mountain evaluates the likelihood of significant adverse environmental effects prior to determining the significance of these adverse effects and that this approach contravenes existing regulatory guidance. For reasons described in the response to NEB IR No. 3.020 (Filing ID A4H1V2), Trans Mountain does not agree. Likelihood was evaluated as one of several significance criteria (referred to as the combined-step approach by the NEB). The combined-step approach to significance determination represents both current accepted practice, and the most practical and defensible alternative to fulfill requirements of the *CEA Act, 2012.*

Finally the Gunton and Broadbent report (Filing ID A4Q1G5, Section 4.2.3, pages 39; Filing ID A4L6A6, Section 4.2.3, pages 39) states that it is not clear how Trans Mountain concludes the likelihood of significant adverse effects is low because they consider spills to be probable events. Their assertion overlooks the inter-relationship between spill size, associated probability, and the duration, geographic extent, magnitude, and reversibility of resulting environmental and socio-economic effects. While small spills do have the highest probability of occurring, the evaluation of accidents and malfunctions included in Volume 5A, Section 7.9 (Filing ID A3S1R0), and Volume 8A, Section 4.3.13, (Filing ID A3S4Y3), and the response to Allan R IR No. 1.1cc (Filing ID A3X5V9), concludes that small spills are also least likely to result in substantial or significant adverse effects (*i.e.,* effects of small spills are likely to be localized, of low to high magnitude, reversible in the short to long term, and not significant). In contrast, credible worst-case spills are more likely to result in substantial or significant adverse environmental and socio-economic effects but much less likely to occur.

28.1.2 Tanker Spill Scenarios

Several intervenors suggested that different tanker spill scenarios or assessment methods should have been adopted. The Pottinger Gaherty Environmental Consultants Ltd. (PGL) report

submitted by Pacheedaht First Nation (Filing ID A4L7D1) asserts that an alternate approach would better characterize the risk to Pacheedaht interests. The JWS Consulting report submitted by Tsleil-Waututh Nation, City of Vancouver, and Living Oceans Society (Filing IDs A4L6A8, A4L7W1, A4L9R8, paragraph 73) asserts that representative scenario locations were neither representative, nor informed by potential spill consequences and also suggests in paragraph 80 that spill effects should have been evaluated at additional locations.

Trans Mountain recognizes that assessment practitioners and intervenors may favour alternate methodologies, but is confident that its assessment of marine shipping accidents and malfunctions follows the NEB's guidance on this issue and meets the requirements of the *CEA Act, 2012*. The *CEA Act, 2012* does not necessitate an assessment of every conceivable accident and malfunction scenario, or of specific effects on individual First Nations, or each resource of public or management concern. Rather, the Responsible Authority under the *CEA Act, 2012* (in this case, the NEB) determined that the assessment must be for representative locations along the shipping route. The process used by Trans Mountain to select the representative scenario locations was informed considering both probability and consequence, as required (Volume 8A, Section 5.6 [Filing ID A3S5Q3] and the response to BC Nature Nature Cda IR No. 2.30a.01 [Filing ID A4H7Y8]).

The Executive Summary of the JWS Consulting report submitted by Tsleil-Waututh Nation, City of Vancouver, and Living Oceans Society (Filing IDs A4L6A8, A4L7W1, and A4L9R8, paragraph 15; repeated again in paragraph 79) incorrectly states that Trans Mountain's assessment was based on a single point of origin in Georgia Strait, rather than relying on trajectory modelling results from several points along the tanker route. In fact, Figure 1 of the JWS Consulting report shows the five locations for which Trans Mountain completed fate and behaviour modelling, and Section 4.1 of this report acknowledges that effects were evaluated at four representative locations along the marine shipping route (Ecological Risk Assessment of Marine Transportation Spills, Filing ID A3S4K7). The conclusion provided in the Executive Summary is therefore unwarranted.

28.1.3 Pipeline Spill Scenarios

Some intervenors suggested that different pipeline spill scenarios should have been adopted. City of New Westminster (Filing ID A4Q0L5, Sections 2.1.1, 2.1.2, 2.1.3, 2.2, 2.3, pages 3,11,12-15), Cowichan Tribes (Filing ID A4Q0U9, Section 6.7, page 22), and Metro Vancouver (Filing ID A4L8C2, Section 5.1.32, pages 86-87) stated that spill scenarios for smaller and medium-sized river systems, such as the Brunette River and Chilliwack Creek, should have been included. Musqueam Indian Band (Filing ID A4Q2F9, Section 5.3, pages 27-28), BC Nature and Nature Canada (Filing ID A4L8K8, Section 2.5.6, page 14), and Metro Vancouver (Filing ID A4L8C2, Section 5.2, page 91) stated that a lower Fraser River spill scenario should have been located closer to the Fraser River Delta. Matsqui First Nation (Filing ID A4L8J3, Sections 7.1.3, 7.1.4, pages 77-110) constructed a narrative about potential effects of hypothetical spills and cleanup activities at two locations in the lower Fraser River valley. G. Senichenko (Filing ID A4L6Q9, Section 3, pages 5-6.) stated that a spill from the Burnaby tank farm should have been evaluated.

As noted above, Trans Mountain recognizes that assessment practitioners and intervenors may favour alternate methodologies, but is confident that its assessment of pipeline accidents and malfunctions follows the NEB's guidance on this issue and meets the requirements of the *CEA Act, 2012*. The *CEA Act, 2012* does not necessitate an assessment of every conceivable

accident and malfunction scenario, or of specific effects on individual First Nations, or each water body type or water body. The process used by Trans Mountain to select the representative scenario locations was informed considering both probability and consequence (Volume 7, Section 6.0 [Filing ID A3S4V6], and the responses to ALIB IR No. 2.11.3 [Filing ID A4H7X5] and City of New Westminster IR No. 2.B.2iii [Filing ID A4H8F6]). Thus, as described in more detail below, the assessment of spill-related environmental effects provided by Trans Mountain is representative of the environmental effects that could result from a large oil spill at almost any location along the proposed pipeline corridor, including those that could occur in smaller streams.

Trans Mountain adopted a risk-based approach that reflected guidance from the NEB and previous environmental reviews. The below response describes the process used to select and evaluate the pipeline spill scenario credible worst-case representative locations. Note that as described in more detail below, the evaluation provided by Trans Mountain was applied to 'credible worst-case' scenarios that balanced risk and consequences, not on 'catastrophic worst-case' scenarios focusing on specific locations, species of conservation concern (SCC), specific resources of public or government interest, or worst-case outcomes. Results of the assessment were provided in Volume 7, Sections 6 and 7 (Filing ID A3S4V6).

The information provided in Volume 7, Section 6 (Filing ID A3S4V6) based on effects documented from past spills concluded that substantial adverse environmental and socio-economic effects could result if a credible worst-case or smaller spill were to occur from the pipeline or facilities. Although Trans Mountain's operating history and the risk assessment overview provided in Volume 7, Section 3.1 (Filing ID A3S4V5) demonstrate that the probability of a large pipeline spill is low, credible worst-case pipeline spill scenarios were identified to provide a more detailed evaluation of potential ecological and human health consequences. The spill assessment team concluded that the CWCS for environmental receptors would be an oil spill that reaches a large river and is subsequently transported downstream. The rationale was that such a scenario could affect ecological receptors and resources important to people over a comparatively large area.

Potential environmental effects were evaluated at four locations. These representative locations were selected to: reflect areas of expressed concern by Aboriginal groups or the general public; support evaluation of potential effects to traditional use, other human use or infrastructure; support evaluation of potential effects to environmentally sensitive resources (*e.g.,* salmon spawning grounds); be close to a large river so that a large spill volume could credibly enter the river; and represent the range of watercourse types found along the pipeline corridor. Selected locations included an inland river system in Alberta (Athabasca River scenario), an inland river system in BC (North Thompson River scenario), a coastal river system in BC (the lower Fraser River); and a scenario that could affect nationally and internationally recognized resources in the Fraser River delta (Lower Fraser River – Port Mann Bridge scenario).

Trans Mountain commissioned an independent outflow analysis based on preliminary valve spacing to quantify the oil volume that would be released in the event of an incident at these four representative locations. Modelling assumed a full-bore rupture with hole on the bottom of the pipe, which provided worst-case outflows for the purpose of the ecological risk assessment (ERA). All outflow was assumed to reach the river and be available for transport downstream, except where noted in the scenario evaluations. The outflow volumes derived from this independent analysis are provided in Table 7.1.1 of Volume 7 (Filing ID A3S4V6). Potential ecological effects of the four representative hypothetical pipeline spill scenarios were discussed

in Volume 7, Section 7 (Filing ID A3S4V6) and in accompanying technical report TR 7-1 Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report (Filing IDs A3S4W9 and A3S4X0).

Contrary to the suggestion of Metro Vancouver, Musqueam Indian Band, and BC Nature and Nature Canada, the Lower Fraser River Port Mann Bridge scenario was selected as a credible location to evaluate potential effects on the Fraser River delta. The Project corridor moves away from the Fraser River near this location, and selection of a location closer to the Delta is therefore not appropriate. It is believed that the modelled hypothetical spill into the Fraser River at Port Mann Bridge represents a conservative and CWCS of a hypothetical large spill in a river, partly based on the amount of oil that could be released from ruptures along the pipeline.

Potential human health effects of hypothetical pipeline spill scenarios are discussed in Volume 7, Section 7 (Filing ID A3S4V6). Physical health effects of credible worst-case and smaller pipeline spill scenarios in Metro Vancouver were evaluated in the technical report - Human Health Risk Assessment (HHRA) of Pipeline Spill Scenarios (Intrinsik 2014; Filing ID A3X6U1). This representative location was selected in part because of the large number of people potentially at risk in an urban centre such as Metro Vancouver, including greater numbers of sensitive individuals, compared to smaller communities. In addition, participants at various community meetings, and the Fraser Health Authority and Vancouver Coastal Health Authority expressed an interest in understanding the potential human health effects that could result from an oil spill in an urban area. Aboriginal group concerns about potential health effects were similar to those of other urban and rural residents, and the potential health effects identified through this HHRA are considered to be representative of the types of physical health effects that could be experienced within urban areas, Aboriginal communities, and other smaller communities along the pipeline corridor.

Documented environmental effects of the Burnaby spill were summarized in Volume 7, Section 6.2.4 (Filing ID A3S4V6). Potential human health effects were evaluated for an urban oil spill scenario as noted above. The evaluation of potential effects from the five pipeline spill scenarios and the Burnaby spill incident is considered to be representative of the effects that could be associated with a spill from the Burnaby tank farm, as suggested by G. Senichenko.

28.1.4 Species of Conservation Concern

The City of New Westminster stated that spill effects on Nooksack dace and other SCC should have been evaluated. As described in numerous IR responses (*e.g.*, response to Matsqui FN IR No. 2.0f.1 to 2.0f.5, Filing ID A4H8U3), Trans Mountain chose to evaluate spill-related effects on broad habitat and species groups rather than specific SCC. For example, the pipeline ERA evaluated potential effects on fish habitat as well as fish represented by a generic salmon species. The conclusions provided in Volume 7, Sections 6.4.3 and 6.4.4 (Filing ID A3S4W9) for potential effects on fish and fish habitat ecological receptors for the two lower Fraser River spill scenarios represent the cumulative effect of a spill in the Fraser River on fish eggs and larvae, juveniles, and adults. Potential effects were predicted to vary somewhat depending on the season of a hypothetical spill, but combined effects on fish and fish habitat were concluded to be of medium to high magnitude, potentially including local mortality. Recovery time could take as much as five years where effects occur at the population level. Trans Mountain is confident that its assessment of pipeline accidents and malfunctions follows the NEB's guidance on this issue and meets the requirements of *CEA Act, 2012*.

28.1.5 Credible Worst-Case Scenarios

Metro Vancouver (Zoetica Environmental Research Services [Zoetica] report; Filing ID A4L8C2, Sections 5.0, 9.0, pages 79, 102-104) states that Trans Mountain's failure to consider worst-case scenarios is a serious limitation to the Facilities Application. City of New Westminster (Filing ID A4Q0L5, Sections 2.1.2, 2.1.3, pages 11-12) also states that a worst-case scenario should have been completed for the Brunette River and Fraser River, and BC Nature and Nature Canada (Filing ID A4L8K8, Section 2.5.6, page 14) state that worst-case ecological scenarios should have been evaluated. These assertions are inconsistent with NEB filing requirements (Filing ID A3V6I2), which state that the Facilities Application should evaluate the potential effects of credible worst-case and smaller spills, not worst-case events. The Metro Vancouver Zoetica report also suggests that the evaluation deliberately excluded high magnitude scenarios, which is not correct. The Facilities Application (Volume 7, Sections 6.2, 6.3, and 7.0, [Filing ID A3S4V6] and Volume 8A, Section 5.6.1 and 5.6.2 [Filing IDs A3S5Q3, A3S4Y7, A3S4Y8, A3S4Y9]) concluded that credible worst-case and smaller pipeline and marine shipping spills could have high magnitude effects that would be rated as significant should they occur. This risk of significant adverse effects already exists from current onshore and marine facilities and transportation activities, and the probability of such high magnitude, significant events is demonstrated to be low, both with and without the Project.

28.1.6 Water and Sediment Quality

The Ecofish Research Ltd. report submitted by Cowichan Tribes (Filing ID A4Q0U9, page 11), incorrectly suggests that water and sediment quality were not considered because they were not identified as valued components when evaluating the potential effects of accidents and malfunctions. Spill-related effects on water and sediment quality were considered in fate and transport modelling conducted to support the pipeline and marine shipping ERA for credible worst-case and smaller spills (Pipeline Qualitative ERA of Pipeline Spills [Filing ID A3S4W9], Westridge Marine Terminal Preliminary Quantitative ERA [Filing ID A3S4X1], ERA of Marine Transportation Spills [Filing ID A3S4K7], and NEB IR No. 1.62d - Attachment 1 [Detailed Quantitative ERA for Loading Accidents and Marine Spills, Filing IDs A3W9K1, A3W9K2, A3W9K3, A3W9K4, A3W9K5, A3W9K6, A3W9K7]), and in accidents and malfunctions assessments of small incidents in Volume 5A, Section 7.9 (Filing ID A3S1R0) and Volume 8A, Section 4.3.13 (Filing ID A3S4Y3). As an example, fate and transport modelling conducted for the Lower Fraser River Port Mann Bridge pipeline spill scenario used a three-dimensional hydrodynamic model to represent spatially and temporally-varying fields for surface currents, suspended sediment, salinity, and temperature. This information was used to predict oil mass balance in the water column and sediment.

28.1.7 Other Accidents and Malfunctions Scenarios

Cowichan Tribes (Ecofish Research Ltd. report (Filing ID A4Q0U9, Sections 8.1.3 and 12.6, pages 33, 49, 77-78), suggested that potential effects of marine aquatic invasive species should have been considered, along with potential effects of spills, untreated bilge water release, and ship collisions on marine mammals. As noted above, the *CEA Act, 2012* does not necessitate an assessment of every conceivable accident and malfunction scenario, or of specific effects on individual First Nations, or each resource of public or management concern. Nonetheless, Trans Mountain notes that potential effects of bilge water release was identified as an issue in Volume 8A, Section 4.2.2 (Filing ID A3S4X6) and evaluated as an accident and malfunction scenario in Volume 8A, Section 4.3.13 (Filing ID A3S4Y3). Potential spill-related effects on

marine mammals were evaluated in the ERAs completed for each marine spill scenario. Potential effects of marine mammal collisions with ships were evaluated in Volume 8A, Section 4.3.13 (Filing ID A3S4Y3); a quantitative evaluation of mammal-vessel interactions was provided as an attachment to the response to NEB F-IR No. 4.72 (Filing IDs A4K8L9 and A4K8Q0).

28.2 Cumulative Effects

The Ecofish Research Ltd. report submitted by Cowichan Tribes (Filing ID A4Q0U9, pages 12, 45-46, 62), states that the cumulative effects assessment of the water quality indicator fails to consider the potential impact of accidents and malfunctions, and that spill and spill cleanup effects on marine intertidal systems and aquatic vegetation should have been included in the cumulative effects assessment. Similarly, submissions of City of New Westminster submission (Filing ID A4Q0L5, Section 2.1.2, pages 9-10), Metro Vancouver (Zoetica report, Filing ID A4L8C2, Sections 5.1.3.2 and 11.3.2, pages 87 and 109-110), and Shxw'owhamel First Nation (Collier report, Filing ID A4Q1A1, pages 34-35) suggest that the Application should have assessed the cumulative effects of spills in combination with other anthropogenic stressors and pollutants on fish populations. In accordance with the NEB *Filing Manual* (NEB 2015), Trans Mountain's cumulative effects assessment considered only those physical facilities or activities likely to take place as opposed to those not reasonably foreseeable or hypothetical. Trans Mountain notes that because the location, timing, and specifics of accidents and malfunctions cannot be predicted, they do not represent reasonably foreseeable activities and were therefore not considered in the cumulative effects assessment (Volume 5A, Section 8.1 [Filing ID A3S1R1] and Volume 8A, Section 4.1.1 [Filing ID A3S4Y3]). The Cowichan Tribes recommendation to revise the cumulative effects assessment to include effects of spills and cleanup activities (Filing ID A4Q0U9, pages 46 and 63), is therefore not appropriate for this Application.

28.3 Determination of Significance for Routine Effects

The Zoetica report submitted by Metro Vancouver (Filing ID A4L8C2, Sections 9.1 and 9.4, pages 101-104) states that it is not logical to apply "non-significant" ratings to effects requiring mitigation where Trans Mountain has indicated that mitigation may not be feasible, and provides the example that HDD has not been committed to, yet is touted as the reason for a non-significant impact in response to several environmental concerns. The Zoetica report suggests that significant ratings should be retracted and re-assessed only when the project route, high-level construction plan, and mitigation feasibility are determined, and once all sites have been visited and site-specific baseline information has been collected, and should consider the results of all studies that have been commissioned during the course of the review period (*e.g.,* seismic study) and that will be required prior to construction.

In point of fact, Trans Mountain submitted an update to the ESA in December 2014 as part of Technical Update No. 4 (Filing ID A4F4Z3). The ESA update considered route revisions made to the originally applied-for corridor, results of 2014 field studies, meetings with regulators, outcomes of consultation, and all Project-related supplemental material filed with the NEB up to December 2014. Overall, the ESA update determined that the significance conclusions in the ESA of the Facilities Application remain unchanged for Project-related effects.

By taking a comprehensive and inclusive approach to the ESA, significance evaluations would not be expected to change, since potential effects identified in one location or associated with a

certain construction technique might simply arise at another, and would be mitigated accordingly. For example, it is inaccurate to suggest that an HDD method is the only reason any potentially significant impacts to the environment can be avoided. In actuality, if an HDD were determined not to be feasible at a sensitive watercourse, for example, other mitigation measures would be developed to accommodate an open-cut or isolated crossing method to ensure no significant adverse effects result from implementing a trenched crossing method. For additional information on proposed crossing methods and associated mitigation, refer to the Supplemental Fisheries (BC) Technical Report filed as part of the response to NEB IR No. 3.039a (Filing IDs A4H1Z2 to A4H2D0).

In consideration of information filed to date in 2015, such as the seismic study mentioned in the Zoetica report, Trans Mountain is confident that significance conclusions remain unchanged. Mitigation measures will continue to be refined as needed to reflect Project-related changes and outcomes of ongoing and future studies. However, should any new issues or concerns be identified through consultation and the ongoing pre-construction process, Trans Mountain will consider the implications in the context of the ESA and re-evaluate the assessment accordingly.

28.4 Baseline Data

The City of New Westminster (Filing ID A4Q0L5, Section 2.6, pages 20-21) suggests Trans Mountain commit to monitor environmental changes with a minimum level of statistical power. Trans Mountain is confident the level of collection of baseline data and environmental monitoring methods during and post-construction are appropriate for the Project and align with standard industry accepted practices, and all applicable guidelines and requirements, including the C*EA Act, 2012* and the NEB *Filing Manual* (NEB 2015). Trans Mountain provided detailed responses related to this suggestion by the City of New Westminster in City of New Westminster IR No. 2.A.6i and 2.A.6ii (Filing ID A4H8F6). Additional information describing Trans Mountain's approach to qualitative and quantitative environmental monitoring is provided in the responses to City of New Westminster IR No. 2.A.1v (Filing ID A4H8F6), ALIB IR No. 1.6.09a and 2.06.6a (Filing ID A4H7X5), ALIB F-IR No. 2.06.1c (Filing ID A4K9Y9), and in Section 50 (Post-Construction Monitoring) of this Reply Evidence.

28.5 Assessment of Landowner Concerns

Métis Nation of BC provided evidence (Filing ID A4Q2H2, Section 3.1, pages 16 and 17) that discussed environmental concerns raised by landowners, with specific reference to the Executive Summary of Volume 5A. Specifically, the Métis Nation raised an issue of clarity why the environment was not considered a category for landowner concerns even though it was one of the top concerns. While only a summary was provided in Volume 5A, Trans Mountain assures that the environment was considered in the ESA as a top concern raised by landowners as further detailed in Volume 3C, Landowner Relations (Filing ID A3S0V2) and Volume 5A, Section 3.3 (Filing ID A3S1L3).

28.6 References

Environment Canada. 2011. Written Evidence Submission of Environment Canada to the Joint Review Panel, December 2011. NEB Hearing Order OH-4-2011 for the Northern Gateway Pipelines Inc. Enbridge Northern Gateway Project.

National Energy Board. 2015. *Filing Manual*. Inclusive of Release 2015-01 (June 2015). Calgary, Alberta.

29.0 SOIL AND SOIL PRODUCTIVITY

Metro Vancouver, Cowichan Tribes, and the City of New Westminster submitted evidence (Filing IDs A4L8C2, A4Q0U9, and A4Q0L5, respectively) regarding potentially historically contaminated soils along the pipeline right-of-way, especially in the vicinity of the historical industrial activity along the shores of the Fraser and Brunette Rivers. Although the Fraser River is planned to be crossed via HDD and the Brunette River is not planned to be crossed, contamination may exist in the vicinity of areas that are subject to ground disturbance. Specifically, the intervenors questioned the possibility of contaminants from past industrial activities (*e.g.*, wood preservatives from plywood mills and forestry operations) having the potential to cause external corrosion of the pipeline or affecting the environment and socio-economic conditions if altered in the soil and groundwater or released into the air or water through ground disturbance. More specifically, the intervenors questioned the possibility of contaminants from past industrial activities (*e.g.,* wood preservatives from plywood mills and forestry operations) having the potential to cause external corrosion of the pipeline and the potential for re-introduction of existing contaminants into the environment, particularly watercourses.

Many areas around the Brunette River are industrial or brown field sites, which are now suspected to contain contaminated soils. Trans Mountain understands that the City of New Westminster has been advised to not disturb soils in this area before testing and remediation efforts, to prevent contamination of nearby water bodies, and human health concerns. Trans Mountain agrees that public and worker health and safety is paramount and will undertake a site assessment of the proposed Project Footprint.

Trans Mountain will implement the Contamination Discovery Contingency Plan provided in Section 1.0 of Appendix B, and the Waste Management Standard provided in Section 7.0 of Appendix C of the Pipeline EPP (Volume 6B; Filing ID A3S2S3) in the event that contamination is discovered during construction of the TMEP.

29.1 External Corrosion

Trans Mountain recognizes that contamination may be present associated with existing and past land uses and activities, the locations of which may not be readily apparent. However, Trans Mountain is not aware of any past examples, incidents, or studies that document a pipeline leak or rupture resulting from specific contaminants within the soil. In Alberta, 12.7% of pipeline failures between 1990 and 2012 resulted from external corrosion, primarily due to external pipeline coatings failing from either age or excessive production temperatures (AER 2013). Although soil conditions can be a factor in causing external corrosion, advances in external coating systems, such as fusion-bond epoxy and other higher performance coating that will be used for the TMEP, in combination with technological improvements in the delivery and surveillance of cathodic protection, have contributed to enhanced pipeline reliability and protection.

The selection of coatings that are compatible with a cathodic protection system is critical in preventing external corrosion. External corrosion is rarely found on a pipeline coated with fusion-bond epoxy if adequate cathodic protection is available. With proper application of the external coating, degradation or disbondment of the coating is unlikely. However, if this were to occur and groundwater was to contact the pipe, the surface of the pipe would still be protected from corrosion by the cathodic protection (Norsworthy 2009).

Further, Trans Mountain is planning to use thicker pipe in HCAs within the Lower Mainland and for watercourse crossings (as per Table 5.1.8 of Volume 4A [Filing ID A3S0Z5]). With a world class design approach, Trans Mountain is confident the risk mitigation strategies in place will negate any perceived or actual risks from existing contaminants on pipeline integrity.

29.2 Contaminated Site Disturbance

An inventory of potentially contaminated sites within the proposed pipeline corridor was prepared before filing the Application (see Volume 5A, Section 5.2.4; Filing ID A3S1L5) and will be updated before construction (refer to response to City of Vancouver IR No. 1.03.07c; Filing ID A3Y2G6). More detailed contaminated site investigations will be implemented to gather additional site-specific information. If warranted, sampling of the identified areas of concern may be conducted on a site-specific basis depending on the findings of the additional records reviews, the site proximity to the final route, and their potential impact to the Project. Depending on the results of the contaminated soils investigations, Trans Mountain commits to developing a contamination management and monitoring program to mitigate against risks to human health or the environment.

The limited area of sediment disturbance at watercourse crossings, typically confined to the trench line, and mitigation measures in place to reduce total suspended solids (refer to Section 8.7.3 of the Pipeline EPP [Filing ID A3S2S3]), will reduce the re-introduction of any contaminant-laden sediment into the aquatic environment. Nevertheless, Trans Mountain commits to conducting Phase I ESAs where historical sediment contamination is suspected along the proposed pipeline construction footprint where there is potential to alter water quality during watercourse crossing activities in the Lower Mainland. If necessary, a Phase II ESA will be conducted to determine sediment quality, and to confirm the presence and composition of residual contamination, and whether conditions at the site are likely to cause adverse effects to the environment during construction activities. Based on the results of the Phase II ESA, site-specific mitigation and remediation measures will be developed to prevent the exacerbation or dispersion of contaminants.

Trans Mountain will handle the soils using conventional soil handling techniques where soil contamination is not suspected and for which there are limited perceived risks to the environment. In the event that Trans Mountain staff or contractors observe any previously unknown areas of contamination or suspected contamination during construction, the Contamination Discovery Contingency Plan (Volume 6B [Filing ID A3S2S3]) and/or measures in the contamination management and monitoring program will be implemented.

Parks Canada submitted evidence (Filing ID A4L5U9) which contained a proposed condition relating to soil contamination:

> *J. In the event Trans Mountain discovers, at previously unidentified locations any substance present in the soil, surface water or groundwater at a concentration greater than the applicable Federal or Provincial Regulations, Standards or Guidelines, Trans Mountain shall submit to Parks Canada for its review and approval, within 45 days of discovery, a Remediation Plan including at the minimum:*
>
> *a. a summary of the data collected;*
>
> *b. a map that outlines the affected areas and sample locations;*

c. design methods and sampling used;

d. a list of the contaminants of concern to be addressed;

e. remediation objectives to be achieved;

f. methods by which remediation will be conducted; and

g. a detailed schedule for the implementation of the Remediation Plan.

Trans Mountain is committed to this recommendation by PCA and also plans to use this approach elsewhere along the proposed Project. The Remediation Plan would just focus on the potentially contaminated area to be disturbed within the Project Footprint.

29.3 Summary of New Commitments

- Contaminated site investigations will be implemented to gather additional site-specific information and, if warranted, soil sampling of the identified areas of concern may be conducted on a site-specific basis depending on the findings of the additional records reviews, the site proximity to the final route, and their potential impact to the Project. Depending on the results of the contaminated soils investigations, Trans Mountain commits to developing a contamination management and monitoring program to mitigate against risks to human health or the environment.

- Trans Mountain commits to conducting Phase I ESAs where historical sediment contamination is strongly suspected along the proposed pipeline corridor where there is potential concern for public and worker health and safety, or to alter water quality during watercourse crossing activities in the Lower Mainland. If necessary, a Phase II ESA will be conducted to determine sediment quality and confirm the presence and composition of residual contamination, and whether conditions at the site are likely to cause adverse effects to the environment during construction activities.

- In the event Trans Mountain discovers, at previously unidentified locations in Jasper National Park, any substance present in the soil, surface water or groundwater at a concentration greater than the applicable Federal or Provincial Regulations, Standards, or Guidelines, Trans Mountain shall submit to Parks Canada for its review and approval, within 45 days of discovery, a Remediation Plan including, at the minimum:

  a. a summary of the data collected;

  b. a map that outlines the affected areas and sample locations;

  c. design methods and sampling used;

  d. a list of the contaminants of concern to be addressed;

  e. remediation objectives to be achieved;

  f. methods by which remediation will be conducted; and,

  g. a detailed schedule for the implementation of the Remediation Plan.

29.4 References

Alberta Energy Regulator. 2013. Report 2013-B: Pipeline Performance in Alberta, 1990-2012. August 2013. Calgary, AB. 104 pp.

Norsworthy, Richard. 2009. Coatings Used in Conjunction with Cathodic Protection - Shielding vs Non-shielding Pipeline Coatings. Prepared for: NACE International, Paper No. 4017. Ennis, Texas. 11 pp.

30.0 AGRICULTURAL LANDS

Two intervenors provided evidence on the topic of the effect of the Project on agricultural lands. Trans Mountain is providing written Reply Evidence in response to the evidence filed by Yarrow EcoVillage (Filing ID A4Q1L3) and Mr. Philip Graham of CGLAP (Filing ID A4L5J9).

30.1 Right-of-Way and Temporary Workspace Impacts on Physical Assets

The Yarrow evidence raises a number of concerns with respect to impacts of the pipeline construction on physical assets of Yarrow. These include their waste water treatment system, irrigation, and hothouse operation. The latest routing of the right-of-way and TWS from February 2015, alleviates most of the physical asset impact issues presented in their submission.

30.1.1 Waste Water Ponds and Marsh

Trans Mountain will be refining the route within the preferred corridor and commits to ensuring the waste water ponds and marsh located north of the right-of-way and TWS will not be impacted by construction.

30.1.2 Disruption of Irrigation System

Yarrow is concerned that construction of the pipeline will disrupt their irrigation system and they will not be able to water crops.

Procedures for ensuring irrigation water is not interrupted are described in Volume 5D, Technical Report 5D-6: Agricultural Assessment Technical Report, Section 5.3.8 (McTavish 2013; Filing ID A3S2K9); and in the Agricultural Management Plan (Appendix C, Section 2.3.5) of the Pipeline EPP in Volume 6B (Filing ID A3S2S3). If pipeline construction takes place during the irrigation season, Trans Mountain is committed to working with Yarrow well in advance of the construction to develop a strategy that ensures that adequate temporary irrigation lines are installed and that permanent irrigation lines are re-established as quickly as possible after construction.

30.1.3 Disruption of Greenhouse Operations

Yarrow expresses concerns that location of the TWS and operations within the TWS during construction will negatively impact their greenhouse operation.

The three greenhouses referred to by Yarrow are plastic covered metal structures used for the growing of horticulture crops. The eastern greenhouse is located immediately south of the right-of-way and within the TWS, and the western greenhouse is partially within the TWS. The TWS will be modified to ensure that no pipeline construction activities will affect these two greenhouse structures.

The third greenhouse identified by Yarrow as being affected is located directly south of the TWS and is not within the TWS, and therefore will not be affected by construction.

Other concerns Yarrow has expressed in their evidence is the cutting of irrigation lines to the greenhouses and their ability to access the greenhouses during construction.

Trans Mountain will ensure that temporary irrigation is established as described in Section 30.1.2: Disruption of Irrigation System.

Trans Mountain will ensure that there is access to the greenhouses at all times. There are presently two north-south access roads across the right-of-way, one of which will be kept accessible at all times.

30.2 Disturbance of Farm Fields and Soil

Yarrow expressed concerns on the impact of the pipeline construction on the soil at Yarrow. Their evidence states:

> "The proposed mitigation measures for soil disturbance in the construction right-of-way are not sufficient to protect the soil quality at the Ecovillage. Even if the soil is removed in layers, this removal will disturb the subsurface and surface soil organisms and the structure they depend on, thus reducing the soil quality, and hence its fertility and ability to provide biocontrol against pests and pathogens. Soil moisture will be affected, and exposure to light will impact a subsection of soil microorganisms. Any disruptions of organic farmland for pipeline construction will be severely detrimental to that lands quality and capacity for organic production."

Their submittal also states:

> "The soils at the Ecovillage farm benefit from having been fallow (with some cutting of meadow hay) for almost two decades after being a Mennonite dairy farm and before going into organic production. This fallow/hay period following dairy use both contributed to the soil quality, and enabled the Ecovillage land to obtain organic certification more quickly than normal (they successfully applied for "third-year transitional status" in 2003, rather than the standard "first-year transitional status," and were granted certified organic status in 2004). The Ecovillage land has how been maintained as certified organic for over a decade, and farmers have continued to use manure."

The TMEP will affect two farm plots, indicated as "Chris and Ana" and "Marcel." During construction and rehabilitation of the fields, approximately 1/3 of Chris and Ana's plots (the northern most plot of the three) will not support crops as this part of the parcel is affected by the right-of-way and the TWS. Marcel's plot size will be reduced by about 75%.

Aerial photographs of the City of Chilliwack (2009, 2012) and Google Earth (2006, 2012, 2014) show that active farming on the two parcels started between 2009 and 2012. Before 2009, no agricultural activity was visible and the site appears to be under bush and shrubs. By May 2012, aerial photographs show row crop activity. This would indicate that active soil building outside of having the land covered with perennial grasses and shrubs has been not taken place for more than 4 years as of the spring of 2015.

The two affected properties are currently cultivated and under intensive cropping. The intensive cultivation now practiced under organic principles means that organic matter in the form of manure and/or compost is added to the soil and that the soil is worked/tilled on an annual basis and possibly more often. This results in the soil biology of the land being primarily based on bacteria, arthopods, and earthworms. Fungal populations will be less abundant as fungi are typically more abundant in non-tilled soil with permanent cover comprised primarily of shrubs, trees, and some herbs.

During pipeline construction, topsoil will be removed from the construction area and set aside. This soil handling may affect the soil organisms. Bacteria have been shown to survive in laboratory-stored soil for a period of 2 to 6 months; however, air drying soil samples reduces the numbers in stored soil (Martyniuk and Oron 2008), unless the bacteria form spores and cysts to resist unfavourable drought conditions (Dawes 1989). Fungal populations are more prone to damage because their long hyphae and filaments tend to be damaged by tillage and soil removal. However, fungal populations tend to re-establish rather quickly in the presence of the right support species. Micorrhizal fungi will survive in stored soil for some time, with drier stock piles retaining higher reinfection rates, as high moisture may allow spores to germinate, but without hosts they will die. All available organic matter in the topsoil should be incorporated into the stockpile to prevent loss of soil organic matter (Dawes 1989). Arthopods and other small soil organisms tend to survive disturbance.

Earthworms are affected relative to their size. Small earthworms and those that have a dormancy period and coil up or survive in the soil in cocoons are less affected, while the larger types will be affected by plowing action and major soil disturbance. Topsoil salvage should include careful stripping of the top layer; storing it separately in shallow, steep piles that are kept dry to preserve micro-organisms and seed; and compaction should be prevented (Bainbridge 2007). Studies from Minnesota, England, Wales, and New Zealand show that soil biology of stockpiled topsoil bounces back relatively quickly once replaced, but that topsoil should be stored in shallow piles for short periods of time (Strohmayer 1999).

Topsoil salvage protocols are outlined in Technical Report 5D-6: Agricultural Assessment Technical Report (McTavish 2013; Filing ID A3S2K9). Topsoil will be set aside and will not be mixed with subsoil, and where subsoil is found in distinct separate layers, these layers will be separated using a three-lift process.

Onsite inspection will be carried out by a professional Agrologist during construction to ensure appropriate soil handling protocols are implemented (refer to the response to the CGLAP IR No. 2.2; Filing A4G0G6).

Additional steps for the preservation of the topsoil on this organic farm will be developed in cooperation with the landowners and land users, and their Organic Certification Board. Steps may include topsoil storage in lower heights of up to 1.3 m to prevent lack of oxygen to the soil organisms and reduction of topsoil storage times. Such methods will prevent the loss of organic matter and soil organisms during soil storage and ensure rapid reestablishment of the soil biological factors.

Mr. Philip Graham of CGLAP presented a report as his intervenor evidence that was prepared for KMC by Bruce McTavish and Hubert Timmenga, titled *Soil Handling Recommendations for Pipeline Excavation and Back Filling on Agricultural Land Based on Investigations at 3968 Dixon Road Abbotsford BC* (McTavish report; Filing ID A4L5J9).

The McTavish report makes ten recommendations on soil handling for Trans Mountain operations based on investigations of fine-textured soils found in Sumas and Matsqui Prairie. These recommendations have been incorporated into various filing documents.

The recommendations are:

- Evaluation of site by soil scientist to check soil profile and depth, with specific attention to depth of A (topsoil), and subsoil layers that are different in texture (coarser or finer), substance (organic), and oxidation state (which can indicate high sulphur levels and low pH).
- Strip the A (topsoil) and store separately. Stored A (topsoil) should never be used as a driveway.
- If there are subsoil layers that are significantly different, they should be separated and stored separately.
- In backfilling, the deepest layer goes first.
- Compaction of the subsoil by pounding, smearing, or vibrating should only be done where required for engineering reasons to stabilize the pipe. Compaction should not be performed in the upper lifts of the subsoil. Upper layers of the subsoil should be placed gently by dropping from low height if an excavator is used.
- Before placing the A horizon (topsoil), the placed subsoil and the travelled part of the right-of-way should be deep ploughed or ripped, and then disked in three passes.
- Degree of compaction of the subsoil should be checked using a penetrometer before placement of A horizon (topsoil).
- A horizon (topsoil) should be placed gently.
- Trench filling of the upper layer of subsoil and the A horizon (topsoil) should not be done in inclement weather and when the soil is moist to the point of maximum compaction.
- After the soil is settled, compaction testing should be done to compare the trench and right-of-way with the undisturbed soil, using a penetrometer in transects perpendicular to the pipe centre line.

A detailed soil evaluation by a soil scientist has been completed for the Fraser Valley of BC (Filing ID A3S1T6). As committed to in the response to CGLAP IR No. 2.2 (Filing A4G0G6), there will also be a soil scientist onsite during construction on agricultural lands in the Fraser Valley.

Soil handling is described in detail in Volume 5D, Technical Report 5D-6: Agricultural Assessment Technical Report (Filing ID A3S2K9) and Volume 6B, Appendix B, Sections 9.0 and 10.0 and in Table B.13-1 of the Pipeline EPP (Filing ID A3S2S3). Soil handling details are also provided in the Agricultural Management Plan in Section 2 of Appendix C of the Pipeline EPP (Volume 6B; Filing ID A3S2S3).

30.3 Biodiversity and Pest Control

The Yarrow evidence states:

> "Farmers at the Ecovillage rely heavily on non-crop vegetation at the edges of their fields to foster biodiversity and provide habitat for beneficial species, including pollinators and those that prey on agricultural pests."

Yarrow farm operations and those of organic crop farming in general, depend on set-aside areas such as hedgerows, and leaving strips and buffers as safe havens for and supply of pollinators and organisms that are helpful in pest control. Such areas increase the biodiversity in the farming operation and they can also serve as wildlife corridors.

The right-of-way crosses three distinct biodiversity areas: the riparian zone of Stewart Creek to the west of the property; a hedgerow or potential hedgerow along the main access road; and strips alongside the production areas in the main cropping area.

Access regulation regarding pipeline safety requires that the right-of-way not be covered in trees or large bushes. This means that the riparian zone and the hedgerow cannot have tree establishment on the 18 m width of the right-of-way. The TWS for the Project is currently projected to be full width crossing the riparian zone and the hedgerow/access road area. Trans Mountain will review the TWS width in this area.

The Yarrow property includes fruit forests, which consist of a mixture of fruit bearing trees and shrubs. These areas are not indicated on the diagram supplied by Yarrow in their submission and therefore cannot be identified without a field investigation. If small areas of the fruit forest will be affected by the TWS, trees and shrubs in these areas can be removed, stored, and replanted after construction, replaced with similar trees and shrubs, or Yarrow can be paid compensation adequate to purchase replacement trees and shrubs.

30.4 Organic Certification, Branding, and Marketing

The Yarrow evidence states:

> "Assessment of the Canadian Organic Standards indicates that while pipeline construction will not necessarily lead to a loss of certification, and not for the entire farm, care will be needed to avoid disruption to certification."

The potential effects on organic farms will be mitigated as described in Section 7.2.3 of Technical Report 5D-6 (McTavish 2013; Filing ID A3S2K9).

Activities that will take place in addition to normal farm mitigation measures are:

- prohibit refuelling/servicing of equipment/vehicles on organic fields unless otherwise approved by the landowner;
- prevent the installation of waste collection receptacles or portable toilets on organic fields;
- collect all waste materials such as bevel shavings by using a tarp;

- obtain permission on organic farms from the farm operator and Certification Board for all reclamation activities; and
- refrain from using any prohibited substances in weed control and fertility management.

Guidance for construction activities on organic farms is provided in the Agricultural Management Plan (Appendix C, Section 2.3.1) of the Pipeline EPP (Volume 6B; Filing ID A3S2S3). This includes:

- Clean all construction equipment before its arrival on the construction right-of-way to minimize the spread of weeds. Determine the type of cleaning required based on information in the Line List and the Environmental Alignment Sheets. The use of shovel cleaning supplemented by high pressure air wash stations is the method recommended at most locations along the route where a wash station is required; however, organic farm landowners may request high pressure water or steam cleaning. Equipment that leaves the organic field and returns is to be re-cleaned.
- Install signs to notify construction personnel of the organic farm lands as well as key traffic restrictions, cleaning requirements, refuelling/servicing restrictions, and prohibited materials.
- Restrict traffic on the affected fields to equipment/vehicles actively involved in construction on those fields.
- Ensure one-way vehicle travel along the construction right-of-way. Inspector(s) may be used to monitor traffic and vehicle cleaning to minimize the number of cleaning stations and reduce the risk of weed introduction.
- Prohibit refuelling/servicing of equipment/vehicles on organic fields unless otherwise approved by the landowner.
- Prohibit the installation of waste collection receptacles or portable toilets on the organic fields.
- Ensure a tarp is used when working on organic fields to collect all bevel shavings.
- Salvage topsoil/root zone material from the full right-of-way during non-frozen conditions where localized weed infestations are encountered and contain the subsoil pile containing noxious weeds to prevent mixing with the surrounding soil during regrading and final cleanup.
- Monitor topsoil/root zone material piles for weed growth during the course of construction and implement corrective measures (*e.g.,* hand pulling) if warranted. The use of herbicides will be prohibited.
- Install additional erosion and sediment control measures before or during wet conditions and extreme weather events, to ensure the protection of sensitive environments. Where necessary, cover soil stock piles with a suitable material (*i.e.,* geotextile, polyethylene tarps) and secure properly to reduce the risk of nutrient leaching and sedimentation from these locations.

- Record any sites where equipment is cleaned due to concerns associated with weeds and monitor during the following growing season. Control weed growth using physical measures, if warranted.
- No application of fertilizer on organic fields will be permitted unless otherwise requested by the landowner.

Trans Mountain is committed to collaborating with certified organic farms and their certifying bodies to ensure that there is no interruption to their organic certification (Technical Report 5D-6 [McTavish 2013; Filing ID A3S2K9]). Trans Mountain has also committed to ensuring that a professional Agrologist is onsite during construction activities on all farms in the Lower Mainland of BC. This will ensure that all requirements for agriculture (including organic farms) are followed during construction (refer to the response to CGLAP IR No. 2.2; Filing ID A4G0G6).

Trans Mountain does not believe that the TMEP will affect Yarrow's organic certification, and therefore their marketing as certified organic produce will not be negatively affected. This is supported by the fact that the existing TMPL right-of-way was established in the 1950s and the pipeline crossing the Yarrow property has been in operation for over 60 years. Yarrow bought the property in 2004 and started intensive organic farming on the northern part of the property. Intensive farming for crop production over the existing pipeline started approximately 5 years ago. There is no apparent negative market reputation from the current pipeline operation and none is anticipated after construction of the TMEP.

The Yarrow submission also states that Farmer C was cited as having 800 blueberry bushes in the last year of transition to organic, as they were not bought organic. This means that the blueberry bushes are at the most 2 years old as non-organic perennial plants require 1 year under an organic regimen before being certified. The location of the field was not indicated in the Yarrow submission; therefore, no assessment can be made on whether the field will be affected. Should the TMEP construction affect the blueberry field, Trans Mountain will work with the farmer to either dig and store these plants or negotiate adequate compensation for the loss of the plants.

30.5 Heavy Metal Contamination

The Yarrow submission quoted a paper by Shi *et al.* (2014) showing elevated metals in the working space and the right-of-way of two recently installed Chinese pipelines. The paper suggested that contamination related to metals was a result of pipeline construction:

> "…the anthropogenic sources which are associated with mechanical wear (*i.e.*, automobile tires and brake wear), welding (the incomplete cleanup of residual materials after welding) and burning of oil. Pipeline welding was the main source of Cd pollution in the trench area. Brake wear emissions from traffic increased Cu pollution in the working zone. Ni contamination in pipeline RoW may come from emissions due to mechanical wear and oil burning. Traffic in the pipeline construction is the main source for Pb pollution."

Accumulation of lead (Pb) in soil from traffic is not a concern in Canada because all gasoline is lead-free. Any lead issues in urban and rural areas relate to pre-1970 lead-based paint and historic lead emissions from heavy traffic.

Metals are not homogeneously distributed in the soil profile. McKeage *et al.* (1979) indicates that there is variation in metal levels related to soil type and soil depth/horizon with higher concentrations at lower depth. Mixing of topsoil with subsoil during trench backfilling and replacing topsoil during reclamation of stripped workspace areas may cause increased metal concentrations in the topsoil. The Shi *et al.* (2014) paper does not include information on the excavation practices, soil storage and reclamation protocols, or metal concentrations beyond 10 cm depth; therefore, metal effects from mixing subsoil with topsoil cannot be ruled out.

Soil variability for heavy metals can be very high and could reach 50% of the mean. McGrath (2000) shows variability (as coefficient of variation [CV] %) for metals in farm soils between 10% and 40% (zinc 13% to 38%, copper 27%, cadmium 20% to 44%, chromium 9% to 14%, nickel 10% to 15%). Carter and Gregorich (2008) showed that in statistical analysis and project design, the number of samples needed depends on the CV and the level of confidence selected. They indicate that for the typical concentrations of metals in soil, at least 9 to 12 or (better) 45 to 70 samples are required for statistical analysis and determination of average. Although it appears that for some metals (cadmium and lead) the concentration in soil above the trench and working space is higher, this may be covered within the variability. Three composite samples may not be a sufficient sample size to perform meaningful statistics.

Leaded gasoline was phased out in China after 2000. As such, the lead found in agricultural soil may be attributed to the use of phosphate fertilizer, which can contain traces of lead, cadmium in significant concentrations, as well as arsenic, chromium, mercury, nickel, and vanadium depending on the origin of the phosphate rock (U.S. EPA 1999 and others). Fertilizer is used to improve growth in the reclamation of disturbed areas, and phosphate fertilizer is added as a source of starter nutrient. If phosphate fertilizer was used, it was not described how fertilizer additions or sources of fertilizer were used to revegetate the pipeline right-of-way or working space (Shi *et al.* 2014).

Shi *et al.* (2014) suggests that one source of metals in the soil is incomplete cleanup after welding. Trans Mountain has committed to collect all waste materials such as bevel shavings by using a tarp; therefore, there is no source of metals from welding or grinding on the Project (Section 7.0 of Technical Report 5D-6 [McTavish 2013, Filing ID A3S2K9]).

Shi *et al.* (2014) suggests that another source of metals in the soil is the burning of oil on the pipeline. In Canadian pipeline construction, oil is not burned on the pipeline or in the working space, and therefore cannot be a source of metal contamination on the Project.

Lastly, Shi *et al.* (2014) suggests that another source of metals is from mechanical wear of tires and brakes. Traffic on organic farms is restricted to equipment and vehicles actively involved in construction. All other vehicle access is prohibited.

A comparison of the metal levels reported by Shi *et al.* (2014) to the allowable levels for agricultural soils in BC (Table 30-1) shows that with the exception of chromium, all metal levels were below the allowable limit in BC. However, elevated chromium (and also nickel) in soil is a natural phenomenon related to Serpentenitic soils (Baugé *et al.* 2013). This is a well-known issue in soil and groundwater in BC especially in parts of the Fraser Valley.

TABLE 30-1

COMPARISON OF SOIL METAL LEVELS FOUND BY SHI *ET.AL* (2014) AND THE ALLOWABLE BC LIMITS

Metal	AL Soil Standard in BC (mg/kg)	Soil Concentrations as per Shi *et.al.* (2014) (mg/kg, range)	CSR BC Reg 324/2004; 343/2008
Cd; pH <6.5	1.5	0.09 to 0.21	Schedule 5
Cd; pH 6.5 – 7	3		Schedule 5
Cr (above aquifer)	60	68 to 100	Schedule 5
Cu (pH <5)	250	40 to 48	Schedule 5
Cu (pH 5.5 – 6.0)	400		Schedule 5
Ni	150	28 to 48	Schedule 4
Pb (pH <6)	100	19 to 42	Schedule 5
Zn (pH <5.0)	150	62 to 76	Schedule 5
Zn (pH 5.0 – 5.5)	200		Schedule 5

Source: Shi *et al.* 2014

The results from the review of the Shi *et al.* (2014) paper quoted in the Yarrow submission and the scientific literature shows that the alleged increase in metal concentrations in soil above newly constructed pipelines in China may not be statistically significant. The metals that were indicated to be increased (cadmium, chromium, nickel, and lead) are not related to welding of steel, but to welding of stainless steel or to soldering. Neither technique is related to pipeline construction.

Phosphate fertilizer may add metals to the soil, primarily cadmium. However, it is not expected that a single application on a specific area would cause the results reported by Shi *et al*. (2014). The metal concentrations indicated in Shi *et al.* (2014), except for chromium, are well below the regulatory concentrations for metals in soils in BC. Chromium is known to be enriched in Serpentenitic soils and is of natural causes. Therefore, chromium concentrations as reported by Shi *et al.* (2014) may be related to natural concentrations in the soil. Other metals could be related to high concentrations in fertilizer originating from certain phosphate mines with high levels of metals in the phosphate rock. Such materials are high in cadmium and chromium (U.S. EPA 1999), which are the two metals that have been referred to in the Shi *et.al* (2014) paper as having the highest impact on the soil and on risk assessment parameters. Jia *et al.* (2010) have shown that in China, the effect of heavy metal contamination from fertilizer is minimal, and increases of metals in crops and soils are related to indigenous concentrations in the soil.

The possible increase in metals in shallow soil above the trench and the temporary working space in China (if statistically significant) is likely from mixing of soil from the trench with topsoil without proper segregation of the two.

30.6 Effects on Permaculture

The Yarrow submission discusses the importance of their food forest and its integration into their permaculture site. A food forest is typically an area with perennial plantings, shrubs, and trees that bear fruits to be harvested (Jacke 2005). Food forests are typically sustainable

agricultural systems that can survive with low maintenance and internal cycling of nutrients through nitrogen fixers and natural mulch covers.

The submission from Yarrow does not include the location of food forests. Food forest areas will be identified before construction and decisions will be made in consultation with the landowner to either clear, remove, and store trees and replant the young food forest, or protect it from damage, if feasible. It is anticipated that the affected area of food forest will be limited to the TWS since planting of trees on the right-of-way is not allowed.

30.7 Access to Farmland and Stability for Young Farmers

The Yarrow submission discusses the issue of access to affordable farm land as a societal issue, especially in the Fraser Valley of BC. The TMEP will not impact the access to affordable farm land at Yarrow.

30.8 Amenity Landscape Values

The Yarrow submission discusses the impact of outside incursions on their site. There will be short-term effects to their agricultural areas and construction activities will take place on the right-of-way and TWS. All efforts will be made by Trans Mountain to minimize the impact on the site as described in this response to Yarrow.

30.9 Summary of New Commitments

- Trans Mountain will be refining the route within the preferred corridor and commits to ensuring the waste water ponds and marsh located north of the right-of-way and TWS will not be impacted by construction.

30.10 References

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31.0 SURFACE WATER/HYDROLOGY

31.1 Riparian Areas Management

Evidence submitted by Metro Vancouver (Filing ID A4L8C2, Sections 4.1.5 and 4.1.6, pages 58 and 61) states that construction and development within riparian zones leads to impacts on water quality, including increased sediment load, increased runoff, increased water temperatures, and changes to the buffering microclimates that riparian zones provide and that mitigation, such as the typical erosion control fencing and revegetation, may not fully eliminate these impacts and aquatic ecosystems. Trans Mountain acknowledges that riparian areas within the pipeline easement will be altered during the construction of the Project (Volume 5A, Section 7.2.7.6; Filing ID AS31Q9) and that any disturbance to these areas, if not managed appropriately, does have the potential to adversely affect water quality.

Where trenched pipeline construction methods are to occur at watercourses, clearing of riparian vegetation to the watercourse edge will be required. However, as indicated in Volume 6B, Section 8.1 (Filing ID A3S2S3), clearing within the riparian buffer will be limited to the trench area and any required workspace within the proposed pipeline corridor. As indicated in Table 7.1 of the Fisheries (BC) Technical Report 5C-7 in Volume 5C (Filing ID A3S2C2), and in Section 8.1 of the Pipeline EPP (Volume 6B; Filing ID A3S2S3), Trans Mountain intends to adhere to the *Forest Practices Code*, *Riparian Management Area Guidebook* in BC (BC Ministry of Forests 1995) during clearing activities associated with the construction of the Project.

Upon completion of construction, all riparian buffers will be revegetated. Typically, woody vegetation will be allowed to grow back over the right-of-way, with the exception of 3 m on either side of the pipeline that will be kept free of large trees for safety considerations and to provide access to the watercourses for Trans Mountain operations crews, if required. Effectiveness of the replanting and revegetation of riparian buffers will be monitored for up to 5 years during the post-construction environmental monitoring (PCEM) program to ensure that riparian vegetation is in a functional state as to avoid any impacts on water quality. As a recent example, Trans Mountain experienced great success in the restoration of riparian areas following construction of the Anchor Loop Project.
(http://www.transmountain.com/restoration-planting).

Please refer to Section 44.4 of this Reply Evidence for additional evidence on the effectiveness of the replanting and revegetation of riparian buffers as well as an example from the Anchor Loop Project of the functional riparian vegetation that can be achieved post-construction.

31.2 Historical Contamination

A number of interveners (City of New Westminster [Filing ID A4Q0L5, Section 2.5, pages 19 and 20], Cowichan Tribes [Filing ID A4Q0U9, Section 5.1, pages 7 and 8], and Metro Vancouver [Filing ID A4L8C2, Sections 4.1.5 and 4.1.6, pages 62 and 63]) identified concerns associated with the presence and potential disturbance and release of historical contaminants along the proposed pipeline corridor during construction. Specifically, the interveners questioned the possibility of contaminants from past industrial activities (*e.g.,* wood preservatives from plywood mills and forestry operations) having the potential to cause external corrosion of the pipeline and the potential for re-introduction of existing contaminants into the environment, particularly watercourses. These concerns have been addressed under Section 29 (Soil and Soil Productivity) of this Reply Evidence.

31.3 Implementation of Mitigation

The Ecofish report submitted by Cowichan Tribes (Filing ID A4Q0U9, Sections 5.5 and 5.6, page 10) recommends that, although no technical gaps were identified for mitigating herbicide use, potential acid generation, and water quality during construction, the Application should explain how, where, and when all mitigation measures will be implemented, and how they will be monitored. These more specific details would help to provide confidence in mitigation plans and residual effects assessments.

To meet environmental commitments and permit requirements during Project activities, Trans Mountain will implement the Pipeline, Facilities and Westridge Marine Terminal EPPs of Volumes 6B, 6C, and 6D, respectively (Filing IDs A3S2S3, A3S2S6, A3S2S9). The EPPs identify mitigation and reclamation measures that may be implemented during detailed design, pre-construction, construction, and post-construction activities on the pipeline. The EPPs provide Trans Mountain, its contractors, and personnel with an understanding of the general environmental background of the construction right-of-way and the extent and limitations of the EPPs. The EPPs also provide information to identify specific or unique mitigation measures to be implemented to address environmental issues associated with pipeline construction and general mitigation measures or industry accepted standards and procedures that are typically applied to a pipeline project. These measures are generally provided in accordance with the sequence of construction of the pipeline or grouped by Project component.

To ensure implementation of recommended mitigation, the EPPs outline environmental inspection and construction inspection roles and responsibilities during and following construction. TMEP personnel responsible for ensuring effective implementation and monitoring of mitigation measures during construction activities include the construction manager, environmental manager, permit and approvals manager, environmental compliance manager, supervisor of environmental inspection and lead activity inspector, as well as environmental inspectors, aboriginal monitors, and resource specialists. Refer to Table 1.2-1 and Section 1.2.1 in the Pipeline EPP (Volume 6B; Filing ID A3S2S3) for a summary of specific roles and responsibilities.

Potential environmental mitigation measures are identified under the heading "Potential Mitigation Measures" by "Activity/Concern" in accordance with the progression of construction activities and are intended to be read in conjunction with the Environmental Alignment Sheets. The Environmental Alignment Sheets (provided in Volume 6E; Filing IDs A3S2T1 to A3S3Y0) identify specific locations where mitigation measures are to be implemented during pipeline construction, including resource-specific mitigation developed by resource specialists during various studies, site investigations, and surveys. Resource-specific mitigation measures (also provided in Appendices E through Q of the Pipeline EPP; Filing ID A3S2S3) are outlined in the technical reports developed by resource specialists in support of the ESA.

In addition to standard, site-specific and resource-specific mitigation measures provided in the EPPs and Environmental Alignment Sheets, various management plans containing specific environmental management procedures that may apply during construction will be implemented, including the Acid Rock Drainage Management Plan, Weed and Vegetation Management Plan, and Water Crossing Construction Monitoring Management Plan (Volume 6B, Appendix C; Filing ID A3S2S3). When unanticipated situations arise, various contingency plans are in place to mitigate any potential associated impacts on water quality, including the Spill Contingency Plan, Drilling Mud Release Contingency Plan, and the Soil Erosion and Sediment Control

Contingency Plan (Volume 6B, Appendix B Filing ID A3S2S3). These mitigation measures will be implemented, as warranted, by Trans Mountain, its contractors and subcontractors before and during construction.

Information provided in the appendices of the EPPs is designed to support the specific mitigation measures identified throughout the EPPs and provide guidance to decision-making processes, should conditions arise that warrant implementation of remedial or contingency measures. Site and resource-specific mitigation will be implemented as necessary depending on finalization of a Project footprint and based on the results of supplemental studies, and will be incorporated into the updated EPPs and Environmental Alignment Sheets to ensure features are accurately marked and mitigation is implemented during construction. The updated EPPs and Environmental Alignment Sheets will be filed with the NEB 90 days before construction as per NEB Draft Condition No. 29 to 31 of the NEB's letter – Draft Conditions and Regulatory Oversight (April 16, 2014) (NEB 2015; Filing ID A3V8Z8).

Where possible, the Application and supporting materials document how, where, and when mitigation measures will be implemented, and how they will be monitored. For example, measures pertaining to the use of herbicides are provided in Section 7.0 and the Weeds and Vegetation Management Plan in Appendix C of the Pipeline EPP. The Weeds and Vegetation Management Plan details the methods for applying herbicide and the conditions for which application would be necessary in compliance with all guidelines outlined in KMC's Integrated Vegetation Management Plan (KMC 2011) as well as weed and pesticide legislation for BC. It is not possible at this time to identify specific locations where herbicides will be applied; however, there are specific locations where herbicide use is prohibited, such as organic farm lands, and within 30 m of a water body or rare plant community.

Mitigation measures for water quality are detailed in Section 8.7.3 of the Pipeline EPP, and include specific measures for the protection of water quality during construction activities, including water quality monitoring. The Water Crossing Construction Monitoring Management Plan in Appendix C of the Pipeline EPP provides the specific strategies and conditions for water quality monitoring during construction activities. Specific watercourse crossings where water quality monitoring is planned include those where trenchless (*e.g.,* HDD) method will be used and at sensitive watercourse crossings where a trench installation method is proposed. The recommended crossing methods, monitoring, and reclamation strategies specific to each proposed watercourse crossing are provided in Appendix A1 of the Supplemental Fisheries (BC) Technical Report (Filing ID A4H1Z2).

In some cases, technical studies are still ongoing for the Project and, consequently, specific mitigation details have not been defined. For example, as described in the response to Upper Nicola Band IR No. 2.14d (Filing ID A4H9I4), further sampling for ML/ARD characterization and delineation is currently underway and will be completed before construction. This additional work will focus on geologic units with "high" and "moderate" ARD/ML potential that were not previously sampled and areas where 2013 investigation results indicated the presence of potentially acid generating (PAG) material. In addition to the 2015 and pre-construction field investigation, as committed to in the response to Upper Nicola Band IR No. 2.15e (Filing ID A4H9I4), an ARD Mitigation Toolbox will be developed for use during construction. The ARD Mitigation Toolbox will summarize construction management practices and ARD/ML mitigation methods for pipeline construction. In the event that it may be necessary to disturb PAG material during the construction phase of the Project, an Acid Rock Drainage Management Plan (Volume 6B, Appendix C) will be developed before construction to ensure that the receiving

environment (including fish and fish habitat) is not adversely impacted. Furthermore, Trans Mountain will conduct inspections and post-construction seepage sampling at areas where PAG material has been identified or exposed during construction.

It is Trans Mountain's responsibility to ensure Project personnel understand and adhere to the applicable mitigation measures in the EPPs. To achieve this, before the start of construction, Trans Mountain will prepare an Environmental Compliance Plan (Volume 6A, Section 5.3; Filing ID A3S2S1) as committed to in the response to City of Burnaby IR No. 1.26.01a (Filing ID A3Y2E6). Non-compliances will be resolved using a process as described in the response to the City of Burnaby IR No. 1.38.07a (Filing ID A3Y2E6).

Furthermore, as committed to in the response to ALIB IR No. 1.6.02b (Filing ID A4H7X5), Trans Mountain will develop a management of change process where measures are ineffective at addressing the concern and facilitate development and implementation of more effective, and technically and economically feasible measures. The management of change process will ensure changes to mitigation measures are approved and communicated to appropriate project personnel and regulatory agencies as required. Any changes will be captured in the Environmental Issue Tracking List and ultimately reported in the as-built report that is submitted to the NEB following construction.

31.4 References

British Columbia Ministry of Forests (B.C. MOF). 1995. Forest Practices Code, Riparian Management Area Guidebook. Government of British Columbia. 68 pp.

Kinder Morgan Canada Inc. (KMC). 2011. Integrated Vegetation Management Plan. Calgary, Alberta. 81pp.

National Energy Board (NEB). 2015. NEB *Filing Manual*. Inclusive of Release 2015-01 (June 2015). Calgary, Alberta.

32.0 GROUNDWATER QUALITY AND QUANTITY

32.1 Groundwater Quantity and Flow

32.1.1 General Hydrogeology Issues

Groundwater flow direction through the Coldwater Indian Reserve is from the southeast to the northwest, flowing from near the Coquihalla Highway downgradient toward the Coldwater River at the bottom of the valley. The written evidence of the Coldwater Indian Band (Filing ID A4Q0W6, page 5) provides anecdotal evidence that *"...the members have experienced changes in water flows through the reserve affecting irrigation, which they believe has been caused by the existing pipeline."*

Apparent changes in irrigation flows could be caused by numerous factors, including climate conditions, community growth, and changes in Band groundwater usage, influences of other neighbouring activities that could influence drainage or water balance conditions, and changes in well performance. According to the BC Groundwater Consulting Services Report (Coldwater BC Groundwater report) (Filing IDs A4Q0W9 and A4Q0X0), which was submitted as part of the Coldwater Indian Band's written evidence, the existing pipeline is installed above the water table, as illustrated on Figure 2 of the BC Groundwater report, and as such, would not influence flow within the aquifer exploited by the Band for irrigation purposes. It should be noted that the existing pipeline pre-dates the existing community water supply wells, which were installed in 1973 (Lower Kwinshatin Well), 1980 (Skugan), 1991 (Upper Kwinshatin Well), and 2010 (Replacement Kwinshatin Well), and that the groundwater concerns expressed by the Band were apparently not considered when siting the source wells or considering alternative water supplies located further from the existing pipeline.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) states "*The vadose zone underlying Kwinshatin Creek will control the rate of recharge to the aquifer."* This statement suggests that the hydraulic characteristics of the creek bed restrict groundwater infiltration such that the creek remains perched and an unsaturated zone is sustained beneath the creek bed along the uphill reaches above the community water supply wells approaching the proposed pipeline alignment. Under this scenario, there is no direct hydraulic connection between the aquifer and the creek along these reaches. Due to the physical characteristics of the oil, any oil infiltration will be much more attenuated in this environment relative to infiltrating groundwater. Under the conceptual model presented by BC Groundwater, Trans Mountain expects very limited opportunity for substantial aquifer risks due to a potential release of oil from the proposed pipeline.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) states *"The potential for non-point source impacts from the pipeline are an important consideration since they are cumulative over time.*" "Non-point source impacts" generally refer to sources of contamination that are spread out spatially; for example, fertilizers or pesticides applied over cropland or multiple septic fields within a community. These sources may be short-term or long-lived. In that sense, neither the existing nor the proposed pipeline would act as a non-point source for contamination. A leak from the pipeline is generally considered a point-source release. Trans Mountain assumes in this case, that "non-point source impacts" refers to water quantity rather than water quality impacts, where the flow of groundwater could be impacted over a length of pipeline. The pipeline or the associated trench and backfill could act to locally increase or decrease groundwater flow by altering the permeability of the backfill material relative to the

native ground. For this to occur, and substantially influence groundwater conditions, the pipeline excavation must extend beneath the water table. Within the Coldwater Indian Reserve, it is almost certain that the pipeline will be buried above the water table to a depth of 1.8 m to 2.2 m to the base of the pipe.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) includes a variety of charts depicting groundwater monitoring data collected during the testing of the 2010 Kwinshatin Replacement water well. These charts clearly show the hydraulic response of the Skugan well, to pumping at the Kwinshatin Replacement well. This confirms aquifer continuity between these two wells, and suggests that the system is not ` separate aquifers oriented and restricted to the area of each of the Skugan or Kwinshatin creeks, but a more extensive aquifer system associated with the flanks of the Coldwater River valley. This suggests opportunities for alternative or replacement wells for the Coldwater Indian Band would not be restricted to the Kwinshatin or Skugan channels, or the lower terraces of the Coldwater River as indicated in the Coldwater BC Groundwater report.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) also states *"Datalogger monitoring shows a clear connection between the wells and recharge from Kwinshatin and Skugan Creeks. Connection with shallow springs and the Coldwater River floodplain is indicated in the private dug wells."* It is not entirely explained in the text nor is it evident in the figure how this conclusion is reached, although Trans Mountain would tend to agree with this expectation.

32.1.2 Seepage into Tunnels

Natural Resources Canada expressed concern in their written evidence (Filing ID A4Q0V2) that the seepage has not been defined robustly and recommends that quantitative estimates of seepage be provided. Trans Mountain agrees with this.

TBM technology has been selected for construction of the TMEP corridor tunnel beneath Burnaby Mountain. Two basic types of TBMs were considered:

- Open-Face type – The ground in front of the cutterhead is unsupported, allowing groundwater seepage from in front of the TBM into the tunnel. An expanded initial support system consisting of either ribs and lagging or precast concrete is installed which supports the ground behind the TBM, and seepage water from ahead of the TBM is removed and treated outside the tunnel environment.

- Pressurized-Face type – The ground in front of the cutterhead is supported by face pressure exerted by the TBM, which also resists groundwater seepage into the tunnel from ground ahead of the TBM. A gasketed precast concrete tunnel lining is erected to support the excavation behind the TBM.

The Project will continue to pursue additional information on groundwater pressure head at tunnel depth and rock mass permeability along the tunnel alignment to more accurately predict tunnel seepage during construction. For example, groundwater seepage modelling is currently underway and a site investigation program at the Westridge Terminal is planned. In addition, in advance of the start of tunnel excavation, further investigation (including the drilling of an HDD pilot hole along the tunnel path) is being considered in order to verify groundwater and seepage conditions. In the absence of definitive groundwater seepage information and as a risk

management measure, the design may incorporate a TBM with pressurized-face capability and a gasketted precast concrete tunnel lining.

Irrespective of the construction method selected, the potential effect of seepage on the groundwater table will be temporary and only occur during the construction phase of the tunnel. Once the tunnel is completed, it will be backfilled with cementitious material and all seepage will be sealed off. Therefore, following completion of the Project, the groundwater regime is expected to return to its pre-construction condition.

32.2 Groundwater Quality

32.2.1 Potential Groundwater Contamination

In the unlikely event that petroleum hydrocarbon (PHC) dilbit (a material resembling crude oil) is released from the pipeline, the oil would first infiltrate into the surrounding trench soils. Then, depending on numerous variables (*e.g.,* spill volume, release pressure and duration, properties of the oil, etc.), the oil may migrate from the release area upward to the ground surface, and/or down through the vadose zone towards the water table. As stated in Volume 7, Section 5.3 of the Application (Filing ID A3S1U8), hydrocarbons would tend to fill pore spaces in the fill provided adequate relative permeability of the soil with respect to the released oil. As the soils surrounding the release point become saturated, oil would tend to flow to adjoining media along the trench fill and follow the general surface and subsurface topography. If soils are saturated, oil may become evident on the ground surface and extend downward to an impermeable layer or groundwater. Should oil be released from a pipeline, especially over an unconfined aquifer, initial cleanup options would be evaluated and approved by the UC, and would vary, depending upon the nature of the specific site conditions. Spill response efforts would "aim to reduce potential for groundwater contamination by removing pooled oil and affected surface materials as quickly as possible, and as deeply as needed to remove contamination so that aquifers are not affected."

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) states *"The presence of nitrate (on-site sewage disposal) detected throughout the aquifer system suggests the aquitard does not provide complete protection from the existing or proposed pipelines. Polycyclic aromatic hydrocarbons (PAH) including Napthalene, Phenanthrene, Fluorine and Pyrene have also been identified in the primary drilled community well at several times the reportable detection limit (Upper Kwinshatin). The existing pipeline is a potential source of these PAH's"* (partly reiterated also in written evidence of the Coldwater Indian Band; Filing ID A4Q0W6).

The presence of nitrate in the groundwater suggests that domestic sewage treatment and disposal has potentially compromised the quality of groundwater in the aquifer. If the nitrate pathway is considered to be leakage across the confining unit, then the Coldwater BC Groundwater conceptual model appears to be oversimplified. This condition contradicts the hypothesis that strong artesian conditions exist below 705 m-geod as suggested by Coldwater BC Groundwater report, with no apparent hydraulic connection to the Coldwater River alluvial deposits. The limited connection of the aquifer system to the Coldwater River alluvial deposits is also contradicted by the Coldwater BC Groundwater report statements defining steep gradients and high permeability porous media whereby *"rapid groundwater travel (a few days to a week or two) through the aquifer(s) at approximately 90% of the Band wells."* Based on these descriptions, the conceptual model must be based on a foundation of high recharge, high

natural flow within the aquifer and high discharge to the receiving basin. In this respect, it is probable that the Coldwater River alluvial deposits are hydraulically connected to the aquifer or substantial spring flow occurs along the lower slopes of the Coldwater River valley, above the Coldwater River. This model supports an extensive aquifer system for which the boundaries are poorly defined. Therefore, limiting further groundwater exploration to the existing well sites is not warranted by the model.

With respect to contamination of groundwater by nutrients, it should be noted that nitrate is a highly mobile dissolved constituent in groundwater. The hydrocarbons transported in the pipeline, on the other hand, are substantially less mobile and less likely to migrate through the unsaturated zone. Rapid response to spill events is key to ensuring that spills from the pipeline have little or no impact to the aquifer.

PAHs are often associated with coal or heavier (long carbon chain) hydrocarbons. Some PAH content does exist in some products carried in the existing pipeline, although not without a considerable proportion of other lighter hydrocarbons. In general, the migration of PAHs in groundwater is slower than that of lighter hydrocarbons such as BTEX compounds. The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) makes no mention of detections of these other lighter and more mobile hydrocarbons, and if detected in the samples submitted for analysis. Thus, it is unlikely that the PAHs reportedly detected could be associated with the existing pipeline, and likely that they are derived from another source such as coal, or reflect a possible sampling QA/quality control (QC) issue.

The affidavit of Asher Rizvi of the Township of Langley (Filing IDs A4L7R8 and A4L7R9) states *"Due to lack of a protective layer, any contaminants, such as a hydrocarbon spill resulting from a pipeline leakage, can possibly migrate into the water supply aquifers and contaminate the groundwater. In addition, since local surface water features are hydraulically connected to groundwater, a contaminant in surface water can migrate into an aquifer thus polluting the groundwater source. Thus, if a spill reaches the Salmon River (depending on volume and flow rate of the spill), the spill contents will be carried along the river flow contaminating all hydraulically interconnected surface water and groundwater features."*

Potential spills from the proposed pipeline could flow along the ground surface from higher ground to lower ground. The infiltration of the spill material into the ground depends on a number of factors, including the thickness or head of oil on the ground, the type of soil materials, and the viscosity and density of the spilled material. Due to viscosity and hydrocarbon surface tension properties, the infiltration of any spilled oil into the ground through the unsaturated zone, to the water table will be much slower than any water infiltration. The time required for heavy oil to reach the water table is also influenced by the thickness of the unsaturated zone, and variability in geologic conditions across the vadose zone. Rapid response to spill is the key to reducing or eliminating the impact of a spill to the groundwater.

The affidavit of Asher Rizvi (Filing IDs A4L7R8 and A4L7R9) indicates a variety of groundwater impact situations and potential outcomes related to the Township of Langley, such as:

- "…that the Fort Langley municipal production well would have to be shut down or production scaled back in the event of a spill that gets into the Salmon River or migrates into the Fort Langley aquifer. The well would require continuous testing for hydrocarbons."

- "…a decision by Langley to undertake remediation would result in additional site investigations, contaminant clean up and other remedial works."
- "…the Fort Langley production well would have to be shut down in order to undertake a risk assessment and to evaluate the extent of the affected area. A long-term monitoring infrastructure including sentinel wells and water quality monitoring, would need to be set up to monitor the health of the water supply if the well is continued to be used for drinking water supply or to assess when to take measures to save the water infrastructure from pollutants migrating towards the well."
- "Another scenario that may occur in the long term is that the spill could result in contaminating a wide range of local aquifers in Langley, so a local water supply source may not be available at all."

In the event of a leak or rupture from a pipeline or facility, Trans Mountain will follow the remedial steps outlined in the NEB Remediation Process Guide (NEB 2011) to ensure that the groundwater contamination is remediated to applicable remediation standards. Remediation would involve an initial assessment of the site and contaminant conditions, development of a remedial action plan which will be reviewed by the NEB and other interested parties, followed by remediation work and closure reporting to NEB.

32.2.2 Security of Groundwater Supply

Trans Mountain realizes a release from the pipeline system could significantly impact communities in various ways. Trans Mountain made a commitment (Province of BC IR No. 2.12; Filing ID A4G5Y0) to work with communities that have specific concerns related to protection of municipal water sources and will consider installation of monitoring wells in strategic locations. During these engagements, Trans Mountain anticipates that potential consequences of groundwater contamination will be discussed along with a review of the maintenance policies, systems, programs, procedures, practices, and activities to prevent pipeline releases, as noted in Province of BC IR No. 2.12.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) presents a conceptual hydrogeological model (cross-section) showing the extent of the aquifer supplying water to the Coldwater Indian Band, with an overlying aquitard consisting of glacial till. The aquifer is confined beneath the aquitard which, where the aquitard is present, likely provides some protection from contaminants percolating down from the surface. Upgradient, to the southeast toward the Coquihalla Highway, the aquifer becomes unconfined and unsaturated to dry in its upper reaches. This upland area is considered the aquifer recharge area where the Kwinshatin and Skuagan creeks likely contribute to recharge. The conceptual model appears to be over simplified based on the presented evidence. Assuming that the conceptual model, as interpreted from the borehole data from the community wells and the surficial geology mapping, reasonably reflects the aquifer conditions, then the Modified East Alternative proposed pipeline route provides the community with the best alternative for the protection of their water supply. Although the Modified East Alternative proposed pipeline corridor is located in the Coldwater River watershed, the pipeline route is located higher in the watershed in an area where the overburden material is apparently unsaturated, beyond the upper reaches of the aquifer.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) suggests *"The steep lateral hydraulic gradients in the aquifer system and datalogger monitoring results suggest rapid groundwater travel (a few days to a week or two) through the aquifer(s) at approximately 90% of the Band wells."* Trans Mountain agrees that the large amount of relief in the area to the south between the Coldwater community and the Coquihalla Highway of almost 300 m will mean that the predominant migration of spilled contamination will be overland in the event of a spill. However, potential leaks or spills from the proposed pipeline are likely to migrate at a much slower rate through the extensive unsaturated material, and the opportunities to impact the aquifer are limited by both the unsaturated deposits and the behaviour of the oil compounds in this environment.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) states *"The existing Trans-Mountain Pipeline is located directly adjacent to the existing Upper Kwinshatin and Lower Kwinshatin community wells and in close proximity to the Skugan community well. The existing pipeline is located on the only aquifer considered viable to meet the domestic and fire protection needs of the Band."* The existing pipeline has operated for more than 60 years with only four spills that are known to have affected groundwater resources, none of which affected the Coldwater Indian Reserve. In all cases where a leak affecting groundwater resources has been detected, Trans Mountain has assessed and implemented mitigation measures to control or remediate the impacts. As a result of routine pipeline integrity efforts on Trans Mountain's existing pipeline in 2014, soil hydrocarbon impacts were recently identified on Coldwater Indian Reserve lands at a tie in between the pre-existing and re-aligned pipeline segment. Following a 1968 landslide, this segment of the existing TMPL was re-aligned. Trans Mountain's investigation and mitigation is ongoing, but investigation to date has identified no detectable concentrations of hydrocarbons in groundwater, and no impacts to the local aquifer resources are indicated. Additional testing is planned to further confirm groundwater conditions. The Upper Kwinshatin well was installed in 2010, long after the existing pipeline was in place. It is reasonable to assume that the risk of location of the Coldwater Band water supply wells adjacent to the operating pipeline was considered, and that the risk of aquifer contamination due to a pipeline spill was considered to be low likelihood. With respect to the proposed route higher in the water shed, the risk has been reduced considerably. Regardless, this reply evidence is intended to assess risks from the proposed pipeline, not the existing pipeline.

The glacio-fluvial aquifer identified beneath the Coldwater Band community, while not mapped in the BC Aquifer database (Berardinucci and Ronneseth 2002), may extend much further up and downstream along the Coldwater River valley, or potentially laterally away from the Kwinshatin or Skugan valleys. Aquifer mapping is, in part, based on data collected during the drilling of water wells. Where there are no wells, the aquifer mapping cannot be easily completed.

The proposed pipeline corridor has several alternate routes (Alternate and Modified East Alternative), which lie either above the water table at the furthest south eastern extent of the aquifer according to the submitted Figure 2 in the Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0). These alternative routes are approximately 600 m from the existing pipeline, near the theoretical limits of the saturated unconfined aquifer, or in the unsaturated material beyond the limits of the aquifer, approximately 1,200 m from the existing pipeline. The fact that the proposed pipeline corridor lies between 600 and 1,200 m from the community water supply wells, albeit upgradient suggests that any spilled hydrocarbons may be fully attenuated before reaching the aquifer and/or water source wells.

As highlighted in the response to Province of BC IR No. 2.07d (Filing ID A4H8W6), aquifers are weighted heavily in the consequence scoring calculation that is used in the risk assessment that informs the risk-based design process for Line 2 and the new delivery lines.

Through the risk-based design process, potential risks along Line 2 and the new delivery lines are identified and prioritized. Working in order of risk priority, mitigation measures that are appropriate to the factor that is responsible for driving risk at each specific location are developed and incorporated into final design. These mitigation measures, once incorporated into the final design, will reduce failure likelihood and/or consequence (and hence risk) by targeting risk mitigation strategies directed at the principal drivers of risk that have been identified in the risk assessment.

The Preliminary Results of the risk analysis that has been performed on Line 2 and the new delivery lines were provided in tabular format, showing risk at 1 km spacing in Filing IDs A3Z8G5 (pages 11-37), A4F5G8, and A4F5F9. These results are characterized as "preliminary" because they represent the results of a risk analysis of a baseline design (*i.e.,* prior to the implementation of all the risk mitigation measures that will ultimately be incorporated into the final design). These risk results serve as a "starting point" for the risk-based design process, which as is discussed in Section 5 of the Line 2 Risk Report (Filing ID A3Z8G1) is an iterative process of Risk Assessment/Identify and Prioritize Risk/Develop Mitigation Plans/Re-evaluate Risk.

The iterative risk-based design approach described above is currently underway and will continue to progress through to detailed design. Until this process is completed, a full list of detailed and specific risk mitigation measures that will be incorporated into the final design, and the risk that is associated with that final design will not be available. Examples of typical risk mitigation strategies include the mitigation of third-party damage through increased depth of cover, increased wall thickness or pipeline markers, the mitigation of environmental consequences through the installation of mainline valves, and the mitigation of geotechnical threats through threat avoidance.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0), recommends *"the Band continue existing monitoring of their community and private wells through existing dataloggers and water quality monitoring. We specifically recommend the construction of several independent monitoring wells to monitor aquifer yields, sustainability, and quality in perpetuity. Select monitoring wells ("sentinel" wells) should also be installed between the existing pipeline and the existing wells. These wells should also be installed between any east route pipelines and the existing wells in addition to an upstream baseline monitoring well."* Trans Mountain can appreciate these recommendations with respect to the Coldwater Indian Band's interest in understanding and maintaining their groundwater based community water supply systems. However, Trans Mountain does not comprehend how all facets of these recommendations apply to the proposed pipeline Project. BC Groundwater acknowledges that the existing and proposed pipelines are constructed above the water table in the area, and in the case of the Modified Alternative and Modified East Alternative routes, the proposed pipeline would be constructed beyond the limits of the aquifer exploited by the Coldwater Indian Band for their water supplies. Trans Mountain believes there is no opportunity for the existing or proposed pipeline to undermine the physical hydrogeology in the area that would create any concerns with respect to groundwater flow and aquifer sustainability or yield. As a result Trans Mountain does not accept that there is any justification related to their activities to consider the need for their contribution to monitoring aquifer sustainability or yield as recommended by BC

Groundwater. However, given the potential for a pipeline release to contribute to subsurface contamination, Trans Mountain can understand the desire to supplement water quality monitoring within the aquifer resources to provide reassurance that pipeline activities do not undermine the communities reliance and confidence on groundwater resources, and ensure that the community can respond to issues in advance of any potential water quality impact to the community water supplies.

BC Groundwater presents the conceptualized southeastern limits of the aquifer relied upon by the community as roughly coincident with the proposed modified alternative pipeline alignment (Figures 1 through 4, PDF pages 9 through 12; Filing ID A4Q0W9), and suggests that areas to the southeast of this limit remains unsaturated. With respect to the specific monitoring locations recommended by BC Groundwater, one of the four proposed monitoring well locations is beyond the conceptualized limits of the aquifer presented by BC Groundwater and two of the locations are located at the conceptualized hydraulic boundary of the aquifer. Trans Mountain questions whether monitoring data from such wells can provide any useful monitoring of aquifer sustainability or yield, let alone meaningful information related to potential aquifer contamination, or pipeline-related impacts to the community's water supply aquifer. One of these wells and a surface water monitoring pair are located upgradient of the most upland Modified East Alternative pipeline alignment being considered, and beyond any potential impact of Trans Mountain's proposed activity. Trans Mountain can understand BC Groundwater's interest in developing background or upgradient data for the Band's aquifer management purposes, or to evaluate potential alternative aquifer resources, but since these are otherwise beyond or outside any potential Trans Mountain influence, it is difficult for Trans Mountain to accept the justification to link the installation and perpetual monitoring of such a well or surface water monitoring location to Trans Mountain's Project.

The proposed surface water monitoring station associated with Skugan Creek is located upgradient of the Modified Alternative alignment, but downgradient of the Modified East Alternative alignment. There would be little value monitoring such a location should the Modified Alternative alignment be constructed. Only one of the proposed monitoring wells is located within the conceptualized limits of the aquifer with limited influence of the hydraulic boundary. However, this proposed well is located downgradient and outside of BC Groundwater's reported influence of the existing community wells, more than 500 m from the existing pipeline alignment, and even further from the alternative alignments. Trans Mountain recognizes that this proposed location is consistent with the location of a proposed community well and understands the potential need for monitoring in the vicinity of a community well should it be installed in this area. However, Trans Mountain would also question the justification or value of monitoring such a location, offset at this distance from their operations.

Despite the above questions of effectiveness or justification related to BC Groundwater's recommendations, Trans Mountain does not intend to halt all dialogue of groundwater investigation or monitoring, rather to suggest that it is premature to consider such monitoring specifics while the alignment in the area remains uncertain. The purpose and objective of any investigation or monitoring contributed to by Trans Mountain should have a direct connection or bearing to potential influences of the proposed pipeline construction or operation. Trans Mountain remains committed to engaging with communities regarding possible installation of groundwater monitoring wells as previously indicated in response to Province of BC IR No. 2.12 (Filing ID A4H8W6). During these engagements, Trans Mountain anticipates that potential consequences of groundwater contamination will be discussed along with a review of the

maintenance policies, systems, programs, procedures, practices and activities to prevent pipeline releases as noted in the response to Province of BC IR No. 2.12.

As a preventive measure, the safety and reliability of the proposed pipeline will be enhanced, over and above industry standards. Trans Mountain is specifying 14.7 mm heavy-wall pipe at all major and most minor watercourse crossings and road crossings where only 11.8 mm is required for the 36-inch pipe. For the same crossings on the 42-inch section to be constructed, Trans Mountain has specified 17.2 mm wall thickness which is over and above the code requirement of 13.8 mm. This represents approximately 25% increase above code requirements as per Province of BC IR No. 2.13a (Filing ID A4G5Y0).

According to the affidavit of Asher Rizvi (Filing IDs A4L7R8 and A4L7R9), there are 18 sand and gravel aquifers in the Township of Langley. A review of the BC Aquifer database (BC MOE 2015; Berardinucci and Ronneseth 2002), showed that the Township of Langley overlies all or a portion of 21 aquifers whose main constituents are sand and gravel, where their vulnerability varies from low to high. The affidavit also indicates that the proposed pipeline corridor passes through a number of aquifers that are highly vulnerable. Comparison of the BC Aquifer database and the proposed pipeline corridor show that the proposed pipeline corridor crosses five aquifers within the Township of Langley; all of which are considered low vulnerability, as summarized in the following table:

Aquifer	From	To	Vulnerability
27 (IIC)	RK1137.3	RK1139.3	Low
32 (IIC)	RK1137.8	RK1145.4	Low
58 (IIC)	RK1145.6	RK1156.1	Low
59 (IIC)	AK1149.6	AK1150.3	Low
60 (IIC)	AK1149.2	AK1150.7	Low

The affidavit of Asher Rizvi (Filing IDs A4L7R8 and A4L7R9) indicates an attached Exhibit ‘A’ including two maps of the Township of Langley’s aquifers and drinking water supply. These maps were not attached to the original submission but were subsequently provided. The Township of Langley Aquifers figure (dated 2011) is similar to, but not entirely consistent with the BC Aquifers data used for the original hydrogeologic assessment. Regardless, this figure confirms that the proposed pipeline alignment traverses low vulnerability aquifers within the Township of Langley, as detailed above.

The affidavit of Asher Rizvi (Filing IDs A4L7R8 and A4L7R9) states *“The Fort Langley municipal production well located at 88 Ave and Salmon River, is a high capacity production well… located in a vulnerable aquifer and hydraulically connected to the local surface water features. This is one such waterworks that could be impacted by hydrocarbon contamination of surface water or local aquifers. In the case of a hydrocarbon spill, which reaches the Salmon River or migrates into the Fort Langley aquifer, this well would have to be shut down…”*

This well is located more than 1 km north of the proposed pipeline corridor. It is unlikely that hydrocarbons introduced to the environment from a leak in the proposed pipeline would infiltrate through the unsaturated zone at the point of release and migrate as a dissolved-phase plume the distance between the pipeline and the well. While low likelihood, it is possible that a spill released into the Salmon River at or near RK 1147.5, where the proposed pipeline corridor cross the Salmon River, would travel down-river toward the confluence with the Fraser River.

Depending on the local conditions and the rate of the pumping of the production well, the hydrocarbons may enter the shallow unconfined aquifer #36 from the surface water. Trans Mountain assumes that Well Tag No. 35546 represents the well in question, based on its location and Township of Langley ownership. This well record suggests approximately 6 m of finer grained materials (*i.e.,* clays, and silts) near surface followed by sands, then sands and gravels, notably water bearing from approximately 7.6 to 20.4 m. The well record provided little details related to the wells completion or seals; therefore, no other comments can be provided regarding whether the well is producing from the entire coarse-grained and wetted interval, or some portion such as the shallowest or deepest. This aquifer is associated with Fraser River sediments. While it is expected to be hydraulically well connected with the Fraser River, the shallow fine grained materials in the well record suggest it may not be particularly well connected to the Salmon River. As a result, this well and the aquifer in the area would not be particularly susceptible to potential impacts from a direct spill to the Salmon River.

32.2.3 Potential Water Supply Replacement

A concern raised by several intervenors (*e.g.,* Coldwater Indian Band and the Township of Langley) is that of the replacement of their water supply in the event of a potential spill from the pipeline impacting their drinking water source.

In the case of the Coldwater Indian Band, their current water supply is being withdrawn from water source wells which, in some cases, were installed very close to the existing pipeline. The Coldwater Indian Band water supply is primarily sourced from confined alluvial sand and gravel deposits along the margins of the Coldwater River valley. It appears, based on the conceptual hydrogeological model presented in the Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0), that the Coldwater River is hydraulically disconnected from the alluvial aquifer developed as the Coldwater Indian Band water supply. Although the cross-section supporting the BC Groundwater conceptual model indicates a disassociation between the aquifer and the Coldwater River, other evidence provided by BC Groundwater contradicts this model. A water balance that supports the conceptual model for this area must include a sizable discharge component into the lower valley, likely through direct discharge to the alluvial deposits associated with the Coldwater River. If discharge is manifested by strong upward gradients in the base of the valley, Environment Canada and First Nations Health will not likely consider the groundwater to be Groundwater under the Direct Influence of surface water, as suggested in the Coldwater BC Groundwater report.

The Coldwater BC Groundwater report (Filing IDs A4Q0W9 and A4Q0X0) states "*The only proven recourse available to the Band in the event of impact or contamination from the existing and proposed east routes will be to drill replacement wells in the Coldwater River floodplain*" and "*Trans Mountain's west route offers an alternative to additional development in the watershed*." As discussed above, the continuity of aquifer resources between the Skugan and Kwinshatin wells suggests that in fact the aquifer resources exploited by these wells is laterally extensive, and other alternative source water targets may exist along the upland flanks of the valley. Trans Mountain disagrees with the assertion that there will be no replacement well alternative other than installing wells in the Coldwater River floodplain. The west alternative pipeline corridor proposed in the Application filed with the NEB in December 2013 is no longer being considered.

In addition, statements in the affidavit of Kevin Larson of the Township of Langley (Filing ID A4L7S0) indicate that *"In the event of a potential spill from the TMEP, Fort Langley municipal*

well may have to be shut down" and that *"…Langley would be required to purchase the water from Metro Vancouver…"* and "…*purchase water from Metro Vancouver at $2million per year.*" Also "*The costs to Langley of setting up a monitoring infrastructure and testing for the presence of hydrocarbons in the municipal well system after a potential TMEP spill would also add to overall costs."* Lastly, "*If the current well is deemed to be unusable due to aquifer-wide contamination, a new long-term water source would have to be identified and developed."*

Trans Mountain acknowledges a commitment to apply an appropriate response to a release from the pipeline or facility resulting from construction-related or operational activities on the pipeline and to replace or maintain any water supply impacted by their activities. Trans Mountain has previously stated (Province of BC IR No. 2.09f; Filing ID A4H8W6) that if a pipeline release impacts a community's use of an aquifer, Trans Mountain will source and pay for an alternate water supply to meet the needs of area residents. This would continue until treatment is complete and groundwater quality meets government criteria for its intended use.

32.3 References

British Columbia Ministry of Environment (BC MOE). 2015. BC Water Resources Atlas (online) - http://www.env.gov.bc.ca/wsd/data_searches/wrbc/index.html.

Berardinucci J. and K. Ronneseth. 2002. Guide to Using the BC Aquifer Classification Maps for the Protection and Management of Groundwater. BC Ministry of Water, Land and Air Protection.

National Energy Board (NEB). 2011. Remediation Process Guide. Her Majesty the Queen in Right of Canada as represented by the National Energy Board.

33.0 AIR QUALITY

33.1 Air Emissions

This section provides Trans Mountain's reply to the intervenor evidence regarding Project-related emission calculations.

33.1.1 Speciation of Emissions

Living Oceans Society - Dr. Simpson: Section No. 3.3.4 of the evidence submitted by the Living Oceans Society (Filing ID A4L9R9) suggested that the speciation profiles used to obtain BTEX; for example) from fugitive emission rates were less than accurate. Dr. Simpson stated "*it was recognized that the speciation profiles were based on limited sampling data and their uncertainty cannot readily be quantified. In general, very few error bars were presented in The Application. While the existence of uncertainty was sometimes recognized, not enough effort was made to quantify the uncertainties and understand how they impact the reliability of subsequent calculations*."

Dr. Simpson also requested more details on the products and speciated VOCs in IR No. 3.4.5 (Filing ID A4L9R9).

Trans Mountain Response to Living Oceans Society - Dr. Simpson Section No. 3.3.4: For the Supplemental Air Quality Report and ESA Significance Findings for Technical Update No. 2 (Filing ID A4A4E3), VOC emissions from vapours created during tanker filling and from the displacement of inert gas in the cargo holds were based on HYSYS model process simulation results.

As mentioned by Dr. Simpson in quoting the Rowan Williams Davies and Irwin Inc. (RWDI) report, "*the air quality assessment was based on six representative products: High total acid number (TAN) Dilbit and Low TAN Dilbit to represent super heavy grades, High TAN Synbit/Dilsynbit to represent heavy grades, light sour and synthetic/sweet grades, and ethanol blended gasoline (to represent iso-octane) to represent refined products*." Representative products were selected from each group based on a combination of two factors: highest vapour pressure, and highest VOC content (BTEX, H_2S, and mercaptans). To add additional conservatism to the emission estimates, the worst three products were selected for each contaminant to model emissions from the two vapour recovery units (VRUs) and the vapour combustion unit (VCU) operating at the same time. This represents a conservative "super blend" of product speciation profiles for each specific contaminant. The simultaneous loading of all three tankers is expected to occur less than 5% of the time. At all other times, the VCU will be operated as a back-up or standby unit, and only one or both VRUs will be in operation depending on whether one or two tankers are being filled.

With respect to the uncertainties addressed in the request, the HYSYS inputs were based on data from several sources including lab analyses of product samples and Crudemonitor (Crude Quality Inc. 2015). The Crudemonitor webpage derives a 5-year average of BTEX data, using about 60 to 100 lab analyses from several locations.

Realizing the uncertainty associated with the product selection, Trans Mountain incorporated conservative measures into estimating emission rates for the speciated VOCs as listed above. The specific products and product names used to devise speciation profiles are proprietary information and cannot be provided by Trans Mountain.

33.1.2 Vapour Collection Efficiency and Associated Fugitive Emissions

The following section addresses how the vapour collection efficiencies from the tanker cargo loading to the VCU and two VRUs was estimated and was used to assess the uncollected fugitive emissions.

Metro Vancouver: Sections 3.4.1 and 3.5.1 (Filing ID A4L7Y3) suggest the collection efficiency of 99.9999% used to estimate fugitive emissions from tanker cargo loading is too high. Re-assessment of the air quality effects for a lower collection efficiency (such as benzene), was provided in the Novus Environmental Inc. report, Trans Mountain Expansion Westridge Marine Terminal Air Quality Modelling Burnaby, BC (Filing ID A4L8A2).

To address the Metro Vancouver comments, Trans Mountain:

- determined a more reasonably conservative collection efficiency during product loading at the Westridge Marine Terminal and demonstrated that the applicable ambient air quality objectives are still met; and,
- assessed the differences in the dispersion modelling conducted for the fugitive sources in the evidence filed by Metro Vancouver's consultants (Novus; Filing ID A4L8A2) and Trans Mountain's consultants (RWDI) in the assessment below, original application (Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report; Filing IDs A3S1U0 to A3S1U7) or Supplemental Air Quality Report and ESA Significance Findings for Technical Update No. 2 (Filing ID A4A4E3). This part is addressed in Section 33.2 Air Quality Modelling.

Trans Mountain Response to Metro Vancouver Section No. 3.4.1: The default collection efficiency of 95% during vessel loading recommended by the Texas Commission for Environmental Quality and used in Metro Vancouver's evidence, along with the 99% collection efficiency for benzene and other VOCs dispersion modelling are too conservative.

The air quality assessments are part of an on-going and iterative process which informs (and is informed by) the engineering design regarding required specifications for the final design. Therefore, the best estimate for the collection efficiency should be used as the design evolves.

An average value of 99.9999% collection efficiency was previously calculated by Trans Mountain for the peak loading rate of 111,290 m^3/d (700,000 bbl/d; Filing ID A4F5C9) and this value was criticized by Metro Vancouver as being "near perfect."

Kinder Morgan previously tested three tankers loading at their facility in Galena Park, Texas, USA (which has a vapour collection setup similar to the Westridge Marine Terminal) and demonstrated VOC collection efficiencies during loading between 99.865% and 99.985% (International Liquid Terminals Association 2014). This study notes that the AP-42 emission factors along with the default collection efficiency of 95% are outdated and unrealistic (U.S. EPA 2008).

In response to these findings, Trans Mountain estimated fugitive emission rates from loading for VOCs and BTEX assuming the more conservative collection efficiency of 99.5% instead of using 99.9999%. Uncollected fugitive emissions (0.5%) from the three vessels' loading were calculated using the HYSYS model process simulation results of tanker loading at the Westridge

Marine Terminal using a similar approach as described in Section 4.3 of the Supplemental Air Quality Technical Report for Technical Update No. 2. The emission rates for uncollected VOCs and BTEX are summarized in Table 33.1-1.

TABLE 33.1-1

MAXIMUM HOURLY AND ANNUAL FUGITIVE EMISSIONS PER THREE BERTHS FROM THREE TANKER LOADING WITH A COLLECTION EFFICIENCY OF 99.5%

Contaminant	Hourly Emission Rate (g/s)	Annual Emission Rate (t/y)
Total VOCs	11	50
Benzene	0.035	0.161
Toluene	0.019	0.087
Ethyl Benzene	0.003	0.010
Xylenes	0.012	0.039

To evaluate the effect of these emission rates, benzene was selected to be modelled in CALPUFF as the limiting contaminant for the VOCs as it has the combination of the lowest ambient air quality objective and the highest emission rate among BTEX. The Alberta Ambient Air Quality Objectives (AAAQOs) were used for comparison, as there are no British Columbia, Metro Vancouver, or national objectives available for these contaminants. The maximum predicted concentrations (due to the fugitive emissions only from Westridge Marine Terminal) are provided in Table 33.1-2 along with the applicable AAAQOs.

TABLE 33.1-2

MAXIMUM PREDICTED 1-HOUR AND ANNUAL BENZENE CONCENTRATIONS AS A RESULT OF FUGITIVE EMISSIONS PER THREE BERTHS FROM THREE TANKERS LOADING WITH A COLLECTION EFFICIENCY OF 99.5% (in μg/m^3)

Pollutant	Averaging Period	Maximum Concentration	Alberta Ambient Air Quality Objective
Benzene	1-hour	10.0	30
Benzene	Annual	0.20	3

Table 33.1-3 provides the maximum predicted 1-hour and annual benzene concentrations for the Project loading, operations, and ambient background. All predicted concentrations in Table 33.1-3 are below their respective AAAQO. These maximum predicted concentrations were added to the maximum predicted concentrations from Project operations (combined effects of Burnaby Terminal, Westridge Marine Terminal, and Project-related marine traffic). These combined effects were provided in response to Metro Vancouver IR No. 2.2.5a (Filing ID A4H8U8). Both maximum predicted concentrations along with the background values were summed (so it is more conservative than if they were summed using the CALSUM post-processing tool). These summed values are still less than the 1-hour and annual benzene AAAQO concentrations. Therefore, predicted concentrations for higher, more typical collection efficiency (~99.9%), will also be below the AAAQOs as more of the available VOC's are recovered.

TABLE 33.1-3

MAXIMUM PREDICTED 1-HOUR AND ANNUAL BENZENE CONCENTRATIONS AS A RESULT OF FUGITIVE EMISSIONS PER THREE BERTHS FROM THREE TANKERS LOADING WITH A COLLECTION EFFICIENCY OF 99.5% PLUS OPERATIONS AT BURNABY TERMINAL, WESTRIDGE MARINE TERMINAL AND PROJECT-RELATED MARINE TRAFFIC (in μg/m³)

Pollutant	Averaging Period	Ambient Background	Maximum Conc. from Fugitives at Three Berths	Maximum Conc. from Combined Effects of Project Operations	Total Combined Effects of Project Operations plus Fugitives at Three Berth plus Ambient Background	Alberta Ambient Air Quality Objective
Benzene	1-hour	5.1	10.0	7.4	22.5	30
	Annual	0.55	0.20	0.06	0.81	3

Note: Taken from the response to Metro Vancouver IR No. 2.2.5a (Filing ID A4H8U8)

33.1.3 VCU Emission Factors

Metro Vancouver: Sections 3.7.1 and 3.7.2 (Filing ID A4L7Y3) suggest that the emission factors used to estimate the particulate matter (PM) emissions from the VCU are not representative.

Trans Mountain Response to Metro Vancouver Sections 3.7.1 and 3.7.2: Two specific comments were raised in the intervenor evidence: the emission estimates from the VCU require further justification; and monitoring is recommended to justify the PM emission estimates during VCU operation.

Trans Mountain submits that its assessment of PM emissions from the VCU is reasonable based on the industry engineering practices (AER 2014). In the absence of operating specifications from the provider of VOC control equipment, which is currently undergoing design engineering, the estimates provided are reasonable. The AER spreadsheet also adopts PM emission factors from the United States Environmental Protection Agency (U.S. EPA) AP-42 database Chapter 1.5 (U.S. EPA 2008) for incinerators. After the final design is completed, Trans Mountain has committed to conduct another round of dispersion modelling to inform design engineering, and further, is committed to more detailed dispersion modelling in 2016 for PMV (per response to PMV IR No. 2.25b; Filing ID A4H8W5) in support of Project permitting. In addition, Trans Mountain is supportive of NEB Draft Condition 21, which requires Trans Mountain to file an Air Emissions Management Plan for the Westridge Marine Terminal that includes, among other things, a PM management plan that will monitor PM emissions. The plan was committed to be filed 4 months before construction at Westridge Marine Terminal through NEB Draft Condition 21.

33.1.4 Emission Reduction Programs

PMV: Section 4.0 (Filing ID A4L6Q7) stated that "*PMV expects that Trans Mountain will participate in … and promote the EcoAction Program to marine carriers calling at Westridge Marine Terminal that sets goals for air emissions reductions for ocean-going vessels that enter our port and rewards those that excel in environmental stewardship.*"

Trans Mountain Response to PMV Section No. 4.0: The following response was provided in PMV IR No. 2.24 (Filing ID A4H8W5), and this response is still applicable:

Trans Mountain's current and future Tanker Acceptance Criteria will always require nominated tankers to meet local, national, and international regulatory requirements. Where a local regulation is available but is voluntary in nature (*i.e.,* it is not enforced by an authority such as PMV, Transport Canada, or the Canadian Coast Guard [CCG]) Trans Mountain will encourage vessels to operate in accordance with such regulations. Trans Mountain retains the right to make certain standards mandatory.

For air quality, International Safety Guide for Oil Tankers and Terminals best practices are required to be met. Amongst regulatory requirements a primary regulation would be to meet Emissions Control Area rules and regulations (national requirement enforced by Transport Canada, verified by the Loading Master) and meet Safety for Life at Sea requirements regarding fitting and working of cargo tanks pressure relief (international and national requirement; enforced by Transport Canada, verified by the Loading Master). The use of a vapour collection system is a Westridge Marine Terminal mandatory requirement enforced and verified by the Loading Master. At the time of submitting the Application to the NEB, the mandatory use of a vapour collection system and processing of the collected vapours by marine oil handling facilities and terminals is not a published local or national requirement; therefore, it is considered to be above and beyond minimum standards. The current Tanker Acceptance Criteria document is NEB IR 1.59a - Attachment 1 (Filing ID A3W9J8).

Should PMV develop a particular facet of its EcoAction Program affecting tankers, Trans Mountain shall publicize it through its Tanker Acceptance Standard and thereby encourage vessel operators to try and meet the program's standards to the extent that vessels can do so.

33.1.5 Climate Change

BROKE and North Shore No Pipeline Expansion (NS NOPE) (Takaro et al.): BROKE and NS NOPE filed a report written by Dr. Takaro *et al.* (Filing ID A4L6U5). Recommendation 8.2 is that "*It is important to recognize the impact this project will have on climate change and understanding the project risks in terms of future climate projections. The authors of this report acknowledge climate change as a serious public health concern and consider this a paramount factor that is completely ignored in the TMEP application. As noted above, temperature increases have been observed in recent years and are expected to continue. By continuing to build large fossil energy infrastructure such as the expansion proposed here, TM will contribute to temperature increases that may be catastrophic for human health and the environment.*"

Trans Mountain Response to BROKE and NS NOPE (Takaro et al.) - Recommendation No 8.2: Trans Mountain does not agree that climate change has been ignored in the TMEP Application. Project effects on climate change were assessed in Section 6.2 of the Marine Air Quality and Greenhouse Gas Technical Report #2 (Filing ID A4F5H8), which stated, "*assuming that operational emissions will not change over the lifetime of the Project, total emissions over 50 years of the Project life would be 3.4 Mt CO2e, which is estimated to result in an increase in the Earth's global temperature by 1.6 × 10-6 °C. Other changes to the climate system and physical environment associated with the Project are summarized in Table 6.2.*"

Further explanation on the scope on the climate change effects assessment was explained in the Trans Mountain reply to NS NOPE and BROKE IR No. 2.3 (Filing ID A4H8W0).

33.1.6 Marine-Source Emissions - NOx Emissions

In Section 3.2.2.2 (Filing ID A4L8Y6), Environment Canada requested a reason for the decrease in annual NO_X emissions between:

- Supplemental Marine Air Quality and Greenhouse Gas Technical Report #2 (Filing IDs A4F5H8, A4F5H9, A4F5H10, A4F5H11 and A4F5HI2; dated November 2014; total NOx emissions are 1984 tonnes per year); and,
- Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report for the Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, Supplemental Report (Filing IDs A3Y1G0, A3Y1G1, and A3Y1G2; dated June 2014; total NOx emissions are 2348 tonnes per year).

Trans Mountain Response to EC Section 3.2.2.2: A summary of the changes in the modelled scenarios that influenced estimates of combustion-related NO_X emissions for the Project-related marine transportation in the three Trans Mountain marine air quality studies was provided in Appendix A of the Marine Supplemental Report 2.

The total estimated NO_X emissions for each location and activity in the Marine Air Quality regional study area (RSA) for the Application Case are summarized in Table 33.1-4. The reduction in NOx emissions attributable to Project-related Aframax tanker boilers at anchorage and berth was estimated to total 27.1 tonnes per year. Relative to the total Project-related emissions from marine transportation of 1,984 tonnes per year, removal of the tanker boiler NOx emissions from the Air Quality Marine RSA represents a change of 1.4%, which is quite small. Relative to the total non-Project related emissions from marine transportation for year 2030 (underway, berth, and anchorage) of 12,079 tonnes per year (refer to Tables 3.16 and 3.17 of Supplemental Marine Air Quality and Greenhouse Gas Technical Report #2; Filing IDs A4F5H8, A4F5H9, A4F5H10, A4F5H11 and A4F5HI2), removal of the tanker boiler NOx emissions from the Air Quality Marine RSA represents a change of 0.22%, which is extremely small.

Other differences in the estimation methodology are summarized as footnotes under Table 33.1-4 for each applicable segment and activity. Some of the other changes between these two technical reports that would affect combustion emission estimates included:

- Aframax auxiliary engine power rating decreased from 2,827 HP to 1,320 HP;
- load factor for Aframax main engines in Segment 4 was updated from 0.8 to 0.4;
- Segment 7 length was adjusted to its actual length in the Marine Air Quality RSA;
- anchorage and berth times were updated based on engineering design simulations; and,
- number of escort tugs increased (from 2 to 4) between berth and anchorage locations.

TABLE 33.1-4

UPDATED NO_X EMISSIONS FOR PROJECT OPERATIONS IN THE MARINE AIR QUALITY RSA (in tonnes/y)

Mode	Location	June 2014 Report (TR1)	November 2014 Report (TR2)
Incoming	Segment 1 [a]	13.4	12.9
	Segment 2 [a]	65.0	61.7
	Segment 3 [a]	62.0	53.6
	Segment 4 [a, b]	158.5	94.7
	Segment 5 [a]	211.1	199.6
	Segment 6 [a]	45.4	42.9
	Segment 7 [a, c]	372.0	360.4
Outgoing	Segment 1	13.4	12.9
	Segment 2 [a]	85.3	82.1
	Segment 3 [a]	93.4	81.8
	Segment 4 [a, b]	189.9	130.4
	Segment 5 [a]	292.5	280.7
	Segment 6 [a]	42.4	40.7
	Segment 7 [a, c]	483.7	419.2
Incoming/Outgoing Jet Fuel Barges Only	Segment 4b	2.9	2.9
Anchor	Aframax Auxiliary Engines [d]	83.4	11.8
	Aframax Boilers	13.0	0.0
Berth	Aframax Auxiliary Engines [e]	106.3	94.8
	Aframax Boilers	14.1	0.0
Between Berth and Anchor	Escort Tugs [f]	0	1.8
Total		**2,348**	**1,984**

Notes:
[a] Aframax auxiliary engine power ratings decreased from 2,827 HP to 1,320 HP. TR1 auxiliary engine power was based on an estimate and TR2 auxiliary engine power was based on actual data for the Aframax tankers.
[b] The load factor for Aframax main engines in Segment 4 was updated from 0.8 to 0.4 based on the updated vessel speed in the segment based on the simulation results and from working with pilots.
[c] Segment 7 length was updated to its actual length in the Marine Air Quality RSA. The TR1 submission included some length outside of the Marine Air Quality RSA.
[d] Anchor times were updated based on engineering design simulations.
[e] Berth times were updated based on engineering design simulations.
[f] Emissions increased due an increase in the number of escort tugs between berth and anchor locations (2 to 4) that were added in TR2.

33.1.7 Emissions due to Anchorage and Berth Outside the Westridge Local Study Area, Time in Mode, and Analysis of Anchorage Locations and Times

In Section 3.2.2.3 (Filing ID A4L8Y6), Environment Canada requested information on how Project operations will achieve the reduced time in port with additional vessels at berth and anchorage locations, while Environment Canada analysis indicates that time in port, and hence emissions from engines, should be much higher. Environment Canada conservatively estimated the possibility of an additional 250 tonnes/year of NO_x emissions based on the conservative assumption of 70 hours of anchorage time.

Environment Canada asked for confirmation of the assumptions used to derive the anchorage times, and to confirm that only the Indian Arm anchorages would be used by the Westridge tankers to ensure that all Project-related marine emissions had been accounted for.

In their response to NEB IR No. 2c (Filing ID A4R7L3) PMV stated that

> "For the purposes of assessing future demand on existing anchorages east of Second Narrows, PMV is satisfied with Trans Mountain's estimate for the amount of time Project tankers may spend at anchor east of Second Narrows and their rationale for confirming that anchorage demand will be minimized by increasing berth utilization (A4H8W5). For the purpose of calculating Project-related air emissions, we note that the anchorage utilization assessment is incomplete. The anchorage utilization assessment does not include the amount of time Project tankers may spend at anchorages west of Second Narrows, a factor that should be included in calculating total air emissions from vessels at anchor."

Trans Mountain Response to EC Section 3.2.2.3 and PMV Response to NEB IR No. 2c: It should be noted that EC's and PMV's comments regarding the extended anchorage times will only affect the annual emission rates, while for the 1-hour and 24-hour averaging periods, three occupied anchorage positions and three occupied berths were conservatively assumed to occur all of the time in the modelling.

With respect to the annual emissions, Trans Mountain notes that EC provided their analysis based upon Automated Identification System data observations of existing operations. As described in the Application, Trans Mountain currently services about 60 tankers a year, which is expected to increase to about 408 tankers a year. This means that, whereas currently on average a cargo is loaded on a tanker about once a week, in the future, a loaded tanker will leave the dock at least once every day. Also, given the tidal restrictions at the Second Narrows, currently, sometimes tankers wait between different parcels of cargo in order to maximize the utilization of the tanker. In the future, should the Project be permitted to proceed, in order to ensure a regular throughput of loaded tankers, Trans Mountain intends to revise its dock scheduling procedures for future operations including the measures presented below.

a) Optimize the cargo throughput at Westridge Marine Terminal and adjust the volume on each Aframax class tanker by part loading; and load, on average, only about 550 kbbl of heavy crude equivalent, which will allow safe and regular transit of the Marine Restricted Area;

b) Upon arrival at Vancouver Harbour, every Westridge Marine Terminal-destined vessel will be advanced to berth as soon as possible, provided that its designated berth was available and all weather conditions (*i.e.*, daylight, wind, visibility, and current) were satisfactory. If its berth is occupied, the vessel will look for an available anchorage east of the Second Narrows where it could wait for the berth to become available;

c) Trans Mountain expects that vessels will time their arrivals (by slow steaming) based on known or anticipated First Narrows and Marine Restricted Area transit windows, to avoid waiting time west of the Marine Restricted Area; and,

d) Once a tanker has completed loading, if all Marine Restricted Area transit conditions are satisfied (*i.e.*, daylight, visibility, wind, current, and tide) the vessel would depart the berth and exit through the Marine Restricted Area immediately. If one or more conditions

were not satisfied, Westridge Marine Terminal vessels will remain at berth to avoid over-using the anchorages. As soon as an inbound vessel needed the berth, and if the required channel conditions had still not been met, the loaded vessel would be shifted to one of the inner anchorages to wait for favourable current or tide conditions.

Trans Mountain has carried out an analysis of the turn-around time of tankers based upon the proposed rules of operation and that showed that:

a) About 70% of arriving tankers will go directly to berth. The remaining balance of 30% will wait at anchorage for an average period of about 2 hours; and,

b) Nearly half of the loaded Aframax class tankers will anchor for about half a day on average to wait for sufficient Marine Restricted Area conditions.

Based upon the above analysis and Trans Mountain's intention to pursue the above described operating practices, there is sufficient conservatism built into the assumptions and time estimates as noted in the response to GoC EC IR No. 2.065 (Filing ID A4H6A5), pages 306 to 315 of 467.

Berth and Anchorage time used in the Supplemental Report No 2 are summarized in Table 33.1-5. Numbers used in the original submission (Volume 8B, TR8B-3, Filing ID A3S4J7) are provided for the comparison purpose only.

Trans Mountain is not the owner or operator of tankers, and therefore, cannot dictate, but only influence, the movement pattern of Project-related tankers. Trans Mountain believes that the conditions modelled are reflective of typical future operating conditions and also wishes to point out that even if a Project tanker should require to anchor west of the Second Narrows for a short while in order to await suitable Marine Restricted Area transit conditions, the conservatism built into time estimates in the response to GoC EC IR No. 2.065 (Filing ID A4H6A5) suitably compensates for such anomalies during actual operations. As such, no additional emissions or any associated impacts on air quality are envisaged; therefore, an additional assessment is not deemed to be necessary.

TABLE 33.1-5

ASSUMED BERTH AND ANCHOR TIMES FOR AN AFRAMAX TANKER DURING PROJECT OPERATIONS AT THE WESTRIDGE MARINE TERMINAL (in hours)

Report	Marine Supplemental Report 2 (November 2014)	Marine Technical Report (December 2013)
Berth	48	34
Anchor Outbound Vessel	12	-
Anchor Inbound Vessel	2	-
Anchor Total	14	20

33.1.8 References

Alberta Energy Regulator (AER). 2014. Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting "AERflare-incin.v203.141010.xlsx" October 2014.

Crude Quality Inc. 2015. CrudeMonitor.ca. Website: http://www.crudemonitor.ca/home.php. Accessed: July 2015.

International Liquid Terminals Association. 2014. Measurement of VOC Losses During Marine Vessel Loading: A Case Study. 34th Annual International Operating Conference & Trade Show. June 2-4, 2014. Presented by Brian Cochran (URS Corporation) and Shannon DiSorbo (Kinder Morgan/DiSorbo Consulting).

United States Environmental Protection Association (U.S. EPA). 2008. AP-42, Section 5.2: Transportation and Marketing of Petroleum Liquids, July 2008.

33.2 Air Quality Modelling

This section provides Trans Mountain's reply to the intervenor evidence regarding air quality dispersion modelling and the assessment of air quality modelling results.

33.2.1 Significance Evaluation of Project Effects

Metro Vancouver (MV): In Section 3.3 of MV's evidence (Filing ID A4L7Y3), MV disagrees with the methodology used by Trans Mountain to assess the residual effects of the Project on air quality as set out in MV's Notice of Motion to that effect (Filing ID A3Y8R7). It asserts that Trans Mountain has based its assessment on the predicted relative (incremental) increase in concentration for its determination of effects of the Project on air quality, when it should instead be based on an absolute value (*i.e.,* the sum of the incremental increase and the existing background concentration).

Trans Mountain Response to MV Section 3.3:

Trans Mountain has based the assessment of residual effects on the NEB *Filing Manual*, which meets the requirements of the *Canadian Environmental Assessment Act, 2012*. Potential residual project effects are determined based on the potential effect of the Project on the environment, and cumulative effects are based on the potential likely residual effects of the Project in combination with the potential residual effects of likely future projects. The Project-specific cumulative effects assessment determines if the Project is incrementally responsible for adversely affecting the environment, and makes clear to what degree the Project is contributing to the total effect. Existing conditions, especially where the environment is already heavily modified or under stress, are considered as they contribute to the context (*i.e.,* resiliency of the receiving environment) and magnitude of potential project effects and potential cumulative effects. However, it is not required or industry accepted practice to assess potential residual effects as being in additive with all the previous effects to the environment in the area.

Furthermore, Trans Mountain has demonstrated that both Project-only and Application Case (*i.e.,* cumulative) results are predicted be less than the applicable ambient air quality objectives and, therefore, the ESA evaluation determined that Project effects would be not significant.

33.2.2 Effects of the Vapour Combustion Unit and Vapour Recovery Units

MV: Sections 3.4.1 and 3.5.1 of MV's evidence (Filing ID A4L7Y3) suggest the VOCs collection efficiency of 99.9999% used to estimate fugitive emissions from tanker cargo loading is too high. Reassessment of the air quality effects for a lower collection efficiency (such as benzene), was provided in the Novus Metro Vancouver Air Quality Modelling Final Report (Filing ID A4L8A2).

To address the MV Section Nos. 3.4.1 and 3.5.1, Trans Mountain:

- determined a more reasonably conservative collection efficiency during loading at Westridge Marine Terminal and demonstrated that the applicable ambient air quality objectives are still met; and
- assessed the differences in the dispersion modelling conducted by MV's consultant (Novus; Filing ID A4L8A2) and Trans Mountain's consultant (RWDI AIR Inc.).

The first part of the response is provided in Section 40.1.2 Air Emissions of Reply Evidence. This section of the reply is focused on the second bullet point.

Trans Mountain Response to MV Section 3.5.1:

The modelling conducted by Novus for MV (Filing ID A4L8A2) was inconsistent and inaccurate in comparison with the previous modelling of fugitive emissions at Westridge Marine Terminal (Filing IDs A3S1U0 to A3S1U7) and in the Supplemental Air Quality Technical Report for Technical Update No. 2 (Filing ID A4A4E3). The modelling conducted by Novus deviated from the original modelling conducted by Trans Mountain's consultants in the following ways:

- Different data in CALMET: The CALMET data were claimed to be unavailable; however, data such as the CALMET input files could have been provided to MV upon request, as those data were provided to other intervenors who requested it.
- Area sources representing fugitive emissions from tankers at berth in the Novus study were inconsistent with the modelling source parameters used in the Trans Mountain study. The Novus modelling could be considered more representative if the modelling parameters stated in the Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report (Page 68 of Filing ID A3S1U0) were used for the Novus report. Table 33.2-10 compares these differences in modelling parameters. These parameters affect the calculated by CALPUFF plume rise.

TABLE 33.2-10

COMPARISON OF DISPERSION MODELLING PARAMETERS FOR FUGITIVE EMISSION FROM TANKER LOADING SOURCES

Parameter	Values used in Novus Report (Filing ID A4L8A2)	Values used in the Trans Mountain Study (Page 68 of Filing ID A3S1U0)
Release Height (m)	10	17 (half the height of Aframax tanker)
Elevation (m)	0	0 (sea level)
Sigma Z (m)	5	10 (to cover the upper and lower height of the cargo hold)

Furthermore, as stated in the Novus report, the exceedances predicted in the Novus study with 99% collection efficiency do not occur at any sensitive or public receptors (Filing ID A4L8A2). They are mostly localized (Figure 7 of the Novus report, Filing ID A4L8A2) in the Westridge

Marine Terminal conceptual water lot lease boundary, as shown in Figure 33.2-, where there is no public access.

Section 40.1.2 of the Air Emissions section provides dispersion modelling results for benzene conservatively assuming a collection efficiency of 99.5% based on three previously tested tankers loading in Galena Park, Texas, USA (which has a vapour collection configuration similar to Westridge Marine Terminal) and demonstrated VOC collection efficiencies during loading between 99.865% and 99.985% (International Liquid Terminals Association. 2014). The results demonstrate that applicable ambient air quality objectives are met for benzene as shown in Table 33.2-11.

TABLE 33.2-11

MAXIMUM PREDICTED 1-HOUR AND ANNUAL BENZENE CONCENTRATIONS AS A RESULT OF FUGITIVE EMISSIONS PER THREE BERTHS FROM THREE TANKERS LOADING WITH A COLLECTION EFFICIENCY OF 99.5% PLUS OPERATIONS AT BURNABY TERMINAL, WESTRIDGE MARINE TERMINAL AND PROJECT-RELATED MARINE TRAFFIC (in µg/m^3)

Pollutant	Averaging Period	Ambient Background	Maximum Conc. from Fugitives at Three Berths	Maximum Conc. from Combined Effects of Project Operations [1]	Total Combined Effects of Project Operations Plus Fugitives at Three Berth Plus Ambient Background	Alberta Ambient Air Quality Objective
Benzene	1-hour	5.1	10.0	7.4	22.5	30
	Annual	0.55	0.20	0.06	0.81	3

Note: [1] Taken from Trans Mountain's response to MV IR No. 2.2.3a (Filing ID A4H8U8)

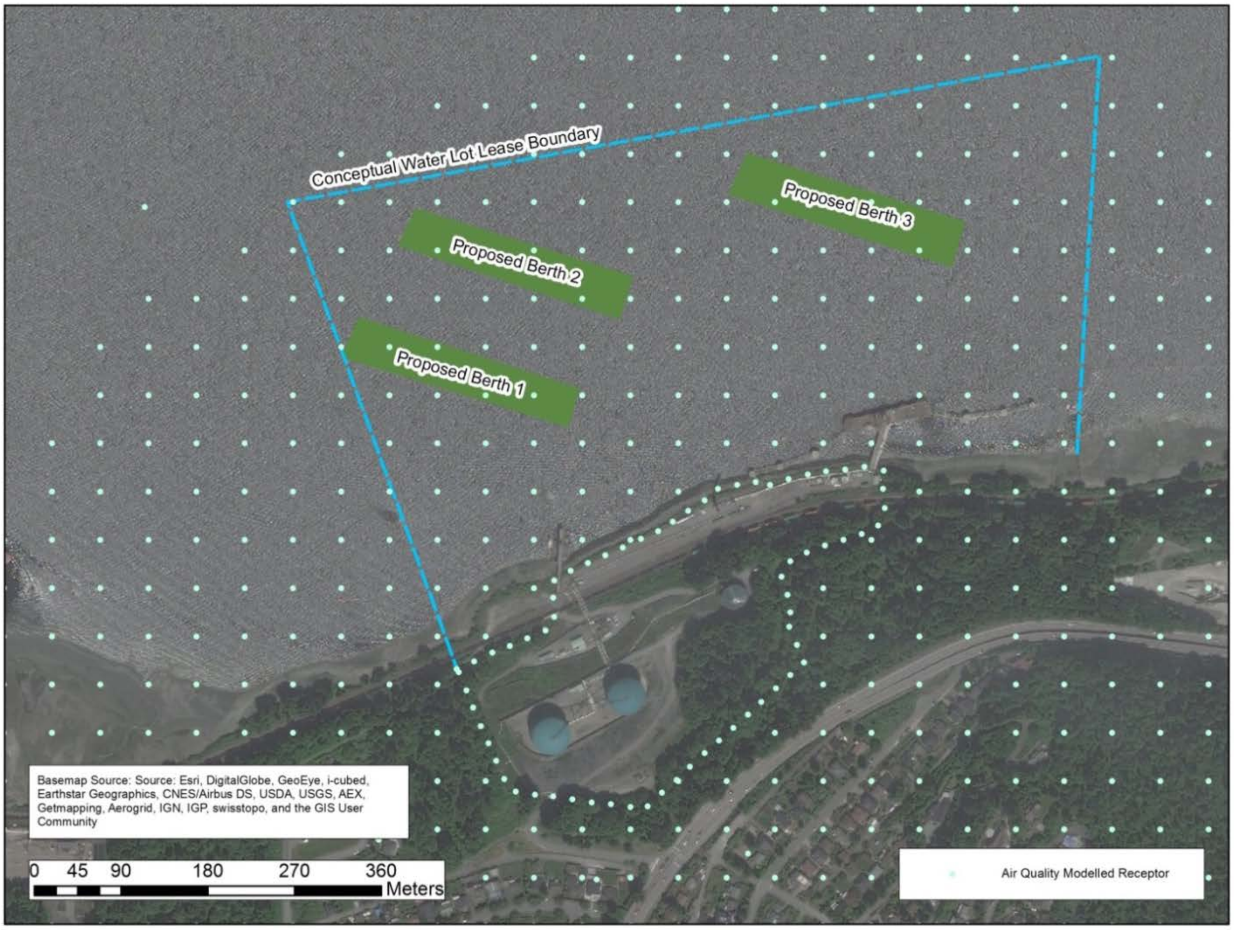

Figure 33.2-1 Trans Mountain Dispersion Modelling Receptors over Conceptual Water Lot Lease Boundary

33.2.3 Ambient Background

Living Oceans - Dr. Simpson: Several sections of Living Oceans Society's evidence (Sections 3.3.5, 3.3.6, 3.3.7 and 4.2; Filing ID A4L9R9) criticize the ambient background concentrations added to the predicted modelled results. For example: decision of using 90th and 98th percentiles for the background data is not realistic (too high); high background concentrations make Project contribution look small; a single value was used to represent the background; the calculated background concentrations were not compared with the literature; the quality of the measurements is not known; and too many significant figures were presented for the background values making false precision.

Trans Mountain Response to Living Oceans Society - Dr. Simpson Sections 3.3.5, 3.3.6, 3.3.7 and 4.2:

The background concentrations were calculated in accordance with the Guidelines for Air Quality Dispersion Modelling in BC (BC MOE. 2008). Detailed model plans, submitted as Appendix B of Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report (Filing ID A3S1U3), was approved by MV and BC MOE. Trans Mountain agrees that

ambient background concentrations vary in time and space; however, to evaluate the Project effects elevated background values are calculated to assist with developing a reasonable maximum operating scenario.

MV, in their response to Trans Mountain IR No.1, provided a concise and detailed summary of the sampling, monitoring, calibrations, audits and reporting protocols with U.S. EPA equipment model and method numbers or equivalent that MV uses for their monitoring stations (Filing ID A4R3F1 including seven attachments Filing IDs A4R3F2 to A4R3F8).

It is not Trans Mountain's responsibility to audit MV ambient monitoring stations data.

33.2.4 Predicted Concentrations

This section summarizes the intervenor evidence and corresponding Trans Mountain responses regarding the predicted dispersion modelling concentrations and their effect on ambient air quality:

MV: Section 3.9.1.2 of MV's evidence (Filing ID A4L7Y3) requested an explanation for the lower nitrogen dioxide (NO_2), particulate matter less than 2.5 µg/m^3 ($PM_{2.5}$) and particulate matter less than 10 µg/m^3 (PM_{10}) concentrations predicted in the Supplemental Air Quality Technical Report for Technical Update No. 2 (August 2014) (A4A4E3) as compared to the Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report (Figures 5.7, 5.9 and 5.11, Filing ID A3S1U2).

Trans Mountain Response to MV Section No. 3.9.1.2:

The predicted concentrations are lower based on the refined engineering assumptions in the updated modelling report. There have been refinements to both the facilities and marine dispersion modelling. These updates to the dispersion modelling are summarized in the following filings:

- the summary of the changes to the facilities modelling is available in Attachment 1 of Trans Mountain's response to NEB IR No. 3.018a (Filing ID A4H1X3);
- the summary of changes to the marine modelling is available in Appendix A of the Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2 (Filing ID A4F5I2); and
- additional discussion with respect to NOx emissions was provided in Trans Mountain's response to NEB IR No. 6.04b (Filing ID A4R6I4).

MV: Section 3.9.1.3 of MV's evidence (Filing ID A4L7Y3) noted the predicted combined effects of the Application Case (terrestrial and marine emissions) with ambient background for 1-hour maximum SO_2 concentration exceeded MV's proposed objective of 75 parts per billion (ppb; or 196 µg/m^3) as provided in the response to MV IR No. 2.1.05a (Filing IDs A4H8U8 and A4I0A8).

Trans Mountain Response to MV Section 3.9.1.3:

The modelling for the Application Case in the Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2 (Filing ID A4F5H8) for non-Project

emissions associated with vessel underway traffic, berth, and anchorage locations were based on 2010 Marine Emission Inventory Tool (MEIT).

A decrease in the PM and SO_2 concentrations will occur as a result of more stringent fuel sulphur regulations. By year 2030, there will be more stringent emission requirements in place for marine vessels. As discussed in the Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2 (Filing ID A4F5H8), the maximum sulphur content in fuel oils within emission control areas (ECAs) decreased to 0.1% starting January 1, 2015. Therefore, it is more appropriate to assess SO_2 maximum concentrations using non-Project vessel underway traffic, berth, and anchorage emissions from 2030 MEIT which accounts for all new regulations in place. These results were presented for Cumulative Case Assessment in Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2 (Filing ID A4F5H8).

Table 33.2-12 provides updated maximum predicted SO_2 results for combined effects of emissions from Burnaby Terminal[1], Westridge Marine Terminal and all marine transportation traffic (using the GoC EC MEIT for year 2030) including Trans Mountain boiler emissions from tankers at berths.

The maximum predicted SO_2 concentration is about a third of the proposed MV 1-hour objective of 196 μg/m^3. Figure 33.2-2 displays contour levels from these predicted concentrations.

TABLE 33.2-12

MAXIMUM PREDICTED 1-HOUR SO_2 CONCENTRATION FOR THE COMBINED EFFECTS OF EMISSIONS FROM WESTRIDGE MARINE TERMINAL AND ALL MARINE TRANSPORTATION TRAFFIC (INCLUDING 2030 MEIT DATA AND PROJECT-RELATED MARINE BOILERS AT BERTHS [in μg/m^3])

Pollutant	Averaging Period	Ambient Background	Application Case with Boilers at Berth (Including Ambient Background)	Metro Vancouver Objective
SO_2	1-hour	26.3	68.7	196 [1]

Note: [1] The objective of 196 μg/m^3 is based on daily 1-hour maximum, annual 99th percentile of 1-year data.

[1] The only continuous emission sources of interest at Burnaby Terminal are product storage tanks; therefore, there were no SO_2 emissions modeled from Burnaby Terminal.

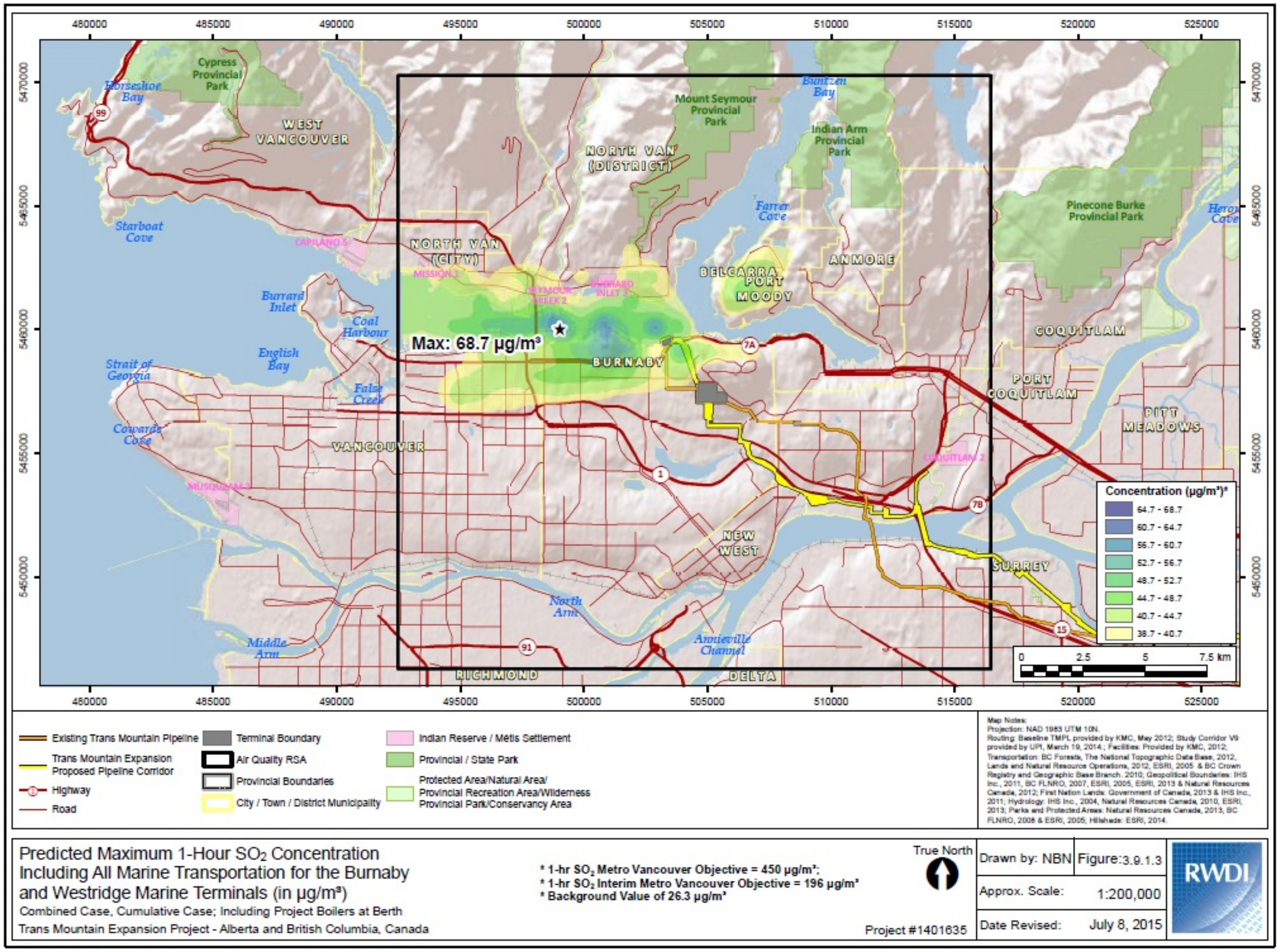

Figure 33.2-2 Predicted Maximum 1-Hour SO_2 Concentrations Inlcuding All Marine Transportation and Westridge Marine Terminal Operations, Cumulative Case (in µg/m³)

BROKE and NS NOPE (Takaro *et al.*): BROKE and NS NOPE filed a report written by Dr. Takaro *et al.* (Filing ID A4L6U5) which expresses several health and air quality concerns. Section 7.1.1.1 of the report raised the concerns about existing high SO_2 and PM ambient background values exceeding or nearly exceeding the objectives.

The report also stated (Section 7.1.3) that *"in 2009, Metro Vancouver experienced a minor heat wave consisting of three or more consecutive days of 30 degrees or higher temperatures. On July 28, 29 and 30th of 2009, the temperatures ranged from 31–34C, with low winds of 6-10 km/h. … These scenarios are prime examples of worst-case weather conditions that need to be considered in the modelling for the TMEP application."* The concern was specifically with respect to VOCs and BTEX concentrations.

The report (Section 7.1.2) also suggested that butadiene was not considered in the Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report (Filing ID A3S1U0).

Trans Mountain Response to BROKE and NS NOPE (Takaro *et al.*):

Volume 5C, Section 3.4.4.1 of the Technical Report 5C-4, Air Quality and Greenhouse Gas Technical Report (Filing ID A3S1U0) noted that the most recent year (2011) was modelled in CALMET. The CALMET model included low wind speed conditions mentioned in the evidence filed by BROKE and NS NOPE. Calm winds (wind speed less than 0.5 m/s) at the MV Burmount monitoring station (near Burnaby Terminal and Westridge Marine Terminal) were predicted to occur less than about 4% of the time in the CALMET model, as shown in Figure A-1, Appendix A of the Supplemental Air Quality Technical Report for Technical Update Number No. 2 (Filing ID A4A4E3). The summer months were included into the CALMET modelling, the maximum temperature considered in the modelling for Westridge Marine Terminal and Burnaby Terminal was about 30°C which is similar to the requested temperatures.

The CALMET modelling was done in accordance with the Guidelines for Air Quality Dispersion Modelling in BC (BC MOE 2008) which lists the acceptable methodology for meteorological modelling. The dispersion model inputs, such as meteorological data, were documented in a Detailed Model Plan before the dispersion modelling took place. The Detailed Model Plan (Appendix B of Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report, Filing ID A3S1U3) was submitted by Trans Mountain's air quality consultants in 2013, and approved by MV and the BC MOE.

Representative 98th percentile 1-hour and 24-hour concentrations were calculated as background values for the dispersion modelling (in accordance with the Guidelines for Air Quality Dispersion Modelling in BC; BC MOE 2008). The ambient background values included data from the MV Burmount station located near the terminals based on 2009 to 2011 monitoring data. These elevated background values are calculated to assist with developing a reasonable worst-case operating scenario to evaluate the Project effects. Table 33.2-13 compares the ambient BTEX concentrations, which were added to the predicted concentrations in the Burnaby Air Quality Study Area, to the BTEX concentrations measured at the same station on July 30, 2009. Concentrations were calculated based on the data from the Burmount station using the methodology described in (page 104-105 of Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report, Filing ID A3S1U0). The concentrations used to represent ambient background are higher than those on July 30, 2009.

The potential health risks for 1,3-butadiene in the air were presented and described in response to NS NOPE and BROKE IR No. 2.4a (Filing ID A4H8W0).

TABLE 33.2-13

COMPARISON OF AMBIENT BACKGROUND CONCENTRATIONS USED FOR DISPERSION MODELLING AND AVERAGE CONCENTRATIONS ON JULY 30, 2009

Pollutant	Averaging Period [1]	Ambient Background	Average Concentration on July 30, 2009
Benzene	1-hour	5.1	2.4
Ethyl benzene	1-hour	2.7	1.0
Toluene	1-hour	14.3	6.8
	24-hour	5.7	2.7
Xylene	1-hour	13.1	3.9
	24-hour	5.2	1.6

Note: [1] Averaging periods are only shown if there is an applicable ambient air quality objective for this period.

Métis Nation BC: Section 3.3 of Métis Nation BC's evidence (Filing ID A4Q2H2) expresses concerns about existing high ambient contaminant concentrations and notes that the proposed Project mitigation measures will reduce but not halt all emissions so there will be an increment to existing ambient levels.

Trans Mountain Response to Métis Nation BC Section 3.3:

There are several initiatives at various levels of regulations to help maintain ambient air quality levels to acceptable concentrations. These initiatives include (as was provided in Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2, Filing ID A4F5H8):

- NO_2 concentrations from the marine traffic will decrease due to the higher Tier-II and Tier-III standards for marine vessels built on January 2, 2011, and January 1, 2016[2], or later respectively;
- SO_2 and PM concentrations will decrease as a result of more stringent fuel sulphur regulations, which require fuel oils within ECAs to decrease sulphur content to 0.1% starting January 1, 2015;
- Starting from June, 2014, the limit for vessels with small diesel engines (less than or equal to 30,000 cc) is 0.0015% and the limit for vessels with large diesel engines (greater than 30,000 cc) is 0.1%;
- new NO_X and SO_2 objectives instated by MV (the overall air quality management authority for the Lower Fraser Valley airshed is provided by MV); and

[2] Subject to a technical review by International Marine Organization, this date could be delayed.

- other future initiatives include the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP).

These initiatives and regulations are not exclusive to Trans Mountain; they will apply to all facilities in the Lower Fraser Valley airshed. For example, SO_2 exceedances previously measured near the Chevron Refinery at the Capitol Hill ambient air quality station (Table 3.16 of Kennedy *et al.* 2002) will be addressed by introducing the new stringent SO_2 objective (as previously stated in this section). As stated in the MV Interim Sulphur Dioxide Objective Intentions Paper: *"This Intentions Paper will be of interest to residents, the shipping industry, the refining industry, municipalities, health authorities, and other stakeholders who manage, or are affected by, air quality in the Lower Fraser Valley airshed."* (Metro Vancouver 2015)

The expected percent reductions from year 2010 to 2030 in the marine emissions of NO_2, PM, SO_2 and other pollutants were provided in Tables 3.16 and 3.17 (last row) of Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2, Filing ID A4F5H8).

NS NOPE: Several North Shore residents (members of NS NOPE: S. Dickinson [Filing ID A4L5Y4], C. Hartley [Filing ID A4L5Y6], J. Wells [Filing ID A4L5Y7], T. Kier [Filing ID A4L5Y8], J. Crawford [Filing ID A4L5Z0]) express concerns regarding health effects of the Project emissions on the existing air quality conditions.

Dr. Brahm Miller: Dr. Brahm Miller (Filing ID A4L8L7) expresses concern that anchorage locations are not considered under the Project along with other vessels. General concerns with respect to air quality were expressed by Dr. Miller.

Squamish Nation: Squamish Nation indicates in Table E (NEB Filing ID A4L7E6) that emissions from cargo venting *"releases of toxic substances (hazardous products including fuel and the diluent components of diluent bitumen) that have the capacity to volatile (evaporate) to the atmosphere could change air chemistry and particulate concentrations…The changes in air quality could alter or reduce actual or perceived ecosystem health which could after use and enjoyment patterns with in the territory.*"

Trans Mountain Response to NS NOPE, Dr. Brahm Miller and Squamish Nation:

Although fugitive vapours from tanker holds while underway or anchorage are unlikely during normal conditions (as was described in Section 3.4.2.1 of Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2, [Filing ID A4F5H8]), these fugitive vapours were included in modelling as a modelling conservatism. Fugitive emissions from product loading were also assessed as described in Trans Mountain's response to MV Section No. 3.5.1 above.

The maximum predicted air quality concentrations in the North Shore residential areas and Bowen Island (South of Squamish) were less than the applicable ambient air quality objectives in the region. Many of these ambient air quality objectives are health protective. Therefore, all the applicable ambient air quality objectives are met within air quality RSA.

There will be an increase in Project-related emissions, which will result in an increase to predicted concentrations near the terminals, as indicated in:

- Table 26 and Table 35 of the Supplemental Air Quality Technical Air Quality Technical Report for Technical Update No. 2 (Filing ID A4A4E3); and
- Table 5.4 of Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2 (Filing ID A4F5H8).

However, the Project will continue to meet the ambient air quality objectives and regulatory requirements, as indicated in these (and supplemental) reports.

The following information provides additional details:

- The combined effects of Burnaby Terminal, Westridge Marine Terminal and marine traffic associated with the Project were provided in the response to MV IR No. 2.1.05a (Filing ID A4H8U8).
- SO_2 exceedances of MV's proposed objective of 75 ppb (or 196 μg/m^3) are addressed in Air Emissions Section 33.2.4.
- Diesel particulate matter emissions associated with the Project were assessed in the response to MV IR No. 2.5.4 (Filing ID A4H8U8). Additional information on this topic can be found in Section 62.1.1.3 of Reply Evidence (Diesel Particulate Matter).

All the air quality issues raised by Dr. Miller (Filing ID A4L8L7) were addressed in the above reports. In addition, Table 1.2 of Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report Supplemental Report No. 2 (Filing ID A4F5H8) specifically indicates that emissions at all anchorage locations (Project-related and non-Project-related) were included in the assessments.

MV and Fraser Valley Regional District: Section 3.3.10 of MV's evidence (Filing ID A4L7Y3) and Sections 21 to 23 of FVRD's evidence (Filing ID A4L8W6) suggest that Trans Mountain assess the potential carcinogenic risks associated with long-term exposure to diesel particulate matter (DPM) using the California Office of Environmental Health Hazard Assessment chronic inhalation cancer unit risk of 0.0003 per μg/m^3.

Response to MV Section No. 3.10 and FVRD Sections 21-23:

In response to concerns raised by FVRD and MV, air dispersion modelling was completed in support of the assessment of the potential carcinogenic risks associated with long-term exposure to DPM emitted from the Project-related marine vessel traffic. Details regarding the HHRA for DPM can be found in Section 62.1.1.3 of Reply Evidence (Diesel Particulate Matter).

33.2.5 Land Use Selection for Terrain Inputs

MV: The following submission (Section 3.8.1) was made by MV regarding land use inputs in dispersion modelling (Filing ID A4L7Y3):

> "The land-use applied by Trans Mountain in the terrestrial air quality dispersion modelling does not depict the area surrounding the Westridge Marine Terminal and Burnaby Mountain accurately. Trans Mountain has used inappropriate land-use in the model throughout the model domain as well as area adjacent to the largest emission sources at Westridge Marine Terminal and Burnaby Terminal. Land-use is an important input into CALMET/CALPUFF and the model is

> particularity sensitive to land-use in areas adjacent to emission sources in the model as well as areas of complex terrain. Incorrect assignment of land-use types in CALMET/CALPUFF may result in different maximum points of impingement, different spatial and frequency distributions of concentrations, and different areas of impact to residents. Given the fact that land-use was inappropriately assigned in the Trans Mountain model; the results are not credible and should not be relied upon. Modelling of air quality and potential impacts should be conducted again, with input from air quality agencies in the Lower Fraser Valley airshed. In the absence of reliable modelling predictions, the NEB cannot assign the correct weight to the environmental burden of this Project."

Trans Mountain Response to MV Section 3.8.1:

Trans Mountain's air quality consultants followed the Guidelines for Air Quality Dispersion Modelling in BC (referred to as the "Guidelines," which lists the acceptable methodology for digital mapping and land use; BC MOE 2008). A Detailed Model Plan was submitted by Trans Mountain's air quality consultants Rowan Williams Davies and Irwin Inc. (RWDI; Appendix B of Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report, Filing ID A3S1U3) which was co-approved by MV and BC MOE.

Land-use data for this Project was based on Baseline Thematic Mapping (BTM) Present Land Use Version 1 Spatial Layer, provided by GeoBC of the BC Government and downloadable from BC government website. The Guidelines for Air Quality Dispersion Modelling in BC (BC MOE 2008) recommend the use of GeoBC's BTM or the United States Geological Survey's Global Land Use Characterization data (USGS). Both data sets have perceived strengths and weaknesses. However, no preference is given in the Guidelines, nor are there any recommendations or requirements to manually manipulate the land use. It was therefore decided to follow regulatory guidance and leave the land-use characterization unchanged as presented.

A change in the land use selected for modelling purposes is not expected to materially affect the predicted results; however, Trans Mountain commits to updating the inappropriately defined land use areas as mentioned in Novus memo re: Importance of Land Use Data applied to CALPUFF Modelling (NEB Filing IDs A4L7Z5 and A4L8A7) for the updated dispersion modelling in 2016 for PMV in support of Project permitting (response to PMV IR No. 2.25b, page 59 of Filing ID A4H8W5).

33.2.6 Secondary Formation of Ozone – Photochemical Modelling

MV: Sections 3.6.1-3.6.3 of MV's evidence (Filing ID A4L7Y3) suggested it is premature to conduct the modelling without confirming emission scenarios. MV states that it is of critical importance that the potential impacts of the Project, with respect to secondary formation of ozone, be assessed in a more comprehensive manner. It also proposes the following condition:

> "Prior to a decision being made on the Project, Trans Mountain should be required to revise the assessment of the potential effect of VOC emissions from the Project on the secondary formation of ozone in the Lower Fraser Valley based on revised Community Multi-Scale Air Quality (CMAQ) modelling that addresses the concerns raised to date by Lower Fraser Valley air quality agencies. The methodology, inputs and assumptions for the revised modelling

should be finalized in consultation with the Lower Fraser Valley Air Quality Coordinating Committee."

Trans Mountain Response to MV Sections 3.6.1-3.6.3:

Trans Mountain submits that MV's proposed condition is not required and notes that Trans Mountain has conducted a revised assessment as requested by MV and EC.

Trans Mountain has addressed the concerns raised to date by the Lower Fraser Valley Air Quality Coordinating Committee (LFVAQCC), where provided, and in particular from the face-to-face meetings in 2014 (Filing ID A4F5C9). In response to MV IR No. 2.3.1 a) and b), Trans Mountain committed to consult with the members of the LFVAQCC and update the original photochemical modelling (presented in the Appendix C of Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report, Filing ID A3S1U3) of potential impacts of the Project on ozone, photochemical $PM_{2.5}$, and visibility in the Low Fraser Valley for four historical meteorological episodes as originally suggested by MV IR No. 2.3.1 (Filing ID A4H8U8). Trans Mountain submitted its draft work plan for the updated CMAQ modelling to the LFVAQCC members for their review and comments (Filing ID A4L8A5) and the LFVAQCC declined to provide any comments despite an offer by RWDI to extend the comment period for input and meet face-to-face with the LFVAQCC members again (see correspondence in Appendices 33A and 33B). The revised CMAQ modelling addressed four additional meteorological episodes, used EC's MEIT to estimate non-Project marine emissions, used the most recent Project-related emissions, included additional emissions in the Lower Fraser Valley from larger projects announced after 2013 and included a more refined inner modelling domain (1 km grid resolution). All of these technical details were requested by the LFVAQCC in 2014 and RWDI included them in the updated modelling (Appendix 33C).

Government of Canada, Environment Canada: In Section 3.3.2.2 (NEB Filing ID A4L8Y6) of their evidence, EC provides the following recommendation with respect to further photochemical modelling:

1) "Additional analysis to characterize Project emissions – especially those related to high activity days should be a priority in any follow-up study. Such a study analysis could include:
   a) the monitoring of fugitive VOC emissions during the loading of tankers using real time observations of ambient speciated VOC concentrations at the Westridge Marine Terminal;
   b) the logging of all Project marine activity data and engine specification including tugs and barges as required to calculate marine emissions and as per the methodology the Proponent describes in their June 2014 Supplement Report (Exhibits B109-1 to B109-3);
   c) estimate of 'non-ideal' fugitive Vapour Recovery Unit VOC capture and Vapour Combustion Unit (VCU) destruction efficiencies; and
   d) stack test data for the characterization of composition and flow rates of VCU emissions."
2) "Any follow-on photochemical modelling should consider modelling ozone episodes that have occurred under all the meteorological regimes discussed in Steyn *et al.* (2013). EC has suggested that modelling the month of July 2009 - a relatively recent period in which the LFV [Lower Fraser Valley] air shed would have had similar emissions and background concentrations as the present, as

well as a period with a number of ozone episodes covering all the meteorological variability identified by Steyn *et al.* (2013) – would represent a suitable modelling timeframe."

Trans Mountain Response to EC Section 3.3.2.2:

Trans Mountain has addressed most of the points raised by EC in previous IR responses and the responses are reproduced below. In short, the EC comments are based on the 2013 CMAQ photochemical modelling (Appendix C of Technical Report 5C-4 of Volume 5C, Air Quality and Greenhouse Gas Technical Report, Filing ID A3S1U3) which is currently being updated to address several suggestions provided by EC and other LFV regulators in 2014.

Trans Mountain has conducted additional analysis to characterize Project emissions and follow-up on photochemical modelling. The updated CMAQ photochemical modelling results in 2015 produced by RWDI for Trans Mountain indicate predicted air quality effects for ozone, $PM_{2.5}$ and visibility that remain small, are less than those reported by EC (Filing ID A4L8Z6) and are also within the noise or uncertainty of the photochemical model itself. None of these EC concerns listed below are expected to materially affect the updated CMAQ photochemical modelling results nor suggest a need for a third round of photochemical modelling. Rather, they are research-oriented and interesting but are outside the scope of the environmental assessment process. The report for the updated CMAQ study report is provided as part of Trans Mountain's Reply Evidence as Appendix 33C to address the concerns expressed by both EC and MV in their respective written intervenor evidence submissions.

i) Monitoring of fugitive VOC emissions during the loading of tankers using real time observations of ambient speciated VOC concentrations at the Westridge Marine Terminal.

Trans Mountain understands that EC wishes to gain a better confirmation on the gas tight effectiveness of tanker's cargo tank covers and connections, which could otherwise lead to "fugitive emissions" while transferring or carrying cargo. In response to GoC EC IR No. 2.071b (Filing ID A4H6A5), Trans Mountain has already committed to undertaking surveys onboard randomly sampled tankers at the Westridge Marine Terminal during which time cargo tank covers and associated seals will be checked for leaks of real time total hydrocarbon (THC) or total volatile organic compounds (TVOCs) measurements using a portable monitor. These tests will be carried out by the Loading Master and four such works shall be completed, one per season.

It should be noted that these fugitive leak detection surveys will not include laboratory analysis for speciated VOCs as that is not the purpose of the surveys nor formed part of the commitment. As noted in the response to MV IR No. 2.1.10a (Filing ID A4H8U8), total VOC sampling at the Westridge Marine Terminal during tanker loading has been ongoing in 2014 and 2015 to inform engineering design of the vapour control equipment. These surveys have been measuring the same VOCs in the cargo headspace that are being requested here. Some speciated VOC results were provided by Levelton to Trans Mountain for a few products during tanker loading in 2015. These results can be made available upon request in a suitable summary such as average concentrations by product class. It is expected that these measurements will be informative and reasonably predictive of the composition of fugitive emissions.

ii) *Logging of all Project marine activity data and engine specification including tugs and barges as required to calculate marine emissions and as per the methodology the Proponent describes in their June 2014 Supplement Report.*

Trans Mountain keeps records of the names of all tankers and barges calling but does not keep records of any tugs used to assist the ships. Engine specifications of all vessels calling Westridge Marine Terminal are currently not recorded and will not be recorded in the future. This level of detail is typically not recorded by PMV either as it lies outside the boundary of regional initiatives which are more focused on fleet-wide, industrial sector or operator programs.

iii) *Estimates of 'non-ideal' fugitive Vapour Recovery Unit (VRU) VOC capture and Vapour Combustion Unit (VCU) destruction efficiencies.*

The updated 2015 CMAQ modelling was performed assuming the collection efficiency of 99.5%. Kinder Morgan previously completed testing of three tankers loading in Galena Park, Texas, USA and demonstrated that the VOC collection efficiencies during loading between 99.865% and 99.985% (ILTA 2014). The remaining 0.5% of VOCs which could be emitted as fugitive gases to atmosphere is a very small amount; nonetheless, and they were accounted for in the updated CMAQ modelling.

Also, Trans Mountain reported non-ideal or non-routine VCU destruction and VRU removal efficiency scenarios in the response to the City of Burnaby IR No. 2.068e as part of an assessment of possible upset scenarios (Filing ID A4H8A1). Potential VOC control equipment failures were defined and modelled in CALPUFF and the predicted concentrations were evaluated for human health effects by Intrinsik Environmental Sciences Inc. (Intrinsik). For the purpose of this assessment, it was assumed that the petroleum hydrocarbon and VOC vapours would escape from the VCU or VRU for 30 minutes before the system could be isolated and loading would stop. It would not be appropriate to assume any extended VRU/VCU upsets beyond 30-minutes as tanker loading would be halted.

iv) *Stack test data for the characterization of composition and flow rates of VCU emissions*.

In 2014, Trans Mountain conducted a comprehensive study on the existing VCU to learn how the operating temperature of the unit affects combustion efficiency. The results of this study were incorporated into a revision of the standard operating procedures for the existing VCU. Moving forward and in response to MV IR No. 2.2.1b (Filing ID A4H8U8), Trans Mountain committed to conduct annual combustion efficiency testing for the existing and proposed VCU to ensure the system is optimized. Composition and flow rates will form part of these measurements.

When the VRU design details are finalized, Trans Mountain will assess the need for annual testing to ensure the system is operating within the designed specifications – any testing surveys will be in line with industry best practices.

v) There is no reason to consider any newly suggested 2009 meteorological episodes as a 5th modelling time frame for the updated CMAQ modelling study; this suggestion was provided by EC after the updated modelling was known to be well underway by RWDI and after EC and the other LFVAQCC members declined to provide any comments on the draft work plan.

The updated results for the CMAQ photochemical modelling are provided as Appendix 33C as part of Trans Mountain's Reply Evidence to address the concerns expressed by both EC and MV in their respective written intervenor evidence submissions. There are no compelling technical grounds to undertake any further updates on the CMAQ photochemical modelling beyond the work currently in progress and Trans Mountain submits the proposed condition is not required.

33.2.7 Selection of CALPUFF Model

Living Oceans Society - Dr. Simpson: Section 3.3.2 of Living Oceans Society's evidence (Filing ID A4L9R9) stated *"The impact of running the CALPUFF model over a smaller domain than it was designed for was not addressed. The CALPUFF model is intended for long-range applications (less than 50 km) but was applied to a 24 × 24 km^2 domain in the MV region. Because a response to this specific question was not provided during the Information Requests, it is still not known how appropriate the model is for the shorter transport distances considered here and what impact this may (or may not) have on the results."*

Trans Mountain Response to Living Oceans Society - Dr. Simpson Section 3.3.2:

The U.S. EPA has indeed proposed the use of CALPUFF for long-range (50+km) applications and for all CALPUFF for "those applications involving complex wind regimes, with case-by-case justification" (U.S. EPA 2003).

BC in general and the Burnaby Terminal area in particular certainly qualify as a region involving complex wind regimes, at the scales and over the extent of the modelling domain. Such complex wind and dispersion regimes include:

- coastal circulations and dispersion effects (land-sea breeze circulation, coastal fumigation, thermally induced boundary layer; TIBL);
- complex terrain driven circulations induced by topography (channeling, slope flows);
- resulting non-homogenous 3D wind fields;
- non-homogenous land use (i.e., ocean, urban, forests, etc.); and
- potential for non-steady state conditions (*e.g.,* stagnation and inversion break up. fumigation).

MV, as evidenced by their "Dispersion Modelling Plan" (MV. 2015) welcome CALPUFF as a dispersion model for the LFV area, with no domain-size requirement to justify the use of CALMET/CALPUFF.

The Guidelines for Air Quality Dispersion Modelling in BC recognize CALPUFF's superiority, with no range restriction, by stating "*it is generally agreed that CALPUFF offers superior treatment of dispersion*" (BC MOE 2008).

Finally, the developers of CALPUFF have consistently presented CALPUFF as a model designed to compute impacts from the fenceline to several 100 km, and recommended and used CALPUFF for both short-range and long-range applications. This is shown beyond U.S.

EPA's guidance as evidenced by the default input switch MREG=0 in the model (*i.e.,* technical options do not have to conform to U.S. EPA Long Range Transport guidance), as evidenced in their CALPUFF course material, their own projects, and their various publications. In particular, the models' developers drafted a reference document on Generic Guidance and Optimum Model Settings for CALPUFF Modelling System on behalf of the New South Wales Office of Environment and Heritage (2013) which reflect their informed recommendations for proper use of the model and states that *"An objective of the [CALPUFF] model is for use in both short-range and long-range applications"* (Barclay and Scire 2011).

33.2.8 Uncertainties in the Dispersion Modelling

Living Oceans Society - Dr. Simpson: Section 3.3.2 of Living Oceans Society's evidence (Filing ID A4L9R9) stated *"the uncertainties in the model results were not quantified. In order to be meaningful, every calculation or emission estimate that is presented needs an associated uncertainty as well as a range of expected values (i.e., maxima and minima). The Information Requests specifically probed the uncertainty in the CALMET/CALPUFF model, but the responses were general in nature and stated that the potential sources of uncertainty were 'managed'. Uncertainties cannot be managed; they need to be quantified. The model's performance in the specific case of The Project was not quantified and therefore remains unknown."*

Trans Mountain Response Living Oceans Society - Dr. Simpson Section 3.3.2:

Trans Mountain disagrees with the suggestion from Living Oceans Society that uncertainties in the dispersion modelling were not addressed. Specifically, they were systematically addressed by:

- selecting conservative values for emissions and background concentrations;
- using the best available meteorological data;
- modelling over a whole range of possible meteorological conditions (as have occurred during the modelling year); and
- using the best regulatory dispersion model available (CALPUFF), which has been shown through many evaluation studies, to predict the higher concentrations well within a factor of two for both short-range and long-range applications.

Uncertainties can be managed in the sense that modelling results will overall be conservative and satisfy regulatory guidelines. It is important to note that as part of its acceptance as a regulatory model in the USA, CALPUFF had to undergo a number of evaluation studies demonstrating its ability to predict reasonable estimates of concentrations. The model developers published a number of such studies. Both long-range and short-range field trials were conducted as listed below.

Long-range Transport

- Cross Appalachian Tracer Experiment (CAPTEX 1983), field data for long-range transport distances (Irwin *et al.* 1996);

- The Idaho National Engineering Laboratory (INEL) field data for intermediate transport distances (Irwin 1997);
- Wyoming dataset, South West Wyoming Technical Air Forum (SWWYTAF) dataset (Wu and Scire 2011);
- Cumberland Plume Study Dataset (SWWYTAF, 1999) (Scire *et al.* 2012a); and,
- European Tracer Experiment (ETEX 1994; Scire *et al.* 2012b).

Short to Intermediate Distances

- Kincaid SF_6: Tracer releases from 187 m stack in flat terrain (Strimaitis 2009);
- Lovett SO_2: Ambient monitoring on ridge near 145 m stack in Hudson River valley (Strimaitis *et al.* 1998);
- PRIME datasets (building downwash) (Schulman *et al. 2000*); and
- Dipole Pride 26 (1996, Nevada Test Site) and OLAD (1997, Dugway Proving Ground, UT) (Hanna and Chang 2012, Chang *et al.* 2003).

Overwater and Coastal Datasets

- Ventura, Carpinteria, Pismo Beach, Cameron (1/2 to 8 km); Oresund (22 to 42 km);Coastal (Red Sea) – Rabigh (tracer experiment) (Earth Tech 2006, Scire *et al.* 2005);
- Tennessee (SO_2 from aluminum facility) (Schulman and Scire 1981); and
- Arkadelphia, Arkansas (SF6) – Line source dispersion. BLP (Scire 2008).

33.2.9 Marine-Source Boiler Emissions

EC Sections 3.2.2.1 and 3.3.2.1:

In Section 3.2.2.1 of their evidence (Filing ID A4L8Y6), EC requested boiler emissions be included in the dispersion modelling when tankers are within the port within the emission control area (which encompasses the Air Quality Marine Study Area and Burnaby Study Area).

In Section 3.3.2.1 of their evidence, EC presents the Trans Mountain dispersion modelling results for maximum predicted 1-hour NO_2 concentrations which "*only included Project-related marine vessels anchored within the Local Study Area which did not include all of the Vancouver harbour anchor locations.*"

Trans Mountain Response to EC Sections 3.2.2.1 and 3.3.2.1:

Trans Mountain performed additional dispersion modelling for the combined effects of emissions from Burnaby Terminal[3], Westridge Marine Terminal and all marine transportation traffic (using

[3] The only continuous emission sources of interest at Burnaby Terminal are product storage tanks; therefore, there were no NOx emissions modeled from Burnaby Terminal.

the EC MEIT) including Trans Mountain boiler emissions from tankers at berths for the Application Case. MEIT data includes all of the Vancouver Harbour anchor and berth locations. Dispersion modelling results are compared with the previously presented results (in response to GoC EC IR No. 2.064b, Filing ID A4H6A5) in Table 33.2-14 for 1-hour averaging period.

TABLE 33.2-14

MAXIMUM PREDICTED 1-HOUR NOX AND NO_2 CONCENTRATIONS FOR THE COMBINED APPLICATION CASE, MARINE AND WESTRIDGE MARINE TERMINAL (in µg/m^3)

Pollutant	Averaging Period	Application Case with Boilers at Berth (Including Ambient Background)	Application Case Excluding Boilers at Berth (Including Ambient Background)	Maximum Boiler Contribution at any Receptor (Application Case with Boilers Minus Application Case Without Boilers)	Ambient Background	Metro Vancouver Objective
NO_X	1-hour	1,623	1,623	23	111	n/a
NO_2	1-hour	162.3	162.3	2.3	n/a[1]	200-188[2]

Notes: n/a – not applicable
[1] Ambient background is added as NO_X to the NO_x modelled results, then total NO_x concentrations converted to NO_2 using the Ambient Ratio Method.
[2] The objective of 188 µg/m^3 is based on daily 1-hour maximum, annual 98th percentile of 1-year data.

The effect of Project boilers operating at berth is negligible with respect to the maximum 1-hour NO_2 concentration – the maximum concentration is the same both with and without the boilers operating at berth. The maximum contribution of boiler emissions to the maximum predicted 1-hour concentration at any receptor in the modelling domain is 2.3 µg/m^3 (which represents 1.15% and 1.22% of the 200 µg/m^3 and 188 µg/m^3 ambient air quality objectives, respectively) [4].

Figure 33.2- displays the concentration contour plots maximum predicted 1-hour NO_2 concentrations for the combined effects of emissions from Burnaby Terminal, Westridge Marine Terminal and all marine transportation traffic (using the MEIT) for the Application Case including Trans Mountain boiler emissions at berths.

It should also be noted that Project-related vessels are required to adhere to federal and international emission standards which are expected to reduce future air emissions associated with the marine component of the Project, relative to existing conditions. Implementation dates for the proposed International Marine Organization (IMO) Tier-III NO_X emission reductions in the ECA are proposed starting in year 2016. The Tier-III emission reductions were not accounted for in this updated assessment for the Project-related marine traffic and MEIT sources in the Application Case (which is based on year 2010). As a result of this assumption, these updated results are likely overestimated with respect to predicted NO_2 levels in year 2030 and should be considered to be conservative.

[4] For simplicity maximum (100th percentile) values were conservatively compared to the 188 µg/m^3 objective

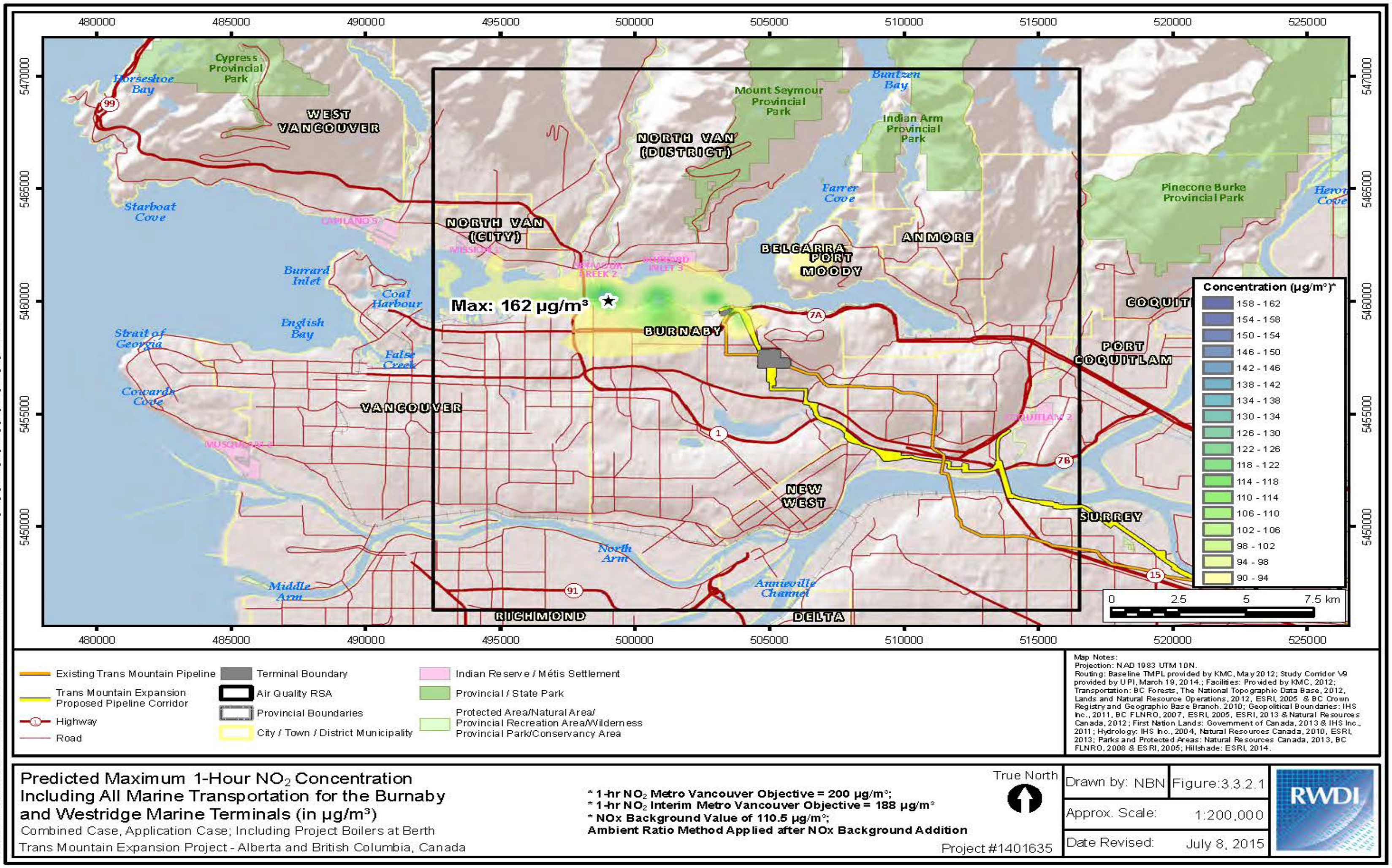

Figure 33.2-3 Predicted Maximum 1-Hour NO_2 Concentration Including All Marine Transportation for the Burnaby Terminal and Westridge Marine Terminal (in µg/m³)

33.2.10 Summary of New Commitments

Trans Mountain commits to updating the inappropriately defined land use areas as mentioned in Filing IDs A4L7Z5 and A4L8A7 for the updated dispersion modelling in 2016 for PMV in support of Project approval (page 59 of Filing ID A4H8W5).

33.2.11 References

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33.3 Air Quality Monitoring

General Comments

Several intervenors have expressed interest in ambient air quality monitoring as a requirement for Project approval. Dispersion modelling results indicated that no exceedances of ambient air quality objectives are predicted to occur; however, Trans Mountain has agreed to conduct monitoring at the Westridge Marine Terminal and Burnaby Terminal in addition to a commitment to meet these objectives. Uncertainties are inherent in any predictive modelling and "ground truthing" through actual measurements can be useful, where warranted.

The following submissions were made by intervenors regarding ambient air quality monitoring.

33.3.1 Ambient Monitoring During Construction

Fraser Valley Regional District - Affidavit Of Rebecca Abernethy: Both IRs (1.16(a)-(d); 2.18(b)) (Filing ID A4H8S0) asked Trans Mountain questions regarding ambient air monitoring that will be conducted with respect to the TMEP, particularly during construction. FVRD noted that there is precedent from other recent construction projects in the LFV for ambient air monitoring before, during, and after construction. FVRD provided an attachment (Exhibit "H") as an example of the South Fraser Perimeter Road Project, which required dustfall monitoring (Filing ID A4L8V6).

Trans Mountain Response to FVRD Affidavit of Rebecca Abernethy: In response to FVRD IR No. 2.18b, a commitment was made such that Trans Mountain will engage FVRD during the development of the Dust Management Plan and components of the plan, such as the need for ambient dustfall monitoring, will be finalized at that time.

33.3.2 Ambient Monitoring During Normal Operations

Metro Vancouver Sections 3.71, 3.7.2, 3.91, 3.92, and 3.10.2: MV is seeking a condition that Trans Mountain establish additional air quality monitoring capabilities, to assess the impacts of the Project on an ongoing basis. These new monitoring capabilities are requested to include additions or enhancements to existing MV monitoring stations, as well as new permanent stations, along with consideration of mobile air quality monitoring units. MV asserts that Trans Mountain should provide funding for this additional monitoring infrastructure and work with air quality authorities in the LFV airshed to determine the parameters to be measured, the method of reporting, and the location of the stations (Filing ID A4L7Y3).

MV's evidence states that there is precedent for monitoring of BTEX at oil and gas related facilities in Canada. As such, MV stated that BTEX should be added to the proposed ambient station at the Westridge Marine Terminal (Filing ID A4L7Y3).

MV asserts that Trans Mountain should establish monitoring of additional air pollutants at existing MV air quality monitoring station locations. These include fine particulate matter ($PM_{2.5}$) and nitrogen oxides (NOx) measurements at the Burnaby-Capitol Hill (T23) station and $PM_{2.5}$ and inhalable particulate matter (PM_{10}) measurements at the Burnaby Mountain (T14) station (Filing ID A4L7Y3).

MV is seeking a condition that Trans Mountain establish monitoring of SO_2 at a new community monitoring location in the Queensbury neighbourhood of North Vancouver. The justification for this condition is that Trans Mountain has predicted exceedances of MV's newly adopted interim ambient air quality objective for SO_2 (75 ppb) in this area (Filing ID A4L7Y3).

MV is also seeking a condition that Trans Mountain establish a new permanent air quality monitoring station in the Westridge community. The condition should include the following requirements (Filing ID A4L7Y3):

1) The station must include continuous measurement of SO_2, nitrogen oxides (NOx, NO, NO_2), carbon monoxide (CO), ozone (O_3), $PM_{2.5}$, and PM_{10}.

2) The station must include continuous (*i.e.*, hourly or sub-hourly) VOCs measurement that at a minimum includes n-Propane, i-Butane, n-Pentane, n-hexane, Benzene, n-Heptane, Toluene, n-Octane, Ethylbenzene, Xylenes (-m,-o,-p), Nonane, and Napthalene. Monitoring of VOC must meet the specifications and standards outlined in Exhibit 29.

3) The station must include measurement of non-continuous VOC sampling in accordance with the federal National Air Pollution Surveillance (NAPS) program.

4) The station must include measurement of representative meteorological observations of wind speed, wind direction, air temperature, and relative humidity, collected with high quality instrumentation.

5) The station must be established in consultation with MV whereby the station specifics will be agreed to in advance of construction of the Project. The station specifics include station location, pollutant and meteorological parameters, monitoring equipment instrument exposure, measurement height, sampling frequency, real-time reporting of data to the public, QA/QC procedures, and data validation procedures.

6) Trans Mountain will work with MV to formalize an agreement with respect to funding and operation of the station.

7) The results of the monitoring must be made available to the public in real time.

Finally, MV is seeking a condition for Trans Mountain to establish additional ambient air quality monitoring in the area near Westridge Marine Terminal. In addition to the fine particulate matter ($PM_{2.5}$) parameters, MV is also seeking co-located monitoring of black carbon particulate via continuous aethalometers, as well as speciated particulate filter sampling of $PM_{2.5}$ in accordance with the methodologies employed by the EC NAPS program. The additional monitoring in the vicinity of the Westridge Marine Terminal must be commissioned at least one year in advance of the commencement of Project operations, to ensure that a period of baseline data will be gathered before start-up (Filing ID A4L7Y3).

Trans Mountain Responses to MV Sections 3.71, 3.7.2, 3.91, 3.92, and 3.10.2: Trans Mountain has committed to conduct ambient monitoring at Westridge Marine Terminal during construction and post-construction operation under NEB Draft Condition No. 21 – Air Emissions Management Plan for the Westridge Marine Terminal of the NEB's Letter – Draft Conditions and Regulatory Oversight (NEB 2014). This Condition requires methods and schedule for ambient monitoring of air contaminants of potential concern such as PM, CO, nitrogen dioxide (NO_2), SO_2, hydrogen sulphide (H_2S), and VOCs. In this draft condition, the NEB also requires that Trans Mountain consult with the LFVAQCC members on the methodology and schedule as part of the Air Emissions Management Plan (NEB 2014). Justification for the considerably larger list of contaminants to be measured at Westridge Marine Terminal has not been provided by MV.

Trans Mountain disagrees with the assertion from MV that the dispersion modelling results reported for the Project still indicate predicted exceedances of the ambient air quality objectives, and on that basis, additional new ambient stations or substantial upgrades to existing MV stations are required at Trans Mountains' expense. Trans Mountain has committed to meet all applicable ambient air quality objectives including the new MV interim 1-hour SO_2 objective and

they have demonstrated the ability of the Project to comply with this commitment through several rounds of dispersion modelling for both marine traffic and storage terminals such as Westridge Marine Terminal and Burnaby Terminal. The results showing that the new MV interim 1-hour SO_2 objective will be met are provided under the response to the MV Section No. 3.9.1.3 (Filing ID A4L7Y3) in Section 33.2. Accordingly, these additional proposed conditions relating to monitoring are not required.

EC Recommendations 3-1 and 3-2 (Filing ID A4L8Y6): *Recommendation 3-1:* Given the uncertainties related to prediction of marine-source combustion emissions, EC recommends the Proponent develop an Air Quality Monitoring, Reporting, and Mitigation Plan in conjunction with the LFVAQCC. EC further recommends that the Plan include monitoring of emissions to provide data necessary to verify the Project emissions.

Recommendation 3-2: EC recommends that the Proponent establish a program to monitor air contaminants, including NO_2 and $PM_{2.5}$, at, or adjacent to, the Burrard Inlet No. 3 reserve of the Tsleil-Waututh Nation. The monitoring program would operate for one year before operations and for at least the first three years of full project operation. The monitoring would be used to verify predicted Project impacts under the full range of expected meteorological conditions.

Trans Mountain Responses to EC's Recommendations 3-1 and 3-2: In reply to Recommendation 3-1 and as noted in the response to MV IR No 2.2.1a (Filing ID A4H8U8), Trans Mountain has committed to discussing the monitoring parameters and reporting requirements through consultation with the LFVAQCC members and will address these issues in the work plan for the Westridge Marine Terminal. With respect to Recommendation 3-2, Trans Mountain is willing to consider and discuss this request with the interested parties such as Tsleil-Waututh Nation and members from groups such as NS NOPE who also reside on the North Shore and expressed interest in ambient air quality measurements.

33.3.3 Ambient Monitoring During Emergency Events

FVRD - Affidavit of Rebecca Abernethy: FVRD requested that mobile monitoring capacity be created to allow real-time monitoring for speciated VOCs and PM during an emergency event such as a fire or explosion. They cited recent emergency examples requiring immediate monitoring which were attached as Exhibit "K" (PMV shipping container fire) and Exhibit "L" (Squamish Dock fire) (Filing ID A4L8V6).

Trans Mountain Response to FVRD - Affidavit of Rebecca Abernethy: Trans Mountain agrees with the suggestion from FVRD that monitoring would be helpful during an emergency event and this is addressed within the Kinder Morgan Public Health Risk Exposure Plan. This plan is focused on the public health aspects of the response, which reflect the monitoring of air quality outside the "exclusion zone" established by KMC and emergency responders when reacting to an unplanned product release. In other words, the plan is intended to measure and monitor air quality characteristics in areas where the public may be exposed, outside mandatory evacuation areas. Trans Mountain is willing to consider and discuss this request for air quality monitoring outside the exclusion zone during an emergency event with any interested parties such as FVRD.

33.3.4 Use of Ambient Measurements from Regulator Operated Networks

Living Oceans Society – Dr. Isobel Simpson Section 3.2: The Living Oceans Society submitted evidence (Filing ID A4L9R9) that is summarized as follows.

1) The basic quality of the ambient air quality measurements taken from the MV ambient network still has not been demonstrated. The first round IRs asked for specific details regarding measurement precision, accuracy, calibration, audits, and so forth. Details were not given for accuracy, calibration, and audits, and the referenced documents did not provide specific answers. Therefore, the basic quality of the measurements, the calibration scale to which they are traceable, and the results of any third-party audits are still unknown. This is very fundamental information that is needed to assess the air quality data.

2) Background levels of several pollutants lie within the noise of the instruments. In response to an IR, precision was given for six pollutants (SO_2, H_2S, NOx, O_3, CO, and THC). However, for some compounds, the stated precision was surprisingly high, leading to concern that the measurement quality is not sufficient. For example, the CO precision was 2-5 times higher than background concentrations at Vancouver latitudes, meaning that the background CO concentrations, and how they vary with time, cannot actually be measured. Likewise, the THC precision was too coarse to detect even broad signals such as normal seasonal variations in levels of the main component of THC, methane. Therefore, it is unclear how elevated concentrations caused by the Project will be distinguished from normal background variations.

3) Any instrumentation deployed for routine air quality monitoring or spill assessment must be capable of measuring not only peak (high) concentrations but also background (low) levels. In the case of routine air quality monitoring, the measurements must be able to detect whether background concentrations are increasing in the long term because of Project emissions. In the case of a spill, the measurements must be able to determine whether a concentration has returned to background levels following the spill. In other words, the instruments must be able to actually measure the background concentrations in any season. However, as stated above, for some pollutants the stated measurement precision is too coarse to distinguish background concentrations from instrument noise. As well as needing precise measurements, the detection limits of the instruments (which were not provided) must be lower than the background concentration in order for the background to be measurable (rather than falling below a high detection limit).

4) It is unclear whether speciated VOC measurements are available. The hydrocarbon measurements do not appear to be speciated, in which case spikes in individual components such as n-hexane or benzene cannot be identified. In the case of an emergency event or spill, knowing the precise concentrations of individual hydrocarbon pollutants is critical for understanding both direct human health impacts as well as secondary impacts such as the formation of ground-level ozone (O_3).

Trans Mountain Response to Living Oceans Society – Dr. Isobel Simpson Section 3.2: Trans Mountain agrees with the Living Oceans Society that accuracy and precision of any ambient air quality measurements that were relied upon in the Project-related studies should be traceable and verifiable to known standards. Unfortunately, it would appear that MV does not make public the results of any internal audits, equipment calibration results, or specific QA or

QC measures, although MV has asked Trans Mountain to commit to providing details of their sampling and monitoring protocols while not specifying their own internal MV requirements. It should be noted that all of the details of the air monitoring and sampling protocols used and annual station audit results from the Alberta air shed networks are publicly available on the internet.

In their response to Trans Mountain IR No.1, MV provided a summary of the sampling and monitoring protocols that are aligned with the U.S. EPA and include details for equipment model and method numbers or equivalent that MV uses for their monitoring stations (Filing ID A4R3F1 including seven attachments: Filing IDs A4R3F2 to A4R3F8). MV did not disclose any details with respect to results for their internal network or station audits or calibrations and they do not publish any reporting requirements.

Trans Mountain does not have any comment on MV's ambient monitoring stations or their reported data. Trans Mountain uses the best available baseline information in their assessment of effects and modelling predictions.

33.3.5 Other Ambient Monitoring Comments

The Living Oceans Society submitted evidence (Filing ID A4L9R9) that is summarized as follows.

Living Oceans Society – Dr. Isobel Simpson Section 3.2.5: Ambient data at the Sumas and Burnaby terminals are not available and could not be verified. Ambient monitoring data from the Sumas and Burnaby terminals since 2012 and 2013, respectively, are not available because they are undergoing calibration. Therefore, these field data could not be viewed or verified. It is also not known where these fenceline monitors are located relative to the emission sources and the prevailing wind direction, in other words whether elevated concentrations can be detected for all wind directions.

Living Oceans Society – Dr. Isobel Simpson Section 4.2.2: Local communities are often distrustful of air quality information that is provided by the same organization that is responsible for creating the pollution (*i.e.*, industry self-monitoring).

Trans Mountain Response to Living Oceans Society – Dr. Isobel Simpson Sections 3.2.5 and 4.2.2: In the response to NEB IR No. 1.35 parts a) to g), Trans Mountain provided technical details of the sensors used at the Sumas Terminal and Burnaby Terminal ambient air quality monitoring stations, methods, schedule, data handling, assessment, reporting, and the dispersion modelling studies that were completed to select their sampling locations (Filing ID A3W9H8). With respect to the sensor downtime issue, the original sensors first used in the ambient monitoring units were found to be adversely affected by the high ambient moisture levels so they were replaced with more robust sensors. The extended period being off-line reflects the duration of time in 2012-2013 to replace, calibrate, and commission the more robust sensors.

Elevated concentrations would not be detected for all wind directions as the ambient stations are intentionally sited to measure maximum concentrations under specific dispersion conditions with a focus on being downwind of the storage tanks and close to residential properties. In the response to the Village of Del Ponte IR No. 1.2g, prevailing winds at the

Burnaby Terminal are from the east and east-southeast so placing the ambient station to the northwest corner of the site recognizes the importance of prevailing winds in correctly siting the station (Filing ID A3Y2J0).

With respect to the issue of industry self-monitoring, Trans Mountain agrees with the suggestion that an independent third party is more likely to provide a more trustful relationship with the public audience. Kinder Morgan Canada has retained a third-party firm for the supply, maintenance, and reporting of measurements from the existing SAMS ambient monitoring units at the Sumas Terminal, Burnaby Terminal, and Westridge Marine Terminal.

Living Oceans Society – Dr. Stuart Batterman Section 3.1.3: The Living Oceans Society also submitted evidence (Filing ID A4L9S0) that is summarized as follows.

There is no plan for environmental monitoring or health surveillance to verify the assumptions, predictions, and conclusions in the HHRA. The Application should consider monitoring key environmental parameters, beyond the usual compliance-oriented monitoring, to ensure that the assessment is protective of health and the environment. For example, Trans Mountain should consider establishing air quality monitors for $PM_{2.5}$, NO_x, SO_2, and other pollutants at hotspot locations.

Trans Mountain Response to Living Oceans Society – Dr. Stuart Batterman Section 3.1.3: Trans Mountain acknowledges these concerns and has already moved forward on these matters by installing ambient air quality monitoring equipment onsite at their three storage terminals in the Lower Mainland. Specifically, the Sumas Terminal, Burnaby Terminal, and Westridge Marine Terminal have SAM units in place that continuously record ambient SO_2, H_2S, and TVOCs as well as wind speed and wind direction. As well, there is an MV ambient station near the Burnaby Terminal (Burnaby Burmount), whose operation is co-funded by Kinder Morgan, that continuously monitors THCs and total reduced sulphurs, and samples for VOCs as part of the NAPS network.

Finally, in their response to the City of Burnaby IR No. 1.03.07f and other intervenors, Trans Mountain committed to installing a new station at Westridge Marine Terminal (Filing ID A3Y2E6). This station will meet the requirements of draft NEB Condition #21 which requires methods and schedule for ambient monitoring of contaminants of potential concern in air including PM, CO, H_2S, nitrogen dioxide, SO_2, and VOCs. A work plan will be prepared first in consultation with the LFV regulators. TM has committed to meeting the most stringent ambient air quality objectives in BC and Alberta for these contaminants of interest (and others) and their direct measurement as noted above will assist with ongoing confirmation that the objectives are being met. It should be noted that combustion-related emissions of CO and NO_x are very small from Sumas Terminal and Burnaby Terminal due to the lack of sources so there is no reason to measure these contaminants at these terminals.

The existing SAM stations at Sumas Terminal and Burnaby Terminal were sited with the aid of dispersion modelling to identify predicted location of plume impingement. Although access to land-based locations may be more difficult for the upgraded NEB-required station at the Westridge Marine Terminal, a dispersion model will also likely be used to site this station. This opinion will also be factored by the input and direction of the LFV during the NEB-required consultation process.

33.3.6 Summary of New Commitments

- Trans Mountain is willing to consider and discuss the request with the interested parties such as Tsleil-Waututh Nation and members from groups such as NS NOPE who also reside on the North Shore and expressed interest in ambient air quality measurements.
- Trans Mountain is willing to consider and discuss the request for air quality monitoring outside the exclusion zone during an emergency event with any interested parties such as FVRD.

33.3.7 Reference

National Energy Board (NEB). 2014. Draft Conditions and Regulatory Oversight. Hearing Order OH 001-2014. Trans Mountain Pipeline ULC (Trans Mountain) Application for the Trans Mountain Expansion Project (Project). April 16, 2014 (Filing ID A3V8Z8).

34.0 ACOUSTIC ENVIRONMENT/NOISE

34.1 General Comments

The evidence submitted by the Musqueam Indian Band (Filing ID A4Q2F9) indicated a general concern with potential cumulative effects on noise pollution due to increased tanker traffic in Burrard Inlet and the Strait of Georgia. No specific detail was provided.

Noise from tanker traffic moving in Burrard Inlet and in the Strait of Georgia was assessed cumulatively in Volume 8A Marine Transportation (Filing ID A3S4X3) and in the Marine Noise (Atmospheric) - Marine Transportation Technical Report (Filing ID A3S4K2). Tankers at anchor were initially assessed in Technical Report 5C-3 in Volume 5C, Terrestrial Noise and Vibration Technical Report (Filing IDs A3S1T7, A3S1T8 and A3S1T9), and were further reviewed in IR responses to B. Miller, specifically No. 1.2b (Filing ID A3X6R9) and IR No. 2.03b (Filing IDs A4H8V0 and A4H8V1).

Trans Mountain will prepare an updated Westridge Marine Terminal EPP, a Noise Management Plan, and conduct post-construction noise surveys as per NEB Draft Conditions No. 31, 33 and 57 of the NEB's *Letter – Draft Conditions and Regulatory Oversight* (Filing ID A3V8Z8). Any verification of operations noise from the Westridge Marine Terminal would include tanker movements in Burrard Inlet as part of the cumulative noise level.

34.2 Tanker Noise in Burrard Inlet

A number of intervener submissions indicated that noise (and light; Section 42: Human Occupancy and Resource Use) from tankers docked at the expanded Westridge Marine Terminal and at the PMV managed anchorages in Burrard Inlet was of concern. These submissions indicated that noise from tankers had not been adequately addressed.

The following evidence submissions were made regarding tanker noise:

- Village of Belcarra: The evidence stated that noise (and light) are the greatest source of complaint from residents in the community and that "*Trans Mountain should be required to implement measures to minimize and/or mitigate the bright lights and noise from both the Westridge Marine Terminal loading facility and on-board their client vessels both at anchor and at dockside*" (Filing ID A4L5G5).

- District of North Vancouver: "*The proposed Westridge Marine Terminal expansion and designated vessel anchorages have the potential to create noise and light issues for residents of the District. The District has asked for additional information on the design and mitigation measures that will be considered and have been advised that this level of detail is not available at this time but will be forthcoming with a future design stage*" (Filing ID A4Q0E9).

- NS NOPE: There were five submissions from NS NOPE, which indicated the noise (and light) from tankers in Burrard Inlet was a concern (Filing IDs A4L5Y4, A4L5Y6, A4L5Y7, A4L5Y8 and A4L5Z0). For all five submissions, the primary concern was noise from tankers associated with anchorages and not directly noise from the Westridge Marine Terminal. In one case, the concern was noise from tanker movement (Filing ID A4L5Y4), while the remaining four expressed concerns with tanker engines, escorts, and anchor chains,

particularly at night. The evidence from all participants indicates sound from ships at the anchorages is audible, particularly at night.

Noise from tankers which is within Trans Mountain control occurs at the Westridge Marine Terminal. Placement of tankers at various anchorages is controlled by PMV. Regardless, noise from tankers at both Westridge Marine Terminal and at anchorages has been considered in the submissions made to date to the NEB.

Noise from tankers was included in the operations noise assessment conducted in Technical Report 5C-3 in Volume 5C, Terrestrial Noise and Vibration Technical Report (RWDI December 2013 (Filing IDs A3S1T7, A3S1T8 and A3S1T9). Initial mitigation and controls for Westridge Marine Terminal operations was provided in Table 7.6.6-1 of Volume 5A of the Application (Filing ID A3S1L6). Construction noise mitigation is further discussed in Section 7.0 of the Westridge Marine Terminal EPP (Volume 6D, Filing ID A3S2S9). Design elements that act as sound mitigation that were included in the predictive modelling of operations noise are discussed in Section 6.12 of Technical Report 5C-3 in Volume 5C, Terrestrial Noise and Vibration Technical Report (Filing ID A3S1T7).

Additional analyses of noise from tankers at anchor in Burrard Inlet were further reviewed in IR responses to B. Miller, specifically Miller B IR No. 1.2b (Filing ID A3X6R9) and IR No. 2.03b (Filing IDs A4H8V0 and A4H8V1). These analyses showed where noise levels from tankers at anchorage would occur but found that noise levels at homes are within acceptable levels as defined in the BC Oil and Gas Commission Noise Control Guidelines (2009).

Once design and mitigation details have been further developed, Trans Mountain will prepare an updated Westridge Marine Terminal EPP, a Noise Management Plan, and conduct post-construction noise surveys as per NEB Draft Conditions No. 31, 33 and 57 of the NEB's *Letter – Draft Conditions and Regulatory Oversight* (Filing ID A3V8Z8). The focus of the monitoring program will be on confirming noise is controlled to within guideline limits at the most affected receptors. Noise controls that reduce noise for the nearest residences to Westridge Marine Terminal would also reduce noise at residences farther away. Any verification of operations noise from the Westridge Marine Terminal would include tanker movements in Burrard Inlet as part of the cumulative noise levels.

34.3 Reference

British Columbia Oil and Gas Commission. 2009. British Columbia Noise Control Best Practices Guideline, March 17, 2009. Victoria, BC.

35.0 FISH AND FISH HABITAT

35.1 Introduction

In evidence submitted by a number of intervenors (*e.g.,* Cowichan Tribes [Filing ID A4Q0U9], City of Coquitlam [Filing ID A4L9H8]), reviews of the fish and fish habitat element were often based solely on technical information contained within the initial 2013 application to the NEB (Technical Report 5C-6 in Volume 5C, Fisheries [Alberta] Technical Report [TERA December 2013; Filing IDs A3S1W6 and A3S1W7], and Fisheries [British Columbia] Technical Report [Triton Environmental Consultants Ltd. December 2013; Filing IDs A3S2C1 and A3S2C2]). However, a technical update for the fish and fish habitat component, for both the Alberta and BC portions of the Project, was filed with the NEB in February 2015 (Supplemental Fisheries [Alberta] Technical Report [TERA 2014; Filing IDs A4H1Y6, A4H1Y7, A4H1Y8, A4H1Y9, A4H1Z0, and A4H1Z1] and Supplemental Fisheries [British Columbia] Technical Report [Triton Environmental Consultants 2014; Filing IDs A4H1Z2, A4H1Z3, A4H1Z4, A4H1Z5, A4H1Z6, A4H1Z7, A4H2A1, A4H2A2, A4H2A3, A4H2A4, A4H2A5, A4H2A6, A4H2A7, A4H2A8, A4H2A9, A4H2C0, A4H2C1, A4H2C2, A4H2C3, A4H2C4, A4H2C5, A4H2C6, A4H2C7, A4H2C8, A4H2C9, and A4H2D0). This supplemental information included revised watercourse crossing summary tables and atlases, and included additional information that addressed site-specific mitigation and *Species At Risk Act* (SARA)-listed species. Trans Mountain also submitted the results of its *Self-Assessment of the Potential for Serious Harm to Fish and Fish Habitat Resulting From the Trans Mountain Pipeline ULC Trans Mountain Expansion Projection* (Self-Assessment; Filing IDs A4I6C1, A4I6C2, A4I6C3, A4I6C4, A4I6C5, A4I6C6, and A4I6C7).

Evidence submitted by intervenors ranged from comments in support of the adequacy of the fish and fish habitat information collected to date (*e.g.,* Métis Nation BC [MNBC; Filing ID A4Q2H2]), to an unjustified attack on Trans Mountain and its consultants, accusing them of unprofessional behaviour with the NEB/DFO, with respect to what constitutes serious harm (Salmon River Enhancement Society [SRES]; Filing ID A4Q2H6).

Trans Mountain wishes to restate the experience, integrity, and professionalism with which its consultants, GeoMarine Environmental Consultants Ltd., Triton Environmental Consultants Ltd., and CH2M HILL (formerly TERA) have approached the collection of fish and fish habitat information to support an application for the Project. Each of the senior biologists who have collaborated on the Project have more than 10 years of experience with fish and fish habitat information as it pertains specifically to all elements of oil and gas linear developments throughout Western Canada, including channel restoration/reclamation. All are either Registered Professional Biologists (R.P.Bio.) in BC, or Professional Biologists (P.Biol.) in Alberta, or members of both; and meet the definition of a "Qualified Professional (or Specialist)" as provided by one of BC's regulators (BC OGC 2015). Trans Mountain's consultants have and continue to act in a professional manner, upholding the code of ethics within their respective professional associations. Trans Mountain and its consultants take great offense to the assertion by SRES that data has been deliberately withheld to favour the proponent. This is further addressed under Section 35.5 *Serious Harm,* in this Reply Evidence.

For the convenience of the NEB, Trans Mountain has categorized its reply to intervenor evidence pertaining to the fish and fish habitat element based on topics that were either mutually identified by multiple intervenors, or otherwise of interest to intervenors. These topics have been defined as:

- 35.2 Species of Conservation Concern;
- 35.3 Sensitive Habitats/Areas of Interest;
- 35.4 Riparian Habitat; and
- 35.5 Serious Harm.

A summary of intervenor suggestions/recommendations related to the fish and fish habitat element is provided in Section 35.6. The remainder of the introduction addresses notable mis-interpretations identified by Trans Mountain in the intervenor evidence reviewed.

35.1.1 Trans Mountain Pipeline Existing Line

Evidence submitted by SRES (Filing ID A4Q2H6) placed significant emphasis on issues associated with the historical construction and continued operations of the existing TMPL operated by Kinder Morgan. Issues concerning the existing TMPL were also identified in evidence submitted by PIPEUP (Filing ID A4Q0Q7). In the list of issues for the TMEP, none included the operation of the existing TMPL pipeline (except for those aspects of the existing pipeline which will change as a result of the TMEP [*e.g.,* reactivation]). As such, Trans Mountain considers the evidence relating to the existing TMPL pipeline to be out of scope. Nonetheless, Trans Mountain has endeavoured to work with SRES outside the NEB process, to address concerns raised about the existing TMPL right-of-way.

Construction technology, equipment and best management practices (BMPs) within the industry today (*e.g.,* CAPP *et al.* 2012) are far superior to those implemented historically, such as during construction of the TMPL pipeline in 1953. It is therefore reasonable to conclude that the installation of any new pipeline, given the mitigation measures typically used during construction now and the reclamation at each watercourse that follows, would be completed to very high current standards.

35.1.2 Project Watercourse Crossings

A number of intervenors have continued to reference crossing numbers contained in the initial fish and fish habitat technical information submitted in support of the original Trans Mountain application. As noted above, an update to this information (including the numbers and classifications of watercourses that would be crossed by the proposed pipeline corridor [PPC]) was provided to the NEB in a technical update filed in February 2015. An update to both the Alberta and BC fish and fish habitat technical information was submitted in response to NEB IR No. 3.038d and 3.039a (Filing IDs A4H1V2, A4H1Y6, A4H1Y7, A4H1Y8, A4H1Y9, A4H1Z0, A4H1Z1 [Alberta]; and A4H1Z2, A4H1Z3, A4H1Z4, A4H1Z5, A4H1Z6, A4H1Z7, A4H2A1, A4H2A2, A4H2A3, A4H2A4, A4H2A5, A4H2A6, A4H2A7, A4H2A8, A4H2A9, A4H2C0, A4H2C1, A4H2C2, A4H2C3, A4H2C4, A4H2C5, A4H2C6, A4H2C7, A4H2C8, A4H2C9, and A4H2D0 [BC]).

There are also some inaccuracies in specific watercourses purported to be crossed by the PPC. For example, in Table 3.1-1 of evidence prepared by Zoetica Environmental Research Services (Zoetica) for Metro Vancouver (Filing ID A4L8C2), Anderson Creek is listed as crossed by the proposed Project; Trans Mountain has identified this as Davidson Creek, a tributary to Anderson Creek. Note also that Munday Creek is not crossed by the PPC, but East and West Munday arms/branches are. While the intent of Table 3.1-1 is possibly to illustrate which watercourses

appear on which maps, the table is misleading in that it suggests Unnamed Creek, West Creek, Anderson Creek [*sic*], Salmon River, Unnamed Creek 2, Munday Creek [*sic*], and Yorkson Creek all occur within the City of Surrey. Trans Mountain notes that these watercourses all occur within the Township of Langley and not within the City of Surrey.

In Table 3.1-2 of evidence submitted by Metro Vancouver (Filing ID A4L8C2), the relevance of Palmateer Creek to the Project is unclear. Given the headwaters of this creek are almost 1 km outside the PPC, it is not seen as relevant to the PPC.

In the evidence summary submitted by the City of Coquitlam (Filing ID A4L9H8), reference is made to a potential encroachment on Mundy Creek. Trans Mountain notes that no crossing of Mundy Creek is proposed. Other specific watercourses of concern identified by the City of Coquitlam, City of Surrey, and Metro Vancouver are discussed in more detail in Section 35.3 of this Reply Evidence.

35.1.3 Effects of Spills

A number of intervenors (*e.g.,* Senichenko [Filing ID A4L6Q9], Cowichan Tribes [Filing ID A4Q0U9], Metro Vancouver [Filing ID A4L8C2], PIPEUP [Filing ID A4Q0Q7], City of New Westminster [Filing ID A4Q0L5], and City of Surrey [Filing ID A4Q2K6]) raised concerns of the effects to fish and fish habitat from an oil spill resulting from an accident or malfunction. Concerns ranged from the effects to salmon and fishes in general, to the effects on fishes in a particular location (*e.g.,* the Brunette River -Senichenko and City of New Westminster; Centre Creek in Surrey Bend Park - City of Surrey and Metro Vancouver). The effects on fishes and their habitat of an accidental release of oil from an accident or malfunction is addressed under Section 46 (Ecological Risk Assessment) of this Reply Evidence.

35.1.4 Fish and Fish Habitat Investigations

In its approach to the investigation of fish and fish habitat along the PPC, Trans Mountain has endeavoured to visit all 1,163 potential watercourses identified along the PPC (256 in Alberta, 907 in BC). To date, over 95% of these have been investigated in the field by a qualified fish biologist, with many sites receiving multiple seasons of sampling. Land access has not been provided to the remaining < 5% of all potential watercourses identified. A conservative ‘risk management’ approach has been taken with all sites not yet investigated, with those still to be determined defaulted to a fish-bearing status where connectivity to already documented fish-bearing watercourses exists.

35.1.4.1 Indicator Species

Throughout the evidence prepared for Cowichan Tribes (Filing ID A4Q0U9), Ecofish Research Ltd. refers to the term “Valued Components” (VCs), derived from the Environmental Assessment Office guidelines. Ecofish does acknowledge that the Project is being reviewed by the NEB against its own regulatory requirements. Although stating that they will use the term “Elements of Concern” in their review of the freshwater fisheries component in Section 6.1 of their evidence, they actually continue to refer to VCs. Nonetheless, Trans Mountain assumes that the term VCs is interchangeable with the term “Indicator Species” (*i.e.,* in that all indicator species are of course VCs of the ecosystem). In its evidence, Cowichan Tribes specifically questioned the exclusion of chum and pink salmon from consideration in the Application.

By Ecofish's own definition, "*Since it is not possible to assess risk to every individual species during an Application, VCs are generally selected to represent a group of similar species within which impacts are expected to be similar*." It is for this reason that Trans Mountain selected Chinook salmon, coho salmon, and rainbow trout/steelhead. Further explanation for the exclusion of sockeye was provided in the response to NDP IR No. 1.1.8e (Filing ID A3Y2X5) and again in response to Azevedo IR No. 2.1.1 (Filing ID A4H7Y3). Sockeye salmon was not one of the indicator species selected in the Application because this species is not as well distributed throughout the Project area as chinook or coho salmon. Because of their geographical distribution, abundance, and value in commercial, recreational, or Aboriginal (CRA) fisheries, chinook and coho were considered a better indicator for Pacific salmon interactions with the Project as a whole. Further discussion on specific stocks or Conservation Units (CUs) is provided in Section 35.2 of this Reply Evidence.

The assessment of potential Project effects on chinook salmon, coho salmon, and rainbow trout/steelhead is summarized in Table 7.2.7.3 and accompanying text in Section 7.2.7 of Volume 5A ESA - Biophysical (TERA December 2013; Filing ID A3S1Q9). Additional information specifically regarding sockeye salmon was provided in the response to NEB IR No. 1.53h (Filing ID A3W9H8) and TBSEF IR No. 1.2.2 and No. 1.2.3 (Filing ID A3X6U5). The MNBC noted in their evidence that: "*In general, the selected indicator species, best management practices, mitigation and monitoring methods are all appropriate for the study.*" (Filing ID A4Q2H2).

Overall, the assessment method for pipeline and watercourse crossings of the Project focused on fish and fish habitat with the greatest potential to be affected by the Project at each individual crossing location. Where warranted, additional consideration was given for sensitivity, rarity, and habitat availability for species of provincial management concern. As a result, recommendations were made for the most suitable construction methods and associated mitigation measures for a broad range of species, <u>including species that were not selected as indicator species</u> for the purposes of the Project's Effects Assessment. For example, effects on the population of sockeye salmon (Cultus Lake population) is expected to be no different than for other fish species at the Lower Fraser River (BC-780) and the Chilliwack/Vedder River (BC-717) crossing locations as described in Section 7.2.7 of Volume 5A ESA -Biophysical. Overall, the implementation of environmental mitigation measures and BMPs provided are expected to eliminate or reduce potential Project-related effects to fish and fish habitat, and protect CRA fish species, including those that are federally and provincially listed for conservation consideration, while maintaining the overall health and productivity of the aquatic ecosystem. This also addresses the concern noted by the City of Coquitlam in its evidence (Filing ID A4L9H8), whereby all fish species need to be protected.

Trans Mountain notes a previous IR response to Cowichan Tribes (Cowichan Tribes IR No. 2.1.01c.i and No. 2.1.01c.ii [Filing ID A4H8L1]) that addressed the exclusion of sockeye, Chum, and pink salmon from the list of indicator species. In addition to this previous response, Cowichan Tribes are also directed to the response provided to Kwantlen FN IR No. 1.09.1 (Filing ID A3Y2T0) regarding the exclusion of oolichan (eulachon) as an indicator species.

In their evidence, Cowichan Tribes (Filing ID A4Q0U9) also indicated a lack of clarity around the habitat potential ratings provided; more specifically, which species habitat was rated for. During the fish and fish habitat investigations by Trans Mountain and its consultants, habitat potential was rated for indicator species (VCs) present or historically documented within that system.

If none were present, then habitat was rated for other CRA species of significance or species at risk either present or documented.

In addition to Trans Mountain's choice of indicator species (VCs), Cowichan Tribes also identified concern that indicators were chosen to reflect risks related to the construction and operation phase of the Project, and did not include potential effects from pipeline accidents and malfunctions. Trans Mountain acknowledges that the emphasis of the fish and fish habitat investigations was on the construction and operations phases of the Project. Cowichan Tribes are directed to Section 6.1.3 *Identification of Ecological Receptors,* in Volume 7 - Risk Assessment and Management of Pipeline and Facility Spills (Filing ID A3S4V6) submitted with the initial Application, that indicated it was neither practical nor necessary to individually assess every receptor (*i.e.,* indicator species) that may be potentially affected by a spill, instead the potential negative effects of a pipeline spill to the freshwater environment assessed for different groups of ecological receptors that might be exposed to spilled oil as a result of the habitats and lifecycles.

35.1.4.2 Study Area Boundaries

In Section 5.2 of the report by Ecofish, prepared for Cowichan Tribes (Filing ID A4Q0U9), questions over the selected spatial boundaries were raised, in particular, that individual local study areas (LSAs) were not provided for each watercourse. Ecofish also stated that the LSA definition was not adequate to assess the impact of potential oil spills on water and sediment quality.

Although a derivation for the fish and fish habitat LSAs was provided in Section 7.2.3.2 of Volume 5A, ESA - Biophysical (Filing ID A3S1Q9), and repeated again in Section 7.2.7.2 *Spatial Boundaries* of the same volume, it is acknowledged that resulting LSAs for each respective watercourse were not included in Appendix A (Watercourse Crossing Summary Table) of the same report as stated in Section 7.2.3.2 of the ESA; this reference was in error, as it was not intended to include the specific LSA for each watercourse. Instead, two example LSAs were included; one a typical minimum LSA, the other, an example of an LSA on a larger system (Fraser River; refer to Figures 7.2.7-1 and 7.2.7-2, respectively). As stated in Section 7.2.7.2, because of the number of proposed watercourse crossings and differences in the downstream length of the respective Fish and Fish Habitat LSA, based on the estimated zone of influence, it was not feasible to map the Fish and Fish Habitat LSA for each individual crossing location.

Ecofish stated that the LSA definition provided was not adequate to assess the impact of potential oil spills. However, it should be noted that the intended use of the Fish and Fish Habitat LSA was for the construction and operations phases of the Project and was not intended for use in spill modelling. A separate LSA was used to model the fate and behaviour of oil resulting from four spill scenarios, two of which included the Lower Fraser River (see Sections 7.1.4 and 7.1.5 of Volume 7 - Risk Assessment and Management of Pipeline and Facility Spills [Filing ID A3S4V6], filed in December 2013 as part of the original application).

35.1.4.3 Invertebrates

Evidence submitted by Metro Vancouver (Filing ID A4L8C2), made reference to certain species of aquatic invertebrates that are of conservation concern, and also to the high diversity of aquatic invertebrates within Centre Creek (Surrey Bend Park). In general, reference to aquatic

invertebrates within this evidence focused on the resulting effects on the invertebrate community from an accidental oil spill.

Information on the potential effects on invertebrate communities arising from an oil spill was addressed previously in Sections 6.1.3.3 and 6.2.3.3 of Volume 7 - Risk Assessment and Management of Pipeline and Facility Spills (Filing ID A3S4V6), filed in December 2013 as part of Trans Mountain's Application. Further information on potential effects of spills is addressed in Section 23 (Pipeline Risk Assessment) of this Reply Evidence.

Section 5 of the Ecofish evidence submitted by Cowichan Tribes (Filing ID A4Q0U9), discusses the role of invertebrates as an indicator of both water and sediment quality. In general, previous studies on pipeline watercourse crossings (*e.g.,* Reid and Anderson 1999, Reid *et al.* 2002, Tsui and McCart 1981, Wood and Armitage 1997, Young and Mackie 1991) showed that benthic invertebrate populations are normally able to withstand short-term increases in suspended sediment and recover quickly following open-cut (trenched) crossings. For this reason, they were not selected as an indicator for water quality.

Equivalent rationale for the exclusion of invertebrates as an indicator of water quality was provided by Ecofish (Filing ID A4Q0U9) in Section 5.1 of their evidence, where they state:

> "…benthic invertebrates were not identified as measurement indicators of water quality. We agree with this because evidence from previous research demonstrates that benthic invertebrate communities quickly recover from short-term increases in suspended sediment such as those observed during construction activities (Robertson *et al.* 2006)"

35.1.5 Construction and Reclamation

35.1.5.1 Construction

Some confusion was evident in comments submitted by intervenors regarding construction methods proposed by Trans Mountain. This may be attributed to subtle differences in the terminology used by intervenors and Trans Mountain. Typically, pipeline construction methods at watercourse crossings are either "trenched" or "trenchless." Trenchless crossings include a number of methods, such as: HDD, micro-tunnelling, or short bores that are typically used to cross under roads or other utilities. When referring to trenched crossing methods, Trans Mountain makes a clear distinction between an "open-cut" method (without flow isolation) and an "isolation" or "isolated trenched" method, which refers to a trenched crossing method with flow isolation. An updated list of both the primary and contingency watercourse crossing methods proposed was contained in Appendix A of the Supplemental Fisheries (Alberta) Technical Report for the Trans Mountain Pipeline ULC Trans Mountain Expansion Project (TERA December 2014; Filing ID A4H1Y6), and Appendix A of the Supplemental Fisheries (British Columbia) Technical Report for the Trans Mountain Pipeline ULC Trans Mountain Expansion Project (Triton December 2014; Filing ID A4H1Z2).

Under Section 3.2 *Crossing Methods* in the Northwest Hydraulic Consultants Ltd. report prepared for Nooaitch Indian Band (Filing ID A4Q0F4), paragraph 37 states Trans Mountain has indicated that open-cut crossing would be constructed in the wet, without hydraulic isolation, and are anticipated for smaller crossings with no water quality concerns. Also, that the use of open-cut methodologies for small crossings with no fisheries or water quality concerns is acceptable.

Trans Mountain acknowledges that the above reference by Nooaitch Indian Band was taken from Section 2.10.1 of Volume 4A - Project Design and Execution - Engineering for the Trans Mountain Pipeline ULC Trans Mountain Expansion Project (UPI December 2013; Filing ID A55999). Further clarification of this is provided herein, mainly that Trans Mountain acknowledges all flowing watercourses, fish-bearing or non-fish-bearing, contribute to overall downstream water quality. For this reason, for defined watercourses where a trenched crossing method is proposed, and flow encountered at the time of construction, an isolated trenched method (*i.e.,* flow isolation) will be used if practical.

A number of intervenors (Nooaitch Indian Band [A4Q0F4], Metro Vancouver [Filing ID A4L8C2], and City of New Westminster [Filing ID A4Q0L5]) highlighted concerns around sediment that may be released during construction, and the need for water quality monitoring during crossing installations. In evidence prepared for Nooaitch Indian Band by Northwest Hydraulic Consultants Ltd. (Filing ID A4Q0F4), it was recommended that mitigation and standard BMPs be followed during construction.

Trans Mountain reaffirms that appropriate mitigation is proposed for all watercourse crossings, in conjunction with BMPs. This includes water quality monitoring and the adherence to measures for construction in and around watercourse crossings outlined in the EPP (Volume 6B, Pipeline EPP; Filing ID A3S2S3) filed as part of Trans Mountain's Application. Additional site-specific mitigation, particularly where *SARA*-listed species may be encountered, was also detailed in the Supplemental Fisheries (British Columbia) Technical Report for the Trans Mountain Pipeline ULC Trans Mountain Expansion Project (Triton December 2014, Filing ID A4H1Z2). The use of isolated trenched crossing methods (where practical) will also reduce the likelihood of suspended sediment being released during the crossing installation.

In addition to concern around water quality during construction, the City of New Westminster (Filing ID A4Q0L5) also requested that Canadian Council of Ministers of the Environment water quality guidelines (CCME 2007) be followed. Trans Mountain considers this an inherent component of the industry BMPs. With the proposed timing of instream construction at fish-bearing watercourses in the Lower Mainland to primarily occur outside critical spawning periods, the City of New Westminster stated that the mitigation proposed by Trans Mountain should be sufficient. This was also acknowledged in evidence submitted by Dr. Pearson for PIPEUP (Filing ID A4Q0Q7). It should be noted that Trans Mountain has committed to completing a precautionary salvage of all fishes, from all fish-bearing watercourses where an isolated crossing method is proposed, and flow is present at the time of construction.

For further explanation of the flow threshold values cited in Volume 4A - Project Design and Execution - Engineering, please see Section 14 (Watercourse Crossing Design) of this Reply Evidence.

35.1.5.2 Reclamation

The Nooaitch Indian Band and Stó:lō Collective (Filing IDs A4Q0F4 and A4L7C2, respectively) both expressed concern of the potential loss of habitat that could result from scour. Stó:lō Collective elders also noted that the presence of large boulders indicated greater evidence of, and susceptibility to, scour.

Trans Mountain acknowledges that a number of watercourses with the Nooaitch Indian Band and Stó:lō Collective area of interest are characterized as debris flows, and have historically

demonstrated high energy events, as characterized by the presence of large boulders and episodes of scour. Periods of scour and/or avulsion are characteristic of debris flows and not unexpected in these catchments (*e.g.,* Jones/Wahleach Creek). Bedload in any watercourse with moderate flows and energy is considered mobile, and subject to shifts over time.

In evidence submitted for Nooaitch Indian Band (Filing ID A4Q0F4), Northwest Hydraulic Consultants Ltd. identified the potential need for additional instream work for maintenance or responding to unforeseen events. Installation of the pipeline at watercourse crossings is completed with the intention of avoiding or minimizing risks to the pipeline and the need for any additional works. Mitigation such as using an increased pipe wall thickness at watercourse crossings, ensuring appropriate depth of cover and setbacks from banks susceptible to migration, can help avoid the need for any future instream works.

In Section 4.1 of evidence submitted by SRES (Filing ID A4Q2H6) it is suggested that *"…softer approaches such as coco mats and willow*" are still *"bank hardening*." While the use of rip-rap or other rock armouring will obviously result in a 'hardening' of a watercourse's bank, Trans Mountain does not agree that softer, bio-engineered, approaches to bank restoration and stabilization result in a "*hardening*" of a given watercourse bank.

Contrary to assertions by SRES that the installation of pipelines requires the disruption of natural fluvial processes (*i.e.,* through armouring with "non-natural [*sic*] rock"), Trans Mountain notes that today's industry practices look to install pipeline watercourse crossings in such a way as to maintain all natural fluvial processes. This includes allowing channels to meander over time, through erosion and accretion. Pipe bend setbacks and depth of cover under watercourses is designed to accommodate the fluvial processes in the respective channel. The reclamation of watercourse banks should replicate the existing bank shape and material. Rock armouring is typically only carried out in high-energy environments to match the native channel materials (*e.g.,* existing sloping banks comprising cobble and/or boulder). Following the installation of the pipeline crossing at each watercourse, careful reclamation of each watercourse is proposed by Trans Mountain. Detailed site-specific plans are still being developed for select, larger watercourses.

SRES asserts that the result of land clearing and installation of vehicle watercourse crossings (*i.e.,* clear-span bridges) will damage the natural stability of the bank. Trans Mountain does not agree with this assertion. The installation of vehicle watercourse crossings does not require grubbing or the removal of plant root material from the bank edge. Vegetation is typically brushed, leaving the root material intact. Clear-span bridge abutments are then placed over the root material which allows vegetation to recover quickly following removal of the bridge. Stability of the bank is maintained through the retention of plant root structure.

Figure 10 of SRES evidence submitted (Filing ID A4Q2H6) is a photograph taken from workshop material presented by Trans Mountain. This is referred to by SRES as evidence of the current "*scorched earth policy*" actions by pipeline construction around streams. Further, SRES cites this as an example of "*egregious levels of damage*," "…*including disruption of fluvial processes, narrowing of the stream, loss of recruitment of bank sediments for spawning gravel and large-scale loss of riparian vegetation and other attributes*."

Trans Mountain strongly disagrees with the suggestion that it does not complete construction in an environmentally responsible manner. It is unclear how SRES were able to conclude from the aerial photograph referenced (Figure 10 of Filing ID A4Q2H6) that the restoration of the channel

bed and banks has resulted in a loss of spawning gravel recruitment from the restored banks. Trans Mountain and its consultants were present during the restoration of this particular watercourse (Moose River), and reported that native channel cobble, boulder, and gravels were used in its reconstruction. Further, this reach of the channel narrowed slightly to create a section of riffle before construction of the Anchor Loop pipeline (refer to Figure 35-1). Restored banks were recontoured to match the adjacent existing banks. Contrary to the assertion by SRES that there has been a "…*large-scale loss of riparian vegetation*…", Figure 35-1 illustrates that the Anchor Loop pipeline crossing of the Moose River was carried out in a reach that was largely devoid of mature riparian vegetation on both banks; therefore, there was almost no loss of existing riparian vegetation.

Figure 35-1 Moose River, Before Installation of Trans Mountain Anchor Loop Pipeline in 2008. Approximate Location of Pipeline Centreline Installed Shown in Red (Photograph Taken from Google Earth, Imagery Date 2004).

The reclamation/revegetation of riparian habitat is discussed further under Section 35.4 *Riparian Habitat* of this Reply Evidence.

35.1.6 Post-construction Monitoring

In Section 4.6 of its evidence, SRES (Filing ID A4Q2H6) identifies the need for a post-construction monitoring program that will be sufficient to determine the effectiveness of instream restoration, streambank reclamation, and riparian revegetation. Further, SRES reference the initial 5-year period for post-construction monitoring identified by Trans Mountain, then state that this monitoring should continue for the life of the Project.

The need for post-construction monitoring was acknowledged in Section 7.1.5 of Volume 5C Fisheries (British Columbia) Technical Report (Triton Environmental Consultants Ltd. December 2013, Filing IDs A3S2C1 and A3S2C2), and in Section 9.0 of Volume 6A Environmental Compliance (TERA 2013; Filing ID A3S2S1). As with other equivalent linear development projects, an initial post-construction monitoring period of 5 years is typical and anticipated by Trans Mountain. While intensive environmental post-construction monitoring beyond 5 years has not been proposed by Trans Mountain, it should be noted that ongoing operational inspection of the line is intended for the life of the Project, as requested by SRES. Should any potential environmental concerns be noted during inspection by operations staff (either from aerial or on-ground monitoring), immediate follow-up would be taken by the necessary discipline (*i.e.,* a qualified fish biologist for any instream, bank stability, erosion, or riparian habitat works).

In evidence submitted by Ecofish for Cowichan Tribes (Filing ID A4Q0U9), it was asked why quantitative data, including a Before-After-Control-Impact (BACI) type experimental design, is not being considered for monitoring residual effects to fish and fish habitat.

Trans Mountain notes that BACI designs are typically considered to be poor for: small potential changes after a disturbance, gradual changes after a disturbance, long-term monitoring, and for monitoring for changes in variability (Schwarz 2014). This does not make them particularly suitable for use in monitoring of the TMEP. In addition, the collection of population-level data was beyond the scope of the aquatic assessments conducted by Trans Mountain (refer to responses to ALIB IR No. 1.3.02 and No. 1.3.09a; Filing ID A3X5V6). Data collection methods and standards used for the fish and fish habitat assessments (*i.e.*, pipeline construction and operation) conformed to provincial and federal regulatory requirements.

Trans Mountain previously stated in the response to SSN IR No. 2.23(04) (Filing ID A4H9D5) that it is not proposing to quantitatively sample fish populations before, during, or after construction, because information on population abundances or catch per unit effort (CPUE) is not required, nor would it change any of the mitigation proposed. However, as proposed by Ecofish (Filing ID A4Q0U9), Trans Mountain agrees that the collection of CPUE data could be derived during any salvage of fishes from isolated sections of channel during construction, and add value to provincial fish data records. In addition, this could be considered further baseline data on the species present.

35.2 Species of Conservation Concern

35.2.1 SARA-listed Species

35.2.1.1 Nooksack Dace and Salish Sucker

A number of intervenors were concerned with impacts to *SARA*-listed populations of nooksack dace and salish sucker, particularly species-specific occurrences, proposed critical habitat, and current Recovery Strategies for these populations (Senichenko [Filing IDs A4L6Q9 and A4L6R4], City of New Westminster [Filing ID A4Q0L5], and Metro Vancouver [Filing IDs A4L7Y3 and A4L8C2]).

The fish and fish habitat information collected to date by Trans Mountain, with respect to nooksack dace and salish sucker, has been thorough and has included detailed watercourse crossing assessments and review of BC provincial databases (FIDQ 2015 and DataBC 2015), as well as consultation with DFO (Nantel, O'Meara Pers. Comm.) and Dr. Pearson (Pearson Ecological; Pers. Comm.) as directed by DFO, concerning species-specific occurrences and

proposed mitigation. Trans Mountain has also reviewed both the Recovery Strategy for Nooksack Dace (Pearson *et al.* 2008) and the Recovery Strategy for Salish Sucker (DFO 2012). Moreover, a number of IR responses to the NEB have previously addressed salish sucker and nooksack dace, and have included consultation records, proposed critical habitat, crossing methods, site-specific mitigation, and effects on riparian habitat. These include NEB IR No. 1.52d (nooksack dace) and NEB IR No. 1.52e (salish sucker; Filing ID A3W9H8), NEB IR No. 3.039 (Filing ID A4H1V2), and NEB IR No. 4.07b to 4.07d (Filing ID A4K4W3). There are six watercourse crossings within the PPC that have potential for species at risk (salish sucker and/or nooksack dace), and where an isolated trenched crossing method with fish salvage and water quality monitoring has been proposed (refer to responses to NEB IR No. 3.039a [Filing ID A4H1V2] and NEB IR No. 4.07a [Filing ID A4K4W3]):

- Elk Creek (BC-713);
- Semmihault Creek (BC-714);
- Chilliwack Creek (BC-715);
- Unnamed Channel (south of Vedder River; BC-719);
- Salmon River (BC-753); and,
- Stoney Creek (BC-785).

Other sensitive crossings include Hopedale Slough (BC-718) and an unnamed watercourse (north of Vedder River; BC-716), which will be included in the trenchless crossing proposed for the Chilliwack/Vedder mainstem (BC-717). It should also be noted that the crossing of the Salmon River (BC-753) may also be constructed using a trenchless pipeline construction technique; although this is still to be determined by ongoing geotechnical evaluations. It was acknowledged in NEB IR No. 1.52d (Filing ID A3W9H8) that the Brunette River is considered proposed critical habitat for nooksack dace (addressed in Section 35.3.1). Site-specific mitigation measures (*e.g.,* isolation and fish salvage methods G*uidelines for the Salvage and Collection of Nooksack Dace [Rhinichthys cataractae spp.]*; Pearson 2013a) have also been outlined for tributaries to the Brunette River should nooksack dace be encountered during construction. In line with Recovery Strategies for nooksack dace (Pearson *et al.* 2008) and salish sucker (DFO 2012) measures will be taken to avoid serious harm to fish and fish habitat. Recommendations were made for the most suitable construction methods and associated mitigation measures for a broad range of species, including nooksack dace and salish sucker; effects on the population of these two species is expected to be no different than for other fish species.

With respect to species-specific occurrences of nooksack dace and salish sucker, Trans Mountain would like to clarify some of the information submitted by Zoetica for Metro Vancouver (Filing ID A4L8C2). Zoetica has cited references of nooksack dace in West Creek (BC-749) and Anderson Creek. Trans Mountain notes that a search of provincial fish records for these two watercourses did not show documented presence of nooksack dace (FIDQ 2015 and DataBC 2015). As stated in the introduction, Anderson Creek is not crossed by the PPC. West Creek was also cited by Zoetica as hosting a large population of salish sucker (Filing ID A4L8C2). This is contrary to the results of Trans Mountain's most recent review of provincial fish records search (FIDQ 2015 and DataBC 2015). Further, Trans Mountain notes that West

Creek is not identified by Dr. Pearson, or referenced in either species' recovery strategy, as proposed critical habitat for either species.

35.2.1.2 Westslope Cutthroat Trout

Intervenor evidence submitted to the NEB including that from City of New Westminster (Filing ID A4Q0L5) and Metro Vancouver (Filing IDs A4L7Y3 and A4L8C2) has cited *SARA*-listed populations of westslope cutthroat trout in watercourses crossed by the PPC. Trans Mountain would like to reiterate (as addressed in NEB IR No. 1.52c [Filing ID A3W9H8]) that endangered populations of this sub-species are restricted to southeastern BC (primarily the Upper Kootenay and Upper Columbia drainages) and southwestern Alberta (*SARA* Public Registry 2014). Moreover, because of its introduced status within the Lower Mainland, non-native westslope cutthroat trout in the Lower Fraser River are not considered to be a priority sub-species of special conservation concern.

Trans Mountain has acknowledged records of introduced westslope cutthroat trout population in the Sumas River (BC-726), Salmon River (BC-753), and Lower Fraser River (BC-780). Historical records of westslope cutthroat trout in watercourses in the Lower Mainland overlap with distribution of coastal cutthroat trout; as such, refuting historical records for westslope cutthroat trout records (*e.g.,* as cited by Zoetica [Filing ID A4L8C2] as being present in West Creek and Yorkson Creek) is not relevant. All watercourse crossings with potential for cutthroat trout (westslope or coastal) were provided in Technical Report 5C-7 in Volume 5C of the Application, Fisheries (British Columbia) Technical Report (Filing ID A3S2C1) and Supplemental Fisheries (British Columbia) Technical Report (Filing ID A4H1Z2), and were assigned a high sensitivity. The significance evaluation also considered all cutthroat trout populations, regardless of sub-species or native/introduced status.

35.2.2 Provincially-listed Species

35.2.2.1 White Sturgeon - Lower Fraser River Population

Evidence submitted to the NEB by Metro Vancouver (Filing IDs A4L7Y3 and A4L8C2) has cited white sturgeon as federally-designated. Trans Mountain acknowledges that Lower Fraser River population of white sturgeon is stable and not listed in Schedule 1 of the *SARA,* but is listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; 2003) as Threatened (refer to response to NEB IR No. 1.53i [Filing ID A3W9H8]). Further evidence provided by Metro Vancouver states that watercourses such as Nathan Creek (BC-747), Salmon River (BC-753; cited as occurring at the confluence of the Salmon River), and Centre Creek (BC-773) have documented presence of white sturgeon. Provincial fish distribution information does not indicate documented presence of white sturgeon at or adjacent to the PPC (FIDQ 2015 and DataBC 2015). As a result, Trans Mountain is confident that records of white sturgeon as cited by the intervenor are largely anecdotal and/or are records of this species near the confluence with the Fraser River. Regardless, Trans Mountain has recognized (refer to response to NEB IR No. 1.53i [Filing ID A3W9H8]) that the lower reaches of such watercourses as the Salmon River (BC-753) and other similar watercourses such as Anderson Creek (BC-705), Chilliwack Creek (BC-715), Chilliwack/Vedder River (BC-717), Sumas River (BC-726), and McLennan Creek (BC-734), as provided in the response to NEB IR No. 1.53i (Filing ID A3W9H8), may be used for occasional feeding and migration corridors, but have not been addressed in the literature as critical habitat for white sturgeon. Dr. Pearson, in his ecological assessment report for PIPEUP (Filing ID A4Q0Q7), also acknowledges that adult white sturgeon will enter side channels and sloughs to feed during the spring and summer, and

that juveniles are most frequently found in lower reaches of large tributaries. Key white sturgeon spawning locations were discussed by Trans Mountain in response to NEB IR No. 1.53i (Filing ID A3W9H8) and spawning and rearing in the Herrling Side Channel (near Waleach Pump Station) was documented during the Project's aquatic assessments (refer to Technical Report 5C-7 in Volume 5C of the Application, Fisheries (British Columbia) Technical Report [Filing ID A3S2C1]). Trans Mountain notes that spawning sites are located in the Fraser River (east side of Herrling Island) and not within the direct zone of influence of proposed watercourse crossings. Potential for sediment migration downstream from the PPC and into the Fraser River is not anticipated to disrupt potential Fraser River spawning sites in Herrling Side Channel.

35.2.2.2 Mountain Sucker - Pacific Populations

The distribution and habitat requirements for mountain sucker have been adequately addressed in Technical Report 5C-7 in Volume 5C of the Application, Fisheries (British Columbia) Technical Report (Filing ID A3S2C1), and in the response to NEB IR No. 1.53g (Filing ID A3W9H8). Information filed with the NEB is aligned with evidence provided by PIPEUP (Filing ID A4Q0Q7). Dr. Pearson reports that mountain sucker are found in the Fraser River and its side channels throughout the study area, but that virtually nothing is known about their abundance or population trends. Distribution is generally confined to the Fraser River, but juveniles may be found around the mouths of small tributaries, although the extent to which mountain sucker use such small stream in the LFV is unknown (COSEWIC 2010).

Through the evidence provided, Dr. Pearson suggests that mountain sucker may occur within the zone of influence of all creek crossings between Chilliwack and Hope. However, based on the evidence provided, it should be noted that Pacific populations of mountain sucker are confined generally to larger river mainstem habitat (*e.g.,* Lower Fraser River and North Thompson River). There are no known historical occurrences of mountain sucker in small tributaries crossed by the PPC. Similarly, as for white sturgeon, isolated watercourse crossing construction (*i.e.,* where there is potential for sediment migration downstream from the PPC) is not anticipated to disrupt mountain sucker habitat use in the Fraser River and its side channels.

While Dr. Pearson has suggested additional sampling could be carried out to specifically search for mountain sucker, he states that existing information based on habitat potential should be sufficient to assess the likely occurrence of mountain sucker. As such, additional sampling for this species is not likely warranted.

35.2.2.3 Pygmy Longfin Smelt - Pitt and Harrison Lakes

Evidence submitted by Metro Vancouver (Filing ID A4L8C2) has cited pygmy longfin smelt (Red-listed) in Table 3.2.4 as a "*Fish SCC (Species of Conservation Concern) Potentially Occurring within Habitats Associated with the Proposed TMX Project*." Trans Mountain would like to clarify that anadromous populations of longfin smelt, which ascend through the Lower Fraser River and a far as Pitt Lake, are not threatened or endangered (Roberge and Stanley 2001). Only landlocked sub-populations of 'pygmy' longfin smelt in Harrison and Pitt Lake are considered to be Red-listed (Roberge and Stanley 2001). Nonetheless, as Harrison and Pitt Lake populations of 'pygmy' longfin smelt are located outside the Project footprint this fish record is not considered to be of relevance.

35.2.2.4 Brassy Minnow - Pacific Group

Evidence submitted by Metro Vancouver (Filing IDs A4L7Y3, A4L8C2, and A4Q2R0), City of New Westminster (Filing ID A4Q0L5), PIPEUP (Filing ID A4Q0Q7), City of Coquitlam (Filing ID A4Q0K7), and City of Surrey (Filing ID A4Q2K2) cites references to brassy minnow occurring within watercourses crossed by the proposed Project. Trans Mountain acknowledges that lower Fraser populations of brassy minnow (Pacific Group) is a provincially Blue-listed species of special concern or potentially at risk. Trans Mountain further notes that the provincial status for brassy minnow was not previously cited in Technical Report 5C-7 in Volume 5C of the Application, Fisheries (British Columbia) Technical Report (Filing ID A3S2C1) nor in the Supplemental Fisheries (British Columbia) Technical Report (Filing ID A4H1Z2).

An updated review of all evidence submitted, including the Fisheries (British Columbia) Technical Report (Filing ID A3S2C1) and search of BC provincial databases (FIDQ 2015 and DataBC 2015) have confirmed records of brassy minnow in the Brunette River, and at the following watercourse crossing locations:

- Sumas River (BC-726)
- Nathan Creek (BC-747)
- West Creek (BC-749)
- Yorkson Creek (BC-768)
- Unnamed Channel (BC-770)
- Unnamed Channel (BC-772)
- Centre Creek (BC-773) - recorded at confluence with Fraser River
- Nelson Creek (BC-782)
- Salmon River (BC-753)
- Fraser River (BC-782)

Evidence provided by the City of Coquitlam (Filing ID A4Q0K7) cites anecdotal records of brassy minnow in Como Creek (Pamela Zevit, Pers. Comm., July 2013); however, a citation for Pamela Zevit could not be found in the reference section of the report. A recent search of BC provincial databases found no records of brassy minnow in Como Creek (FIDQ 2015 and DataBC 2015).

All watercourse crossings with potential for brassy minnow in the Lower Mainland are rated as having habitat of high sensitivity; however, specific watercourse crossing mitigation and restoration measures adopted by the Project are intended to mitigate the potential effects on all fish and fish habitat, including brassy minnow. Trans Mountain notes that evidence provided by Metro Vancouver (Filing ID A4Q2R0) incorrectly lists brassy minnow as a provincially Red-listed species.

35.2.2.5 Coastal Cutthroat Trout

Evidence submitted by Metro Vancouver (Filing IDs A4L7Y3, A4L8C2 and A4Q2R0), City of New Westminster (Filing ID A4Q0L5), PIPEUP (Filing ID A4Q0Q7), City of Coquitlam (Filing ID A4Q0K7), and City of Surrey (Filing ID A4Q2K2) each reference coastal cutthroat trout as being a provincially Blue-listed species. Trans Mountain acknowledges that coastal cutthroat trout populations are Blue-listed and that the provincial status was not specifically cited in Technical Report 5C-7 in Volume 5C of the Application, Fisheries (British Columbia) Technical Report (Filing ID A3S2C1) nor in the Supplemental Fisheries (British Columbia) Technical Report (Filing ID A4H1Z2). Nonetheless, cutthroat trout were selected as an indicator species for the Project (significance evaluation considered all cutthroat trout regardless of sub-species; although most records are considered to be coastal populations). A detailed summary of coastal cutthroat trout, including life history requirements and known habitat crossed by the PPC, has been provided to the NEB (refer to Technical Report 5C-7 [Filing ID A3S2C1] and Supplemental Fisheries Technical Report [Filing ID A4H1Z2]).

35.2.3 Other Species of Management Concern and Conservation Units

35.2.3.1 Coho Salmon

Evidence submitted by Metro Vancouver (Filing ID A4L8C2) and City of New Westminster (Filing ID A4Q0L5) cites populations of Lower Mainland coho salmon as federally designated and as being listed by COSEWIC as endangered. Trans Mountain clarifies that only Interior Fraser River coho salmon populations have been identified by COSEWIC as endangered. No coho salmon populations are federally-listed under Schedule 1 of *SARA*. Relevant to the Project area, this would include North Thompson and Lower Thompson sub-population groups. Coho salmon populations that spawn and rear in Lower Mainland streams (*e.g.,* lower Fraser tributaries) are not considered Threatened or Endangered under Schedule 1 of *SARA*. However, it is acknowledged that all five Interior Fraser River sub-population groups (adults and juveniles) migrate through the Lower Fraser River.

35.2.3.2 Conservation Units

Evidence provided by Cowichan Tribes (Filing ID A4Q0U9) has requested that Trans Mountain justify the exclusion of unique but potentially vulnerable CUs or “stocks” of salmon that are not currently listed as federal or provincial species at risk. Trans Mountain notes that although specific CUs of salmon were not selected as indicators for the Project, the fish and fish habitat assessment considered all fish species which comprise or support CRA fisheries and species of special concern. As such, all species of Pacific salmon were considered in the application and will be considered as Valued Ecosystem Components for watercourses in which they occur (captured or historical, regardless of which CU or stock they comprise). Moreover, the ranking criteria for fish habitat potential at watercourse crossings included salmonid species that are not specifically listed as indicators for the Application’s effects assessment.

Trans Mountain recognizes that potential impacts to Pacific salmon stocks in the Fraser and Thompson River systems would affect Aboriginal communities dependent on them. Trans Mountain will adopt suitable construction methods and associated mitigation measures for a broad range of species, including migratory salmon populations, which could include a number of CUs at any one time; appropriate measures will be taken to avoid serious harm to fish and fish habitat at each pipeline watercourse crossing.

Please note that in a previous response to T. Buck Suzuki Environmental Foundation, Trans Mountain addressed all Pacific salmon stocks (CUs) that DFO considers of conservation concern and specific migratory windows for each (refer to TBSEF IR No. 1.2.2; Filing ID A3X6U5). A case study was also provided in TBSEF IR No. 1.2.3 (Filing ID A3X6U5), which further addressed how certain fisheries could be closed if a weak salmon stock (CU) is negatively affected by an oil pipeline spill that enters the Fraser River or its tributaries. In summary, impacts to CUs and potential fisheries closures are case-specific (*e.g.,* geographic location and timing/magnitude/spatial extent of event) and depend on the species, stock group, and status, run timing, and a number of other environmental variables.

35.2.3.3 Lake Sturgeon (North Saskatchewan River)

Evidence provided from the MNBC (Filing ID A4Q2H2) indicated that potential encounters with migrating sturgeon should be avoided where possible by organizing timing of works appropriately.

As referenced in the response to NEB IR No. 1.53a (Filing ID A3W9H8), lake sturgeon is only known to occur in the North Saskatchewan River (AB-14) within the Project RSA. A trenchless pipeline construction method (*i.e.,* HDD) is proposed for the North Saskatchewan River (AB-14). Although the Project's contingency pipeline construction method is trenched open-cut, it is planned (if required) to occur outside the restricted activity period (*i.e.,* inside the least risk biological window). An HDD crossing will avoid direct disturbance to the streambed and banks, and will preclude construction activities within riparian areas and below the high-water mark on the North Saskatchewan River.

Trans Mountain acknowledges that migration is important to the spawning, feeding, and recruitment success of lake sturgeon, but that movement patterns of lake sturgeon still remain poorly understood. Moreover, should a contingency open-cut crossing of the Saskatchewan River (AB-14) be required, further confirmation of the least risk biological window with respect to known sub-populations of lake sturgeon would involve consultation with regulators before construction.

35.3 Sensitive Habitats/Areas of Interest

35.3.1 Brunette River Conservation Area

Senichenko (Filing IDs A4L6Q9 and A4L6R4), City of New Westminster (Filing ID A4Q0L5), Metro Vancouver (Filing IDs A4L7Y3 and A4L8C2), and City of Coquitlam (Filing IDs A4L9H8, A4L9K1, A4L9K2, and A4L9K3) referenced concerns with the PPC route through the Brunette River Conservation Area. Particular concerns included species at risk (*e.g.,* nooksack dace), riparian setbacks, proposed crossing methods, potential data gaps, and potential for spills into the Brunette River. Please refer to Section 46 (Ecological Risk Assessment) of this Reply Evidence for discussion on the potential impacts and mitigation for spills. Trans Mountain notes that the PPC parallels but does not cross the Brunette River.

Trans Mountain is acutely aware of the species within and habitat sensitivity of the Brunette River and its tributaries, including nooksack dace (one of four sub-watersheds in BC with confirmed populations [DFO 2008]), brassy minnow, and abundant salmonids (*e.g.,* coho, chum, pink and chinook salmon, coastal cutthroat trout, rainbow trout, steelhead, dolly varden, and brook trout). Trans Mountain also acknowledges that the Brunette River has been a focus of extensive restoration and enhancement efforts from agencies and the public, which includes a

number of adjacent spawning tributaries (*e.g.,* Stoney Creek and Eagle Creek) and recovering salmon stocks.

Fish and fish habitat potential has been well documented in the Brunette River and tributaries. This has included consultation with various public groups, DFO Species at Risk and a local provincial expert (Dr. Mike Pearson) with respect to the Project and its potential effects. Workshops with public groups have involved Eagle Creek Streamkeepers, Stoney Creek Environmental Committee, and Sapperton Fish and Game Club. The potential for nooksack dace presence and overall fish habitat value in Brunette tributaries crossed by the PPC was outlined in a memorandum from Dr. Pearson (refer to NEB IR No.3.039a [Filing ID A4H1V2]), in which the Brunette River and lower reaches of Stoney Creek were confirmed as potential critical habitat for nooksack dace. Additionally, tributaries to the Brunette River crossed by the PPC were investigated during the 2013-2014 fish and fish habitat assessments. Updated information for these watercourse crossings was most recently summarized in Appendix A1 (Watercourse Crossing Summary Table) and Appendix B1 (Fish-Bearing Atlas) of Supplemental Fisheries (British Columbia) Technical Report (Triton Environmental Consultants 2014). This supplemental technical report was provided in response to NEB IR No. 3.039a (Filing IDs A4H1Z2, A4H1Z3, A4H1Z4, A4H1Z5, A4H1Z6, A4H1Z7, A4H2A1, A4H2A2, A4H2A3, A4H2A4, A4H2A5, A4H2A6, A4H2A7, A4H2A8, A4H2A9, A4H2C0, A4H2C1, A4H2C2, A4H2C3, A4H2C4, A4H2C5, A4H2C6, A4H2C7, A4H2C8, A4H2C9, and A4H2D0).

Where warranted, multiple seasons of fish sampling was completed to determine the presence or absence of fish. Flow isolation at non-fish-bearing crossings (where required) and general mitigation measures outlined in the Pipeline EPP will reduce impacts to downstream watercourses during construction. Furthermore, appropriate mitigation and reclamation measures will be adopted to prevent serious harm at all fish-bearing watercourse crossings, including the downstream zone of influence which may extend into the Brunette River (*e.g.,* avoidance of key spawning periods for nooksack dace and Pacific salmon). Site-specific mitigation measures have also been provided for watercourse crossings that are considered to be proposed critical habitat or potential habitat for nooksack dace (refer to Section 35.2.1). Please note that a number of previous IR responses from Trans Mountain have addressed the Brunette River Conservation Area. Potential impacts and proposed mitigation measures relative to the Brunette River and its tributaries are discussed in Hackett A IR No. 1.3m to 1.3p (Filing ID A3X6G8), and in the responses to City of Burnaby IR No. 2.096c and No. 2.114b (Filing ID A4H8A1).

Key fish-bearing tributaries to the Brunette River within the Conservation Area, crossed by the PPC are:

- Unnamed Channel (BC-783a2)
- Unnamed Channel (BC-783a4)
- Holmes Creek (BC-783b)
- Austin Creek (BC-784a)
- Stoney Creek (BC-785)

Metro Vancouver and City of New Westminster have raised concerns with respect to watercourse crossing methods and riparian removal within the Brunette Conservation Area. In an effort to avoid potential impacts to riparian and instream habitat at the Brunette River, Trans Mountain reaffirms that it proposes to use trenchless pipeline construction methods for the fish-bearing watercourses listed above and two non-fish-bearing sites (BC-783a1 and BC-783a3). Details concerning the locations for staging of 60 × 60 m HDD entry and exit pads are still being designed; however, efforts will be made to minimize any disturbance to the riparian buffer along the northern edge of the Brunette River (*e.g.,* 30 m setbacks within riparian areas). One exception is Stoney Creek (BC-785), where it is proposed to install the pipeline above the high water mark (in the shoulder of the Lougheed Highway). However, should trenchless methods for any of the above watercourses not be feasible, an isolated trenched crossing with fish salvage inside the least risk biological window will prevent fish mortality and minimize sediment transport downstream (*i.e.,* minimize disturbance to sensitive life-history stages including species of conservation status). If required, any disturbance to riparian habitat at isolated watercourse crossings, or adjacent to the Brunette River, will likely be short- to medium-term in duration (*i.e.*, effects within functional riparian areas will extend > 1 year post-construction [medium-term] but are reversible [1 to 5 years]). Specific watercourse crossing mitigation and restoration measures adopted for the Project will help to protect all fish and fish habitat in the Brunette River and adjacent tributaries (refer to Table 7.2.7-2 of Section 7.2.7 of Volume 5A ESA - Biophysical [Filing ID A3S1Q9] as well as Section 8.7.3 of the Pipeline EPP [Volume 6B; Filing ID A3S2S3] and the Fish Species of Concern Contingency Plan provided in Appendix B of the same volume).

In summary, Trans Mountain does not agree with statements from Metro Vancouver (Filing ID A4L7Y3; Section 4.4 and 5.6) that stream crossing information assembled by Trans Mountain to date, on the portions of the Brunette greenway potentially impacted by the Project, is *"inadequate or incomplete,"* cursory, or that data collection has not occurred during times of years that such studies should be completed or that the information provided is *"…insufficient for an in depth environmental and socio-economic review."*

Trans Mountain also disagrees with the assertion from City of New Westminster (Section 3.1.2 of Filing ID A4Q0L5) that the proposed pipeline construction will negate or impede existing restoration work, in addition to reducing the ecological integrity of this important riparian corridor. Trans Mountain will ensure that watercourse mitigation and reclamation measures proposed for the Project are in alignment with regional and municipality watershed management plans and objectives (*e.g.,* Brunette Basin Watershed Plan). Additionally, communication between Trans Mountain and a number of the municipalities remains ongoing through Engineering Working Group Sessions, and remains a forum to review any specific concerns relating to existing restoration works within the PPC. At a minimum, restoration activities following construction for any disturbed areas will be restored to pre-construction conditions. Appropriate reclamation measures and post-construction monitoring at watercourse crossings will also ensure that instream and riparian habitat is restored to similar pre-construction conditions, ensuring that fish and fish habitat is not compromised and that riffle structures of waterways are not impacted (refer to response to NEB IR No 4.06a [Filing ID A4K4W3]).

35.3.2 City of Coquitlam

In addition to the Brunette River Conservation Area (previously discussed in Section 35.3.1), the City of Coquitlam (Filing ID A4L9H8) also expressed concern about five additional watercourse crossings which have potential for Pacific salmon and cutthroat trout presence. These include

Fraser River (BC-780), Dawes Hill Creek (BC-780b), Como Creek (BC-781), Nelson Creek (BC-782), and Mundy Creek. There was also some discussion of primary watercourse crossing methods and construction timing, as well as the preferred crossing method for the Fraser River and limitations of HDD. Finally, there was concern that the proposed Project in or near watercourses will have negative impacts on fish and fish habitat because these streams have already recently been impacted and that compensation monitoring is ongoing. The City of Coquitlam has stated that Trans Mountain should avoid further disturbance to streams in Coquitlam, or alternatively, to provide additional habitat compensation. The City of Coquitlam also attached a watershed boundaries map (Filing ID A4L9I4), a Fisheries Habitat Compensation Monitoring Plan - Port Mann Bridge/Highway 1 (Filing ID A4L9K4), and watershed management plans for Mundy Creek (Filing IDs A4L9I5, A4L9I6, A4L9I7, A4L9I8, A4L9I9, A4L9J0, A4L9J1 and A4L9J2), Como Creek (Filing IDs A4Q0K7, A4L9J4, A4L9J5, A4L9J6, and A4L9J7), Nelson Creek (Filing IDs A4L9J8, A4L9J9 and A4L9K0), and Brunette Basin (Filing IDs A4L9K1, A4L9K2, and A4L9K3).

Trans Mountain would like to clarify that the PPC only crosses the following watercourses within the City of Coquitlam:

- Fraser River (BC-780)
- Dawes Hill Creek (BC-780b)
- Como Creek (BC-781)
- Nelson Creek (BC-782)

Please note that as mentioned in Section 35.1.2, a review of the attached watershed management plans has indicated that the PPC will not cross or encroach upon Mundy Creek (*i.e.,* the PPC crosses downstream from Highway 1 and Lougheed Highway). Trans Mountain proposes to cross the Fraser River (BC-780) using an HDD or other trenchless technology (*e.g.,* micro tunnel); as such, the proposed crossing is not anticipated to affect the productive capacities of the river or adjacent riparian habitats. Dawes Hill Creek (BC-780b), Como Creek (BC-781), and Nelson Creek (BC-782) will be crossed using an isolated trenched method with fish salvage, inside the least risk biological window. Instream construction would occur from August 1 through September 15 to avoid spawning and critical life history stages for Pacific salmon, rainbow trout, and coastal cutthroat trout. This construction timing would also avoid critical spawning and incubation periods for brassy minnow (*e.g.,* Nelson Creek); spawning for brassy minnow generally occurs in May or June (evidence provided by Dr. Pearson for PIPEUP [Filing ID A4Q0Q7]) and the incubation period is relatively short (approximately 8 days; McPhail 2007). Updated information for these watercourse crossings is summarized in Appendix A1 (Watercourse Crossing Summary Table) and Appendix B1 (Fish-Bearing Atlas) of Supplemental Fisheries (British Columbia) Technical Report (Triton Environmental Consultants 2014). This supplemental technical report was provided in response to NEB IR No. 3.039a (Filing IDs A4H1Z2, A4H1Z3, A4H1Z4, A4H1Z5, A4H1Z6, A4H1Z7, A4H2A1, A4H2A2, A4H2A3, A4H2A4, A4H2A5, A4H2A6, A4H2A7, A4H2A8, A4H2A9, A4H2C0, A4H2C1, A4H2C2, A4H2C3, A4H2C4, A4H2C5, A4H2C6, A4H2C7, A4H2C8, A4H2C9, and A4H2D0).

Trans Mountain's Self-Assessment of the potential for serious harm (Filing IDs A4I6C1, A4I6C2, A4I6C3, A4I6C4, A4I6C5, A4I6C6, and A4I6C7) determined that the watercourse crossings within the City of Coquitlam (completed inside the least risk biological window with fish salvage)

would be included in the list of *Project Activities and Criteria Where DFO Review Is Not Required* (DFO 2015a) or would include DFO's *Measures to Avoid Harm Causing Harm to Fish and Fish Habitat* (DFO 2015b). As such, no residual effects are anticipated, precluding the potential for serious harm. However, should an Authorization under the *Fisheries Act* be required (*i.e.,* serious harm is determined following NEB/DFO review of Trans Mountain's Self-Assessment), then measures to offset serious harm will be developed. Please refer to Section 35.5.4.4 of this report for additional details pertaining to offsetting.

Trans Mountain considers that watercourse mitigation and reclamation measures proposed for the Project are in alignment with regional and municipality watershed management plans and objectives (*e.g.,* Brunette Basin Watershed Plan, Mundy Creek Integrated Watershed Plan, Como Creek Integrated Watershed Management Plan Update, and Nelson Creek Integrated Watershed Plan). Trans Mountain intends to restore the riparian and instream habitat to similar pre-construction conditions at all fish-bearing watercourse crossings, using existing baseline fish and fish habitat conditions and morphology/stream type as a benchmark for success (refer to response to NEB IR No. 4.06a [Filing ID A4K4W3]).

35.3.3 Surrey Bend Regional Park - Centre Creek (BC-773)

Metro Vancouver (Filing IDs A4L7Y3, A4L8C2, A4L8C5, A4L8C6 and A4Q2R0) and City of Surrey (Filing ID A4Q2K2) identified concerns with the PPC through Surrey Bend Regional Park, which includes a crossing of Centre Creek and unnamed tributaries to the Fraser River. As part of the intervenor evidence submitted, an environmental assessment completed by Associated Engineering and Summit Environmental considered various pipeline alignment options adjacent to Surrey Bend Regional Park. Trans Mountain would like to clarify a number of details with respect to fish and fish habitat information for the PPC through this park. For purposes of this discussion, secondary route alternatives as proposed by Associated Engineering and Summit Environmental are not reviewed. However, the fish and fish habitat potential and watercourse sensitivities for Alternate Option A and B as proposed by Metro Vancouver are not expected to be different than what was filed with the NEB for the primary PPC. Trans Mountain also disagrees with the statements from Metro Vancouver (Section 5.6 of Filing ID A4L7Y3) that the information gathered for watercourse crossings immediately adjacent to Surrey Bend Regional Park is insufficient for an in-depth environmental and socio-economic review.

The PPC in, and adjacent to, Surrey Bend Regional Park will cross six watercourses including:

- Unnamed Channel (BC-772)
- Centre Creek (BC-773)
- Unnamed Channel (BC-773c)
- Unnamed Channel (BC-774a)
- Unnamed Channel (BC-774b)
- Unnamed Drainage (BC-774c)

Three watercourses were confirmed to be fish-bearing and have been assigned a high habitat sensitivity, including Centre Creek (BC-773) and unnamed channels (BC-772 and BC-774a).

Trans Mountain notes that Centre Creek was incorrectly labelled as BC-774a in previously filed technical reports, Technical Report 5C-7 in Volume 5C of the Application, Fisheries (British Columbia) Technical Report (Filing ID A3S2C1) and Supplemental Fisheries (British Columbia) Technical Report (Filing ID A4H1Z2). Trans Mountain notes that the correct location for Centre Creek has been confirmed as BC-773. All fish and fish habitat data presented for BC-774a was accurate to the location of Centre Creek.

Trans Mountain's watercourse crossing assessment for Centre Creek, occurred approximately 200 m upstream from the PPC. Nonetheless, habitat conditions (*e.g.,* low lying wetland complex) and species information collected at the assessment location is considered representative of watercourse conditions within the PPC (below Canadian National [CN] Railway/South Perimeter Road). Centre Creek (BC-773) was assigned a habitat sensitivity rating of high and was acknowledged by the Project as having potential for coho salmon, coastal cutthroat trout, river lamprey, and threespine stickleback. Spawning habitat was rated as low for coho and cutthroat as substrate was 100% fines; dissolved oxygen (DO) recorded in the spring was low (4.20 mg/L), which may limit perennial habitat use for salmonids. BC-772 and BC-774a also have potential for juvenile salmonids, but that spawning potential was poor and low DO levels were potentially limiting; brassy minnow were also captured at BC-772 during fish and fish habitat assessments. An isolation with fish salvage and water quality monitoring, inside the least risk biological window proposed, has been recommended for all confirmed fish-bearing watercourses within or adjacent to Surrey Bend Regional Park.

A small ditch drainage (BC-773c) was also identified adjacent to the CN Railway and north of BC-774a using LiDAR. A fish and fish habitat assessment was not completed at this location, but this drainage will be risk managed as a low sensitivity fish-bearing watercourse with possible connectivity to BC-774a. If water is present, fish will be salvaged at the time of construction. However, this drainage may have been altered or removed during the recent South Perimeter Road expansion. BC-774b and BC774c were classified as non-fish-bearing, as they are marginally defined and have poor connectivity downstream from the South Perimeter Road. Flow isolation (if required) and general mitigation measures (Pipeline EPP) will occur at all non-fish-bearing watercourses to protect downstream water quality during construction.

Centre Creek (BC-773) is cited by Metro Vancouver (Filing ID A4Q2R0) and City of Surrey (Filing ID A4Q2K2) as having records of sockeye, chinook and chum salmon, and abundant non-sportfish species, including brassy minnow. Zoetica, on behalf of Metro Vancouver (Filing ID A4L8C2), states that chum, coho, and sockeye salmon fry are found in Centre Creek (BC-773) and its ditch system, and that white sturgeon, chum, and pink salmon are found within the park. However, a search of Centre Creek and ditch systems in BC provincial databases only show records of coho salmon, coastal cutthroat trout, and threespine stickleback near the PPC; there are records of salmon (general) but the species has not been confirmed (FIDQ 2015 and DataBC 2015). All other fish species referenced in the Metro Vancouver evidence (*e.g.,* Starry Flounder) were captured at the confluence with the Fraser River, which is approximately 1.4 km downstream (FIDQ 2015 and DataBC 2015). Habitat conditions in the lower reaches of Centre Creek (BC-773), particularly near the Fraser River, are expected to be quite different than the PPC, which is predominately bog and wetland habitat (*e.g.,* low DO levels; less tidal fluctuation); as such, the fish distribution is also likely to be different. Some of the species identified by Metro Vancouver and City of Surrey may occupy habitat seasonally within Surrey Bend Regional Park, although these records have not been substantiated through fish capture data or BC provincial database records at or adjacent to the PPC. Permit data returns and capture locations are

required by the province for all valid fish sampling studies conducted. As mentioned previously in Section 35.2.2.1, no records of white sturgeon could be located for Centre Creek.

It is worth mentioning that Zoetica (Filing ID A4L8C2) has referenced the use of "*grey literature*" sources in Section 2.3, which may account for some of the fish distribution discrepancies for Centre Creek and other watercourses in the Lower Mainland. Nonetheless, Centre Creek and other confirmed fish-bearing tributaries adjacent to Surrey Bend Regional Park have been assigned a high habitat sensitivity rating by the Project and appropriate mitigation measures and least risk biological windows will be adopted to protect all CRA species and/or species of special concern (*e.g.,* brassy minnow, coastal cutthroat trout, and Pacific salmon).

Trans Mountain's Self-Assessment has determined that watercourse crossings in, and adjacent to, Surrey Bend Regional Park (completed inside the least risk biological window with fish salvage) would be included in the list of *Project Activities and Criteria Where DFO Review Is Not Required* (DFO 2015a) or would include DFO's *Measures to Avoid Harm Causing Harm to Fish and Fish Habitat* (DFO 2015b). As such, no residual effects are anticipated, precluding the potential for serious harm. However, should an Authorization under the *Fisheries Act* be required (*i.e.,* serious harm is determined following NEB/DFO review of Trans Mountain's Self-Assessment), then measures to offset serious harm will be developed.

35.3.4 Watercourses Between Hope (BC-655) and Highway 9 - Agassiz (BC-706b)

In evidence submitted by PIPEUP (Filing IDs A4Q0Q5 and A4Q0Q7), Dr. Pearson examined a number of watercourse crossings between Hope (BC-655) and Highway 9 (Bridal Creek [BC-706b]).

Some of the concerns raised by Dr. Pearson included the following:

- Assessment of potential fish use within these streams and their zone of influence remains incomplete;
- sampling effort was minimal and confined to a single session in a single season;
- no reference to potential occurrence of species at risk; some sites may have potential for brassy minnow, salish sucker and possibly mountain sucker; and
- an assessment of impacts of stream crossings is inadequate and that salmonid species (*e.g.,* coho salmon and cutthroat trout) should be added to the list of species potentially using habitat.

Further, Dr. Pearson recommends additional sampling at a subset of watercourse crossings for brassy minnow, mountain sucker, and salish sucker (Table 4 of Filing ID A4Q0Q7). Trans Mountain disagrees with this recommendation and with respect to the concerns raised, maintains that fish and fish habitat data collection within this segment (BC-655 to BC-706b) is more than adequate to support an environmental assessment and permitting for pipeline construction and operation, as per provincial and federal regulatory requirements and industry standards. These practices do not include comprehensive species-specific sampling programs as identified by Dr. Pearson, except where there may be high potential for occurrences and where permitted by DFO. However, specific watercourse crossings referenced by Dr. Pearson in Table 4 of the evidence submitted (Filing ID A4Q0Q7) have not been identified in Appendix 2

of the Recovery Strategy for Salish Sucker (DFO 2012). The closest area to proposed watercourse crossings identified in the recovery strategy is Agassiz Slough and Cheam Slough, which are situated on the north side of the Fraser River; these sloughs are not located within the LSA or RSA of the PPC. Other potential critical habitat (*e.g.,* Hopedale Slough) for salish sucker and nooksack dace has already been identified for the Project. Additionally, there are no historical records of brassy minnow or mountain sucker in these watercourses highlighted by Dr. Pearson. Fish and fish habitat sampling through conventional measures such as electrofishing and minnow traps during the field programs were likely sufficient to document presence of brassy minnow and mountain sucker, although the potential for these species to occupy habitats at or adjacent to the proposed pipeline is likely low.

Trans Mountain engaged DFO regarding species at risk to identify priority areas for sampling for nooksack dace and salish sucker during the 2014 supplemental fish and fish habitat program. Where permitted by DFO, and when there was a high probability of occurrence, standard sampling methods (*e.g.,* Feddes traps) were used for salish sucker (refer to *Guidelines for the Salvage and Collection of Salish Sucker, Catostomus catostomus [Chehalis form]* n.d. [Pearson 2013b]). However, during a review of Trans Mountain's permit application, DFO Species at Risk identified watercourse crossings upstream from Agassiz as "*not in the distribution of nooksack dace and salish sucker; however, columbia dace may be present as well as longnose sucker*" (Nantel, O'Meara, Pers. Comm.). Watercourses upstream from Agassiz are listed as historical habitat of salish sucker and nooksack dace only, but there are no historical records of these species in any named watercourses (*e.g.,* Cheam Lake, Bridal Creek, Chawuthen Creek, etc.). As such, these watercourses were not targeted for salish sucker during field programs, nor was an additional review of these sites suggested by Dr. Pearson during consultation on potential critical habitat for salish sucker and nooksack dace crossed by the PPC (refer to response to NEB IR No. 3.039a [Filing ID A4H1V2]).

In evidence submitted by PIPEUP, Dr. Pearson has presented a very conservative approach to fish and fish habitat sampling which targets specific species and multiple habitats/sampling locations. Trans Mountain's fish and fish habitat assessments were inventory-based and targeted a broad range of CRA species and species of special concern, with an emphasis on the Project's LSA (*i.e.,* the PPC and immediate zone of influence downstream). All streams identified by Dr. Pearson were sampled at least once, and where no fish were captured multiple seasons of sampling were completed to conclude non-fish-bearing designations, where required. Multiple sampling events were also carried out when no CRA species or species of special concern were captured during the initial assessment and the habitat potential at the proposed crossing was potentially suitable. However, once a CRA species (*e.g.,* coho salmon or cutthroat trout) was captured, sampling was generally halted. Additional sampling via electrofishing in watercourses with known salmonids is generally discouraged by DFO Pacific. Additional sampling for collection of population abundances and age structure was also not required for the Project. Watercourses with potential for CRA species were also assigned a high habitat sensitivity, except where there may be barriers to fish migration and fish were generally excluded from the PPC (*i.e.,* captured downstream only).

Regardless of species presence/absence, population density, or if occurrences were potentially missed downstream from the PPC, Trans Mountain will adopt suitable construction methods and associated mitigation measures for a broad range of species and potential habitat sensitivity. Appropriate measures will be taken to avoid serious harm to all fish and fish habitat at each pipeline watercourse crossing. Wherever feasible, watercourse crossing construction

activities will be timed to occur within the recommended least risk biological window to avoid causing serious harm to fish in compliance with the *Fisheries Act*.

Dr. Pearson commented that several salmonid species should be added to the list of species potentially using the habitat (*i.e.,* coastal cutthroat trout and coho salmon would be expected to occur in all channels inhabited by salmonids in the study area, even if not captured during Trans Mountain's investigations). Trans Mountain restates that the salmonids referenced by Dr. Pearson were included in the assessment of habitat potential regardless of capture, and conservative least risk biological windows were applied to all watercourse crossings where there was a high potential for both trout and salmon to overlap. The exception to this was where fish and fish habitat assessments may determine that the instream timing window may not be appropriate (*e.g.*, barriers which prevent salmonid access to the PPC and/or spawning habitat is generally absent from the watercourse downstream).

Precautionary salmonid windows (*e.g.,* August 1 to September 15) should also be appropriate to protect spring spawning/incubation periods for salish sucker, brassy minnow, and mountain sucker; further precluding the need for additional sampling for these species. Moreover, the PPC is generally situated along a steep bench between Hope and Agassiz (predominately upstream from Highway 1 and CN Railway), and as mentioned by Dr. Pearson, most of the creeks have very short fish-accessible reaches before the terrain is too steep. As such, habitat potential for salish sucker, brassy minnow, and mountain sucker is likely absent in most watercourses at or adjacent to the PPC.

Proposed additional sampling areas (*e.g.,* sloughs and off-channel areas to the Fraser River) mentioned by Dr. Pearson in Table 4 of the evidence submitted (Filing ID A4Q0Q7) are either largely outside the LSA, have poor connectivity to the Fraser River, or have already been designated as having a high habitat sensitivity; proposed mitigation (isolation with fish salvage and/or water quality monitoring) and reclamation measures for these watercourses are already sufficient to protect all fish and fish habitat regardless of the potential species occurrences.

Trans Mountain has included a summary table (Table 35-1, below) that addresses recommended additional sampling sites for salish sucker and brassy minnow (Table 4 and Pages 26-53 of Filing ID A4Q0Q7). As mentioned previously, additional sampling is not likely warranted for standard pipeline construction and operation practices. However, should an Authorization under the *Fisheries Act* be required (*i.e.,* should serious harm be determined following NEB/DFO review of Trans Mountain's Self-Assessment), then measures to offset serious harm could possibly include comprehensive species-specific sampling programs such as the one proposed by Dr. Pearson.

TABLE 35-1

SUMMARY OF PIPEUP (PEARSON) RECOMMENDED ADDITIONAL SAMPLING LOCATIONS

Watercourse Name (as Referenced by Dr. Pearson)*	Trans Mountain BC Site Number	UTM*		Dr. Pearson Comments	Trans Mountain Fish and Fish Habitat Potential	Habitat Sensitivity	Least Risk Biological Window	Trans Mountain Final Comments
		Easting	Northing					
Unnamed Creek 1	BC-655	612654	5469735	Sample for SSU and BMC with Feddes traps; Large pond 250 m × 30 m located 200 m downstream of PPC; CAS and RSC captured in pond during TM sampling with Gee traps	Seasonal S6/NCD-W; RSC and CAL captured in ponded area 200 m downstream from the PPC; low potential for fish at the PPC is attributed to small channel size, subsurface flow and a 60% gradient section downstream.	Low	Open	Poor fish habitat potential at the PPC (60% gradient and subsurface flow). No fish migration potential to the PPC and ponded area was documented as having a near vertical culvert and poor connectivity to the Fraser River (stormwater drain). Minnow trapping did not capture brassy minnow. Flow isolation (if required) and general mitigation measures (Pipeline EPP) during construction will protect downstream water quality in ponded area.
Chawuthen Creek	BC-658	607156	5468960	Sample with Feddes traps for SSU and BMC (Site A); low gradient, braded low-flow channels with confined floodplain; good pools and channel complexity; flows through willow swamp; very high sediment load	Seasonal S2; low-lying tributary (back channel to the Fraser River); moderate rearing and wintering habitat value for salmonids; historical CCT presence; close proximity to Fraser River but channel has periodic connectivity downstream from the PPC; beaver dams within the zone of influence may present temporary obstructions to fish passage; potential beaver dam removal; least risk biological window proposed includes potential for Pacific salmon and DV/BT.	High	August 1 to August 31	Seasonal watercourse assigned a high fish habitat sensitivity. The primary pipeline construction method will proceed inside the least risk biological window (outside critical period for spring spawning fishes) with fish salvage and water quality monitoring, if flowing. Minnow trapping did not capture brassy minnow. Chawuthen Creek was observed to be dry downstream from Highway 1 in Summer 2014.

TABLE 35-1

SUMMARY OF PIPEUP (PEARSON) RECOMMENDED ADDITIONAL SAMPLING LOCATIONS (continued)

Watercourse Name (as Referenced by Dr. Pearson)*	Trans Mountain BC Site Number	UTM*		Dr. Pearson Comments	Trans Mountain Fish and Fish Habitat Potential	Habitat Sensitivity	Least Risk Biological Window	Trans Mountain Final Comments
		Easting	Northing					
Lorenzetta Creek	BC-666	600885	5464256	Sample with Feddes traps for SSU and BMC; low gradient stream with deep pools and some habitat complexity	Perennial S2; Moderate to high habitat value for salmonids; abundant juvenile salmonids were captured or observed within the zone of influence (CO, CH, and RB/ST); both CO and CM spawners observed within the zone of influence.	High	August 1 to September 15	Assigned a high fish habitat sensitivity. Proposed sample sites are upstream from the PPC. The primary pipeline construction method will proceed inside the least risk biological window (outside critical period for spring spawning fishes) with fish salvage and water quality monitoring. Minnow trapping did not capture brassy minnow.
Unnamed Creek - Herling Island 1	BC-681	596336	5457109	Recommend sampling for salish sucker and brassy minnow with Feddes traps	Numerous juvenile and adult CCT captured and observed within the zone of influence; approx. 20 CCT observed in culvert outlet pool downstream from Highway 1; least risk biological window proposed includes potential for Pacific salmon.	High	August 1 to September 15	Not visited by Dr. Pearson. Assigned a high fish habitat sensitivity. Gradient (16%) and substrate dominated by boulders, with perched culvert in the zone of influence (Highway 1); extremely low probability of non-salmonid fish being present. Regardless, fish salvage and water quality monitoring is recommended.

TABLE 35-1

SUMMARY OF PIPEUP (PEARSON) RECOMMENDED ADDITIONAL SAMPLING LOCATIONS (continued)

Watercourse Name (as Referenced by Dr. Pearson)*	Trans Mountain BC Site Number	UTM*		Dr. Pearson Comments	Trans Mountain Fish and Fish Habitat Potential	Habitat Sensitivity	Least Risk Biological Window	Trans Mountain Final Comments
		Easting	Northing					
Unnamed Creek Herling Island 3 and Herling Island Swamp	BC-683	596180	5455880	Sample with Feddes traps for SSU, BMC, and CCT; pond (Site A) connected to creek situated directly over existing pipeline right-of-way, but not mentioned in TM assessment; include small swampy side channels adjacent to CN tracks; small side channel and ponds in forested swamp at confluence with Fraser River; deep water and abundant large woody debris and vegetation	Seasonal S6/S3; Juvenile RB were captured near the confluence with the Fraser River (off-channel habitat); low fish habitat potential at the PPC is attributed to steep gradient (55%) and 10 m high cascade located immediately downstream.	Low	Open	Poor fish habitat potential at the PPC (55% gradient and falls downstream). No fish migration potential to the PPC. Flow isolation (if required) and general mitigation measures (Pipeline EPP) during construction will protect downstream water quality within Fraser River off-channel areas (Site C). Water quality monitoring is recommended. Pearson Site A is located below the existing TMPL right-of-way and Highway 1 bench, and is not crossed by the PPC.
Unnamed Creek - Herling Island 5	BC-685	596163	5455103	Sample with Feddes traps in swampy side channel that the Unnamed Creek drains into; channelized, shallow, low nutrient creek; known spawning and rearing for salmonids; no realistic probability of non-salmonid fish species at risk in channel	Perennial S1B; Moderate habitat potential for salmonids within the zone of influence; YOY CM, RB, CAL, and adult CO were captured or observed within the zone of influence; high percentages of boulder and large cobble limits spawning potential at the PPC; moderate spawning potential observed downstream near confluence with Fraser River.	High	August 1 to September 15	Assigned a high fish habitat sensitivity. Extremely low probability of non-salmonid fish species at risk occurrence in main channel. Flow isolation and general mitigation measures (Pipeline EPP) during construction will protect downstream water quality within Fraser River off-channel areas. Fish salvage and water quality monitoring is recommended.

TABLE 35-1

SUMMARY OF PIPEUP (PEARSON) RECOMMENDED ADDITIONAL SAMPLING LOCATIONS (continued)

Watercourse Name (as Referenced by Dr. Pearson)*	Trans Mountain BC Site Number	UTM*		Dr. Pearson Comments	Trans Mountain Fish and Fish Habitat Potential	Habitat Sensitivity	Least Risk Biological Window	Trans Mountain Final Comments
		Easting	Northing					
Unnamed Creek - Herling Island 6	BC-686	596145	5454322	Sample pond, but not the Creek; small channel, not fish accessible above CN Railway; drains into small pond in Herling Island Swamp; no realistic chance of non-salmonid fish species at risk in channel	Season S6/S3; TSB were captured in an isolated pond below CN Railway tracks approximately 175 m downstream from the existing TMPL right-of-way; low potential for salmonids in pond; low potential for upstream migration (steep gradient, perched culverts).	Low	Open	Poor fish habitat potential at the PPC (steep gradient and perched culverts at CN Railway and Highway 1). No fish migration potential to the PPC and pond was documented as having no connectivity to the Fraser River. Flow isolation (if required) and general mitigation measures (Pipeline EPP) during construction will protect downstream water quality in ponded area.
Unnamed Creek - Herling Island 9	BC-690	595675	5453642	Sample with Feddes traps in off-channel area within Herling Island Swamp (not recommended in main channel); Shallow, low nutrient creek; known spawning and rearing for salmonids downstream of Highway 1	Perennial S2; Low fish habitat potential at the PPC, which is attributed to a 56% gradient immediately upstream and culvert barriers underneath the existing TMPL right-of-way. No fish were captured or observed upstream from the existing TMPL right-of-way, although there is potential for resident RB as channel is fed by an unnamed lake with historical RB presence. Juvenile CH, RB and adult CM were captured and/or observed within the zone of influence near confluence with the Fraser River (off-channel habitat).		August 1 to September 15	Assigned a high fish habitat sensitivity. Extremely low probability of non-salmonid fish species at risk occurrence in main channel. Flow isolation and general mitigation measures (Pipeline EPP) during construction will protect downstream water quality within Fraser River off-channel areas (450 m downstream). Fish salvage and water quality monitoring is recommended.

TABLE 35-1

SUMMARY OF PIPEUP (PEARSON) RECOMMENDED ADDITIONAL SAMPLING LOCATIONS (continued)

Watercourse Name (as Referenced by Dr. Pearson)*	Trans Mountain BC Site Number	UTM*		Dr. Pearson Comments	Trans Mountain Fish and Fish Habitat Potential	Habitat Sensitivity	Least Risk Biological Window	Trans Mountain Final Comments
		Easting	Northing					
Unnamed Creek - Popkum	BC-700	593660	5451742	Sample with Feddes traps for SSU and BMC in pond in eastern branch	Seasonal S4; RB and CO captured within the zone of influence downstream from Highway 1; perennial habitat use is limited by seasonal flow regime and low water periods (late summer).		August 1 to September 15	Not visited by Dr. Pearson. Seasonal watercourse with shallow depths, low discharge, and coarse substrate. Low probability of non-salmonid fish in watercourse at the PPC. No pond was identified within the 300 m zone of influence investigated during the fish and fish habitat assessments. Fish salvage and water quality monitoring is recommended.
Bridal Creek	BC-706b	591690	5450620	Sample with Feddes traps downstream from Cheam Lake within the park; sample close to Fraser River, as channel is deep and slow moving; potential for SSU and BMC	Perennial S3; Moderate habitat potential for salmonids; 5 YOY CO were captured at the PPC in July 2014; a series of cascades and partial barriers (culverts and weir) downstream from the PPC may limit potential for fish migration during low flow periods.		August 1 to September 15	Sampling sites proposed by Dr. Pearson are approximately 1 km downstream and outside the LSA (PPC crosses upstream from Highway 1). Bridal Creek (BC-706b) and Unnamed Tributary (BC-706a1) were assigned a high fish habitat sensitivity. Reaches upstream from Highway 1 likely have low probability for non-salmonid species. Flow isolation and general mitigation measures (Pipeline EPP) during construction will protect downstream water quality within Cheams Lake and Fraser River off-channel areas. Fish salvage and water quality monitoring is recommended during construction.

Note: *As cited in PIPEUP (Filing ID A4Q0Q7), evidence prepared by Dr. Pearson - Pearson Ecological Research.

35.3.5 Nicola River (BC-504)

Evidence prepared by LGL Limited Environmental Research Associates (LGL) and submitted by Lower Nicola Indian Band (LNIB; Filing ID A4Q7H4), indicates the importance of the Nicola River for anadromous salmon populations, which represent an important component of the LNIB traditional fishery. Moreover, LGL states that "*a trenchless (HDD) crossing should be implemented; however, this must be completed in such a manner as to avoid impacts to the riparian habitats along the Nicola River*."

Trans Mountain intends to cross the Nicola River (BC-504) using a trenchless crossing method; as such, the proposed crossing is not anticipated to affect the productive capacities of the river or adjacent riparian habitats. A contingency of isolation during low flow outside the least risk biological window is proposed should a trenchless crossing not be feasible. As referenced in NEB IR No. 5.4a (Filing ID A4L2A1), it is not anticipated that a contingency crossing of the Nicola River (BC-505) will be required. However, should a contingency crossing method be required, Trans Mountain would complete a further self-assessment of the potential for serious harm, based on details of the specific conditions and time outside the least risk biological window that the crossing would need to be implemented. If serious harm is anticipated, Trans Mountain commits to obtaining the necessary Authorization from DFO. Trans Mountain maintains that with appropriate mitigation and adherence to industry BMPs, the potential for serious harm resulting from temporary disturbances instream and within riparian habitat associated with installation of pipelines, is low.

35.3.6 Jacko Lake, Jacko Creek and Peterson Creek (BC-426)

Evidence prepared by PGL and submitted by Stk'emlupsemc te Secwépemc Nation (SSN; Filing ID A4L6J6), indicates that "*Jacko Lake, Jacko Creek and Peterson Lake are valued as a trout fishery*." As there is no known Peterson "Lake," Trans Mountain assumes this is an error, and is in fact a reference to Peterson "Creek." PGL also maintains that *"rainbow trout are found in Jacko Lake and Peterson Creek"* and that *"spawning is documented in both the Peterson Creek inlet and outlet of Jacko Lake, though the inlet is only used during wet years*." PGL also note that "*Rainbow trout use of Peterson Creek is likely limited to stocked trout migrating downstream*." PGL also states,

> "…the LSA for BC-419k and BC-426 are just on the edge of Jacko Lake (Part 2 of 3; Sheet 9 of 15). As the LSA is 300 m, this would imply there are watercourse crossings within 500 m of Jacko Lake. The figure also shows what appears to be wetlands or ponds related to the watercourses connected to Jacko Lake within the LSA. This casts doubt on the TMEP Application's conclusions on the extent of impact to this area."

Trans Mountain reaffirms that there are no watercourse crossings of Jacko Lake. However, Trans Mountain acknowledges that in the response to SSN IR No. 2.19 (Filing ID A4H9D5), the reference to proposed pipeline crossings of two tributaries to Jacko Lake was incorrect. The proposed watercourse crossings of the unnamed tributary to Jacko Lake (BC-419k) is in fact a poorly connected overflow outlet from Jacko Lake, with a ponded wetland area south of the proposed pipeline draining north through a culvert under Jacko Lake Road. The proposed crossing of Jacko/Peterson Creek (BC-426) remains 635 m from Jacko Lake, with an LSA well upstream of Jacko Lake.

Trans Mountain is proposing to cross Peterson Creek (BC-426; locally known as Jacko Creek)

using an isolated trenched crossing method, outside the least risk biological window. Peterson Creek has a low habitat sensitivity rating attributed to seasonal flow and poor spawning and wintering potential near the PPC and has a high potential to be dry or frozen to bottom during construction. Nonetheless, a salvage of fishes will prevent mortality during construction and additional mitigation measures include water quality monitoring. Peterson Creek was sampled over multiple years and was completely dry at the crossing in 2013. As such, rainbow trout are likely to be present only at the proposed crossing location during high flow years. An isolated crossing of Peterson Creek, with fish salvage, would avoid serious harm to rainbow trout populations and avoid downstream impacts to Jacko Lake (*e.g.*, sedimentation).

Additionally, an isolated crossing of BC-419k is also not likely to result in serious harm to fish or have an effect on Jacko Lake, given that it drains north, away from the lake. This unnamed watercourse (BC-419k) was determined to be non-fish-bearing at the proposed crossing location, as no fish were captured or observed in open water ponded habitats over two seasons of sampling (August and October). Heavy algal growth and poor water quality conditions were also documented (*e.g.,* high water temperature of 18.8 ^{0}C and poor DO [4.60 mg/L] recorded in August). If flowing at the time of construction, the channel would be isolated, maintaining downstream water quality. During investigations, dry conditions and no defined channel were recorded downslope from the PPC.

Additionally, PGL states that Interior Fraser coho are found at the mouth of Peterson Creek, where Peterson Creek converges with the South Thompson River. Trans Mountain is aware of the potential for Interior Fraser coho in the South Thompson River and lower portions of Peterson Creek; however, for purposes of the Application, these records are not considered to be of relevance as they are located approximately 17 km downstream, and well outside the LSA.

Lastly, PGL has cited potential effects to Jacko Lake and Peterson Creek (Section 3.3 of Filing ID A4L6J6) as *"Habitat Removal,*" "*Effects of Increased Human Access*," and "*Effects on Water Quality and Quantity*." Trans Mountain notes that the potential effects listed by PGL in Section 3.3 were addressed sufficiently in the Application and have been considered for all watercourse crossings, especially those that are fish-bearing. Mitigation measures to reduce potential Project construction effects to watercourses are provided in the Pipeline EPP (Volume 6B, Pipeline EPP; Filing ID A3S2S3).

35.4 Riparian Habitat

Trans Mountain has acknowledged that riparian areas within the pipeline easement will be altered during the construction of the Project (Section 7.2.7.6 of Volume 5A ESA - Biophysical; Filing ID AS31Q9). This report section addresses general questions and issues raised by intervenors concerning riparian habitat. Specific issues pertaining to riparian habitat and the potential for serious harm are addressed in Section 35.5.4.2 of this report.

In evidence submitted by SRES (Filing ID A4Q2H6), Dr. Rosenau claims neither Trans Mountain nor its consultants have undertaken adequate measures and/or quantified the extent of the losses of riparian vegetation.

SRES appears to be unaware that an estimate of the disturbance to riparian vegetation was provided by Trans Mountain in its Application. Trans Mountain has indicated that there would be an estimated maximum of 271.5 ha of riparian habitat disturbance resulting from pipeline,

temporary facilities, and pump station construction over the Project's length in BC (Section 8.6.3.1 of Volume 5A; Filing ID AS31Q9). This estimate was based on an assumed 1,000 defined watercourses in BC, and also applied a 30 m riparian buffer setback from either bank of all 1,000 watercourses.

The Project's approximation of riparian disturbance is actually 4.5 times greater than the area predicted by Dr. Rosenau (estimated based on approximately 250 fish-bearing watercourses). Trans Mountain has acknowledged that its estimate of riparian disturbance was conservative (*i.e.,* an overestimate) because: trenchless pipeline construction methods (*e.g.,* HDDs) are proposed at select watercourses (*i.e.*, where riparian habitat will not be affected), there are currently less than 1,000 defined watercourses identified in BC (closer to 500 defined watercourses), many watercourses will have less than the presumed standardized 30 m riparian width (*i.e.,* 15 m likely for smaller [S3, S4, and S6] watercourses), and because riparian vegetation clearing will be limited to the pipeline easement at approaches to watercourse crossings. Despite the obvious overestimation, Trans Mountain maintains that the Project's maximum potential disturbance would only affect < 0.05% of riparian habitat within the Project's RSA (0.01% if Dr. Rosenau's estimation of disturbance was used). As such, Trans Mountain maintains its Not Significant evaluation (Table 7.2.7.2 of Volume 5A ESA - Biophysical: Filing ID AS31Q9) of disturbance to riparian area is accurate with respect to potential cumulative effects. This assertion is consistent and supported by evidence submitted by the Cowichan Tribes (C86-18-1; Filing ID A4Q0U9), who indicated:

> "We generally agree that the construction and operation of the pipeline is likely to contribute only a small amount to cumulative effects to fish and fish habitats. The hectares of disturbance to riparian and instream habitat caused by the Project is generally small relative to existing disturbances in the B.C. watersheds."

The City of New Westminster and Metro Vancouver (Filing IDs A4Q0L5 and A4L8C2, respectively) restated the value of riparian habitat and its ability to filter suspended sediments; more specifically that reduced riparian buffers can lead to reductions in water quality. Evidence submitted by Zoetica for Metro Vancouver (Filing ID A4L8C2) claims that silt fences have been shown to be only 50% effective (Angus *et al.* 2002). Zoetica also cite the benefits of contiguous riparian buffer strips, and the reduced value of riparian buffer strips that become fragmented.

Trans Mountain has consistently acknowledged the value and role of riparian habitat as fish habitat and in maintaining water quality in adjacent watercourses. Any disturbance to these areas, if not managed appropriately, does have the potential to adversely affect water quality through an increase in suspended sediments. Poorly installed silt fence, or silt fence installed in inappropriate locations, can indeed be ineffective, as referenced by Zoetica (Filing ID A4L8C2). Trans Mountain's final Pipeline EPP, to be filed before construction, will clearly identify when silt fence is to be applied.

Evidence submitted by Metro Vancouver and City of New Westminster (Filing IDs A4L8C2 and A4Q0L5, respectively) repeatedly suggest the need for 30 m riparian buffer widths, citing a recent literature review completed by Sweeney and Newbold (2014) as the basis for this suggested width. In particular, City of New Westminster sought retaining a 30 m riparian buffer alongside the Brunette River.

Sweeney and Newbold (2014) also cite a "*high level of uncertainty*" that is present in "*all aspects of the review*." This uncertainty is mirrored by Pearson *et al.* (2008) in the *Recovery*

Strategy for Nooksack Dace, where they state that "…*determining the width of riparian buffers sufficient to protect fish habitat is a scientific discipline in itself*…" and that it was not practical to include within the recovery strategy. The Sweeney and Newbold (2014) review also focused on the width of riparian buffers. However, the length of riparian buffer has been shown to be just as important, if not more so, in disturbances to fish assemblages. Jones *et al.* (1999) found a direct correlation between disturbance length and fish assemblages, ranging from 0.73 to 5.31 km. Further, they state that continuous disturbance of riparian forests restricted to a kilometre or less may "*constitute a relatively minor disturbance to some fish assemblages*." This assumed that there was still adequate riparian vegetation present throughout other reaches in the watershed.

In evidence submitted by City of New Westminster (Filing ID A4Q0L5) and SRES (Filing ID A4Q2H6), both intervenors make specific reference to the *Riparian Areas Regulation* (RAR) developed under the *Fish Protection Act*. City of New Westminster in particular, states that Trans Mountain is not complying with local bylaws.

Trans Mountain notes that the *Riparian Areas Regulation Implementation Guidebook* (MWLAP 2006) clearly defines that the role of the local government is to *"…ensure that projects within the 30 m riparian assessment area do not proceed until it has been advised that the fish habitat requirements of the federal and provincial governments, as set out in the Regulation, have been met."* The RAR does not set a mandatory riparian buffer of 30 m, but looks to control works carried out within this zone. Ultimately, the RAR seeks to ensure compliance with the *Fisheries Act*. Trans Mountain remains confident that throughout the Application process, both the NEB and DFO will continue to ensure Trans Mountain meets its obligations under the *Fisheries Act*, with respect to fish and fish habitat, and the potential for serious harm (refer to Section 35.5 of this Reply Evidence).

Trans Mountain notes that a riparian buffer width of 30 m, as referenced by City of New Westminster and Metro Vancouver, is aligned with the Riparian Reserve Zone (RRZ) width prescribed by the BC Oil and Gas Commission (OGC) for S2 classified watercourses (S2 watercourses being fish-bearing watercourses with a channel width of 5 to 20 m). However, the width of other RRZs prescribed by the BC OGC varies depending on the size and fish-bearing status of a given watercourse; for example, 10 m is used for S5 and S6 non-fish-bearing watercourses. Application of an arbitrary 30 m buffer to the entire riparian area at all watercourses is not aligned with other guidelines typically applied to linear oil and gas projects (*e.g.,* Environmental Protection and Management Guide; BC OGC 2012), and is not practical where trenched pipeline construction methods are used.

The need for varying riparian buffer widths is acknowledged by some of the municipalities within the PPC. For example, the City of Surrey indicates riparian buffer widths ranging from 30 m on watercourses with average channel widths greater than 15 m, down to riparian buffers of 5 to 15 m on smaller watercourses with an average channel width of less than 10 m. As indicated in Table 7.1 of Technical Report 5C-7 in Volume 5C (Filing ID A3S2C2) and in Section 8.1 of Volume 6B EPP (Filing ID A3S2S3), Trans Mountain intends to adhere to the *Forest Practices Code*, *Riparian Management Area Guidebook* in BC (BC Ministry of Forests 1995) during clearing activities associated with the construction of the Project. This is also consistent with the BC OGC defined RRZ (BC OGC 2012). Further, as indicated in Section 8.1 of Volume 6B (Filing ID A3S2S3), clearing within the riparian buffer will be limited to the trench area and any required workspace within the PPC. Upon completion of construction, all riparian margins at fish-bearing watercourses will be revegetated, with the long-term objective of emulating plant communities adjacent to the right-of-way at that location. Trans Mountain has committed to replanting riparian

buffers at all fish-bearing watercourses. Typically, woody vegetation will be allowed to grow back over the right-of-way, with the exception of 3 m on either side of the pipeline that will be kept free of large trees for safety considerations and to provide access to the watercourses for Trans Mountain Operations crews, if required.

One intervenor in particular (SRES) questioned the effectiveness of the replanting and revegetation of riparian buffers, as proposed by Trans Mountain. An example of the functional riparian vegetation that can be achieved is provided below in Figures 35-2 and 35-3, using an example from Trans Mountain's Anchor Loop Project.

Figure 35-2 KL 379.1 Cabin Creek, View Downstream Immediately Following Installation of Anchor Loop Pipeline (December 17, 2007).

Figure 35-3 KL 379.1 Cabin Creek, View Downstream Approximately 5 Years After Installation of the Anchor Loop Pipeline (August 5, 2012).

35.5 Serious Harm

A small number of intervenors provided comment which either directly referenced Trans Mountain's Self-Assessment of the Potential for Serious Harm (Filing ID A4I6C1) or was otherwise presumed by Trans Mountain to be associated with the Project's evaluation of serious harm, as defined by and with context to the federal *Fisheries Act* and at locations in or near freshwater environments. Intervenors which submitted evidence on this topic were: Stó:lō Collective (Filing IDs A4L7A2 and A4L7C2); City of New Westminster (Filing ID A4Q0L3); PIPEUP (Filing IDs A4Q0Q5 and A4Q0Q7); and SRES (Filing ID A4Q2H6).

Collectively, the evidence submitted on this topic was not based on any common theme(s), but rather was specific to unique opinions or situations identified by each of these four intervenors. In general, intervenor assertions about serious harm were not relevant to the current regulatory landscape (*i.e.*, self-assessment process), lacked corroborating scientifically defensible justification, or were not otherwise supported by references to any precedent-setting decisions by the NEB in the context of serious harm (*Fisheries Act* 2013) and specific to projects of similar type, size, and location.

Trans Mountain recognizes that it is reasonable to expect the public (and industry) to have varied levels of understanding of the new self-assessment process being endorsed by DFO. However, in some cases this limited experience or understanding is perceived to have resulted in submissions in intervenor evidence which are not well-informed. Although each of the four intervenors provided a critique of Project's Self-Assessment's approach and results, none

offered feasible or justified alternate methodologies or considerations to better the Project's Self-Assessment or for future consideration by the public or other proponents.

35.5.1 Reply to Stó:lō Collective

In evidence submitted by the Stó:lō Collective (Filing IDs A4L7A2 and A4L7C2), the intervenor indicates a general dissatisfaction with the Project's reliance on DFO serious harm definitions and migration and spawning timing references. The evidence also claims that the Project has excluded Stó:lō Collective ceremonial, sustenance, and social considerations from TMEP's Self-Assessment under the *Fisheries Act*.

Evidence recently submitted by the Stó:lō Collective included components of the Cultural Heritage Overview Assessment (CHOA; Filing ID A4L7A2) and the accompanying CHOA Mapbooks (Filing ID A4L7A4). Trans Mountain also reviewed and considered results and recommendations offered by the Stó:lō Collective's ICA as part of the Project's Supplemental Traditional Land and Resources Use Technical Report (Ts'elxwéyeqw Tribe Management Limited, Stó:lō Research and Resource Management Centre, and Human Environment Group 2014), which was submitted directly to Trans Mountain in March 2014, and also submitted to the NEB for inclusion in its review of the Project (Filing IDs A3Z4Z2, A3Z4Z3, A3Z4Z4, and A3Z4Z5).

Trans Mountain has provided responses to Stó:lō Collective IRs through the NEB IR process when requested (Filing IDs A3X6T8 and A4H9A3). No record of migration or spawning timings with reference to Stó:lō Collective social, ceremonial, or sustenance considerations, or as alternative to those established by DFO are provided in the material or communication noted above, nor in the CHOA (Appendix 1) and Cultural Heritage Overview Assessment Mapbooks (Appendix 2) recently submitted by the Stó:lō Collective (Filing IDs A4L7A2 and A4L7A4, respectively). Similarly, no record of these considerations were noted from members from the Stó:lō Collective who participated in fisheries assessment field surveys led by Triton Environmental Consultants on behalf of the Project in November 2012 and April 2013.

The strategy of incorporating traditional knowledge and information into the overall sensitivity of freshwater environments traversed by the PPC and, therefore, in the consideration of potential serious harm is summarized in Figure 2 of the Project's Self-Assessment (Filing ID A4I6C1) and presented again below for convenience (Figure 35-4). Trans Mountain remains confident in its incorporation (and commitment for continued engagement) of Traditional Ecological Knowledge (TEK) and TLU information, including that focusing on Stó:lō Collective information, into the Project. This position is supported by observations made by other intervenors, most notably in evidence provided by Cowichan Tribes (Filing ID A4Q0U9):

> "Overall fish and fish habitat potential (e.g., spawning, rearing, overwintering and migration) was rated for each watercourse crossing and a fish sensitivity (high or low) was derived based on species presence (recreational, commercial, ecological or Aboriginal importance) and habitat potential. Fish and fish habitat assessments also considered local Traditional Ecological Knowledge (TEK) and Aboriginal Traditional Knowledge (ATK) within watersheds crossed by the Application."

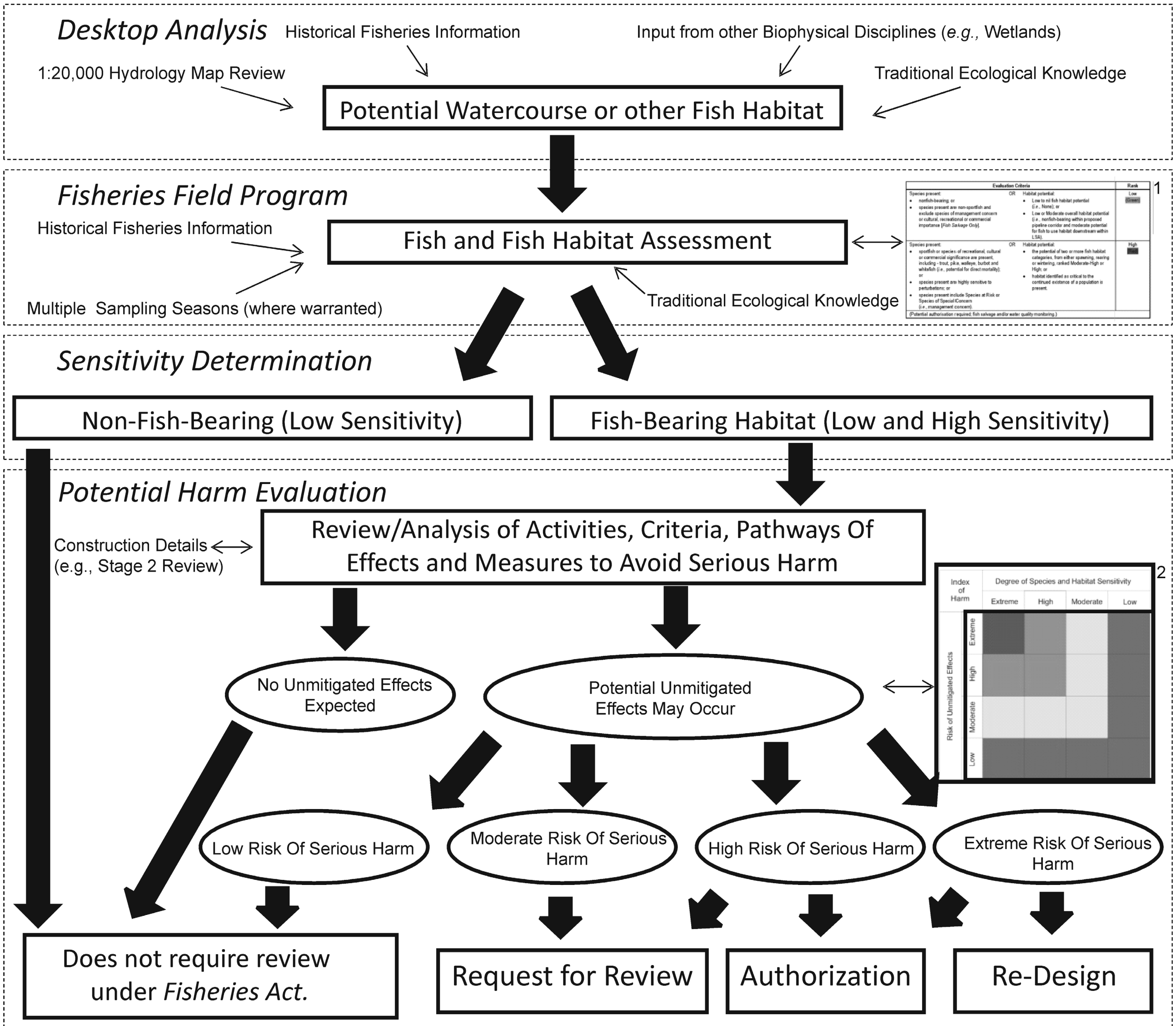

Figure 35-4 The Self-Assessment Process for the Trans Mountain Expansion Project

Trans Mountain maintains that the Self-Assessment was completed under requirements of the revised *Fisheries Act,* in adherence to DFO endorsed self-assessment process and with particular reference to the Project's relevant DFO Pathways of Effects (PoE). By definition under federal legislation and associated policy, the Self-Assessment considered, equally, CRA fisheries and those fish species and their habitats that contribute to the sustainability of the CRA fisheries. As such, under the auspices of the *Fisheries Act*, Trans Mountain maintains that all fish species that may be part of a traditional use fishery, will, inherently, be protected. Where information about Aboriginal Fisheries was unavailable, the Project took a conservative approach and assumed that Aboriginal Fisheries occur at all fish-bearing crossings. As such, each of these crossings where social, ceremonial, or sustenance uses could be anticipated or is confirmed were included in the Self-Assessment by default.

35.5.2 Reply to City of New Westminster

Although not directly referencing Trans Mountain's Self-Assessment (Filing ID A4I6C1), the City of New Westminster has claimed, through evidence submitted (Filing ID A4Q0L5), that:

> "The current preferred pipeline alignment could cause serious harm to a recovered fishery and could compromise the progress of habitat enhancement plans in the Brunette River."

Trans Mountain acknowledges the extensive work carried out by the Sapperton Fish and Game Club, the Stoney Creek Environment Committee, the City of New Westminster, and Metro Vancouver as well as other local stakeholders to restore and enhance aquatic habitat in the Brunette River and its tributaries, as reported in the evidence submitted by the City of New Westminster. Further, Trans Mountain anticipates that the fish habitat and fisheries community information, as well as the review of literature related to toxicity of dilbit presented as evidence under Section 2.1 of C72-5-1 (Filing ID A4Q0L3) to be reasonably accurate. However, Trans Mountain notes that there is no direct reference to, or discernible relevance between, the intervenor's statement (above), associated key issues or evidence, and the DFO endorsed self-assessment process for projects near water. Further, there is no indication or evidence to suggest the City of New Westminster has reviewed the Project's Effects Assessment specific to fish and fish habitat, which is inclusive of the Project's general mitigation measures, (refer to Section 7.2.7 of Volume 5A [Filing ID A3S1Q9]), or Trans Mountain's Self-Assessment. Trans Mountain has, therefore, assumed that the evidence submitted by the City of New Westminster is not intended to refute the methods, considerations, or results of Trans Mountain's Self-Assessment, and that it is being submitted without reference to the general and site-specific mitigation measures that Trans Mountain is proposing in support of Project construction.

As indicated in Section 1.1 of the Self-Assessment, Trans Mountain has evaluated the potential Project effects that could reasonably be anticipated during the construction and standard operational activities. This evaluation was completed with direct reference to PoE identified by DFO and with consideration of all mitigation measures proposed by the Project to date. The Self-Assessment does not include the evaluation of the potential for serious harm resulting from unforeseen and unlikely events (*e.g.,* spill of conveyed material into aquatic environments); nor does Trans Mountain contest the City of New Westminster's assertion of the potential for serious harm to result from unforeseen events such as a spill scenario. However, since these events are not proposed as part of the Project's construction and operation, they have been excluded from the Project's Self-Assessment. Trans Mountain notes that the Project's alignment does not cross the Brunette River, and that all crossings of fish-bearing habitat within the Brunette River watershed are currently proposed to be constructed with trenchless pipeline construction methods as a result of two HDDs currently proposed adjacent to the Brunette River (*i.e.,* the most preferred pipeline construction method).

35.5.3 Reply to Pro Information Pro Environment United People Network

Section 2 of evidence submitted by PIPEUP (Filing ID A4Q0Q5) references an environmental screening report (pursuant to the *CEA Act, 2012*) and a DFO Authorization (under the preceding *Fisheries Act*) of harmful alteration, disruption, or destruction of fish habitat proposed as part of the TMX Anchor Loop Project. The references are made presumably in an attempt to draw a correlation between the currently proposed Project and TMX Anchor Loop, which was

constructed in 2007-2008 and regulated under since-repealed and re-written federal legislation. Trans Mountain notes that the Project is subjected to the current *CEA Act, 2012* and *Fisheries Act* (2013), and that determinations or information from regulatory proceedings or permitting requirements from TMX Anchor Loop should be considered irrelevant.

Trans Mountain does not dispute that fish habitat was documented in the Fraser River (including that for bull trout and other species) during pre-construction assessments in support of the TMX Anchor Loop; however, it fails to see the relevance in this evidence, particularly when presented in the context of serious harm as defined by the revised *Fisheries Act*. The Project's alignment does not cross the Fraser River within proximity to the TMX Anchor Loop crossing. Rather, the Project's lone crossing of the Fraser River is located more than 700 km downstream and is proposed to be constructed using trenchless pipeline construction methods.

Within the same document, PIPEUP directly references the Executive Summary of the Pearson Ecological Report (Filing ID A4Q0Q7), submitted as part of PIPEUP's evidence submission. To avoid redundancy, Trans Mountain's reply to this reference is directed to the original source, C288-16-2, authored by Dr. Mike Pearson.

Within Dr. Pearson's critique of Trans Mountain's assessment of watercourses, and in particular Section 4.4 (Filing ID A4Q0Q7), a list of four bullet point statements is provided. Trans Mountain notes that no evidence supporting the statements is provided, suggesting the bullet points are based solely on the intervenor's perception or interpretation of the Project's Application. Regardless, Trans Mountain provides a reply to each of the bulleted items below. Each response is preceded by the relevant bullet point as provided by Dr. Pearson. The first of the four bullets provided by Dr. Pearson states:

> "The index of harm matrix is only applied to a few of the watercourses. For example it is included in the Silverhope Creek assessment but not for Chawuthen, it is for Hunter Creek, but not for Lorenzetti (*sic*) etc. Why was the index of Harm assessment not applied to all crossings?"

The DFO self-assessment process, in part, replaces previous DFO Operational Statements and eliminates the requested notification process for low risk project types that commonly occur in various regions of Canada. DFO's self-assessment framework guides proponents in the evaluation of their project and its potential to cause serious harm. Trans Mountain notes that the Project's Self-Assessment (Filing ID A4I6C1) uses a two-step process within its Potential Harm Evaluation to: identify if residual effect(s) could be anticipated at a crossing of fish habitat even after general or site-specific mitigation measures are applied (Binary Decision); and then (if warranted) evaluate the potential risk level of the residual effect(s) (Index of Harm). Simply put, if no residual effects are anticipated after the Binary Decision step, the application of the Index of Harm is not required.

With reference to examples provided by Dr. Pearson above, the Potential Harm Evaluation results concluded that no residual effects were anticipated (as a result of sufficient avoidance and mitigation strategies) at Chawuthen and Lorenzetta creeks, but that residual effects were possible at Silverhope and Hunter creeks. This explains why the Index of Harm was applied at Silverhope and Hunter creeks, but not Chawuthen and Lorenzetta creeks. Table 3a and 3b of the Self-Assessment summarized the crossings where residual effects are possible from construction of the Project (Filing ID A4I6C1).

The second of the four bullets provided by Dr. Pearson states:

> "There is no discussion of the role of the ROW on invasive species impacts on riparian areas."

As outlined in response to FVWC IR No. 1.1 (Filing ID A3X6F2), seeding of approach slopes adjacent to riparian areas will use approved (region-specific) annual or perennial grass cover crop or native grass mix, and be planted as soon as feasible after construction (refer to Section 8.6.3 of Volume 6B, the Reclamation Management Plan in Appendix C of Volume 6B and the Aquatic Resources [Resource-Specific Mitigation] tables of Appendix J of Volume 6B; Filing ID A3S2S3). Reclamation and seeding guidelines will follow BC BMPs; the Reclamation Management Plan (Appendix C of Volume 6B; Filing ID A3S2S3) will also identify local and regional areas where certain seed mixes may not be appropriate for reclamation. Post-construction environmental monitoring (PCEM) will be conducted to monitor the stability and functioning of watercourse (bed and banks) reclamation as well as successful revegetation of riparian areas.

Trans Mountain also notes that, as provided in Section 7.2.7 of Volume 5A (Filing ID A3S1Q9), PCEM and weed survey/removal programs were effective following the construction of the TMX Anchor Loop Project. The same general approach to PCEM and weed suppression is proposed for TMEP.

Given the above, Trans Mountain's approach of excluding the consideration of invasive species on riparian areas during its Self-Assessment is reasonable.

The third of the four bullets provided by Dr. Pearson states:

> "There is no discussion of compensation for serious harm to fish habitat resulting from construction activities and maintenance work - in particular ongoing brushing of riparian areas within the ROW and stream bank armoring at crossing sites."

Trans Mountain notes that the Project's intent to identify preliminary offsetting opportunities was described in Section 4.0 of the Self-Assessment. In short, however, Trans Mountain has prepared conceptual fish habitat offset plans (CFHOPs) for both Alberta and BC should serious harm be determined by the NEB/DFO as likely to result from construction of the Project. If required Trans Mountain will pursue offsetting requirements as conditioned by the NEB.

Trans Mountain also notes that riparian vegetation removal which is associated with the maintenance of existing linear developments is listed by DFO (2015a) as an activity which does not require DFO review (pending the successful application of all relevant conditions and measures to avoid harm to fish and fish habitat). As such, it is expected that Project's maintenance activities which include "*brushing of riparian areas within the ROW*" will not constitute serious harm under the *Fisheries Act* and will not require review by DFO. Trans Mountain also anticipates it is premature to speculate on the use of armouring material during maintenance activities, but does acknowledge that instream works associated with any maintenance activities that are identified after construction will be subject to the DFO endorsed self-assessment process on an as-needed basis. The use of rock armouring during reclamation and restoration of watercourse banks was addressed previously under Section 35.1.5.2.

The final of the four bullets provided by Dr. Pearson states:

> "There is no discussion of the ongoing impacts of the 1953 pipeline corridor on fish habitat or of how those will be compensated for."

The existing TMPL line was previously addressed by Trans Mountain in Section 35.1.1 of this Reply Evidence.

35.5.4 Reply to Salmon River Enhancement Society

It is clear from the submission prepared by Dr. Marvin Rosenau for SRES (Filing ID A4Q2H6) that this intervenor generally opposes the methods and results of the Project's Self-Assessment. Trans Mountain respects the opposing perception of the SRES. Trans Mountain notes, however, that the tact taken and language used in the submission are unprofessional. Trans Mountain believes that the unfounded nature of some of the statements contained within the submission and its overall accusatory tone has reduced its value to the review process. Trans Mountain requests that the NEB take into account the provocative nature of this submission, in particular comments specific to serious harm, when considering the SRES evidence. In the interim, Trans Mountain will reply to evidence contained within this submission that is supported by reasonable logic, is otherwise defensible by science or precedent, or where it is perceived the intervenor's expert witness is unaware of relevant existing background information.

Specific to fish and fish habitat, opposing opinions of the SRES are presented with respect to the Project's evaluation of the potential for serious harm in general, the categorization of riparian habitat when in context to serious harm as defined by the *Fisheries Act,* and the level of detailed information that was used to complete the Project's Self-Assessment. Since they are inherently connected, Trans Mountain's reply to the SRES evidence related to serious harm will also include a response on the topic of offset planning. For convenience, separate sub-section headings are used to organize Trans Mountain's reply information.

35.5.4.1 Determination of Serious Harm

In the executive summary and in Section 4.1 of the SRES submission (Filing ID A4Q2H6), Dr. Rosenau claims that Trans Mountain's Self-Assessment has failed to properly categorize the potential effects to instream and riparian habitats. Since the SRES submission further focuses solely on the characterization of riparian habitat in the context of serious harm in a separate section (4.2), Trans Mountain's reply on this sub-topic will be collectively discussed in Section 35.5.4.2, below.

In general, the concern expressed by Dr. Rosenau in Section 4.1 (with reference to instream habitats) relates to the conservation of channel form and function following proposed trenched pipeline construction methods at watercourses. More specifically, it is indicated that when trenched pipeline construction methods will occur at "…*most or all of the streams in the TMEP…*":

> "…there will be the disruption of the fluvial geomorphology in the benthic habitat.";

> "… if stability is needed to protect the crossing from erosional downgrading once the pipe is laid into the stream, large, non-natural rock is used to prevent vertical attrition of sediments.";

> "The consultants suggested that they would use techniques such as coco mats or willow to restore any damaged banks to restore fish habitat. Note that un-natural bank hardening is still bank hardening regardless of whether concrete blocks and rip rap are used, or softer approaches such as coco mats and willow."; and

> "…when bank hardening occurs to protect land or infrastructure, normal erosion and deposition processes of critical sediments, recruitment of large woody debris, development of undercut banks, etc, are interrupted. These concepts are not even brought up in the TMEP fisheries work, much less addressed."

Unfortunately, during the presentation of these unsubstantiated statements (and the assertion that these will occur at most or all crossings), there is no reference to the Project's proposed mitigation and reclamation strategies prescribed at all locations where trenched pipeline construction methods are proposed. It is, therefore, unclear to Trans Mountain if Dr. Rosenau and the SRES have reviewed the mitigation and reclamation strategies prescribed on a site- and existing condition-specific basis or simply fail to acknowledge these strategies represent DFO endorsed BMPs (CAPP *et al.* 2012).

The most-recently prescribed (*i.e.*, by a Qualified Aquatic Environment Professional during field site visits) reclamation strategies for each watercourse crossing in BC is provided in Appendix A-1 of Supplemental Fisheries (British Columbia) Technical Report (Filing ID A4Z1H3), typical drawings for some of the reclamation strategies proposed are provided in Appendix E of the Fisheries (British Columbia) Technical Report (Filing ID A3S2G5) and that select crossings will involve engineering design during the Project's on-going detailed design phase. Sites requiring site-specific reclamation/restoration plans will be considered during the detailed design phase and resulting plans will be filed with the NEB, at least 90 days before construction in accordance with NEB draft condition No. 29. Further, the most recently updated list of general mitigation measures for watercourse crossings, inclusive of the relevant DFO *Standard Measures to Avoid Harm to Fish and Fish Habitat*, adopted by the Project is provided in Section 10.1.1 of the Supplemental Fisheries (British Columbia) Technical Report (Filing ID A4Z1H3). Discussion of site-specific and species at risk specific mitigation measures is also provided in Sections 10.2 and 10.3, respectively, of the same supplemental technical report, while the preliminary application of site-specific mitigation measures was included in the Self-Assessment.

The concerns expressed by this intervenor are not exclusive to the Project, but more relevant to the industry's BMPs as a whole.

35.5.4.2 Categorization of Riparian Habitat

A generalized discussion on riparian habitat, riparian buffers, and the element's effects assessment (*i.e*., at a project-wide or cumulative perspective) is provided in Section 35.4 of this document. The discussion that follows below is specific to riparian habitat within the context of serious harm.

At the single watercourse crossing scale, Trans Mountain maintains its understanding that the removal of riparian habitat may only constitute serious harm depending on the habitat's "functionality," whether or not it has a "limiting" effect on the productive capacity of the watercourse (for definition and information related to these terms, refer to the Self-Assessment;

Filing ID A4I6C1 and to Trans Mountain's responses to SRES IR No. 2(c).06a and SRES IR No. 2(c).06l; Filing ID A4K5C5) and whether its removal/disturbance represents a potential influence on fish communities at a population level. This understanding is based on precedent (*i.e.*, previous DFO determination on a similarly scoped project reviewed immediately following revisions to the *Fisheries Act* in 2013) and a professional working understanding of the *Fisheries Act* and associated policies and processes. At a meeting with SRES on April 16, 2015, Trans Mountain's consultants provided an explanation of this rationale in an effort to assist the SRES with this understanding. Direct quotations taken from this meeting and referenced by Dr. Rosenau have been presented out of context and are misleading.

To be clear, Trans Mountain's understanding of riparian habitat characterization with respect to serious harm considerations is not the result of any untoward "deal" as speculated by Dr. Rosenau and the SRES, but rather was again reinforced during public Fisheries Protection Program *Fisheries Act* Training completed by Trans Mountain's consultants and hosted by DFO's Central and Arctic Region in April 2015. It is unclear if Dr. Rosenau or the SRES participated in any of the *Fisheries Act* training opportunities offered in Burlington, Calgary, Saskatoon, Winnipeg, or Yellowknife in April through June 2015, or what level of practical experience the intervenor has with serious harm determinations. Further, Trans Mountain notes that the SRES evidence does not reference any precedent that suggests a contrary understanding of riparian habitat characterization when in the context of serious harm determinations.

Trans Mountain restates that the basis of the Project's understanding on the characterization of riparian habitat has been expressed to the SRES on multiple occasions, both through face-to-face conversations at the request of the SRES and formally through the NEB IR process (Filing ID A4K5C5). The Project's most recent information exchange on this topic with the SRES occurred during TMEP Environmental Protection Program workshops on May 19 and 20, 2015 (*i.e.*, occurring immediately before the submission of the SRES evidence). Trans Mountain regrets that the intervenor has to date failed to recognize the legitimate basis of the Project's understanding with respect to riparian habitat and continues to mis-represent the additional dialogue they have been afforded by Trans Mountain. Regardless, TMEP remains confident in its characterization and evaluation of disruption of riparian habitat in the context of the potential for serious harm.

35.5.4.3 Information Used During the Potential Harm Evaluation

In general, the concern expressed in Section 4.3 of the SRES evidence submission (Filing ID A4Q2H6) results from a perceived absence of suitable site-specific data available to Trans Mountain in support of the Self-Assessment. Specifically, Dr. Rosenau claims:

> "The information in the self-assessment reports was minimal, superficial and provides little basis for estimating the magnitude of the damage wrought by the TMEP to these streams in both the areas of SRES interest, and through the rest of British Columbia TMEP."; and

> "Clearly, with so little information available to the agencies, the consultants and the public, there is no rigor to the TMP Serious Harm Self Assessments for the TMEP."

Data collected during desktop reviews and field investigations, beginning in 2012 and continuing through 2014, represents the basis of information referenced during the Self-Assessment. As indicated in the Project's original Fisheries (British Columbia) Technical Report submitted with the initial Application to the NEB (Filing ID A3S2C1), a comprehensive suite of data collection standards and sources were referenced during the Project's aquatic assessments. These standards are commonly recognized as the benchmark for provincially and federally regulated projects, and enable the collection of data to the level of detail specified by the NEB (refer to Sections A.2.4, A.2.5 of the NEB *Filing Manual*) and as per NEB Filing Requirements (refer to Table A-2 of the NEB *Filing Manual*). Observations noted in other intervenor evidence submissions support Trans Mountain's assertions that data collected on behalf of the Self-Assessments was complete. For example, Dr. Mike Pearson, writing in support of PIPEUP (Filing ID A4Q0Q7), noted:

> "Habitat data (channel morphology, habitat comments, photographs) appearing on the KM Self Assessments of stream crossings are reasonably comprehensive and accurate, as confirmed by the author's site visits in December 2014."

It is, therefore, not clear to Trans Mountain what additional data SRES feels is lacking from the Project's Self-Assessment, or what additional or alternative standards need to be considered by the Project. Table 35-2, sourced from the Project's original Fisheries (British Columbia) Technical Report (Filing ID A3S2C1) summarizes the standards incorporated into fieldwork completed in BC.

TABLE 35-2

SUMMARY OF DATA COLLECTION STANDARDS USED DURING FISH HABITAT ASSESSMENTS IN BRITISH COLUMBIA

Standard	Date	Source
Environmental Protection and Management Guide	2013	BC Oil and Gas Commission
Fish-stream Crossing Guidebook	2012	BC Ministry of Forests, Lands and Natural Resource Operations; BC Ministry of Environment; and DFO
Fish Habitat Assessment Procedures	1996	N.T. Johnston and P.A. Slaney, Watershed Restoration Program, Ministry of Environment, Lands and Parks; and Ministry of Forests
FPC Riparian Management Area Guidebook	1995	Forest Practices Codes of BC, Ministry of Forests
FPC Fish-stream Identification Guidebook	1998	Forest Practices Codes of BC, Ministry of Forests
FPC Channel Assessment Procedure Field Guidebook	1996	Forest Practices Codes of BC, Ministry of Forests
Field Key to Freshwater Fishes of BC	1994	J.D. McPhail and R. Carveth, Resources Inventory Committee
Fisheries Information Summary System: Data Compilation and Mapping Procedures	1997	B. Desrochers, Enviro-Links
Fish Collection Methods and Standards	1997	BC Ministry of Environment, Lands and Parks, Fish Inventory Unit for the Aquatic Ecosystems Task Force, Resources Inventory Committee

TABLE 35-2

SUMMARY OF DATA COLLECTION STANDARDS USED DURING FISH HABITAT ASSESSMENTS IN BRITISH COLUMBIA (continued)

Standard	Date	Source
Overview Fish and Fish Habitat Inventory Methodology	1999	BC Ministry of Fisheries for the Resources Inventory Committee
Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Fish Collection Form (and Individual Fish Data Form) Field Guide	2008a	BC Ministry of Environment for the Resources Inventory Standards Committee
Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Site Card Field Guide	2008b	BC Ministry of Environment for the Resources Inventory Standards Committee
Reconnaissance (1:20 000) Fish and Fish Habitat Inventory Standards and Procedures	2001	BC Fisheries Information Services Branch for the Resources Inventory Committee

Trans Mountain acknowledges that Appendices C and D of the Self-Assessment (from which Figures 16 and 17 of the SRES submission are sourced) are each a compilation of summarized site-specific baseline data (Atlas page) and Self-Assessment results for high sensitivity fish-bearing habitats in Alberta and BC, respectively. The summary-style delivery of each watercourse's Atlas page is a strategic, yet common practice for information transfer to regulatory and/or reviewing agencies. It is intended to provide a suitable level of detail to enable review, while expediting and limiting regulatory review time for projects that consist of multiple (*i.e.,* hundreds, as in the case of this Project) watercourse crossings. Trans Mountain remains confident that the data provided (inclusive of the original and supplemental technical reports as well as the Self-Assessment) to the NEB meets or exceeds review requirements.

The Self-Assessment results summary page for each crossing included in Appendices C and D of the Self-Assessment is based on Trans Mountain's interpretation of the self-assessment process requirements, and provides direct reference to DFO *Standard Measures to Avoid Harm to Fish and Fish Habitat* as well as the Project's general and site-specific mitigation measures provided in the original and supplemental technical reports and in the Self-Assessment itself. The summary page is unchanged from the template version provided in Appendix A of the Self-Assessment and is the same version which was submitted previously as part of *The Process For: Self-Assessment of the Potential for Serious Harm To Fish and Fish Habitat Resulting from the Trans Mountain Pipeline ULC Trans Mountain Pipeline Expansion Project* to the NEB on December 1, 2014 (Filing ID A4F5C7). No inquiries or comments from the NEB related to the Self-Assessment's process, content, quality, intent, or format has been noted since its submission.

As indicated in Trans Mountain's response to ALIB IR No. 2.03.02d (Filing ID A4H7X5), if serious harm is determined by the NEB/DFO as being likely at any of the proposed crossings, all additional (if warranted) data necessary for the complete classification of the potential serious

harm will be collected in a manner that will satisfy submission requirements as outlined in Section 3 of *An Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(b) of the Fisheries Act* (DFO 2013). If additional data collection (*i.e*., beyond that already completed on behalf of the Project) is required, sampling will be designed to collect comprehensive data related to, among others, fish habitat, species abundance, and potential effects on fish and fish habitat and will consider guidance provided by DFO (2012) and Kenchnington *et al.* (2013).

35.5.4.4 Offsetting

In Section 4.9 of the SRES evidence (Filing ID A4Q2H6), the intervenor indicates that Trans Mountain should consider effects resulting from construction and operation of the original 1953 TMPL, concurrently with those from the proposed Project, when developing offsetting plans focusing on fish and fish habitat:

> "*Because it is not possible to separate the impacts to aquatic ecosystems of the TMEP construction, and subsequent expanded operations, versus the 1953 historic impacts, there needs to be TMEP compensation for the effects associates with the development of the first pipeline.*"; and

> "*SRES maintains that linking 1953 with TMEP and subsequent operation impacts, for compensation purposes, in non-negotiable.*"

As described in Section 35.1.1 above, this is beyond the consideration of the NEB's review of the Project.

The Project has been proactively developing CFHOPs (*i.e.,* one each for Alberta and BC) in the event that a determination of serious harm is made during the Project's review. As part of the development of these CFHOPs, fisheries managers, regulators, stakeholders, and First Nations were invited to provide input on potentially suitable offset opportunities that would be considered for the Project, if offsetting is confirmed as necessary. As indicated in Trans Mountain's response to SRES IR No. 2(c).03i (Filing ID A4K5C5), TMEP remains open to any input that stakeholders (including the SRES) may provide in the development of the CFHOP. Pending the outcome of the NEB's review (*i.e.,* if serious harm is determined to be likely) Trans Mountain will continue to pursue the most suitable offsetting opportunities in order to satisfy all Application requirements.

35.6 Intervenor Recommendations and Suggestions

TABLE 35-3

SUMMARY OF RECOMMENDATIONS AND SUGGESTIONS FROM INTERVENOR EVIDENCE - FISH AND FISH HABITAT SPECIFIC

Recommendation/Suggestion	Intervenor/Evidence (Filing ID)	Trans Mountain Response
Provide funding for fisheries compensation and establishment of another "safety net" population of Nooksack Dace in a system that would not be affected by a potential dilbit spill.	City of New Westminster/C72-5-1 (Filing ID A4Q0L5)	Trans Mountain is pursuing potential offsetting opportunities should serious harm be determined by the NEB/DFO. No new commitment required.
Work with relevant municipalities and Environment Canada to meet their goals of protecting Nooksack Dace habitat.	City of New Westminster/C72-5-1 (Filing ID A4Q0L5)	Trans Mountain continues to work with regulatory authorities (particularly DFO Species at Risk) on all relevant fish species at risk, including nooksack dace. Note, SARA-listed fishes are not administered by Environment Canada. Trans Mountain intends to align with broader strategies identified in the Recovery Strategy for Nooksack Dace (Pearson *et al.* 2008). No new commitment required.
Adhere to 30 m setbacks around watercourses; this includes the placement of HDD entrance and exit clearings outside of the 30 m riparian setback.	City of New Westminster/C72-5-1 (Filing ID A4Q0L5)	Trans Mountain is adopting riparian buffer setback distances derived from provincial and federal guidelines for the setback of all TWSs from watercourses; this is not a fixed 30 m setback distance but is based on the width of the watercourse. Where a trenched crossing method is proposed, some disturbance to riparian vegetation will be required. Where practical, Trans Mountain will minimize this disturbance. The entrance and exit points for such trenchless crossing will be setback beyond 30 m from these watercourses. No new commitment required.
Commit to using HDD techniques under waterways and to placing the entrance and exit points of the HDD more than 30 m from waterways.	City of New Westminster/C72-5-1 (Filing ID A4Q0L5) Metro Vancouver/C234-7-31 (Filing ID A4L8C8)	Trans Mountain has committed to the use of a trenchless crossing method at select fish-bearing watercourses. The entrance and exit points for such trenchless crossing will be setback beyond 30 m from these watercourses. No new commitment required.
Re-route the pipeline such that it is not within 30 m of fish-bearing watercourses to protect aquatic resources now and in the future.	City of New Westminster/C72-5-1 (Filing ID A4Q0L5) Metro Vancouver/C234-7-2 (Filing ID A4L7Y2) Metro Vancouver/C234-7-31 (Filing ID A4L8C8)	It is not possible to construct a linear pipeline of this scope while avoiding all fish-bearing watercourses. No new commitment required.
Collect information on the presence of SCC at each site, along with location-specific life-history schedules (*e.g.,* timing of breeding) for each. Use of this information to design a pipeline construction schedule that minimizes the number of SCC impacted and to accurately predict which SCC would be most impacted (for wildlife, where construction is far from salmon spawning habitat, this will likely be from September to February).	City of New Westminster/C72-5-1 (Filing ID A4Q0L5)	Known occurrences of fish SCC including proposed mitigation was provided in previous IR responses to the NEB (NEB IR No. 1.52a-e and 1.53a-i [Filing ID A3W9H8]). Known occurrences and critical spawning/incubation periods for brassy minnow were provided as part of this Reply Evidence (Sections 35.2.2.4, 35.3.2 and 35.3.4). Trans Mountain will adopt appropriate least risk biological windows and mitigation measures to protect all CRA species and/or species of special concern. No new commitment required.
Use thicker than standard pipeline and/or pipeline casings in sections near or under waterways to protect them from unanticipated scour and flooding.	City of New Westminster/C72-5-1 (Filing ID A4Q0L5) Metro Vancouver/C234-7-2 (Filing ID A4L7Y2) Metro Vancouver/C234-7-31 (Filing ID A4L8C8)	Trans Mountain has previously committed to the use of thicker walled pipe at all major and most minor watercourse crossings (Province of BC IR No. 2.13c [Filing ID A4H8W6]). No new commitment required.
Place paired automatic shut-off valves on either side of fish bearing waterways (or on either side of clusters of small spawning streams in close proximity).	City of New Westminster/C72-5-1 (Filing ID A4Q0L5) Metro Vancouver/C234-7-2 (Filing ID A4L7Y2) Metro Vancouver/C234-7-31 (Filing ID A4L8C8)	Location of MLBVs will be further informed by the Risk Based Design which will incorporate the oil spill analysis provided in Volume 7, Appendix B, Oil Spill Outflow Model Results and Appendix C, Overland and Stream Flow Modelling of Potential Full Bore Rupture (Langley IR No. 1.05a [Filing ID A3X6U7]). No new commitment required.
Trans Mountain should be required to avoid any disturbance to streams in Coquitlam, or alternatively, to provide additional habitat compensation to enhance stream habitat.	City of Coquitlam/C70-3-02 (Filing ID A4L9H8)	Following a review by the NEB/DFO of Trans Mountain's Self-Assessment, if the need for offsetting (*i.e.,* Authorization under the *Fisheries Act*) is identified, Trans Mountain will continue to develop appropriate habitat offsetting projects. No new commitment required.
A commitment to No Net Loss of Habitat by Trans Mountain. Trans Mountain should be required to commit to compensate Metro Vancouver (Biodiversity Offsets).	Metro Vancouver/C234-7-2 (Filing ID A4L7Y2)	Trans Mountain has committed to abiding by the *Fisheries Act* and DFO's policies and guidance documents on the implementation of the Act, in order to ensure the sustainability and productivity of the fisheries crossed by the proposed Project. If, following a review by the NEB/DFO of Trans Mountain's Self-Assessment, the need for offsetting (*i.e.,* Authorization under the *Fisheries Act*) is identified, Trans Mountain will continue to develop appropriate habitat offsetting projects. No new commitment required.
Completing adequate data collection should be a condition of approval by the NEB for the riparian and sensitive ecosystems identified in Zoetica, 2015.	Metro Vancouver/C234-7-2 (Filing ID A4L7Y2)	Trans Mountain maintains that the fish and fish habitat data collection for the Project is adequate to support an environmental assessment for pipeline construction and operation, as per provincial and federal regulatory standards. No new commitment required.

TABLE 35-3

SUMMARY OF RECOMMENDATIONS AND SUGGESTIONS FROM INTERVENOR EVIDENCE - FISH AND FISH HABITAT SPECIFIC (continued)

Recommendation/Suggestion	Intervenor/Evidence (Filing ID)	Trans Mountain Response
Completing adequate data collection on specific occurrences of SCC. This cannot be done concurrently with construction and must be carried out over the period of at least a year in order to be accurate.	Metro Vancouver/C234-7-2 (Filing ID A4L7Y2) Metro Vancouver/C234-7-31 (Filing ID A4L8C8)	Fish and fish habitat data collection for the Project occurred in the Lower Mainland from 2012 to 2014. Known occurrences of SCC, including proposed mitigation, were provided in previous IR responses to the NEB (NEB IR No. 1.52a-e and 1.53a-i [Filing ID A3W9H8). Additional information concerning nooksack dace and salish sucker was also provided in responses to NEB IR No. 3.039a-c (Filing ID A4H1V2) and NEB IR No. 4.07a-d (Filing ID A4K4W3). Known occurrences and critical spawning/incubation periods for brassy minnow have been provided as part of this evidence reply (Sections 35.2.2.4, 35.3.2 and 35.3.4). Trans Mountain will adopt appropriate least risk biological windows and mitigation measures to protect all CRA species and/or species of special concern. No new commitment required.
Commit to using HDD or to re-routing the pipeline to avoid impacting critical habitat, and potentially critical habit, or areas of high importance to SCC.	Metro Vancouver/C234-7-2 (Filing ID A4L7Y2) Metro Vancouver/C234-7-31 (Filing ID A4L8C8)	Trans Mountain has committed to the use of a trenchless crossing method at select fish-bearing watercourses. The application of HDD as a crossing method is not automatically possible given geotechnical issues, or geometry and alignment. Where possible, routing decisions have been made to minimize the potential disturbance to SCC.
The NEB should require that Trans Mountain commit to meeting a minimum level of statistical power for monitoring programs that rely on Before-After, or Before-After-Control-Impact (BACI) comparisons.	Metro Vancouver/C234-7-2 (Filing ID A4L7Y2) Cowichan Tribes/C86-18-1 (Filing ID A4Q0U9)	Trans Mountain notes that BACI designs are typically considered to be a poor fit for: small potential changes after a disturbance, gradual changes after a disturbance, long-term monitoring, and for monitoring for changes in variability (Schwarz 2014). This does not make them particularly suitable for use in monitoring of the Trans Mountain Expansion Project. Data collection in support of the Application has met regulatory standards required.
To improve quantitative information on fish populations we recommend that fish abundance and CPUE be recorded during salvage operations.	Cowichan Tribes/C86-18-1 (Filing ID A4Q0U9)	Trans Mountain has agreed to record this additional information during any salvages carried out for the Project during construction. New commitment.
It is recommended that Tran Mountain more clearly justify the exclusion of Sockeye, Chum and Pink salmon from the list of indicator species and more clearly state whether ranking criteria for fish habitat potential include salmonid species that are not specifically listed as BC indicators for the construction phase of the Application.	Cowichan Tribes/C86-18-1 (Filing ID A4Q0U9)	Trans Mountain considered chinook and coho as a better indicator for Pacific salmon interactions with the Project as a whole. Factors included geographical distribution, abundance, and value in CRA fisheries. Ranking criteria for fish habitat potential included indicator species present or historically documented within that system. If none were present, then habitat was rated for other CRA species of significance or species at risk either present or documented. No new commitment required.
At most proposed crossing sites, several salmonid species should be added to the list of species potentially using the habitat.	PIPE UP Network/C288-16-2 Filing ID A4Q0Q7)	All potential CRA species were considered in the assessment of habitat potential regardless of whether they were captured. Where appropriate, Trans Mountain has adopted conservative least risk biological windows (*e.g.,* where there is a high potential for both trout and/or char and/or salmon species to overlap). No new commitment required.
Some sites clearly have potential for Salish sucker, Brassy minnow and perhaps Mountain sucker, and should be sampled using appropriate methods in appropriate seasons.	PIPE UP Network/C288-16-2 Filing ID A4Q0Q7)	Based on the Reply Evidence (Section 35.3.4), the fish and fish habitat data collection between Hope and Highway 9 (including consultation with DFO Species at Risk) was considered to be adequate to support an environmental assessment and permitting for pipeline construction and operation. Additional comprehensive species-specific sampling programs are not likely warranted as Trans Mountain will adopt suitable construction methods and associated mitigation measures will for a broad range of species and potential habitat sensitivity. Appropriate measures will be taken to avoid serious harm to all fish and fish habitat in compliance with the *Fisheries Act*. No new commitment required.
It should be ensured that potential encounters with migrating sturgeon be avoided where possible by organizing timing of works appropriately.	MNBC/C231-2-1 (Filing ID A4L8S2)	The proposed pipeline construction method at all locations where sturgeon may exist or be migrating is trenchless. If contingency methods are required, further confirmation of the least risk biological window with respect to known populations of sturgeon would involve consultation with regulators before construction.
Hydraulic isolation should be required for any small- to medium-sized streams which are hydraulically connected to fish habitat, regardless of whether there are fish or fish habitat at the crossings.	Nooaitch Indian Band/C250-5-1 (Filing ID A4Q0F4)	Wherever practical, an isolated trenched method (*i.e.,* flow isolation) will be used for all defined watercourses where flow is encountered at the time of construction. No new commitment required.
Use standard BMPs during crossing construction.	Nooaitch Indian Band/C250-5-1 (Filing ID A4Q0F4)	Trans Mountain has committed to construct the proposed pipeline using current BMPs. No new commitment required.
Should this project proceed further as currently being proposed, there needs to be an external audit in respect to TMP's Self-Assessments of Serious Harm for the TMEP.	SRES/C301-5 (Filing ID A4Q2H6)	The Self-Assessment is currently under review by the NEB/DFO. Trans Mountain remains confident in the regulatory regime currently in place and will respect decisions resulting from this process. An external audit of the results of the review is unlikely and not justified. No new commitment warranted.
There is a need and a requirement to undertake an inventory of such vegetation that will be destroyed, or need to be provided.	SRES/C301-5 (Filing ID A4Q2H6)	Should the NEB determine serious harm will result from removal of riparian habitat, Trans Mountain will satisfy all submission requirements as outlined in Section 3 of *An Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(b) of the Fisheries Act* (DFO 2013). No new commitment warranted.
While SRES suggests that the environmental monitoring of the project likely need only be a t a low level after 5 years, in most instances, TMPL must assume responsibility and ownership of the environmental impacts until the pipeline is decommissioned.	SRES/C301-5 (Filing ID A4Q2H6)	Trans Mountain will implement post-construction environmental monitoring as conditioned by the NEB. No new commitment required.

35.7 Summary of New Commitments

- Trans Mountain commits to record CPUE data during any salvages carried out during construction for the Project.

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36.0 WETLANDS

36.1 Wetland Survey and Mitigation Plan

36.1.1 Existing Condition Assessments

In the written evidence submitted by Environment Canada (Filing ID A4L8Y6) it was requested that a detailed and quantitative assessment of baseline conditions for wetlands directly affected and those directly connected be conducted. This would include more survey information on species at risk and migratory birds associated with the wetlands crossed, and be according to Resource Information Standards Committee procedures. Environment Canada also recommends the spatial locations and biological characteristics of each wetland and services/functions they deliver be provided. Environment Canada recommends the assessment be submitted to the NEB at least 120 days before clearing activities.

MNBC (Filing ID A4Q2H2) expressed concerns about the potential lack of ground-based surveys and the potential for rare plants in wetlands. MNBC commented that there should be a specific commitment to ensure that a minimum acceptable percentage of each wetland type is field-surveyed in a timely fashion that would allow for proper management of rare plants or ecosystems potentially impacted. MNBC commented that there appears to be no clear legal binding action for the Project proponent to complete the intended surveys.

As stated in response to NEB IR No. 3.028a (Filing ID A4H1V2), Trans Mountain remains committed to conducting ground-based surveys at all wetlands (including each wetland type) encountered by the Project before construction. Trans Mountain's efforts to date to complete these surveys are discussed below. In the event that through its pre-construction supplemental survey program Trans Mountain is unable to complete surveys of all the additional wetlands not already surveyed to date (*i.e.,* because the landowner does not grant permission and Trans Mountain cannot access the wetland), Trans Mountain will advise the NEB and provide the NEB with a summary of its attempts to obtain access.

An extensive field program was conducted along the PPC in 2012, 2013, and 2014 (*i.e.*, ground-based wetland surveys at all wetlands where access was available), along with aerial surveys (*i.e.*, helicopter reconnaissance), a review of an overflight video, and high resolution satellite imagery. This provided a visual documentation of the wetlands encountered by the Project. As discussed in Technical Report 5C-8 of Volume 5C, Wetland Evaluation Technical Report (Filing ID A3S2H5), approximately 638 potential wetlands were crossed by the PPC (339 in Alberta and 299 in BC). Following the submission of the Application, corridor revisions have occurred. A desktop review of the revised corridor was conducted in 2014, which identified approximately 538 potential wetlands crossed (310 in Alberta and 228 in BC; a reduction of 100 wetlands). Of the 538 wetlands crossed, 413 were ground-truthed during the 2012, 2013, and 2014 field programs (approximately 77% of the wetlands crossed).

Remaining wetlands encountered by the proposed revised pipeline route will be targeted during the 2015 field program. Guidance for survey intensity level in BC suggests that for the wetlands study area, 25-50% of identified wetlands should be ground surveyed (Survey Intensity Level 3) (Ecosystems Working Group, Terrestrial Ecosystems Task Force, Resources Inventory Committee 1998). The expected number of wetlands to be ground-surveyed (*i.e.,* all wetlands that are accessible on the ground and all wetlands through helicopter reconnaissance) has already exceeded recommendations for Survey Intensity Level 3.

36.1.2 Timeline

In the written evidence submitted by British Columbia Wildlife Federation (BCWF; Filing ID A4Q0W2), they commented that the timeline for the submission of the Wetland Survey and Mitigation Plan did not allow for proper review and input from other organizations, including themselves. As a result, they have made a number of recommendations on when the Wetland Survey and Mitigation Plan should be started, what assessment approaches should be taken, and what information should be included in measuring wetland function. BCWF would like to be involved in the development of this plan.

The Wetland Survey and Mitigation Plan document is being developed to satisfy NEB Draft Condition No. 23 (Filing ID A3V8Z8). In order to provide the Pre-construction Wetland Survey and Mitigation Plan 120 days before construction, it would require submission before issuance of the Certificate of Public Convenience and Necessity (CPCN). Therefore; Trans Mountain is asking for consideration of submission of the Wetland Survey and Mitigation Plan 90 days before commencement of construction. This document will include a comprehensive list of all wetlands encountered by the final pipeline route, including any supplemental survey information collected in 2015. In order to complete the remaining field assessments, the same methodology employed for the Project will continue to be used for consistency. This includes the functional assessment that was used for previous surveys. As outlined in in Technical Report 5C-8 of Volume 5C, Wetland Evaluation Technical Report (Filing ID A3S2H5), wetlands in BC were classified to the *Canadian Wetland Classification System* (NWWG 1997) in general, and to the *Wetlands of BC: A Guide to Identification* (Mackenzie and Moran 2004) classification system when wetlands were ground-truthed.

The development of the Wetland Survey and Mitigation Plan has already begun; however, input on possible mitigation measures for specific wetlands would be appreciated from BCWF. Trans Mountain is willing to discuss the Wetland Survey and Mitigation Plan with BCWF.

36.2 Wetland Compensation

36.2.1 Wetland Compensation Ratio

BCWF also expressed concerns that the goal of “no net loss” of wetland function was not sufficient to protect and enhance wetlands, and that it also did not equal the 2:1 ratio often requested by Environment Canada. BCWF is recommending that the 2:1 replacement ratio be applied to all new construction located in watersheds and wetlands in BC.

Any compensatory measures carried out for the Project will be overseen by Environment Canada as outlined in the Preliminary Wetland Compensation Plan (WCP; Filing ID A3Z4V3). Permanent loss of wetland function is not anticipated at wetlands crossed by the final pipeline route since pipeline construction through wetlands is considered a temporary disturbance and experience indicates that residual effects on wetland function can be mitigated. However, compensatory measures may be required following the Wetland Function Post-construction Monitoring (PCM) Program. Determination of a replacement ratio will be conducted through consultation with Environment Canada.

In order to provide the Pre-construction Wetland Survey and Mitigation Plan 120 days before construction, it would require submission before issuance of the CPCN. Therefore; Trans Mountain is asking for consideration of submission of the Wetland Survey and Mitigation Plan 90 days before commencement of construction. A commitment to consider a suitable

compensation ratio will be discussed if compensation is determined to be required (*i.e*., it is determined through post-construction monitoring that no-net-loss of wetland function has been not been achieved).

36.2.2 Compensation Sites

BCWF states that "*when considering a compensation site, the values of the replacement wetlands must be in close proximity to the loss of the wetlands area*" and that like for like offsets should be implemented along with long-term monitoring of the compensation offset sites to ensure wetland function is what was intended.

The types of compensation potentially applied could include, but is not limited to: onsite restoration or enhancement; offsite procurement; restoration or enhancement; or in-leu payment to a wetland restoration agency (*e.g.,* Ducks Unlimited Canada). Permanent loss of wetland function is not anticipated at wetlands crossed by the final pipeline route since pipeline construction through wetlands is considered to be a temporary disturbance. However, should it be identified following the Wetland Function PCM Program that compensatory measures may be required, selection of the type of compensation and the approach to be taken will be determined through discussions with Environment Canada as outlined in the Preliminary WCP (Filing ID A3Z4V3).

36.2.3 Funding for Wetland Restoration

BCWF also states that they would like to see the development of a legacy fund that would provide applicable money required for restoration and enhancement projects in BC. BCWF also requests that the proposed monitoring program be comprehensive and look at "*all watercourses, wetlands and wildlife habitat impacted by this development, and set high environmental standards, with a goal of improved functionality, not just 'no net loss'*".

The Wetland Function PCM Program outlined in in Technical Report 5C-8 of Volume 5C, Wetland Evaluation Technical Report (Filing ID A3S2H5) meets the requirements of NEB Draft Condition No. 63 (Filing ID A3V8Z8). Similar monitoring programs have been successfully implemented for other projects in similar terrain.

For example, a Wetland Function PCM for the Supplemental Wetland Function Study (SWFS) and for the Wetland Follow-up Monitoring Program (WFMP) for the TMX Anchor Loop Project was carried out, with the fifth and final year of monitoring occurring in the summer of 2013 (TERA 2013a,b).

In the years immediately following construction, issues identified included: wetland profile reconstruction; an increased moisture regime due to tree removal; the potential for sediment and/or nutrient loading into surface waters; and the occurrence of anthropogenic materials. Where required, issues such as wetland profile reconstruction were effectively mitigated through reclamation measures (*i.e.*, recontouring). In areas of tree removal, natural regeneration allowed successional species to establish through the growing seasons following construction. Where warranted, anthropogenic materials were removed (*e.g*., silt fencing) if it was determined they impeded wetland function. Weedy species were gradually succeeded by appropriate wetland species and KMC implemented a weed management program as warranted, similar to the Weed and Vegetation Management Plan in Appendix C of the Pipeline EPP for the TMEP (Volume 6B, Filing ID A3S2S3). Natural regeneration, along with sapling plantings and seeding, if warranted, was used in areas where vegetation was slow to re-establish, similar to shrub

staking that is recommended in Appendix K of the Pipeline EPP for the Project (Volume 6B, Filing ID A3S2S3).

In 2010 for the SWFS (third year after construction), three of the nine wetlands studied showed "Proper Functional Conditions" and one was "Functional-at-Risk." No wetlands were determined to be "Non-Functional" and no specific restoration efforts were recommended at that time. Wetlands initially determined to be of "Proper Functional Conditions" maintained that ranking throughout the 5 years of monitoring. By 2011, all wetlands were ranked "Proper Functional Conditions" as vegetation growth continued to improve and the soil moisture regime returned to the wetlands. The 2012 and 2013 field visits observed continued stabilization of wetland function as "Proper Functional Conditions" and no incidents of regressed functional conditions were noted (TERA 2013a).

All wetlands observed during the WFMP showed direct indicators of "Proper Functional Conditions." No wetlands exhibited characteristics that were detrimental to overall wetland function or were documented as being "Functional-At-Risk" or "Non-Functional." This result was supported by the observations of reclaimed seedbanks within wetlands based on the growth of the appropriate successional species on the construction right-of-way and the absence of excessive ponded water or impeded hydrology (TERA 2013b).

Natural regeneration and site-specific supplemental restoration revegetation efforts continued to stabilize and improve vegetation regeneration. Over 5 years of SWFS and WFMP Wetland Function PCM field work, increased moisture levels were observed along the elevated portions and at wetland margins. A substantial improvement in wetlands where vegetation was slow to re-establish was noted during the fourth year surveys. The growth of vegetation microsites and vegetation coverage was observed to have continued to improve during the fifth year surveys (TERA 2013a,b).

Over the 5 years of monitoring, the SWFS and WFMP wetlands have shown that accepted pipeline construction methods and supplemental restoration mitigation measures, along with the passage of time, have allowed for the re-establishment of the soil moisture regime and the successful establishment of naturally regenerating and encroaching species. Species planted during restoration efforts, where appropriate, also assisted with the successful recovery of wetland function, although natural regeneration has proven to be the best method for a majority of wetlands (TERA 2013a,b).

Overall, the fifth year SWFS and WFMP Wetland Function PCM provided confidence that mitigation measures implemented during construction (*i.e.,* natural regeneration) and subsequent restoration and revegetation efforts, as warranted, have proved to be successful; that wetlands are proving to be resilient to the temporary disturbance of pipeline construction; and that the goal of "no net loss" of wetland function has been achieved (TERA 2013a,b).

Although the initial timeframe for the proposed monitoring program for the Project is 5 years, should a wetland still show signs of not being on the trajectory to returning to the functional condition documented during the pre-construction wetland surveys, then the monitoring of this wetland will continue after the fifth year of the PCM program. This process compiles with NEB Draft Condition No. 63 (Filing ID A3V8Z8). Therefore; Trans Mountain will not be providing additional funding for legacy restoration and enhancement projects in BC. Should compensation be required it will be conducted through consultation with Environment Canada as warranted.

36.3 Routing

In its written evidence, the SRES (Filing ID A4Q2H6) raised concern over the alignment of the PPC, especially in the area of Surrey Bend Regional Park.

Several adjustments have been made to the PPC since the Application was filed in December 2013. These adjustments have occurred to improve constructability, avoid congestion in developed urban areas, and to reduce the length of the pipeline corridor that encounters Surrey Bend Regional Park while trying to parallel existing linear facilities or stay within existing transportation/utility corridors. The alignment of the PPC within the area of the Surrey Bend Regional Park is confined by the South Fraser Perimeter Road and the Golden Ears Connector, which have used much of the available space in the transportation corridor. For additional information regarding routing in Surrey Bend Regional Park see Trans Mountain's response to NEB IR No. 6.20 - Attachment 1 (Filing ID A4R6J5). Trans Mountain commits to continue to pursue and investigate options with the Ministry of Transportation regarding sharing their right-of-way through the region with the potential to avoid having to route through Surrey Bend Regional Park.

Trans Mountain will continue to further refine the PPC during the detailed engineering phase of the Project to produce the final pipeline route. Trans Mountain will continue to use the routing criteria and objectives that have guided the pipeline corridor selection process since the inception of the Project in 2012. Trans Mountain will also continue to engage with Aboriginal communities, landowners, regulatory authorities, and other stakeholders during continued pipeline corridor optimization and the definition of the construction footprint.

Following the submission of the Application, corridor revisions have occurred resulting in a reduction of wetlands encountered. It is anticipated that the total number of wetlands will be further reduced following the refinements of the PPC to produce the finalized construction footprint. It is important to note that not all of these wetlands will be disturbed during pipeline construction since the pipeline construction right-of-way is being adjusted (*e.g.,* narrowed, re-aligned) in a manner that avoids wetlands, to the extent practical. Wetlands that have been identified as being sensitive (*e.g.,* Red- or Blue-listed wetlands, habitat for sensitive wildlife and plant species, unique ecosystems) are also being taken into consideration during the process.

36.4 Surrey Bend Bog

In the written evidence submitted by SRES (Filing ID A4Q2H6), concerns were raised about the potential effects that pipeline construction may have on the bog located within Surrey Bend Regional Park.

Hydrological function is an essential feature of wetlands and wetland definitions identify that saturated soils are the key determinant of processes and communities that characterize wetlands (NWWG 1997, MacKenzie and Moran 2004). Restoration of natural hydrologic regimes is critical to the recovery of wetland function following disturbance (Zedler 2000).

Vertical and horizontal water movements in wetlands can be disrupted by any berm-like structure. Linear disturbances through wetlands (*e.g.,* pipelines), may impound water, resulting in flooding upstream and drying downstream (Olson and Doherty 2012). Drying on the downslope face in treed wetlands (*i.e.*, treed bogs and fens) can increase tree productivity, water demand, and evapotranspiration, which facilitates further drying (Baisley 2012). This compounded drying can result in permanent alteration of the peatland hydrologic regimes,

overall wetland function, and potentially vegetative cover (*e.g.*, treed wetland to forest, or marsh to wet meadow or moist grassland; Baisley 2012, Sherwood 2012). On the upstream side, increased saturation from impounded water can result in the loss of trees and other woody vegetation, while allowing the establishment of emergent vegetation in peatlands (Baisley 2012). Prolonged impoundment may potentially convert a treed wetland to a marsh wetland and a more seasonal wetland into a permanent shallow water wetland (Baisley 2012). These alterations (*i.e.,* drying or ponding) are not anticipated to occur during the Project's temporary disturbances (construction) due to the implementation of appropriate mitigation and the maintenance of hydrology across the construction right-of-way and temporary access roads.

The hydraulic conductivity (*i.e.,* connection with the groundwater table) of the wetland's substrate can also be affected by salvaging, compacting, or mixing of the soil structure. For example, salvaging of the unsaturated portion of the peat profile near the surface affects water storage capacity, increases evaporative losses, and affects soil processes (*e.g.*, carbon storage; Price *et al.* 2003). Pore structure is affected through subsidence and compression when peat is drained, which affects water storage capacity and hydraulic conductivity (Price *et al.* 2003). Overlaying woody mulch on replaced peat following pipeline construction can increase the relative humidity on the peat surface and decrease evaporative loss thereby reducing the hydrologic impact (Groeneveld and Rochefort 2005, Price *et al.* 2003). However, lessons learned from previous PCM programs have shown that mulch applied in thick layers can adversely affect vegetation growth.

Plant community composition and structure may change in certain wetland types (*i.e.*, treed and shrub wetlands) following pipeline construction. Standard practice with respect to pipeline construction and operations is to ensure pipeline integrity and safe access for maintenance. As a result, larger woody vegetation, mostly trees, are often not allowed to regrow along a pipeline right-of-way during the life of the pipeline. The roots of the trees can affect the integrity of the pipe walls and coating. This may result in a decrease in wetland habitat function when only the herbaceous vegetation returns to the right-of-way post-construction (Santillo 1993, Shem *et al.* 1993, Van Dyke *et al.* 1994) but does not constitute a loss of overall wetland function, especially in larger sized wetlands.

Furthermore, tree and shrub removal during operations often results in an increased soil moisture regime, which may cause wetlands to return to a previous successional state (*i.e.*, an alteration of wetland type). The increased growth of early successional species may result in an increase in plant diversity following tree removal, which can lead to an alteration of wetland structure (Shem *et al.* 1993, Van Dyke *et al.* 1994). Commonly, treed wetlands revert to sedge-dominant marshes following an increase in groundwater level, which was previously suppressed by transpiration and water uptake by trees (Lee and Boutin 2006).

Improper handling of wetland substrate may lead to bare soil along a right-of-way and result in slow re-vegetation and changes in species composition (Olson and Doherty 2012). Although species richness may not appear to be effected by pipeline construction, improper handling of wetland substrate may result in invasive plant species replacing native plant species along the right-of-way. This in turn may lead to an alteration in species composition (Van Dyke *et al.* 1994).

Additional studies on the effects of pipeline construction on wetland vegetation support natural regeneration of wetlands after disturbance (Shem *et al.* 1993, Van Dyke *et al.* 1994). Shem *et al.* (1993) assessed four locations where pipeline construction had occurred in

wetlands. Natural regeneration was implemented at three of the sites and seeding and fertilizer was used at one site on the disturbed portion of the right-of-way. After 1 year post-construction, it was found that many plant species re-established on the construction right-of-way at sites where natural regeneration was allowed. These sites also had more plant species coverage and less bare soil, when compared to the site where seeding occurred (Shem *et al.* 1993).

Van Dyke *et al.* (1994) assessed the establishment of vegetation at wetland crossings ranging from 8 months to 31 years following pipeline construction. General observations made during the study suggest that diverse vegetation communities can re-establish on the construction right-of-way as a result of the germination of species in the seedbank and the migration of species from surrounding undisturbed areas. Proper salvage and handling of wetland substrate, along with the return of wetland contours to pre-construction profiles, were found to be important components in natural regeneration. Seeding of disturbed wetland areas did not accelerate vegetation establishment (Van Dyke *et al.* 1994).

Minimal disturbance construction techniques are being proposed for wetlands crossed by the final pipeline route. These techniques include preventing ground disturbance in wetlands through the use of matting or biodegradable geotextile, clay ramps, or compacted snow or ice between vegetation and construction equipment.

Maintenance of wetland hydrology is critical to the preservation of soil biogeochemical cycles that occur under varying degrees of saturation. Biological decomposition of organic matter in soils, and release of stored carbon, is controlled by the rate of microbial respiration, which is influenced by saturation (*i.e.,* temperature and oxygen availability). Microbes preferentially use oxygen; however, under anaerobic, saturated conditions, the rate and type of respiration is altered (McLatchey and Reddy 1998). In addition, the heat capacity of saturated soils is higher than that of dry soils. Therefore, maintenance of wetland hydrology ensures that cool conditions are prevalent and slow decomposition rates characteristic of wetland substrates occur, favouring the storage of carbon.

Olson and Doherty (2012) studied seven wetlands, 8 years post-construction, to determine the potential effects of pipelines on wetland vegetation and soils. It was demonstrated that the soils affected by pipeline construction had a higher bulk density and lower soil moisture due to soil compaction. Admixing of soils also resulted in changes in the water retention of soil, soil chemistry, aquatic species, and wetland vegetation composition (Olson and Doherty 2012). The use of mats and low-load bearing machinery may reduce potential soil compaction resulting from pipeline construction. Admixing can be avoided or reduced by salvaging and storing wetland substrate separately from the underlying mineral soil.

PCM of wetland function completed for previous projects in similar terrain as the Project (TERA 2011a-e, 2012a-c, 2013a-f, 2014) have shown that the mitigation measures implemented during construction (*e.g.*, erosion and sediment control measures, re-establishing pre-construction contours, allowing natural regeneration) can be successful. This has been demonstrated by the reduction of environmental issues related to wetland function restoration documented during previous pipeline projects (Critchley and Foote 2009; TERA 2009a-c, 2011a,c,d,e,f, 2012a-c, and 2013a-f, 2014).

The observations made during previous PCM programs are supported by statements made in two ecohydrological overview reports compiled for Surrey Bend (Baird 2012, Enterprise Geoscience Services Ltd. 2010). A sewer forcemain (Greater Vancouver Sewage and Drainage

District sewer forcemain) was installed through Surrey Bend in 1983. The forcemain crosses a number of wetlands within the park. The ecological overview report completed by Enterprise Geoscience Services Ltd. (2010), states that "*there is no indication from the groundwater flow patterns that the sewer forcemain has a noticeable impact on bog hydrology*." This statement supports rationale provided in Section 7.2.8.6 and 8.7.3.1 of Volume 5A (Filing IDs A3S1Q9 and A3S1R2) that discusses pipeline construction being considered a temporary disturbance when proper mitigation measures are implemented.

In the Enterprise Geoscience Services Ltd. (2010) report, field water quality testing revealed that mineral backfill used to fill in the sewer trench may be affecting electrical conductivity and pH in the surrounding groundwater, but that the differences are relatively small and were found to be within the range of variation observed in other areas of the park. This observation supports the mitigation outlined in Table 7.2.8-2 of Volume 5A (Filing ID A3S1Q9), which recommends that native material be utilized to backfill the trench and replaced in the correct order.

An assessment of historical aerial photographs discussed in the Enterprise Geoscience Services Ltd. (2010) report has shown that in the area of the sewer forcemain the vegetation has shifted from predominantly graminoid dominated communities to a higher coverage of low shrubs and smaller areas of graminoid species. This observation corresponds with the discussion provided in Section 7.2.8.6 of Volume 5A (Filing ID A3S1Q9) that discusses how changes in vegetation composition may occur following pipeline installation.

The *Ecohydrological Overview of Surrey Bend Regional Park During Summer Conditions* (Baird 2012) noted that a drop in groundwater levels at the sewer forcemain was observed; however, this drop was found to be relatively small when compared to the overall trend noted throughout the north quadrant (area north of Centre Creek), which was determined to correlate with seasonal changes. The report notes that disturbance to the soil during the installation of the sewer forcemain may have altered the hydraulic connectivity and therefore increased the responsiveness to changes in precipitation compared to other locations. No pre-construction information on the sewer forcemain was presented in Baird (2012) for a comparison. Discussion on potential alteration of hydrological function (*e.g.*, groundwater) associated with the TMEP is presented in Section 7.2.8.6 of Volume 5A (Filing ID A3S1Q9).

The sewer forcemain area has a distinct vegetation assemblage not similar to other areas within the wetland (*i.e.*, deciduous trees, sedge species, rush species, several bog species, and a blanket of Sphagnum species). Baird (2012) concludes that the removal of large trees and peat disturbance during installation of the sewer forcemain have caused these vegetation communities to occur. The discussion of alteration of habitat function in Section 7.2.8.6 of Volume 5A (Filing ID A3S1Q9) presents similar findings related to the introduction of early successional plant species to areas of disturbance.

Baird (2012) found that the sewer forcemain had a localized (*i.e.*, 50 m radius) effect on electrical conductivity, and magnesium and chloride concentrations. The report did not discuss the significance of these findings. In the discussion on potential alteration of biogeochemical function within wetlands, potential changes in water quality as a result of pipeline construction are noted (Section 7.2.8.6 of Volume 5A [Filing ID A3S1Q9]). Contamination containment is addressed in Table 7.2.8-2 of Volume 5A (Filing ID A3S1Q9).

36.5 Timeframe of Wetland Function PCM Program

The SRES expressed concerns in their written evidence (Filing ID A4Q2H6) about the apparent finite period of time over which the Wetland Function PCM Program would be conducted. The SRES argues that the 5 year monitoring program was not sufficient and that monitoring, as well as any restoration activities, should take place over the lifetime of the Project. SRES also recommends that the monitoring program could be of a lower level of intensity after the 5 years but they would like Trans Mountain to "*assume responsibility and ownership of the environmental impacts until the pipeline is decommissioned. Furthermore, oversight must be conducted by a relevant and responsible agency to ensure that these efforts are continued over the life of the pipeline.*"

The Wetland Function PCM Program outlined in in Technical Report 5C-8 of Volume 5C, Wetland Evaluation Technical Report (Filing ID A3S2H5) meets the requirements of the NEB Draft Condition No. 63 (Filing ID A3V8Z8). Similar monitoring programs have been successfully implemented for other projects in similar terrain.

Although the initial timeframe for the proposed monitoring program for the current Project is 5 years, should a wetland still show signs of not being on the trajectory to returning to the functional condition documented during the pre-construction wetland surveys, then the monitoring of this wetland will continue after the fifth year of the PCM program, as warranted.

36.6 Cumulative Impact Assessment Framework

The BCWF identified a number of issues related to wetlands. One such issue was the need for a cumulative impact assessment framework for the province that could be used to monitor the cumulative effect of historical and current development activities. BCWF identified that it has been difficult to set any objectives related to water as current tools do not adequately state what the targets are and currently there is no database in place that outlines all of the activities that have occurred in a particular region. With the lack of a provincial framework, BCWF has asked if Trans Mountain will incorporate a cumulative impact assessment framework into the monitoring program for watercourses, wetlands, and wildlife habitat affected by the Project, and what approaches and tools can be used to advance watershed sustainability.

Development of a cumulative impact assessment framework for monitoring purposes has not been identified by the NEB as a requirement for this Project. The proposed Wetland Function PCM Program will be developed to comply with the NEB Conditions. The Wetland Function PCM Program will be conducted in the subsequent years following construction during the growing season to review the area of disturbance and identify any wetlands where remedial measures should be implemented to assist with the wetland function recovery. By employing the same wetland functional assessment criteria as was used during the existing study, a quantitative measurement of overall wetland function for each wetland encountered by the Project can be determined so that existing (baseline) conditions can be compared to post-construction conditions over time. This monitoring will demonstrate whether a wetland is on the trajectory towards achieving the goal of "no net loss" of wetland function within the post-construction monitoring timeframe, or whether additional remedial action is required to assist the wetland recovery and achieve this goal.

36.7 Stakeholder Involvement and Responsible Parties

In BCWF's written evidence (Filing ID A4Q0W2), they provided a number of recommendations on what parties should be involved in the assessment and monitoring work, and how stakeholder involvement should be considered. Included in this was the recommendation that Trans Mountain provide funds for a third party to conduct an independent audit of the monitoring program as well as any restoration activities.

Any wetland compensatory measures carried out for the Project will be overseen by the NEB and Environment Canada. However, Trans Mountain is committed to respectful, transparent, and collaborative interactions with community groups. Although permanent loss or alteration of wetland function is not anticipated at wetlands that will be crossed by the final pipeline route, Trans Mountain is willing to discuss any proposed compensatory and mitigation measures with BCWF.

Trans Mountain has retained professionals to conduct all of the wetland assessment work in compliance with the requirements outlined in the NEB *Filing Manual*. The methodology used has been reviewed by regulators and has been found to be satisfactory. Though not anticipated, this same approach will be taken should wetland compensatory measures need to be implemented along the final pipeline route.

The NEB has their own auditing process that they undertake during construction of a project. This auditing process ensures that the mitigation measures and construction techniques outlined in an application are being implemented correctly and that cleanup of the construction meets their standards and regulatory approvals.

36.8 Reactivation in Jasper National Park

Parks Canada submitted written evidence (Filing ID A4L5U9) in which they have recommended potential conditions to be included in a final approval. With respect to wetlands, Parks Canada is recommending a pre- and post-reactivation follow-up program to assess wetland function before any reactivation starts.

The full extent of potential impacts to wetlands during pipeline reactivation through Jasper National Park will not be known with any certainty until the in-line inspections have been completed. Once the results of the in-line inspections are available, a desktop review (*i.e.,* satellite imagery interpretation) will be conducted for the area where pipeline reactivation activities are to be located (*i.e.,* surface disturbance) to determine the location of potentially affected wetlands. Following the desktop review, the need for ground-based wetland field surveys will be determined if the surface disturbance resulting from the pipeline reactivation activities is located within 30 m of a wetland. The need for a wetland field survey will also depend on the type of disturbance being proposed (*e.g.,* access, cut-out and replacement). Where it is determined field studies are required, measurement of overall wetland function for each wetland encountered during pipeline reactivation activities can be determined so that existing (pre-reactivation) conditions can be compared to post-reactivation conditions over time. This monitoring will demonstrate whether a wetland is on the trajectory towards achieving the goal of "no net loss" of wetland function, or whether additional remedial action is required to assist the wetland recovery and achieve this goal.

36.9 Summary of New Commitments

- Trans Mountain is willing to discuss the Wetland Survey and Mitigation Plan with BCWF, especially on possible mitigation measures for specific wetlands.

- Trans Mountain is committed to respectful, transparent and collaborative interactions with community groups. Although permanent loss or alteration of wetland function is not anticipated at wetlands that will be crossed by the final pipeline route, Trans Mountain is willing to discuss any proposed compensatory and mitigation measures with BCWF. A commitment to consider a suitable compensation ratio will be discussed if compensation is determined to be required.

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37.0 VEGETATION

37.1 Metro Vancouver Written Evidence (Filing ID A4L7Y3)

Metro Vancouver submitted evidence (Filing ID A4L7Y3), which suggests the Project will negatively impact sensitive ecosystems in the Metro Vancouver region and that routing and construction methods, as proposed, fail to avoid impacting critical habitat or areas of high importance to SCC. Metro Vancouver is concerned with the survey methodology in the Brunette River Conservation Area. Metro Vancouver suggests that adequate data collection on species-specific occurrences of SCC was not completed to standards that reflect the best practices for ecologically sensitive lands in urban and regional park lands. Metro Vancouver also suggests extending the concept of “no net loss” to Regional Parks conservation lands. Each of these issues is addressed in turn below.

37.1.1 Impact on Sensitive Ecosystems

Section 1.4 (Summary of Metro Vancouver’s Position), page 8 states:

- "The Project will negatively impact sensitive ecosystems in the Metro Vancouver region, and the routing and construction methods as proposed fail to avoid impacting critical habitat or areas of high importance to Species of Conservation Concern."

Sensitive ecosystems identified by Sensitive Ecosystems Inventory (SEI) mapping are crossed by the PPC. However, these map units do not directly translate to provincially-listed ecological communities of concern or vegetation species of concern in British Columbia (*i.e.,* Red-listed or Blue-listed) nor do they indicate where federally-listed vegetation species at risk occur. The SEI mapping is a tool that flags remnants of at risk and ecologically fragile terrestrial ecosystems for scientific information, and support to local governments and others who are working to maintain biodiversity (Metro Vancouver 2014).The majority of the native vegetated areas along the PPC in Metro Vancouver, with the potential to contain sensitive ecosystems, have been identified and surveyed by qualified vegetation specialists, including surveys for potential rare ecological communities, rare plants, and invasive plants. Where provincially-listed species or ecological communities have been observed, mitigation measures have been proposed to avoid, reduce disturbance, and restore attributes of the valued ecosystem component as outlined in the ESA and EPP available in Volume 6B: Pipeline EPP (Filing IDs A3S2S3 and A3S2S4).

Trans Mountain assumes that "critical habitat or areas of high importance" as indicated by Metro Vancouver is meant to indicate *Species at Risk Act* (SARA) critical habitat; species at risk identified through the Integrated Wildlife Management Strategy (IWMS) under the *Forest Practices Act*; or British Columbia Conservation Data Centre (BC CDC) provincially Red-listed features (critically imperiled [S1], imperiled [S2] and special concern [S3]; BC CDC 2015). Using desktop and field survey methods, Trans Mountain has assessed vegetation features where "critical habitat or areas of high importance" are intersected by the PPC. Vegetation species and ecological communities of concern have been observed along the pipeline corridor and their extent has been documented. Mitigation measures to avoid or reduce disturbance to the vegetation features have been identified. Trans Mountain is committed to developing mitigation measures for vegetation species and communities of conservation concern to the extent practical, and although potential residual effects remain, they are greatly reduced by avoidance and the suite of mitigation measures proposed. Trans Mountain has conducted surveys where land access has been granted, following appropriate provincial and federal guidelines, to

account for potential SCC if there are vegetation or ecological communities of concern listed by the BC CDC, IWMS, *SARA*, or the COSEWIC known to occur along the PPC.

37.1.2 Data Collection/Surveys

Section 4.4 (Routing of Pipeline - Inadequate Information), page 52 states "latest data received outlined one day of surveying at the Brunette Conservation area. These data should be collected over a variety of times and with seasonally appropriate methodology (Zoetica 2015)."

The vegetation field survey (including an invasive plant survey) at Brunette River Conservation Area was conducted in August 2014. This timing is an appropriate time in the growing season to search for rare plants and invasive plant species because the vegetation is in flower or fruit and is most identifiable in this mature state. Based on the results of the vegetation present within the Conservation Area the vegetation specialists determined that no further surveys were necessary because the survey team followed provincial rare plant methods and guidelines that aim to detect rare and significant plant species within a survey area. The vegetation specialists' field checked all suitable habitat following floristic methods that could potentially contain rare plant species. A mature forested area was field checked and determined to be unique and worthy of flagging for avoidance and/or reduced disturbance even though the community type is not a listed ecological community of concern by the BC CDC. The reason the mature forest community was identified for avoidance was due to its relative rarity in the urban landscape of Metro Vancouver, as recommended by BC ecologist, Tom Braumandl. The mature forest community in the Brunette River Conservation Area will be avoided by the eventual Project footprint; therefore, no further surveys are required.

37.1.3 Sensitive Ecosystems

Section 4.7 (Sensitive Ecosystems), page 53 states: "*The proposed pipeline and shipping route crosses or runs close to 94 sensitive ecosystems, designated conservation areas, parks, fish-bearing waterways, and habitat that supports Species at Risk, public recreation, tourism, and fisheries in Metro Vancouver (Zoetica 2015)*."

37.1.4 Response 3

Native vegetated areas with the potential to contain sensitive ecosystems encountered by the pipeline corridor have been identified and surveyed by qualified vegetation specialists, including surveys for potential rare ecological communities, rare plants, and invasive plants. Where provincially-listed species or ecological communities have been observed, mitigation measures have been proposed to avoid, reduce disturbance, and restore attributes of vegetation features.

SEI maps provide a source from which to map element occurrences of ecological communities at risk (Metro Vancouver 2014). Yet, SEI mapping (polygon areas) does not directly translate to provincially-listed ecological communities of concern in BC (*i.e.,* Red-listed or Blue-listed) rather they flag remnants of native vegetation communities such as riparian, wetlands, and mature forests. While the PPC crosses more than 50 SEI polygons, many of these SEI habitat polygons will actually be avoided by utilizing trenchless construction techniques under riparian and wetland features or by narrowing the construction footprint; therefore, the actual area of permanent vegetation loss due to construction has been over estimated. Furthermore, about 20 of the SEI polygons are modified ecosystems or other ecosystems that have already been modified by human activity (Metro Vancouver 2014). Modified ecosystems are mapped to identify important elements of biodiversity or recruitment sites for ecosystems at risk or

important wildlife habitat requiring recovery or restoration (Metro Vancouver 2014). Approximately 12 SEI polygons that are intersected by the PPC are modified ecosystems, such as young forests (YF), broadleaf mature forests (MF), and an old field (OF). Nine of the SEI polygons that are intersected by the PPC are small young forest (YS) areas possessing a stand age of greater than 30 years and younger than 80 years classified as other ecosystems, which are not considered sensitive ecosystems (Metro Vancouver 2014).

The Burnaby Mountain Conservation Area will not be impacted by conventional trenched construction methods as a tunnel option has been proposed. Trans Mountain has selected a pipeline corridor route through Metro Vancouver that avoids as many parks and natural habitat areas that potentially support species at risk as practical. Further to this, Trans Mountain continues to refine the construction right-of-way to minimize impacts to parks and conservation areas in the region.

37.1.5 Vegetation Loss

Section 4.8 (Habitat Loss [Vegetation Loss]), page 54 states "*It is estimated that the Project will cause the permanent and temporary loss of 1,075,524 m^2 of green space, with 468,548 m^2 considered permanent loss and 606,976 m^2 considered temporary (Zoetica 2015). The loss or alteration of close to one million square metres of green space also has secondary implications on habitat fragmentation, drainage alterations, and the creation of edge habitat; these factors have negative impacts on vegetation as well as on wildlife that extend beyond the footprint and are associated with a greater spread of invasive plant species.*"

The loss of 1,075,524 m^2 (107.5 ha) of green space is an overestimate of vegetation loss because all impervious (green) land (including agricultural areas and golf courses) are included in this estimate. Conversely, native vegetation or areas of modified native vegetation should only be included in habitat and vegetation loss. While agricultural areas and golf courses may moderate stormwater runoff to some degree, these areas contain non-native vegetation species and are managed with irrigation, regularly mowed/harvested, occasionally cleared of vegetation, and are subjected to fertilizers, herbicides and pesticides; their ecological value is undermined by alternate land use objectives.

Based on the supporting Zoetica report and SEI mapping, the permanent loss of 40.8 ha of sensitive ecosystems represents less than 0.03% of the total sensitive ecosystems available (150,500 ha) in the Metro Vancouver region (excluding agricultural areas, golf courses, and green areas). SEI mapping is a tool from which ecological communities at risk can be further investigated. Therefore, sensitive ecosystems do not directly translate to provincially-listed ecological communities of concern (*i.e.,* Red-listed or Blue-listed). As stated above, many of the SEI polygons identified in the supporting Zoetica report are a combination of sensitive ecosystems, modified ecosystems, and other ecosystems that only have the potential to be at risk. Moreover, numerous SEI habitat polygons in the Metro Vancouver region will actually be avoided by utilizing trenchless construction techniques under riparian and wetland features; therefore, these area estimates are an overestimate of permanent vegetation loss. There will be extensive areas where the right-of-way and work space areas will be reduced substantially to minimize impact on environmentally sensitive areas and parks. These constraints will be carefully considered within the construction and engineering plans.

The SEI mapping is intended to flag the existence of important ecological features and provide initial information regarding their ecological significance. It does not replace the need for onsite assessments to support any decisions taken for a particular area (Metro Vancouver 2014).

Mitigation measures provided in the Pipeline EPP (Filing IDs A3S2S3 and A3S2S4) are designed to reduce the introduction and spread of invasive plant species.

37.1.6 Impacts on Species at Risk

Section 4.10 (Impacts on Species at Risk), pages 55-56 states:

> "Zoetica report has identified 57 plants of conservation concern."

The 57 plant occurrences (of conservation concern) identified in the Zoetica report are not all located within the PPC, only 7 plant occurrences are shown on the Zoetica report maps overlap with the corridor. One *SARA*-listed species in Table 3.2-6 in the Zoetica report is not a plant, but is actually an extirpated terrestrial snail called Puget Oregonian (*Cryptomastix devia*). Plants of conservation concern that have the potential to overlap with the pipeline corridor have been identified in the Vegetation Technical Data Report (Filing ID A3S2I7) and vegetation surveys have been conducted to account for their presence. If plants of conservation concern were observed during these surveys, site-specific mitigation measures have been developed to avoid, reduce disturbance, reclaim, and monitor these sites to maintain their presence at each location.

In fact, there are only six existing plant occurrences that have been identified on the PPC, these previously existing occurrences are discussed here. Ussurian water-milfoil (*Myriophyllum ussuriense*) is displayed on Map 5 of the Zoetica report as occurring in a large area near Colony Farm Regional Park. However, this plant is yellow-listed (S4), meaning it is apparently secure in BC. Northern water-meal (*Wolffia borealis*) and Nuttall's waterweed (*Elodea nuttallii*) are also located near Colony Farm Regional Park. Northern water-meal is Red-listed (imperiled, S2) and Nuttall's waterweed is Blue-listed (special concern, S3). Access to this area of the pipeline corridor was not granted and therefore vegetation surveys were not conducted at these potential rare plant locations.

Vancouver Island beggarticks (*Bidens amplissima*) and false-pimpernel (*Lindernia dubia* var. *anagallidea*) were observed in 1999, in a roadside ditch adjacent to a light industrial complex (BC CDC 2015). However, these potential rare plant occurrences displayed on Map 5 of the Zoetica report were not observed during vegetation surveys conducted in August 2014. One other extirpated occurrence of false-pimpernel was located in Coquitlam; however, this population was extirpated when a driving range and waste recycling site were established in the early 1990s. False-pimpernel may still occur at other nearby locations, yet these populations are not located within the PPC, but rather along the Fraser River below the high tide line in an industrial area.

An occurrence of slender-spiked mannagrass (*Glyceria leptostachya*), a plant of special concern in BC (Blue-listed, S3), is located within Surrey Bend Regional Park displayed on Map 4 of the Zoetica report. However, the exact location of the observation is unknown because access to this portion of the pipeline corridor was not granted and therefore vegetation surveys were not conducted at this potential rare plant location.

Roell's brotherella (*Brotherella roellii*) is an Endangered moss in Canada listed by COSEWIC as well as Red-listed in BC. This plant species can occur in the southern mainland of BC and

northern Vancouver Island. An occurrence of roell's brotherella was originally located within the Burnaby Terminal (displayed on Map 6 from the Zoetica report). However, upon recent review of this occurrence by Trans Mountain's vegetation specialist and in consultation with the BC CDC, it was determined to be a location error by the BC CDC due to an incorrect waypoint on the specimen label. The existing occurrence was actually observed approximately 1 km to the east of the Burnaby Terminal near bike trails along the Burnaby Mountain Conservation Area. Therefore, no existing occurrences of roell's brotherella are located within the PPC.

> "Proposed mitigation methods that have been suggested in the Environmental Protection Plan outlined within the Application are largely ineffective for preventing incidental losses and mortalities of SCC."

Site-specific mitigation measures for occurrences found within the construction footprint will be developed in the EPP and will be provided on the Environmental Alignment Sheets for construction planning. Mitigation measures for plants and communities of conservation concern will continue to be refined with engineering and routing modifications as final construction planning proceeds. The Environmental inspectors will ensure the mitigation measures for vegetation features are implemented to reduce any impacts to rare plants or rare ecological communities that could not be avoided. A Contingency Plan for Rare Ecological Communities or Rare Plant Species Discovery (Appendix B, Section 7.0 of the Pipeline EPP [Filing IDs A3S2S3 and A3S2S4]) has been developed to report and mitigate vegetation features in the event that potential ecological communities or rare plants are discovered on or within 30 m of the construction right-of-way or associated components.

> "More data is required on species-specific occurrences to demonstrate a strong understanding of the already known spatial occurrences of SCC, and such data should be considered prior to construction and alignment."

Using desktop and field methods, Trans Mountain has assessed where occurrences of SCC are intersected by the PPC. Using this desktop information, qualified vegetation specialists have observed vegetation and ecological communities of concern, and have documented their extent. Mitigation measures have been outlined to avoid or reduce disturbance to the vegetation feature. If there are vegetation or ecological communities of concern listed by the BC CDC, IWMS, *SARA*, or COSEWIC known to occur along the route, vegetation specialists have conducted surveys following appropriate provincial and federal guidelines to account for potential SCC.

> "When natural vegetation is cut or disturbed and soil is exposed, even temporarily, invasive plant species will often invade, outcompete, and dominate the cleared area. Often, invasive species form complete monocultures in sensitive habitat, decreasing vegetation diversity. The proposed routing with priorities for accessibility will increase the extent of invasive species, which will reduce biodiversity. Good planning and conditions or commitments for monitoring and removing invasive species are lacking in the Project application and subsequent responses to Information Requests."

Mitigation measures provided in the Pipeline EPP (Filing IDs A3S2S3 and A3S2S4) are designed to reduce the introduction and spread of invasive plant species.

37.1.7 Conditions

Section 4.14 (Comments, Commitments and Conditions), pages 59-60 states:

- "Completing adequate data collection should be a condition of approval by the NEB for the riparian and sensitive ecosystems identified in Zoetica, 2015.
- Completing adequate data collection on species-specific occurrences of Species of Conservation Concern. This cannot be done concurrently with construction and must be carried out over the period of at least a year in order to be accurate."

Vegetation field surveys were conducted where land access was available using appropriate standards and following industry guidelines (Penny and Klinkenberg 2012, ANPC 2012) during appropriate times in the growing season and at locations that could potentially contain sensitive ecosystems as well as riparian habitat.

The scope and methods required to adequately assess vegetation resources encountered by the pipeline corridor were determined with the guidance of the *Filing Manual*, in conjunction with published rare plant survey recommendations and guidelines as well as precedence set by developments of similar scope in the vicinity of the Project. Rare plant survey methodology is based on the Alberta Native Plant Council Guidelines for Rare Plant Surveys in Alberta (ANPC 2012) and the BC Protocols for Rare Plant Surveys (Penny and Klinkenberg 2012). The rare plant surveys were conducted throughout the growing season during biologically appropriate times for the species with potential to occur in the area. Mapping methodology for the Project was developed according to the Standards for Terrestrial Ecosystem Mapping in BC (Resources Information Standards Committee 1998) and was applied to both the Alberta and BC portions of the Project. These methods were presented in Volume 5C (Vegetation Technical Report) of the Application (Filing ID A3S2I7) and have been previously accepted by the NEB on other pipeline projects in western Canada.

Surveys for *SARA* vegetation species identified in Tables 2-1 and 2-2 from Environment Canada's evidence are available in the Vegetation Technical Report (Filing ID A3S2I7) for surveys conducted in 2013. Additional surveys for relevant *SARA* vegetation species were also conducted in 2014, which resulted in no observed occurrences of *SARA* vegetation species within the PPC. Additional surveys for toothcup, whitebark pine, and relevant vegetation species of concern will continue in August 2015 and in early summer 2016 before the start of construction. Adequate data collection has been completed for riparian and sensitive ecosystems, and for SCC in 2013 and 2014, and pre-construction surveys in 2015 and 2016 will assist final mitigation measure development. Accordingly, this condition is not required.

Section 5.11 (Comments, Commitments and Conditions), pages 68-69 states:

- "A commitment by Trans Mountain to no net loss of habitat. Consultants to Metro Vancouver estimate the Project will result in the permanent loss or alteration of treed lands, sensitive ecosystem, and modified ecosystem (Exhibit 34). The concept of no net loss is entrenched with respect to fisheries habitat and must be extended to Regional Parks conservation lands as well.
- With reference to no net loss of habitat within the affected Regional Parks and Greenways, Metro Vancouver requires comprehensive baseline studies

completed by certified environmental professionals, prior review of all proposed construction plans and associated mitigation programs, post installation audits and a program to monitor the impacts and assess the effectiveness of restoration and mitigation measures for an appropriate time frame.

- All survey work and pre-construction investigations, pipeline installation, and post-construction restoration is to be completed to standards that reflect the best practices for ecologically sensitive lands in urban and regional park lands. Such standards may exceed those for NEB linear energy corridors and would be generally reflective of the standards Metro Vancouver uses for works that it carries out in its parks and ecological conservancy areas."

The concept of 'no net loss' for Regional Parks is not a commitment by Trans Mountain, nor is this a standard industry recognized mitigation mechanism. The permanent and temporary loss of sensitive ecosystems as stated in the Zoetica report makes up 0.0367 ha (367,104 m^2) consisting of 0.024% of available SEI areas in Metro Vancouver. Areas of TWS during construction will be reclaimed and replanted after construction; therefore, only 0.0137 ha of SEI habitat has the potential to be permanently lost. Furthermore, there will be extensive areas where the right-of-way and work space areas will be reduced substantially to minimize impact on environmentally sensitive areas.

Baseline vegetation studies have been completed by certified environmental professionals and associated mitigation measures will be contained within the EPP based on review of the proposed construction plans. A comprehensive PCEM program will be conducted in the first 5 years following construction or as per CPCN conditions.

While it is not a requirement under the conditions of the NEB to follow best practices for ecologically sensitive lands in urban and regional park lands, the methods that were used to conduct baseline vegetation studies have been completed following similar standards that reflect the best practices as those described in the report titled Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia (BC MOE 2014a). Further studies will be conducted in 2015 and 2016, to mark the extent of any vegetation features of conservation concern that are intersected by the final footprint alignment. The mitigation hierarchy of avoidance, reduced disturbance, reclamation, and monitoring are consistent with best practices for ecologically sensitive lands in urban and regional park lands such as those set out by the BC MOE (2014a and 2014b). Accordingly, this condition is not required.

37.2 Métis Nation BC Written Evidence (Filing ID A4Q2H2)

Métis Nation BC submitted evidence (Filing ID A4Q2H2) seeking clarification regarding weeds, invasive plants and noxious weeds as well as inclusion of marsh plume thistle and common tansy as priority species for avoidance and management. Métis Nation BC also suggests that Latin names (scientific names) of vegetation species should be presented in each volume of the Application as common names may cause confusion. Métis Nation BC would like to have the supplemental rare plant survey results from 2014 made available for their review. Each of these issues is addressed in turn below.

Section 4.4 of the Vegetation Technical Report (Filing ID A3S2I7) describes weed and invasive plant designations under the applicable regulations in BC and Alberta, as well as those listed by Invasive Plant Councils and Regional Districts across BC or identified through consultation processes in BC or Alberta. Furthermore, within Section 4.4 of the Vegetation Technical Report, both marsh plume thistle (*Cirsium palustre*) and common tansy (*Tanacetum vulgare*) have been identified as priority weed species of concern under each applicable Invasive Plant Council, Regional District, or through consultation processes in BC or Alberta. Species nomenclature and applicable references are also described in Section 4.4 of the Vegetation Technical Report and observed plant species (both common names and Latin names) are listed by project segment in Appendix D of the Vegetation Technical Report.

Trans Mountain will provide the supplemental rare plant survey results from 2014 directly to the Métis Nation BC for their review.

37.3 Lower Nicola Indian Band Evidence (Filing ID A4Q7H4)

LNIB requests potential impacts to berry-producing shrubs be assessed specifically in the ESA rather than included under the 'native vegetation' indicator. They state that traditionally used plants are not described in detail or assessed with specific measurement endpoints as well as not broken out into specific pipeline segments as was done for other biophysical components in the ESA. LNIB suggest that mitigations should be applied to culturally important vegetation species and that their participation in supplemental surveys should occur to identify these species to ensure effective mitigation measures. LNIB is concerned with alteration of native vegetation and that proper and effective mitigation is required for their ability to practice Aboriginal rights.

Trans Mountain recognizes LNIB's concern for the potential loss of traditionally used plants in their traditional territory and specifically potential impacts to berry-producing shrubs. The approach to native vegetation as an indicator of vegetation communities of concern was selected because all native vegetation may be important for genetic diversity, including habitat for rare plant species and habitat for traditionally used plants. This approach is consistent with guidance from the *Filing Manual*, in conjunction with previously accepted vegetation survey recommendations, and guidelines as well as precedence set by developments of similar scope in the vicinity of the Project.

As previously filed in Section 7.0 of the Socio-economic Effects Assessment (Volume 5B; Filing ID A3S1S7), key recommendations and mitigation measures for potential effects related to alteration of plant harvesting sites include:

- Provide Aboriginal communities with the anticipated construction schedule and pipeline route maps, a minimum of 2 weeks before the start of construction in the vicinity of their respective communities.
- Work with Aboriginal communities to develop strategies to most effectively communicate the construction schedule and work areas to its members.
- Should additional plant harvesting sites be identified during ongoing engagement with Aboriginal communities, implement the TLU Sites Discovery Contingency Plan.

- Mitigation may include limiting the use of chemical applications, replacing of plant species during reclamation, or alternative site-specific mitigation strategies recommended by participating Aboriginal communities.

Furthermore, mitigation measures for potential effects related to alteration of native vegetation in Volume 5C, Section 7.2.9 of the Application (Vegetation Technical Data Report; Filing ID A3S2I7), recommends planting native shrubs or tree species, where warranted, depending on the site-specific objectives.

For areas that contained native vegetation before construction, reclamation will focus on the establishment of an early successional trajectory of a native vegetation community. Mitigation measures proposed in the Pipeline EPP (Filing IDs A3S2S3 and A3S2S4) provide conditions and commitments for reducing and monitoring invasive species infestations and spread during construction. A comprehensive post-construction monitoring program will be conducted in the first 5 years following construction or as per CPCN conditions.

LNIB will have an opportunity to discuss mitigation measures with Trans Mountain at EPP workshops to be held with Aboriginal groups in fall 2015.

37.4 References

Metro Vancouver. 2014. Sensitive Ecosystem Inventory for Metro Vancouver and Abbotsford 2010-2012 Technical Report. Metro Vancouver. Prepared by Del Meidinger, Meidinger Ecological Consultants Ltd.; Josephine Clark and David Adamoski, Metro Vancouver. Burnaby, British Columbia. http://www.metrovancouver.org/services/regional-planning/PlanningPublications/SEITechnicalReport.pdf

British Columbia Conservation Data Centre (BC CDC). 2015. BC Species and Ecosystems Explorer. http://www.env.gov.bc.ca/atrisk/toolintro.html.

Alberta Native Plant Council (ANPC). 2012. ANPC Guidelines for Rare Vascular Plant Surveys in Alberta – 2012 Update. April 2012. Alberta Native Plant Council. Edmonton, Alberta. 25 pp. http://www.anpc.ab.ca/content/newsfiles/Guidelines%20For%20Rare%20Plant%20Surveys%20in%20AB_2012%20Update.pdf.

Penny J. and R. Klinkenberg. 2012. Protocols for Rare Plant Surveys (Red- and Blue-listed Species). In: Klinkenberg, Brian (Editor) 2013. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, British Columbia. http://www.geog.ubc.ca/biodiversity/eflora/ProtocolsforRarePlantSurveys.html.

British Columbia Ministry of Environment (BC MOE). 2014a. Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia.

British Columbia Ministry of Environment (BC MOE). 2014b. Procedures for Mitigating Impacts on Environmental Values. Version 1.0. Ecosystems Branch. Environmental Sustainability and Strategic Policy Division. Victoria, British Columbia.

38.0 WILDLIFE AND WILDLIFE HABITAT

38.1 Species of Conservation Concern and their Habitat

The potential effects of the Project on species at risk and their habitat is a concern identified by intervenors in their evidence (*i.e.,* Elaine Golds [Filing ID A4L7Q7] evidence filed by the City of Port Moody, City of Coquitlam [Filing ID A4Q0I9], City of New Westminster [Filing ID A4Q0L5], Metro Vancouver [Filing ID A4L7Y3], Métis Nation of British Columbia [Filing ID A4Q2H2], Pro Information Pro Environment United People Network [Filing ID A4Q0Q5]). Trans Mountain recognizes the sensitivity of species at risk and is committed to implementing mitigation to avoid or reduce the Project's potential effects. Field surveys were initiated in 2013 and supplemental field surveys have been ongoing within segments of the pipeline corridor to collect additional information on SCC and their habitat. This information, in addition to targeted, site-specific pre-construction field surveys, will be used to inform the design and implementation of mitigation.

Trans Mountain provided an explanation of how avoidance of critical habitat was being considered as Project planning progresses in the response to GoC F-IR No. 1.023a (Filing IDs A3Z4S9 and A3Z4T0). During the ongoing Project planning and design phase, Trans Mountain has continued to consult with Environment Canada and provincial regulatory authorities regarding refined critical habitat mapping and attributes of critical habitat. In addition, field surveys have been ongoing to collect information at selected locations to inform the presence of biophysical attributes. This information will be used to determine overlap of the Project Footprint with critical habitat and allow for design modifications (*e.g.*, micro-routing) to avoid or reduce Project impacts to critical habitat.

The mitigation measures proposed in Volume 5A, Table 7.2.10-3 (Filing ID A3S1Q9) of the Application and subsequent filings incorporate industry best practices and regulatory guidelines. Additional mitigation measures are being developed in species-specific mitigation plans for several species at risk that are likely to be affected by the Project. These mitigation plans are being prepared for southern mountain caribou (NEB F-IR No. 1.42b; Filing ID A3W9H8), spotted owl (NEB IR No. 1.46c; Filing ID A3W9H8), Pacific water shrew (NEB F-IR No.1.44c; Filing ID A3Z4T3), Townsend's mole (NEB F-IR No. 1.44d; Filing ID A3Z4T4), coastal giant salamander (NEB F-IR No. 1.44d; Filing ID A3Z4T4), Lewis's woodpecker (NEB F-IR No. 1.45c; Filing ID A3Z4T6), Williamson's sapsucker (NEB F-IR No. 1.45c; Filing ID A3Z4T6), Oregon forestsnail (NEB IR No. 4.10; Filing ID A4K4W3) and Oregon spotted frog (NEB IR No. 4.10; Filing ID A4K4W3). These plans are being developed in consideration of the regulatory guidance and conservation or recovery objectives, as well as feedback received in consultation with provincial and federal regulatory authorities.

For terrestrial wildlife, Trans Mountain will update the mitigation presented in Volume 6B, Pipeline EPP, Appendix L, Table L-2 (Filing ID A3S2S3). These mitigation measures, as well as wildlife related contingency plans will address species with critical habitat that do not have a separate mitigation plan. The mitigation measures for wildlife and wildlife habitat are provided on the Environmental Alignment Sheets prepared for the Project. The Environmental Alignment Sheets and resource-specific mitigation tables for environmental resources and issues (such as Tables L-1 and L-2 for wildlife) identify specific locations where mitigation measures are to be implemented. The Environmental Alignment Sheets are used to identify the location of environmentally sensitive values/features and to provide specifications regarding the mitigation measures to be implemented. The EPP, including the Environmental Alignment Sheets will be updated and submitted to the NEB 90 days before construction in accordance with NEB Draft

Condition 29 as outlined in the NEB's Letter – Draft Conditions and Regulatory Oversight (April 16, 2014 [Filing ID A3V8Z8]). Environmental Inspectors will ensure implementation of site-specific measures during all phases of Project construction to reduce potential effects on species at risk and their habitat.

Trans Mountain will adhere to all applicable permit requirements, including any compensation offset requirements that may be associated with these permits. These offsets may entail a combination of compensation under the federal *Fisheries Act*, the federal policy on wetland conservation, and the *Species at Risk Act* (Simpcw FN IR No. 1.109e; Filing ID A3Y3Q5). Offsets to address Project residual effects or cumulative effects to species at risk or their critical habitat, if required, will be implemented (GoC IR No. 2.035a; Filing ID A4H6A5).

38.2 Oil Spills

Several intervenors expressed concerns regarding the potential for an oil spill to adversely affect wildlife and wildlife habitat (*i.e.,* evidence provided by Elaine Golds [Filing ID A4L7Q7] for the City of Port Moody, City of New Westminster [Filing ID A4Q0L5], Metro Vancouver [Filing ID A4L7Y3], Pro Information Pro Environment United People Network [Filing ID A4Q0Q5]). Measures to protect wildlife and wildlife habitat in the event of an oil spill, including species at risk and critical habitat, will be included in the ERP. Section 63 (Emergency Management Program) of this Reply Evidence provides additional information regarding the ERP.

38.3 Noise and Sensitive Timing Windows for Wildlife

The City of New Westminster (Filing ID A4Q0L5) and Metro Vancouver (Filing ID A4L7Y3) identified the potential adverse effects of noise disturbance on wildlife as a concern. Their written evidence highlights the proposed HDD around the Brunette River section of the Project as a particular concern.

The potential effects on wildlife from sensory disturbance during construction (*e.g.*, noise, artificial light, proximity to facilities and infrastructure, human activity and traffic) was assessed in the Application. Effects associated with reduced habitat effectiveness for wildlife and potential for habitat avoidance and temporary displacement or habitat abandonment and mortality risk are described and assessed in Volume 5A, Section 7.2.10 (Filing ID A3S1Q9). The potential effects of sensory disturbance on wildlife will be reduced by implementing mitigation to comply with appropriate regulatory guidelines related to noise during construction and operation of facilities, and avoiding sensitive timing windows for wildlife, to the extent feasible. Regulatory guidelines for avoiding sensitive timing windows and setbacks (buffers) for sensitive wildlife habitat features are incorporated into Project planning and mitigation. Trans Mountain is striving to schedule construction activities outside of sensitive timing windows for wildlife and other environmental and social elements. Field surveys were initiated in 2013 and supplemental field surveys have been ongoing within segments of the pipeline corridor to collect additional information regarding wildlife and their habitat. This information, in addition to targeted, site-specific pre-construction field surveys, will be used to further inform the design and implementation of suitable mitigation measures.

In addition, as construction planning for the Project progresses, noise modelling maps are being developed to depict noise levels and noise attenuation from Project construction into surrounding residential, recreational (including the Brunette River watershed), and business

areas (refer to response to the City of New Westminster IR No. 2C.2 [Filing ID A4H8F6]). The Noise Management Plan will use the result of the noise modelling to identify noise reduction requirements and measures at specific locations along the pipeline route, or for specific construction activities. Existing sources and levels of noise, such as highway, railway or industrial noise, will be considered in the development of appropriate noise mitigation in the Noise Management Plan. The Noise Management Plan will also incorporate the components of the NEB Draft Condition No. 29 (Pipeline EPP) and No. 32 (Horizontal Directional Drilling Noise Management Plan) of the NEB's Letter – Draft Conditions and Regulatory Oversight (April 16, 2014; Filing ID A3V8Z8) to limit the effect of noise at sensitive receptors and to include a monitoring component to verify effectiveness of noise controls.

38.4 Colony Farm Regional Park

The City of Coquitlam (Filing ID A4Q0I9) expressed concerns regarding the proposed pipe layout and staging area. The proposed temporary construction work space is needed to facilitate installation of the pipeline across the Fraser River. Consultation is ongoing to develop a plan that will reduce disturbance within the park. The proposed mitigation measures presented in Volume 5A, Table 7.2.10-3 (Filing ID A3S1Q9) will also be implemented, as necessary, to reduce the Project's residual effect on wildlife, including species at risk, in Colony Farm Regional Park.

38.5 Bats

Métis Nation of British Columbia (Filing ID A4Q2H2) expressed concerns about the lack of information provided for bats. Trans Mountain is aware that habitat features used by bats year-round are important, and that seasonal use needs to be considered into Project scheduling. The following work has been completed and/or is ongoing in an effort to identify rock features (*e.g.,* cliffs, crevices, caves) within the pipeline corridor that have the potential to support bat hibernacula:

- desktop review of aerial imagery and topographical data;
- review of immersive video of the existing TMPL right-of-way along segments paralleled by TMEP;
- aerial overflights completed as part of the wildlife field work includes a review of rock features;
- review of the BC Conservation Data Centre (BC CDC) records for known bat occurrences (none recorded);
- consultation with provincial regulators to receive available information on bats; and
- collaboration with TMEP engineers to review and discuss their assessment of surface rock encountered along the PPC.

In the event that disturbance to a rock feature with potential to support a bat hibernacula is identified, Trans Mountain will contact the appropriate regulatory agency to discuss if further survey work is needed. This commitment was previously stated for spotted bats in GoC IR No. 2.037a (Filing ID A4H6A5).

Summer roosts may include old mixedwood or deciduous forests containing large diameter decaying trees with cavities, crevices, or sloughing bark. Similar to the approach taken for migratory birds, clearing should avoid the period when maternity roosts are active. This period is typically from April to July. In the event clearing occurs within this period, in combination with non-intrusive surveys for migratory bird nests, searches for bat roost trees will be conducted. In the event an active roost tree is found, a protective buffer will be implemented based on consultation with provincial regulators.

38.6 Ungulates

LNIB; Filing ID A4Q7H4) is concerned about the sustainability of mule deer and moose populations in the Nicola River valley. Volume 5A, Section 7.2.10 (Filing ID A3S1Q9) of the Application describes the potential effects of the Project on ungulates, in particular moose, which was identified as an indicator to focus the assessment. The Project will alter habitat suitability for ungulates as a result of vegetation clearing, displacement or avoidance associated with sensory disturbance or perceived predation risk, and mortality risk from predation or hunting. Although clearing of vegetation along rights-of-way can increase forage, there are adverse effects associated with linear features providing improved access for predators and hunters. This is reflected in the habitat suitability model assumptions for moose provided in the Supplemental Wildlife Modelling Report (Filing ID A4H6D2), as habitat suitability is reduced to account for the potential adverse effects associated with linear disturbances. At the local scale (Wildlife LSAs), the Project is estimated to affect approximately 2.1% of effective winter security/thermal habitat and 2.4% of effective winter forage habitat (Lower Nicola IB IR No. 2.06; Filing ID A4H8T9). This level of disturbance is unlikely to have a detectable effect on local moose populations. The magnitude of potential Project effects on deer is expected to be similar.

Routing the Project within and adjacent to existing corridors and disturbances reduces the Project's effects on ungulates. Although substantial areas of the Wildlife RSA and surrounding landscape are identified as Ungulate Winter Range (UWR) u-3-003, the PPC in the LNIB traditional territory is located primarily in areas that are affected by urban and rural settlement, agriculture, forestry, and transportation activities. The PPC crosses UWR u-3-003 for approximately 39.2 km, of which approximately 26.0 km (66%) parallels the existing TMPL and a Spectra pipeline right-of-way. Portions of the remaining 13.2 km parallel other existing disturbances (*e.g.*, roads and highway). As a result, the Project avoids the larger, more intact patches of habitat delineated within UWR u-3-003. The General Wildlife Measures set out in the Order for UWR u-3-003 apply to minor tenures for forest harvest within the Merritt Timber Supply Area. The mitigation measures proposed in the ESA apply industry best practices to reduce clearing, to the extent feasible. This mitigation aligns the Project with the intent of the General Wildlife Measures to reduce loss of forest cover that provides snow interception for mule deer winter habitat. As noted, 13.2 km of the PPC within UWR u-3-003 deviates from existing linear disturbance to create a new linear disturbance. The potential for these segments of the Project right-of-way to increase access for non-Aboriginal hunters in the area will be mitigated with implementation of access management measures.

38.7 Cumulative Effects

Lower Nicola Indian Band's technical review of the ESA (Filing ID A4Q7H4) raised concerns with the cumulative effects assessment methodology. Existing cumulative effects on wildlife and wildlife habitat were evaluated through collection of quantitative and qualitative disturbance information, including a description of historic development and environmental trends. The

assessment incorporates consideration of habitat thresholds, where they are available, to characterize existing cumulative effects and the contribution of the Project and reasonably foreseeable developments to existing cumulative effects. The result is a transparent, quantitative evaluation of cumulative effects on wildlife indicators that accounts for existing, proposed and future disturbance relative to known critical thresholds of environmental change.

Although the LNIB technical review suggests the cumulative effects assessment for the Project scoped out evaluating the cumulative impact of residual effects that were determined unlikely to affect the viability or sustainability of a resource, all likely residual Project effects, whether or not they were determined to be significant, were carried through the cumulative effects assessment for the Project. The cumulative effects assessment approach adheres to the requirements of the NEB *Filing Manual* and is consistent with current cumulative effects practice.

The LNIB technical review suggested the Wildlife RSA is not large enough to understand cumulative effects at the population scale. The Wildlife RSA was delineated to assess the area within which the Project has a reasonable potential to interact with other developments to affect wildlife. As described in Volume 5A, Section 7.2.10.2 (Filing ID A3S1Q9) of the Application, the spatial extent of the study area represents a balance between an expansive study area that would dilute the apparent effects of the Project, and a small area that may be too small to capture cumulative impacts of other disturbances or to reflect the ecology of the wildlife indicator. The Wildlife RSA is consistent with the regional study area delineation approach used in recent assessments of federally and provincially regulated pipeline projects in British Columbia and Alberta.

The LNIB technical review noted literature published after the filing date of the Application that confirmed the reported declines in some moose populations in BC, which were reported in Volume 5A, Section 7.2.10. The ecological context provided for the wildlife indicators assessed includes estimations of wildlife populations and population trends, where this information was available. Additional context pertaining to threats, management and recovery or conservation objectives and guidelines, and literature that relates to resilience to environmental change was also provided. This context informs the assessment of cumulative effects on the wildlife indicators using an approach that integrates the ecological interactions of various effect pathways (*e.g.,* changes in habitat, movement and mortality risk), and the interactions of existing, proposed, and future projects.

Trans Mountain will continue to consult with provincial and federal regulatory authorities to ensure mitigation planning aligns with conservation and recovery objectives. Therefore, Trans Mountain concludes that the implementation of mitigation measures will effectively address the Project's potential residual and cumulative effects on terrestrial wildlife and wildlife habitat.

39.0 HERITAGE RESOURCES

Trans Mountain welcomes the opportunity to respond to the evidence (Filing IDs A4L7H1, A4L7H2 and A4L7H3) submitted by Mr. Fromhold on behalf of Samson Cree Nation. The main criticisms directed by Mr. Fromhold at the archaeological assessment conducted by CH2M HILL on May 22 to 31, 2013 have been addressed in previous IRs (Filing ID A4K6K0), but due to the serious and public nature of the allegations made by Mr. Fromhold, a more detailed response is presented.

- According to Mr. Fromhold, CH2M HILL failed in three main regards:
    1. To conduct and complete a Historical Resources Impact Assessment (HRIA) of the Project to acceptable standards;
    2. To conduct comprehensive and meaningful consultation with Aboriginal groups; and,
    3. To train and develop Aboriginal participants as qualified and professional archaeological field workers.

This response will demonstrate that the written evidence of Mr. Fromhold is inaccurate and seriously flawed regarding the archaeological assessment work conducted by CH2M HILL. Since the start of 2011, CH2M HILL has completed over 130 HRIA surveys in Alberta, none of which have been rejected by Alberta Culture and Tourism (ACT). CH2M HILL has a proven track record of conducting HRIA surveys in full compliance with all permit conditions and regulations under the *Historical Resources Act* (*HRA*) of Alberta. The archaeology crew for the May 22 to May 31, 2013 shift comprised three CH2M HILL archaeologists, three CH2M HILL TEK facilitators and nine Aboriginal participants. The Aboriginal participants are selected by their communities to engage in the archaeology studies and share TEK.

Mr. Fromhold participated on the archaeological survey for eight days of fieldwork between May 22 and May 31, 2013. The archaeological program began in in 2013 under ACT Permit 13-018 and will continue throughout 2015 under the same permit, with further work planned in 2016. To date, 271 crew days of field assessment have been conducted for the Alberta HRIA, including survey, subsurface testing, and mitigation. Mr. Fromhold could only reflect on a short period of time that does not represent the overall effort of the project, nor does it reflect the ongoing support the program has received from ACT. This will further be endorsed when permit approvals are issued for the professional work that has been carried out with a strong effort by Trans Mountain to provide the opportunity for Aboriginal communities to engage on the program.

The degree of survey completeness in any location is subject to a number of factors, including the weather, land access rights, time constraints, the relationship of heritage resources (if present) to the PPC, and the approval of ACT. During the eight days of field survey that Mr. Fromhold was involved in as a participant, persistent rainy weather prevented the crew from completing the archaeological assessment as originally planned. This fact was acknowledged by Mr. Fromhold in his own report and he agreed with the decision of the archaeologists not to proceed with subsurface testing under such conditions.

On the matter of survey quality and the qualifications of the archaeologists who conducted the HRIA, Trans Mountain disagrees strongly with Mr. Fromhold. The views of Mr. Fromhold regarding the experience levels of the CH2M HILL archaeologists are apparently based largely upon the gender, ethnicity, and perceived youthful appearance of those archaeologists.

Furthermore, it appears Mr. Fromhold did not attempt to either learn or record the names of the archaeologists he criticizes in his report, which raises serious doubts regarding his ability to assess and understand the archaeological experience of those women. The objective facts run contrary to the assertions made by Mr. Fromhold. Ashleigh Beard was the archaeological crew lead for the HRIA fieldwork conducted on the shift between May 22 and May 31, 2013. At the time of the assessment, she held her bachelor of arts in archaeology and had accumulated five years of experience working on archaeological projects for CH2M HILL, as well as experience before that. Having grown up in Alberta and Saskatchewan, Ms. Beard is an experienced prairie province archaeologist and in every respect was qualified to be leading the archaeological field crew. Likewise, the other two archaeologists on the crew, Lauren Christian and Joelle Ingram, both held their bachelors of arts in anthropology with a specialization in archaeology at the time of the assessment in May 2013. All three of the field archaeologists brought their previous archaeological experiences, practical skill sets and a wealth of archaeological knowledge to the job and by all measures met the rigorous CH2M HILL hiring standards for the positions to which they were hired. In the opinion of Trans Mountain, the belief that archaeological ability is predetermined by gender or ethnicity is not substantiated. Trans Mountain does not agree that the relative age of an archaeologist automatically corresponds with an individual's level of knowledge or ability. The criticisms of Mr. Fromhold have fundamentally mischaracterized the abilities and experience levels of those archaeologists.

Mr. Fromhold further contends that sites, artifacts, and areas of potential were not correctly identified during the HRIA, and that the archaeologists, at times, did not accept his opinion in these matters. Trans Mountain believes it to be both the prerogative and the legal duty of professional archaeologists in the field to assess potential evidence on the merits of the individual artifact, site, or area of potential. All archaeological crew leads for the Project were and are trained fully in these fundamental skills and have the professional ability to recognize heritage material warranting protection under the *HRA* of Alberta and to differentiate protected heritage resources from materials found during field studies which do not merit *HRA* protection. Field assessment methodologies used on the Project represent provincial best practices. All methodologies employed during the HRIA were vetted by ACT before fieldwork and codified in the Permit requirements for the Project. HRIA fieldwork for the Project during the 2013 field season was conducted in full compliance with the *HRA* and all requirements and conditions of Permit 13-018, and Trans Mountain stands by the results of that assessment. CH2M HILL has a long-standing record of correctly identifying and recording artifacts, archaeological sites, historic sites, and areas of archaeological potential in all regions of Alberta. CH2M HILL has a clear and demonstrable track record of successfully completing HRIAs in Alberta and of fulfilling all Permit requirements to the satisfaction of ACT.

Managing a large, mixed crew of archaeologists, technicians, and Aboriginal participants necessitates a flexible and sensitive approach where the needs of an individual are balanced against the needs of the crew and the Project as a whole. Remote survey areas may be difficult to access, resulting in additional time spent in travel to and from the survey area. Trans Mountain supported the engagement of Aboriginal representatives on the archaeology program. Since there are multiple Aboriginal groups with interests in the area, this will often result in larger groups to mobilize to sites, which takes additional time and planning. Furthermore, when layered on with access constraints and wet weather this can make field days challenging with little progress, as it did during the period when Mr. Fromhold was present. This was not the case for the entire program. Issues can and do arise over the course of what can be a long day in the

field. When a participant voices a concern or a need, an attempt is made to accommodate any reasonable request, even if that request may result in a perceived loss of efficiency.

For potential Aboriginal participants, a form detailing the nature of the work and the requirements for the position is sent to the leadership of Aboriginal groups in the area where fieldwork is to take place. Aboriginal participants are selected by their leadership to represent the interests of their community. Mr. Fromhold asserts that Trans Mountain should have assumed the task of training all Aboriginal participants to professional levels, stating that "*No structured training was provided. There is no structured training plan. Such in-field training* as *may have been done is considered to have been about 5% effective and useful.*" All Aboriginal participants attended a Project kick-off meeting as well as daily safety orientation meetings before each day of fieldwork. While on the job, participants are told about the various types of cultural material they may encounter during the assessment, are shown how to conduct a pedestrian survey and, if applicable, the correct methodology for subsurface testing at an area of archaeological potential. Trans Mountain maintains that it is beyond the scope of the Project to train participants to the level of accredited, professional archaeologists – that is the mandate of academic institutions.