APPLICATION FOR APPROVAL OF THE TAMARACK INTEGRATED OIL SANDS PROJECT

VOLUME 5: SUPPLEMENTAL INFORMATION REQUEST #2

Submitted to:

Energy Resources Conservation Board

and

Alberta Environment

Submitted by:

Ivanhoe Energy Inc.
Calgary, Alberta

June 2012

Ivanhoe Energy

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VIA COURIER

July 6, 2012

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Energy Resources Conservation Board
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Calgary, AB T2P 0R4

Ms. Jolene Shannon
Alberta Environment & Sustainable Resource Development
Room #111, 4999 – 98th Avenue
Edmonton, AB T6B 2X3

Dear Mr. Jagirdhar and Ms. Shannon:

Re: Supplemental Information Request for the Integrated Application for the Ivanhoe Tamarack Project, ERCB Application No. 1665921 and EPEA Application No. 001-267615

In support of the application filed with the Alberta Energy Resources Conservation Board (ERCB) and Alberta Environment (now Alberta Environment & Sustainable & Resource Development (ESRD)) on October 29, 2010, Volume 5 – Supplemental Information Request #2 (SIR #2) is hereby submitted to address the combined ERCB and AESRD Supplemental Information Request letter dated March 28, 2012.

Revisions to Question 30 were received by email on June 28, 2012. Answers to this revised question are forthcoming.

Correspondence regarding the Integrated Application and the EIA should be directed to:

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Yours truly,

Ivanhoe Energy Inc.

Jeremy Hrdlicka
Director, Regulatory, HS&E

Encl.

Preamble

This document, identified as *Volume 5 – Supplemental Information Request #2*, forms part of the application submitted by Ivanhoe Energy Inc. (Ivanhoe) to the Alberta Energy Resources Conservation Board (ERCB) and to Alberta Environment & Sustainable Resource Development (AENV) for approval of the Tamarack Integrated Oil Sands Project.

Pending approval, Ivanhoe plans to build and operate the Tamarack Integrated Oil Sands Project. ERCB Application No. 1665921 and *Environmental Protection and Enhancement Act* (EPEA) Application No. 001-267615 were submitted for approval on 29 October 2010. The application documents (in three volumes of hard copy and in CD format) were also made available for public review and commentary.

The ERCB and AENV completed a review of the Tamarack Integrated Oil Sands Project application and on 28 March 2012, the ERCB issued a second combined Supplemental Information Request (SIR) to Ivanhoe Energy Inc. The SIR contains 115 supplemental questions, and included combined requests from the ERCB, AENV and interested Federal Regulators. Revisions to Question 30 were received by email on June 28, 2012. Answers to this revised question are forthcoming.

Volume 5 is organized as follows:

- Project Update;
- Final ERCB/AENV SIR is the Supplemental Information Request issued on 28 March 2012;
- ERCB and AENV provide Ivanhoe responses to the 115 information requests; information is provided in the same numerical sequence as the questions posed in the SIR; and
- appendices provide additional information to support specific SIR responses as well as additional information requests from the ERCB.

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Glossary, Acronyms and Abbreviations

%	Percent
µg	Microgram (one one-thousandth of a gram)
µg/g	Micrograms per gram
$\mu g/m^3$	Micrograms per cubic metre
<	Less than
>	More than
°C	Degrees Celsius
AAAQO	Alberta Ambient Air Quality Objectives
AAAQO	Ambient Air Quality Objective
AADT	Annual Average Daily Traffic
AAFRD	Alberta Agriculture Food and Rural Development
ACFN	Athabasca Chipewyan First Nation
ADMF	Acid Deposition Management Framework
Admixing	The mechanical mixing of discrete layers of soil during stripping and salvage operations.
Adverse effect	An undesirable or harmful effect to an organism (human or animal), indicated by some result such as mortality, altered food consumption, altered body and organ weights, altered enzyme concentrations or visible pathological changes.
AENV	Alberta Environment and Sustainable Resource Development
AGRASID	Agricultural Region of Alberta Soil Inventory Database
Al-Pac	Alberta-Pacific Forest Industries Inc.
ALSA	Aquatics Local Study Area
Ambient air	The air in the surrounding atmosphere.
Amendment, soil	An alteration of the properties of a soil by adding substances such as lime, gypsum and sawdust to make the soil more suitable for the growth of plants. Fertilizers constitute a special group of soil amendments.
Anthropogenic	Man-made
AOSERP	Alberta Oil Sands Environmental Research Program
API	American Petroleum Institute

AQ	Air Quality
AQLSA	Air Quality Local Study Area
AQRSA	Air Quality Regional Study Area
Aquifer	Any water-saturated body of geological material from which enough water can be drawn at a reasonable cost for the purpose required. A common usage of the term aquifer is to indicate the water-bearing material in any area from which water is most easily extracted.
Aquifer Test	A method of obtaining quantitative information on the hydraulic characteristics of an aquifer by removing water from the aquifer in a controlled manner and measuring the groundwater surface or piezometric response. Often referred to as a pump test or drawdown test.
Aquitard	A material of intermediate permeability between an aquifer and an aquiclude. An aquitard allows some measure of leakage between the aquifers it separates.
ARSA	Aquatics Regional Study Area
ASDT	Average Summer Daily Traffic
ASRD	Alberta Sustainable Resource Development
ASWQG	Surface Water Quality Guidelines for use in Alberta
AT	Alberta Transportation
ATSDR	Agency for Toxic Substances and Disease Registry
Attenuation	A reduction in sound level that occurs with sound propagation over distance by means of physical dissipation or absorption mechanisms, or a reduction in sound level that occurs by means of noise control measures applied to a sound source.
avg.	Average
A-Weighted Level or dBA	A measurement of overall sound pressure level that accounts for the frequency content of the measured sound assessed with a frequency response similar to that of the human ear.
Background	An area not influenced by chemicals or noise released from the site under evaluation.
Background Concentration (environmental)	The concentration of a chemical in a defined control area during a fixed period of time before, during or after a data-gathering operation.
BAF	Bio-accumulation Factors
Baseline	A surveyed condition, which serves as a reference point to which later surveys are coordinated or correlated.
Basic Sound Level	The allowable sound level at a residential location, as defined by the ERCB directive, with the inclusion of industrial presence based on dwelling unit density and proximity to transportation noise sources.
bbls	Barrels

bbls/d	Barrels per day
BC	Base cation
BCF	Bioconcentration Factor
Bedrock	The body of rock that underlies the gravel, soil or other superficial material.
Benthic invertebrates	Organisms that live at the bottom of lakes, ponds or streams.
Benzene	A colourless, liquid, flammable, aromatic hydrocarbon that boils at 80.1ºC and freezes at 5.4-5.5ºC. It is used to manufacture styrene and phenol.
BFW	Boiler feed water
Bioaccumulation	A general term, meaning that an organism stores within its body, a higher concentration of a substance than is found in the environment. This is not necessarily harmful. Many toxicants, such as arsenic, can be handled and excreted by aquatic organisms, so that they are not included among the dangerous bioaccumulative substances.
Bioconcentration	A process in which an organism receives a net accumulation of a chemical as a result of direct exposure to the chemical.
Bitumen	Extra heavy crude oil, generally more dense than 14ºAPI.
BMA	Basal McMurray Aquifer
BMR	Birch Mountain Resources Ltd.
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BTU	British Thermal Unit
C&R	Conservation and Reclamation
CAC	Criteria Air Contaminant
$CaCl_2$	Calcium chloride
$CaCO_3$	Calcium carbonate
CAESA	Canada-Alberta Environmentally Sustainable Agriculture Agreement
CALMET	California Meteorological Model. Used to process meteorological data for input into the CALPUFF model.
CALPUFF	California Puff model, used to estimate ambient concentrations of substances in air and deposition of those substances (e.g., acid deposition).
CAPP	Canadian Association of Petroleum Producers
CARB	California Air Resources Board
Carcinogen	An agent that is reactive or toxic enough to directly cause cancer.
CCME	Canadian Council of Ministers of the Environment

CCS	Carbon Capture and Storage
CCV	Critical Chemical Values
CDF	Commercial Demonstration Facility
CDWQ	Canadian Drinking Water Quality
CDWQG	Guidelines for Canadian Drinking Water Quality
CEA	Cumulative Effects Assessment
CEMA	Cumulative Environmental Management Association
CEPA	Canadian *Environmental Protection Act*
CEQG	Canadian Environmental Quality Guidelines
CHA	Cardiac Hospital Admission
Chronic exposure	A relatively long duration of time (Health Canada considers periods of human exposure greater than 3 months to be chronic while the U.S. EPA only considers human exposures that are greater than seven years to be chronic).
cm	Centimetre
cm/s	Centimetres per second
cm^2	Square centimetre
CMAR	Clearwater Multi-Use Access Road
$cmol(+)kg^{-1}$	Centimole of positive charge per kilogram of soil.
CNRL	Canadian Natural Resources Ltd.
CNS	Central Nervous System
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Concentration (Conc.)	Quantifiable amount of a chemical in environmental media.
COP	Code of Practice
COPC	Chemical of Potential Concern
COS	Carbonyl sulphide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPDFN	Chipewyan Prairie Déne First Nation
CPF	Central Processing Facility

CS_2	Carbon disulphide
CWS	Canada-Wide Standard
dam^3	Cubic decametre
dB and dBA	Decibel
Development Area	The area of sufficient bitumen resource delineation to permit appropriate development.
Devonian	A period of the Paleozoic era thought to have covered the span of time between 400 and 345 million years ago; also, the corresponding system of rocks.
DFO	Department of Fisheries and Oceans
Dilbit	Diluted bitumen
Diluent	Fluids used to reduce the viscosity (thickness) of heavy oils, such as bitumen based-crude oil, in order to thin them enough to transport through pipelines.
DO	Dissolved oxygen
Dose	A measure of integral exposure. Examples include (1) the amount of chemical ingested, (2) the amount of a chemical taken up, and (3) the product of ambient exposure concentration and the duration of the exposure.
Dose Rate	Dose per unit time, for example in mg/day, sometimes also called dosage. Dose rates are often expressed on a per-unit-body-weight basis, yielding units such as mg/kg body weight/day expressed as averages over a specified time period (e.g., a lifetime).
Dose-Response	The quantitative relationship between exposure of an organism to a chemical and the extent of the adverse effect resulting from that exposure.
Drawdown	Lowering of water level caused by pumping. Drawdown is measured for a given quantity of water pumped during a specified period, or after the pumping level has become constant.
DRU	Diluent Recovery Unit
dS/m	Decisiemens per metre
DTS	Distributed temperature sensors
EC	Electrical Conductivity
Effective Porosity	The percentage of the total volume of a given mass of soil or rock that consists of interconnecting voids.
EIA	Environmental Impact Assessment
ELC	Ecological Land Classification
elev.	Elevation
Environmental Impact Assessment	A review of the effects a proposed development will have on the local environment and the regional environment.

EPA	Environmental Protection Agency
EPEA	*Environmental Protection and Enhancement Act* (Alberta)
ERCB	Energy Resources Conservation Board
Erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.
ERP	Emergency Response Plan
ESD	Emergency Shut Down
Evapotranspiration	Combined term for water lost as vapour from the soil/water surface (evaporation) and water lost through plants (transpiration).
Exceedance	An emission or ambient concentration with a measured value that is greater than that allowed by government regulations.
Exposure	The contact between a chemical and a biological system or organism.
Exposure Concentration	The concentration of a chemical in its transport or carrier medium at the point of contact.
Exposure Limit	An estimate of the daily dose of chemical allowed over an entire lifetime, without experiencing adverse health effects, or with an acceptable degree of risk (for non-threshold chemicals) associated with exposures. Exposure limits are expressed in mg/kg body weight/day.
Exposure Pathway	The route by which a receptor comes into contact with a chemical or physical agent. Examples of exposure pathways include the ingestion of water, food and soil, the inhalation of air and dust, and dermal absorption.
FGD	Flue Gas Desulphurization
Flare	A device for disposing of combustible gases from refining or chemical processes by burning in the open.
FMFN	Fort McMurray First Nation
Fresh water	Water with a total dissolved solids concentration below 1 000 g/m^3.
FTF	Feedstock Test Facility
FWMIS	Fisheries and Wildlife Management Information System
g	Gram
g/GJ	grams/Gigajoule
GHG	Greenhouse Gas – a substance in air that may trap radiated heat from Earth, thereby increasing ambient temperatures.
GIS	Geographic Information System
GJ or Gj	Gigajoule (10^9 Joules)

GJ/d or Gj/d	Gigajoule per day
GJ/hr or Gj/hr	Gigajoule per hour
Glaciofluvial	Sediments or landforms produced by meltwaters originating from a glacier or ice sheet.
Gleysolic Soil	A great group of soils in the Gleysolic order. A Gleysolic soil is characterized by the presence of a gleyed horizon (e.g., Bg, Btg) formed by intermittent contact with the water table.
GPS	Global Positioning System
Groundwater	Subsurface water that occurs beneath the water table in soils and geological formations (in the pores/voids within rocks both unconsolidated and consolidated) that are fully saturated. It is the water within the Earth that supplies water wells and springs.
Groundwater Flow Model	A simplified representation of one or more groundwater flow systems. In the present report, a numerical groundwater flow model is used to represent the groundwater flow systems in the regional study area.
H or hr	Hour
H^+	Hydrogen Ion
H_2S	Hydrogen sulphide
ha	Hectare
Habitat	The part of the physical environment in which a plant or animal lives.
Habitat Suitability Index	A model system that integrates the important ecological parameters (food availability, nesting/den requirements, responses to disturbances, etc.) for a wildlife species to allow for an evaluation of baseline conditions and project effects.
HC	Health Canada
HHRA	Human Health Risk Assessment
Historical Resource	A work of nature or by humans, valued for its palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest.
Historical Resources Impact Assessment	A review of the effects a proposed development will have on the local and regional historic and prehistoric heritage of an area.
HP	High Pressure
HQ	Hazard Quotient
HRSA	Hydrogeology Regional Study Area
HTL™	Heavy-to-Light
Human Health Risk Assessment	The process of defining and quantifying risks and determining the acceptability of those risks to human life.

Hydraulic Conductivity	A coefficient “k” depends on the physical properties of geological formation and fluid. It describes the ease with which a fluid flows through a porous material. “k” is the rate of flow per unit cross-sectional area under the influence of a unit gradient and has the dimension of: $Length^3/Length^2$ x Time or Length/Time (e.g., m/s) but should not be confused with velocity.
Hydraulic Gradient	The change in groundwater elevation per unit of distance in a given direction. If not specified, the direction generally is understood to be that of the maximum rate of decrease in head. This coefficient is dimensionless.
Hydraulic Head	A measure of the potential energy of a fluid. For groundwater, the hydraulic head at a specific point is the level to which groundwater will rise above a fixed datum (usually sea level) in an observation well.
Hydrogeology	The science that relates to groundwater. Groundwater, as used here, includes all water in the zone of saturation beneath the earth’s surface, except water chemically combined in minerals.
Hz	Hertz
IARC	International Agency for Research and Cancer
ID	Interim directive
IDA	Initial Development Area
ILCR	Incremental Lifetime Cancer Risk
Infiltration	The flow or movement of precipitation or surface water through the ground surface into the ground. Infiltration is the main factor in recharging groundwater reserves.
Invertebrate	An animal without a backbone and internal skeleton.
IOR	Imperial Oil Resources
IRC	Industry Relations Corporation
IRIS	Integrated Risk Information System
JSA	Job Safety Analysis
k	Thousand
KB	Kelly bushing
keq	Kilogram equivalent – equal to 1 kmol of hydrogen ion (H+)
keq/ha/yr	Kiloequivalent per hectares per year
kg	Kilogram
kg/d	Kilograms per day
kg/ha	Kilograms per hectare
kg/ha/yr	Kilograms per hectare per year

kg/hr	Kilograms per hour
kg/sd	Kilograms per stream day
kJ/kWh	Kilojoules per kilowatt hour
km	Kilometre
km^2	Square kilometre
kPa	Kilopascal
L or l	Litre
L/kg	Litres per kilogram
L/min	Litres per minute
Land Capability Classification	A system of classifying a soil's capability to sustain a commercial forest.
LARP	Lower Athabasca Regional Plan
LCCS	Land Capability Classification
L_{eq}	Energy Equivalent Sound Level
LFH	Leaf-Fibre-Humic Substances; a soil horizon
Lithology	A term usually used to describe the composition and texture of sediments and rocks.
LOAEL	Lowest Observed Adverse Effect Level
LOC	License of Occupation
LP	Low Pressure
LSA	Local Study Area
m	Metre
M	Mega (SI prefix)
m/m	Metres/metre
m/s	Metres per second
m/yr	Metres per year
m^2	Square metre
m^3	Cubic metre
m^3/d	Cubic metres per day
m^3/s	Cubic metres per second

masl	Metres Above Sea Level
max	Maximum
mbgs	Metres below ground surface
MCFN	Mikisew Cree First Nation
mD	MilliDarcies
MD	Measured depth
MDL	Method Detection Limit
mg	Milligrams
mg/d	Milligrams per day
mg/kg/d	Milligrams per kilograms body weight per day
mg/L	Milligrams per litre
mg/m^3	Milligrams per cubic metre
mg/Nm^3	Milligrams per normal cubic metre
min	Minimum
mm	Millimetre
MNA	Métis Nation of Alberta
Model Calibration	The trial-and-error process of matching the hydraulic heads and groundwater flows in a numerical groundwater flow model with observed values. An acceptable model calibration depends on the intended use of the numerical model.
Modelling	A simplified representation of a relationship or system of relationships. Modelling involves calculation techniques used to make quantitative estimates of an output parameter based on its relationship to input parameters. The input parameters influence the value of the output parameters.
MOP	Maximum Operating Pressure
MPOI	Maximum Point of Impingement
mS/cm	Millisiemens per centimetre
MSL	Mineral Surface Lease
MW	Megawatt
MWD	Measurement while drilling
N	Nitrogen
N.D.	No data

N/A (or n/a)	Not applicable
n/d	Not detected
NH_4	Ammonia (particle)
NIA	Noise Impact Assessment
NO	Nitric oxide (gas)
NO_2	Nitrogen dioxide (gas)
NO_3	Nitrate (particle)
NO_3/NO_2	Nitrate/nitrite
NOAEL	No-Observable-Adverse-Effect-Level
NOEC	No Observed Effect Concentration
Noncarcinogen	A chemical that does not cause cancer and has a threshold concentration.
NO_X	Gaseous oxides of nitrogen (NO, NO_2) or all nitrogen species (e.g., NO_X, N_2O, N_3O).
O_3	Ozone
OBIP	Original Bitumen in Place
Oil Sands (or Oilsands)	An unconsolidated, porous sand formation or sandstone containing or impregnated with petroleum or hydrocarbons.
OLM	Ozone Limiting Method
Organics	Chemical compounds, naturally occurring or otherwise, which contain carbon, with the exception of carbon dioxide (CO_2) and carbonates (e.g., $CaCO_3$).
OSDG	Oil Sands Developers Group
OSE	Oil Sands Exploration
Overburden	1. Any loose material that overlies bedrock (often used as a synonym for Quaternary sediments and/or surficial deposits). 2. Any barren material, consolidated or loose, that overlies an ore body.
PAHs	Polycyclic Aromatic Hydrocarbons
PAI	Potential Acid Input
Particulate Matter	May be relatively large and derived from crustal sources such as road dust (>10 µm), or relatively small and derived from combustion sources (both natural and anthropogenic; 2.5 to 10 µm), or may be derived through reactions in the atmosphere (secondary particulates; <2.5 µm).
PDA	Pre-disturbance Assessment
PDC	Planned Development Cases

Permeability	A physical property of a porous medium. Permeability has dimensions of Length^2. When measured in cm^2, the value of permeability is very small, therefore, more practical units – darcy (D) or millidarcy (mD) – are commonly used.
Permissible Sound Level	The allowable overall A-weighted sound level of noise from energy industry sources, as specified by the ERCB Noise Control Directive, which may contribute to the sound environment of a residential location.
PFD	Process Flow Diagrams
pH	A measure of the acidity or alkalinity (based upon the concentration of the hydrogen ion) of a solution. The pH is expressed as the negative logarithm of hydrogen ion concentration.
Phie	Effective porosity
Phreatic Surface	Synonymous with unconfined groundwater surface.
Physiography	Synonymous with geomorphology.
Piezometer	An instrument for measuring fluid pressure.
Piezometric Surface	An imaginary surface that everywhere coincides with the static level of the water in the aquifer. The surface to which the water from a given aquifer will rise under its full head.
PM	Particulate Matter
PM_{10}	Particulate matter, with particles nominally smaller than 10 μm in diameter.
$PM_{2.5}$	Particulate matter, fine fraction (particles less than 2.5 μm in diameter).
Polycyclic Aromatic Hydrocarbons	Chemical by-products of petroleum. Aromatics are considered to be highly toxic components of petroleum products. PAHs are comprised of at least two fused benzene rings, many of which are potential carcinogens. Toxicity increases along with molecular size and degree of alkylation of the aromatic nucleus.
Potential Acid Input	A measure of the total deposition of acidifying substances (including sulphur dioxide, nitrogen oxides, ammonium and base cations).
ppb	Parts per billion
ppm	Parts per million
PSL	Permissible Sound Level
Q	Quarter (i.e., three months of a year)
QA/QC	Quality Assurance/Quality Control
RAMP	Regional Aquatics Monitoring Program
RCMP	Royal Canadian Mounted Police
Receptor	The person or organism subjected to chemical exposure.

Recharge	Water added to the saturated zone from any source. This term is commonly combined with other terms to indicate some specific mode of recharge, such as recharge well, recharge area or artificial recharge.
Reclamation	The process of stabilizing and returning disturbed land to a natural state of equivalent or better capability.
Reference Value	The maximum acceptable dose (per unit body weight and unit of time) of a chemical to which a specified receptor can be exposed, assuming a specified risk (e.g., one in one hundred thousand). May be expressed as a reference dose (RfD) for threshold-response chemicals or as a risk-specific dose (RsD) for non-threshold response chemicals.
Regional Langrangian Acid Deposition Model	A model used to estimate acid deposition (as PAI).
REL	Reference Exposure Level
RELAD	Regional Langrangian Acid Deposition Model
RfC	Reference Concentration
RfD	Reference Dose
RFMA	Registered Fur Management Area
RHA	Respiratory Hospital Admissions
RIC	Resource Inventory Committee
RID	Regional Integrated Decision
Risk	The likelihood or probability that the toxic effects associated with a chemical will be produced in populations of individuals under their actual conditions of exposure. Risk is usually expressed as the probability of occurrence of an adverse effect, i.e., the expected ratio between the number of individuals who would experience an adverse effect at a given time and the total number of individuals exposed to the factor. Risk is expressed as a fraction without units and takes values from 0 (absolute certainty that there is no risk, which can never be shown) to 1.0, where there is absolute certainty that a risk will occur.
Risk Assessment	The process whereby all available scientific information is brought together to produce a description of the nature and magnitude of the risk associated with exposure of human receptors to an environmental chemical.
Risk Specific Dose	The reference value determined for chemicals assumed to act as genotoxic (Risk Specific Dose), non-threshold carcinogens. An RsD is a function of carcinogenic potency (q1) and defined acceptable risk (i.e., q1 divide target level or risk, for example, the RsD for a lifetime cancer risk of one-in-one-million would be equal to q1 divided by 1x 10^6).
Risk Specific Dose	The reference value determined for chemicals assumed to act as genotoxic, (risk-specific dose) non-threshold carcinogens. An RsD is a function of carcinogenic potency (q1) and defined acceptable risk (i.e., q1 divide target level or risk; for example, the RsD for a lifetime cancer risk of one-in-one-million would equal to q1 divided by 1x 10^6).

Risk-Based Concentration	An exposure criterion that is based on the likelihood of an effect occurring.
RIVAD/ARM3	Regional Impact in Visibility and Acid Deposition/Acid Rain Mountain Mesocale Model
RIWG	Regional Issues Working Group
RMWB	Regional Municipality of Wood Buffalo
ROW	Right-of-way
RPD	Relative Percent Difference
RSA	Regional Study Area
RSC	Reduced Sulphur Compound
RsD	Risk Specific Dose
s	Second
SAGD	Steam Assisted Gravity Drainage
SAR	Species at Risk
SARA	*Species at Risk Act*
SCO	Synthetic Crude Oil
SD	Sustainability Department
Sec	Section
Seepage	1. Slow water movement in subsurface. 2. Flow of water from man-made retaining structures. 3. A spot or zone where water oozes from the ground, often forming the source of a small spring.
SEWG	Sustainable Ecosystems Working Group of the Cumulative Environmental Management Association (CEMA)
SIR	Supplementary Information Requests
SME	Surface Materials Exploration
SO_2	Sulphur dioxide
SOC	Statement of Concern
SOP	Standard Operating Procedure
SOR	Steam to Oil Ratio
Sound Power Level	A measurement of the acoustic energy of a sound source, which uses a logarithmic scale and which is normally calculated from sound pressure level measurements near the source.

SO_X	Oxides of sulphur
sp.	Species (singular)
spp.	Species (plural)
Stakeholder	People or organizations with an interest or share in an undertaking, such as a commercial venture.
STC	Sound Transmission Class
Steam Assisted Gravity Drainage	A process of extracting bitumen by injecting steam through a series of wells into a formation containing bitumen and recovering the released bitumen through a second set of wells.
STP	South Tailings Pond
Stratigraphy	The geological science concerned with the study of sedimentary rocks in terms of time and space.
t	Tonne
t/d	Tonne per day
t/e^3m^3	Tonnes per 1000 cubic metres
TC	Tolerable Concentration
TD	Total Depth
TDI	Tolerable Daily Intakes
TDS	Total Dissolved Solids, in water
TEF	Toxic Equivalency Factor
TEK	Traditional Ecological Knowledge
TKN	Total Kjeldahl Nitrogen
TLSA	Terrestrial Local Study Area
TLU	Traditional Land Use
TOC	Total Organic Carbon
Tonne	Metric ton (1 000 kg)
TOR	Terms of Reference
Total Suspended Solids	Particles suspended in water.
Toxic	A substance, dose, or a concentration that is harmful to a living organism.
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.

TPH	Total Petroleum Hydrocarbon
TPM	Total Particulate Matter
Transmissivity	The product of the average coefficient of hydraulic conductivity (or permeability) and the thickness of the aquifer. Consequently, transmissivity is the rate of flow under a hydraulic gradient equal to unity through a cross-section of unit width over the whole thickness of the aquifer. Transmissivity is designated by the symbol T and has the dimension of: Length^3/Time x Length or Length^2/Time (e.g., m^2/day)
TRSA	Terrestrial Regional Study Area
TRV	Toxicity Reference Value
TSS	Total Suspended Solids
TU	Traditional Use
TUS	Traditional Use Study
U.S.	United States of America
U.S. EPA	United States Environmental Protection Agency
UN	Unnamed Creek
Uptake	The process by which a chemical crosses an absorption barrier and is absorbed into the body.
USGS	United States Geologic Survey
UWI	Unique Well Identifier
VEC	Valued Ecosystem Component
VOC	Volatile Organic Compound
Volatile Organic Compound	A class of organic chemicals that volatilize under ambient conditions. May be of natural or anthropogenic origin.
VRU	Vapour Recovery Unit
WBEA	Wood Buffalo Environmental Association
WHO	World Health Organization
WMU	Wildlife Management Unit
WCSS	Western Canadian Spill Service
WSC	Water Survey of Canada
yr	Year

Ivanhoe Energy

Project Update

Project Update

Ivanhoe proposes the following updates to the Project:

- amended Project Development Area;
- change the proposed cap rock from the Wabiskaw D shale to the Wabiskaw B shale;
- revision to pattern configuration;
- update to the Reservoir Monitoring Plan; and
- watercourse assessment and well pad layout modifications.

Ivanhoe met with the ERCB technical staff on three occasions from May through June 2012 to discuss the following topics:

- Reservoir Monitoring Plan update (10 May 2012);
- Tamarack seismic review and cap rock assessment (16 May 2012);
- geomechanical modelling (16 May 2012); and
- maximum operating pressure (MOP) (12 June 2012).

As a result of the meetings, the ERCB provided Ivanhoe with five additional Supplementary Information Requests (SIRs) by email on 12 June 2012, the responses to which have been provided in Appendix SIR2 A.

In addition, the ERCB requested that any revisions to well trajectories for patterns A-H include the resubmission of the cross sections identified in Volume 1, Section 2.0, Figures 2.1-46 to 2.1-53. Appendix SIR2 B includes the following:

- Figure 2.1-46 (Rev): SAGD Well Cross Section for Pattern A in Phase 1 Development Area;
- Figure 2.1-47 (Rev): SAGD Well Cross Section for Pattern B in Phase 1 Development Area;
- Figure 2.1-48 (Rev): SAGD Well Cross Section for Pattern C in Phase 1 Development Area;
- Figure 2.1-49 (Rev): SAGD Well Cross Section for Pattern D in Phase 1 Development Area;
- Figure SIR2 B-1: SAGD Well Cross Section for Pattern E in Phase 1 Development Area (replaces Figures 2.1-50 (Rev) and 2.1-50);
- Figure 2.1-52 (Rev): SAGD Well Cross Section for Pattern F in Phase 1 Development Area;
- Figure 2.1-53 (Rev): SAGD Well Cross Section for Pattern G in Phase 1 Development Area; and
- Figure SIR2 B-2: SAGD Well Cross Section for Pattern H in Phase 1 Development Area.

Two new figures, originally presented during the 12 June 2012 meeting, are provided in Appendix SIR2 C:

- Figure SIR2 C-1: Wabiskaw B Shale Isopach map; and
- Figure SIR2 C-2: Top Clearwater Shale to Top Wabiskaw C Isopach Map.

Project Development Area

After consultation with the ERCB, the Project Development Area is amended such that the boundaries of the Project Development Area conform to full legal sub-division (LSD) boundaries along the perimeter of the proposed development (Figure SIR 6-1 (Rev)).

Proposed Cap Rock

Previously Ivanhoe has advocated that the Wabiskaw D shale was the effective cap rock over the Project Development Area since it was laterally continuous shale/siltstone with very low measured permeability and no evidence of significant *in situ* fracturing. As an additional margin of safety, the presence of mixed facies inclined heterolithic stratification (IHS) in the Upper McMurray sand, which underlies the Wabiskaw D shale, is expected to be the effective barrier to steam rise. This is consistent with observations from other operating steam assisted gravity drainage (SAGD) projects.

The newly acquired 2D seismic data has allowed Ivanhoe to understand the structure at the Wabiskaw B level in more detail. As a result of this work and discussions with the ERCB, Ivanhoe is now proposing that the Wabiskaw B shale be the cap rock for the Project. The Wabiskaw B shale is a laterally continuous shale interval overlying the Project Area and has consistent thicknesses between 5 to 6 m (Appendix SIR2 C, Figure SIR2 C-2). Directly overlying the Wabiskaw B shale are the Wabiskaw A and Clearwater shales which forms an effective cap rock thickness of between 46 to 73 m (Appendix SIR2 C, Figure SIR2 C-2). The seismic data has allowed Ivanhoe to understand a structural high and associated faulting principally located in Pattern G in more detail. It has been determined that the interpreted faults bounding the local high are insignificant in scale compared to the thickness of the continuous shale interval comprised of the Base Wabiskaw B through top of Clearwater shale. This topic is discussed in more detail in the SIR2 3 to SIR2 12 and Appendix SIR2 A, responses 1 through 3.

The previously proposed MOPs by pattern have not changed as a result of the cap rock change from the Wabiskaw D shale to the Wabiskaw B shale, however, the modelled factor of safety has improved as a result of the change. The factors of safety at the Base of Wabiskaw B shale using the Worst Case and Best Case model assumptions are 1.7 and 2.8, respectively.

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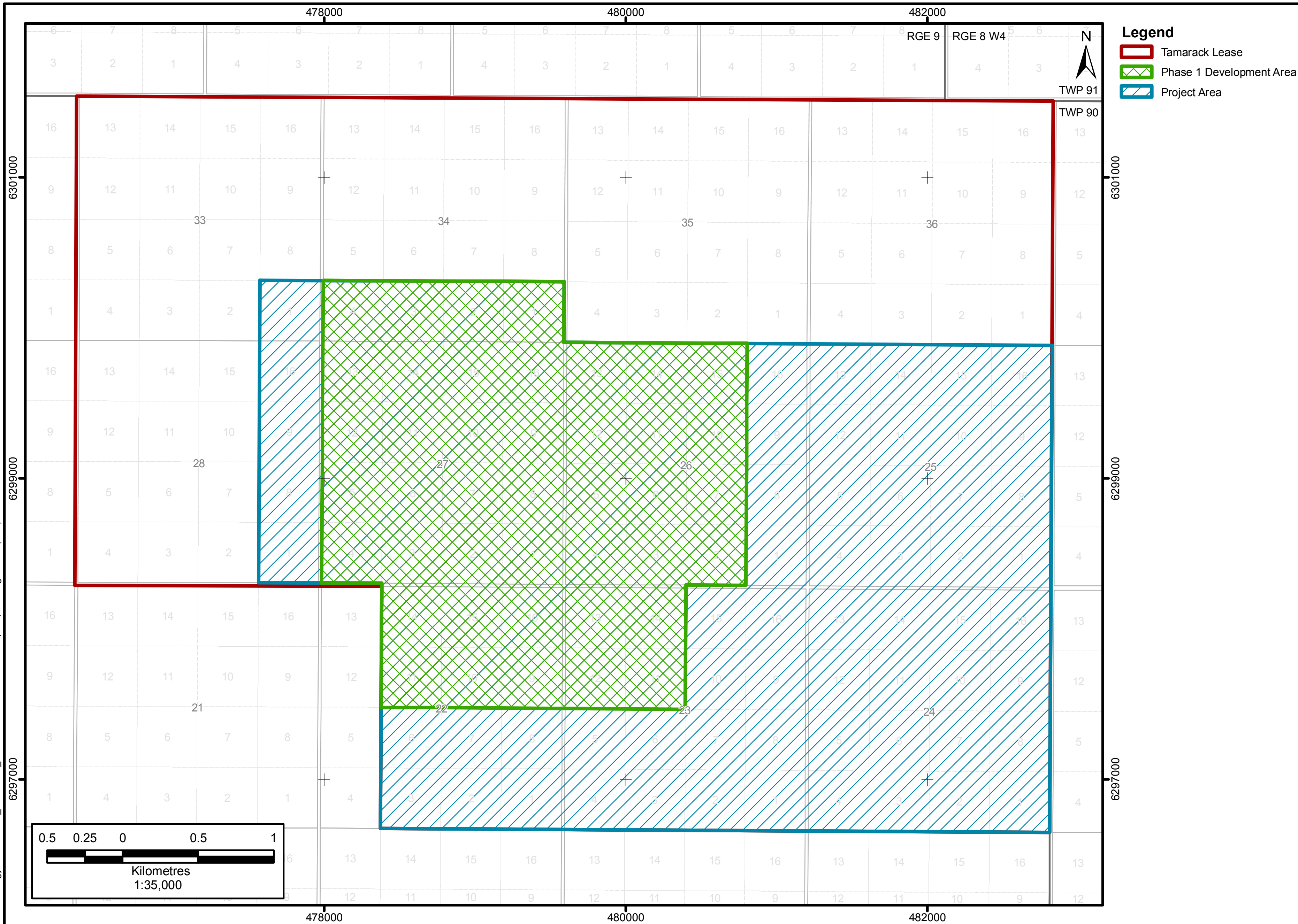

Sources: Ivanhoe, Spatial Data Warehouse Ltd.

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Ivanhoe Energy

Tamarack Project

Project Area and Phase 1 Development Area

DATE: June 2012		SIR-Fig006-01 (Rev) 12-06-29			**Figure SIR 6-1 (Rev)**
PROJECT: CE0374601		PROJECTION/DATUM: UTM Zone 12 NAD83			
ANALYST: TM	QA/QC: TJR MAJ EH	DRAWN BY: AMEC	PREPARED BY: AMEC		

Pattern Configuration

As a result of an improved understanding of the local high in Pattern G Ivanhoe is proposing that well pattern boundaries for Patterns A and G be slightly modified to reflect adjusted well paths in the vicinity of interpreted faults. Figure SIR2 PU-1 shows the new pattern boundaries, as well as the Phase 1 Area reservoir statistics and original bitumen in place (OBIP) calculations (Table SIR 9-1 (Rev)). The SAGD well cross sections for Pattern A and G are presented Appendix SIR2 B. The well-pairs were adjusted to maintain a 100 m buffer around fault features and to maintain as close to a horizontal trajectory as possible.

Reservoir Monitoring Plan

The observation wells and monitoring locations discussed in Volume 4 have been modified in order to establish a near real time monitoring program to assess surface and subsurface impacts associated with SAGD operations while at the same time minimizing surface disturbance. The program will encompass the acquisition of both surface and downhole well data (observation wells, producing wells and injection wells) to provide real time information for the monitoring of the Project. The program will also monitor for any effects on the Suncor mineral surface lease (MSL) due to the Project operations.

The monitoring program is designed around a holistic approach which will combine measurements and data from a number of different sources in order to obtain an accurate understanding of the SAGD processes within the reservoir and to monitor for any subsurface changes. This information will provide the basis for operational adjustments to improve performance and to provide an early warning of subsurface changes that may require action to mitigate any adverse impacts.

Ivanhoe's Reservoir Monitoring Plan will consist of the following:

- observation wells;
- tiltmeter array with GPS stations;
- production and injection well downhole monitoring; and
- InSAR corner point reflector array.

The revised plan is described in more detail in Appendix SIR2 D.

Watercourse and Well Pad Footprint Assessment

Based upon SIRs from ERCB, AENV and Alberta Sustainable Resource Development (ASRD) regarding the final location and footprint of well pads and other Project infrastructure, particularly in relation to watercourses and appropriate buffer zones for development, as per Directive 056: *Energy Development Applications and Schedules*, 01 September 2011 (Directive 056) and the *Approval Standards Enhanced Approval Process*, 30 May 2011 (Approvals Standards EAP), Ivanhoe undertook additional field investigations to identify potential impacts related to the Project footprint.

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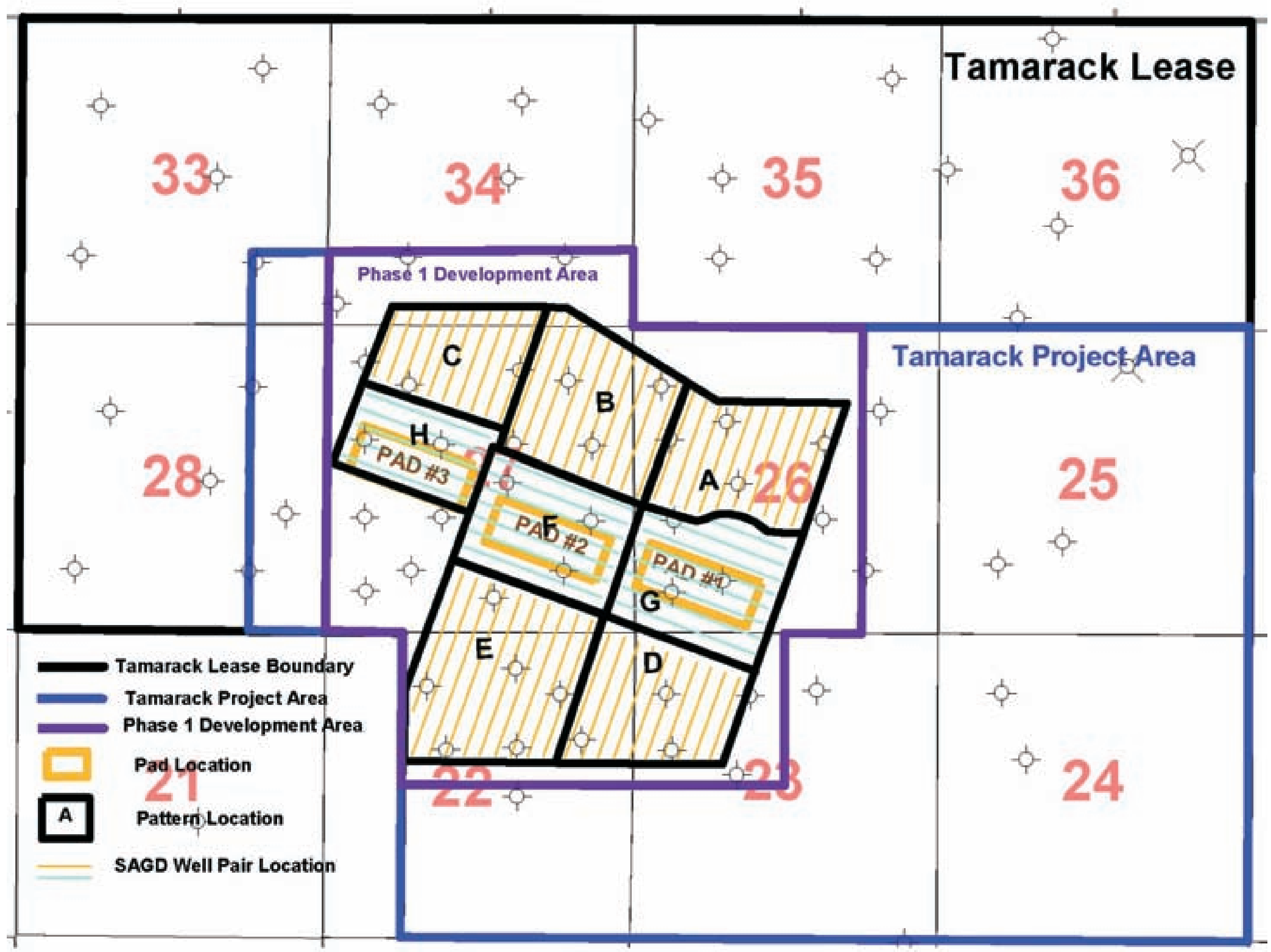

Source: Ivanhoe.

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Ivanhoe Energy
Tamarack Project

Phase 1 Well Pads, Patterns and SAGD Well Pairs

DATE: June 2012	SIR2-FigPU-01 12-06-27	
PROJECT: CE0374601	DRAWN BY: AMEC	
ANALYST: TM / QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

Figure SIR2 PU-1

Table SIR 9-1 (Rev): Tamarack Project Reservoir Properties and OBIP per Pattern

Pattern	A	B	C	D	E	F	G	H	Total Phase 1 SAGD Drainage Revised 06-09-2012	Total Phase 1 SAGD Drainage from Application Volume 1	Phase 1 Development Area	Project Area
Area (ha)	55.950	62.500	43.670	56.553	81.918	52.680	57.838	35.540	446.649	446.649	682.163	1657.122
Area (Acres)	138.3	154.5	107.9	139.8	202.4	130.2	143.0	87.8	1 104	1 104	1 685	4 095
Ave Gross Pay Thickness (M)	38.6	45.5	40.4	27.3	34.5	44.4	34.6	44.2	39.3	37.75	37.6	27.58
Ave Developable Pay Thickness (M)	33.3	34.0	35.1	25.3	30.5	34.2	22.4	36.1	32.6			18.14
N/G Ratio (Gross Pay/Developable Pay)	0.86	0.75	0.87	0.93	0.88	0.77	0.65	0.82	0.84			0.66
Ave Porosity in Gross Pay	0.31	0.33	0.34	0.30	0.32	0.33	0.33	0.34	0.32	0.33	0.32	0.30
Ave Porosity in Developable Pay	0.32	0.33	0.35	0.28	0.32	0.34	0.33	0.32	0.32		0.32	0.31
Ave Oil Saturation in Gross Pay	0.78	0.74	0.67	0.75	0.72	0.76	0.82	0.69	0.73	0.75	0.73	0.71
Ave Oil Saturation in Developable Pay	0.78	0.75	0.67	0.76	0.73	0.74	0.82	0.71	0.73		0.73	0.73
0BIP from Gross Pay (million M^3)	5.2	6.9	4.0	3.4	6.5	5.8	5.5	3.6	41.0	41.6	58.9	98.7
OBIP from Gross Pay (million bbls)	32.9	43.4	25.3	21.5	40.7	36.7	34.3	22.8	257.7	261.4	370.3	619.8
OBIP from Developable Pay (million M^3)	4.7	5.3	3.6	3.1	5.9	4.5	4.1	2.9	34.1		50.0	67.2
OBIP from Developable Pay (million bbls)	29.4	33.3	22.5	19.4	37.0	28.1	26.0	18.5	214.1		314.3	422.2
Ratio Developable OBIP/Gross OBIP	0.89	0.77	0.89	0.90	0.91	0.76	0.76	0.81	0.83		0.85	0.68
Recovery Efficiency (% of Developable OBIP)	65	65	65	65	65	65	65	65	65		65	65
Developable Reserves (M^3)	3.0	3.4	2.3	2.0	3.8	2.9	2.7	1.9	22.2		32.5	43.7
Developable Reserves (million bbls)	19.1	21.6	14.6	12.6	24.1	18.2	16.9	12.0	128.8	121-161	185.2	274
SAGD Producer Elev. Above Sea Level	238-240	236-239	238-240	246-248	242-245	238-239	258	236-240				

On 15 May 2012, an aerial reconnaissance of the Project Area was conducted to confirm the distance of the proposed well pad footprints to adjacent watercourses. Upon further investigation, it was determined that the north tributary to Unnamed Tributary 2 did not have a discernible channel along its length. The low gradient drainage/fen was primarily composed of sedges and no evidence of scour or deposition was found. In addition, the south fork of Unnamed Tributary 1 does not have a discernible watercourse along its length there is no evidence of deposition or scour. Therefore, Well Pads 1, 2, 3, 4, 5, 10 and 12 are not in proximity to a watercourse (Table SIR2 PU-1). Photo documentation of most well pad locations is provided in Figures SIR2 PU-2 through PU-9.

Table SIR2 PU-1: Minimum and Average Distances of Project from Watercourses

Well Pad	Minimum Distance to High Water Mark of Nearest Watercourse (m)	Minimum Distance to High Water Mark of Nearest Watercourse (m) for Adjusted Well Pad Footprints
1	1 492.8	1 492.8
2	1 284.4	1 284.4
3	1 146.2	1 146.2
4	1 684.1	1 684.1
5	1 530.8	1 530.8
6	94.1	100.0
7	69.6	105.1
8	1 566.3	1 566.3
9a	1 753.6	1 753.6
9b	1 630.2	1 630.2
10	774.5	774.5
11	818.9	818.9
12	771.4	771.4
CPF	711.1	711.1
Average	1 094.9	1 097.8

The larger watercourse that occupies the middle of the Unnamed Tributary 2 watershed had sections of defined and undefined channel interspersed with large beaver impoundments. Short, defined sections of channel were typically associated with impoundments as water spilled over or through the dams causing scour and deposition downstream. The upper reaches of the watercourses had little to no beaver activity and therefore no sections of defined channel. Pad 7 is located upstream of majority of the beaver activity and no defined channel is present. However, Well Pads 6 and 7 are within the minimum setback distance of 100 m from the bed and shore of semi-permanent ponds/wetlands and shallow open water ponds and lakes as prescribed in the Approval Standards EAP Section 100.4.5. To avoid the potential impact, Ivanhoe has adjusted the current footprint of these well pad locations to maintain the minimum setback distance by adjusting the southwest corner of Well Pad 6 and moving Well Pad 7 approximately 30 m to the east (Table SIR2 PU-1). Figure SIR2 PU-10 shows the updated Project footprint and Unnamed Tributary 1 and Unnamed Tributary 2 reclassified as watercourses with No Defined Channel.

Based on the reclassified drainages and the revision of the Project footprint, channel diversions are no longer required and the 100 m watercourse buffer is being maintained. Ivanhoe is confident that this information and the Project footprint adjustments result in a reduction in potential Project environmental impacts.

Photo 1: Looking east along boundary of Pad 2. No discernible channel was found within the drainage adjacent to the pad location.

Photo 2: Looking west, no watercourse was found in the muskeg drainage.

Ivanhoe Energy	**Well Pad 2**	PROJECT: Tamarack Project	**Figure SIR2 PU-2**
		DATE: June 2012	
		JOB No.: CE0374601	

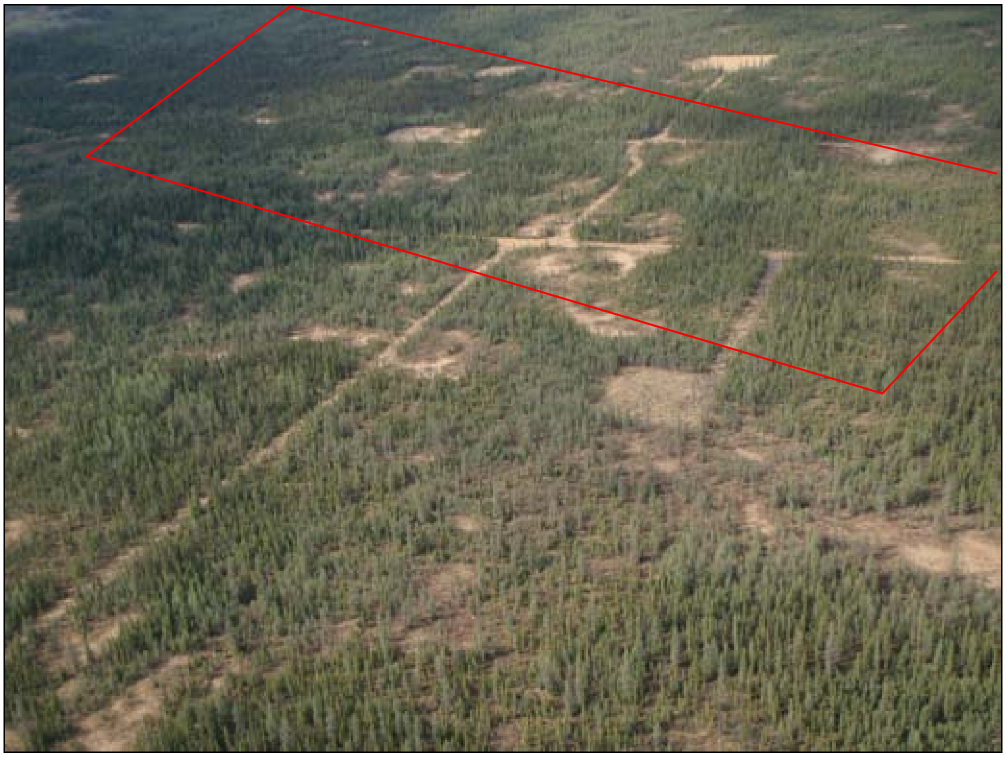

Photo 1: Looking north at Pad 3 showing no watercourse in the vicinity of the pad boundary.

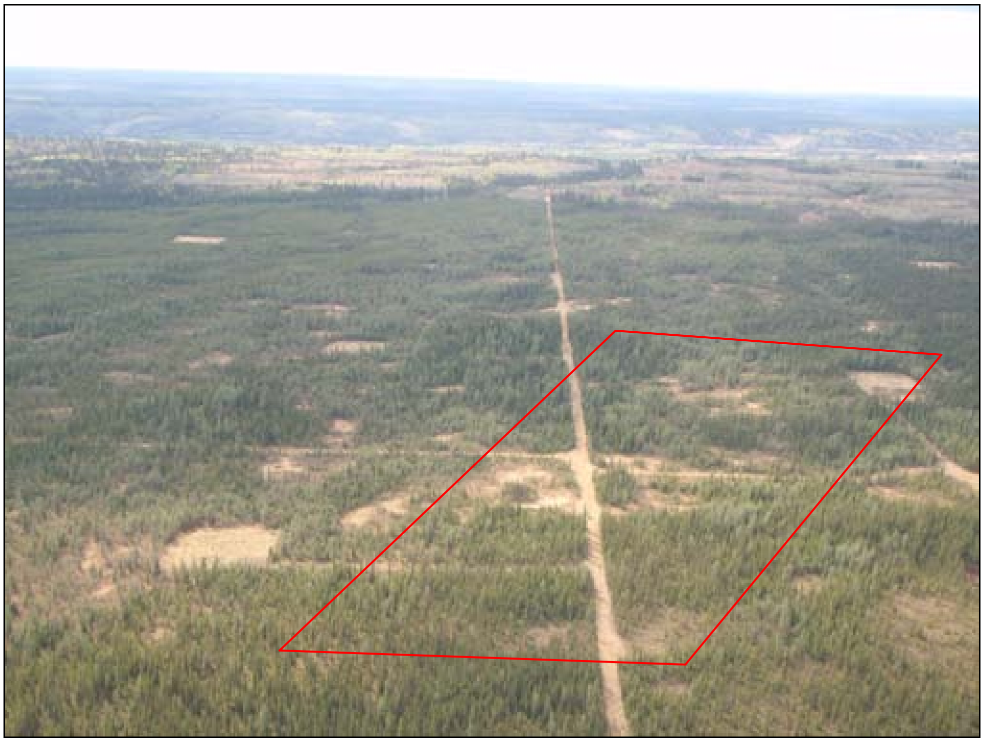

Photo 2: Looking west at Pad 3. No watercourse observed south of pad boundary.

Ivanhoe Energy	**Well Pad 3**	PROJECT: Tamarack Project DATE: June 2012 JOB No.: CE0374601	**Figure SIR2 PU-3**

Photo 1: Looking east at Pad 5, no discernible channel was observed in identified muskeg drainage west of the pad boundary.

Photo 2: Looking west, no watercourses in the vicinity of the pad boundary.

Ivanhoe Energy	**Well Pad 5**	PROJECT: Tamarack Project DATE: June 2012 JOB No.: CE0374601	**Figure SIR2 PU-4**

Photo 1: Looking north at the northwest corner of Pad 6, no discernible channel within or along the west boundary of the Pad 6.

Photo 2: Looking southeast at northwest corner of Pad 6, no watercourse in the vicinity of the pad boundary.

Ivanhoe Energy	**Well Pad 6**	PROJECT: Tamarack Project DATE: June 2012 JOB No.: CE0374601	**Figure SIR2 PU-5**

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Photo 1: Looking east at west boundary of Pad 7. No discernible channel was observed upstream of the large beaver impoundment.

Aerial 1: Figure shows pad boundary in relationship to beaver impoundments. No discernible channel was found flowing through the pad location connecting the beaver impoundments within the drainage.

Ivanhoe Energy	**Well Pad 7**	PROJECT: Tamarack Project DATE: June 2012 JOB No.: CE0374601	**Figure SIR2 PU-6**

Photo 1: Looking south at Pad 10. No discernible channel in the vicinity of the pad boundary.

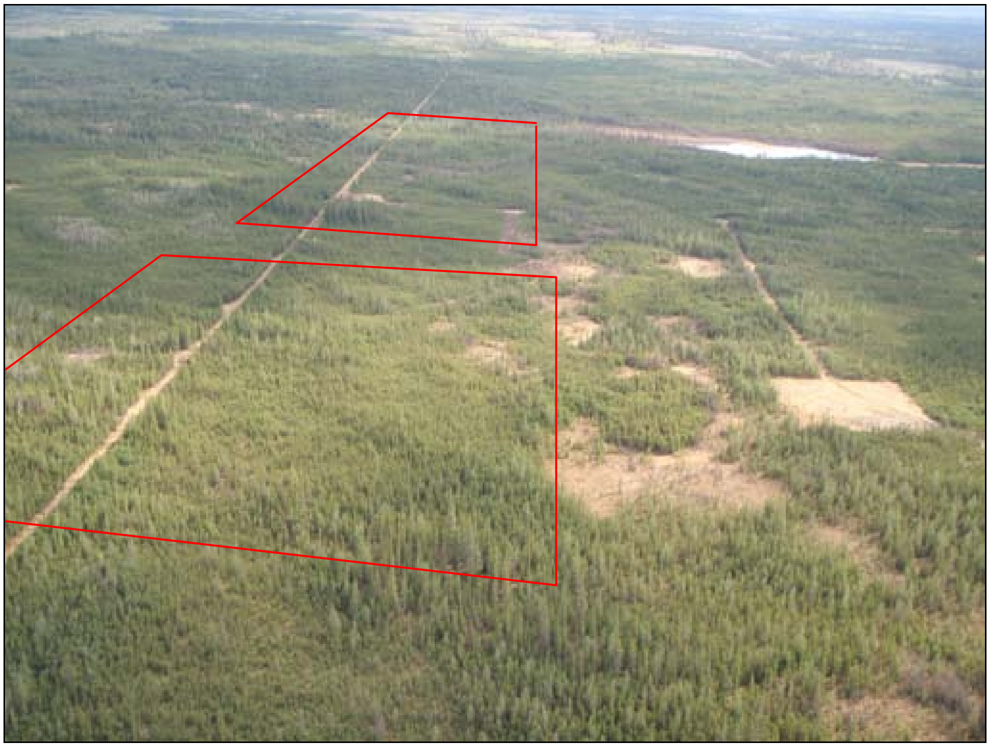

Photo 2: Looking south with Pad 10 in the foreground and Pad 6 to the south. No discernible channel located along the west boundary of either pad.

Ivanhoe Energy	Well Pad 10	PROJECT: Tamarack Project DATE: June 2012 JOB No.: CE0374601	Figure SIR2 PU-7

Photo 1: Looking northeast along boundary of Pad 11. No discernible channel observed along muskeg drainage.

Photo 2: Looking west, no discernible channel observed in drainage.

Ivanhoe Energy	**Well Pad 11**	PROJECT: Tamarack Project DATE: June 2012 JOB No.: CE0374601	**Figure SIR2 PU-8**

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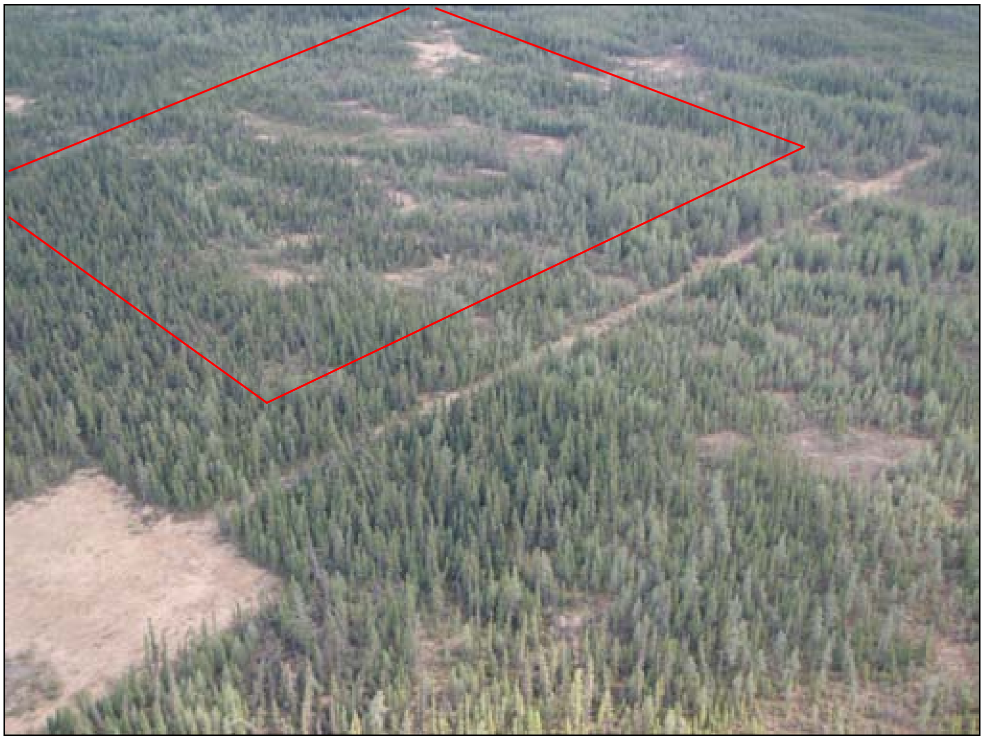
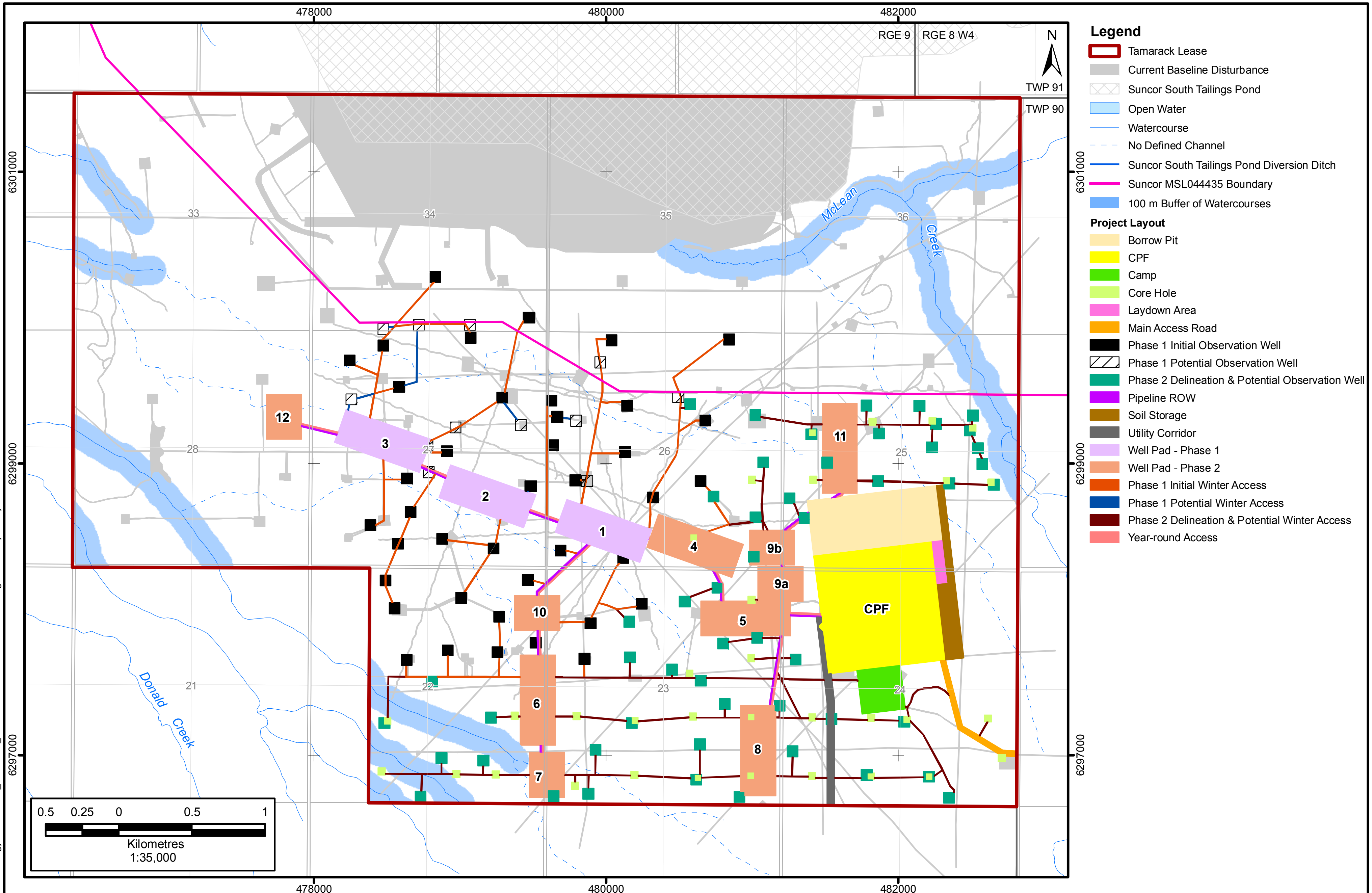


Photo 1: Looking southeast at Pad 12. No watercourse was found in the vicinity of the pad.

Photo 2: Looking north along the east boundary of Pad 12. No watercourse was found running through the proposed pad location.

Ivanhoe Energy	**Well Pad 12**	PROJECT: Tamarack Project DATE: June 2012 JOB No.: CE0374601	**Figure SIR2 PU-9**



Sources: Ivanhoe, Spatial Data Warehouse Ltd.

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Ivanhoe Energy
Tamarack Project

Project Layout

DATE: June 2012		SIR2-FigPU-10 Project Layout 12-06-29		Figure SIR2 PU-10
PROJECT: CE0374601		PROJECTION/DATUM: UTM Zone 12 NAD83		
ANALYST: TM	QA/QC: TJR MAJ EH	DRAWN BY: AMEC	PREPARED BY: AMEC	

Ivanhoe Energy

Final ERCB/AENV
Supplemental Information Request #2

Ivanhoe Energy
Tamarack Integrated Oil Sands Project
Supplemental Information Request
EPEA Application No. 001-267615
ERCB Application No.1665921
March 28, 2012

Table of Contents

1. Acronyms used in this Supplemental Information Request

The following acronyms are used in this Supplemental Information Request.

AAAQO	Alberta Ambient Air Quality Objectives
AQRSA	Air Quality Regional Study Area
BATEA	Best available technology economically achievable
CMAR	Clearwater Multiuse Access Road
CO_2e	Carbon Dioxide equivalents
CPF	Central Processing Facility
FGD	Flue Gas Desulphurization
GHG	Greenhouse Gas
HTL	Heavy-to-Light
NO_x	Nitrogen oxides
PAH	Polycyclic Aromatic Hydrocarbons
PDA	Pre-disturbance Assessment
VOC	Volatile Organic Compound

2. ERCB Commercial Application

The responses to questions in this ERCB section will not be considered as part of the EIA completeness decision made by Alberta Environment and Water.

2.1. General

1. Provide an update on the status of stakeholder (public and industry) notification and consultation respecting the subject application, including a discussion on any concerns or objections respecting the subject application (including any objections submitted to the ERCB and statements of concern submitted to Alberta Environment and Water) and the efforts to resolve them.

2. **Supplemental Information Response #6, Figure SIR 6-1, Tamarack Project Area and Phase 1 Development Area, Page ERCB-24.**
Supplemental Information Response #15, Figure SIR 15-1, Gross SAGD Reservoir Thickness (m) Isopach, Page ERCB-58, and Figure SIR 15-4, Developable SAGD Reservoir Thickness (m) Isopach, Page ERCB-61.
   a. The project area illustrated in Figures SIR 6-1 and Figure SIR 15-4 differ in the inclusion of five Legal Subdivisions (LSD) in the eastern portion of Sections 28 and 33-090-09W4M. Clarify the apparent discrepancy and confirm the applied-for project and development area boundaries, using Alberta Township Survey (ATS) grid to a LSD level to define the areas.
   b. Figure SIR 15-1 illustrates that the southeast quarter of Section 25 and the north half of Section 24 contain no developable McMurray bitumen. The ERCB recognizes that

Ivanhoe plans to construct the central processing facility on portions of Sections 24 and 25. Clarify whether bitumen recovery is also planned for this area over the life of the Tamarack Project.

2.2. Geology

3. **Supplemental Information Response #9, Figure SIR 9-1, Phase 1 Pattern and Pad Development Areas, Page ERCB-44.**

Figure SIR 9-1 illustrates an additional drainage pattern, H, beneath Pad 3 that was not previously illustrated in Figure 2.1-3 in the application. In the original application, Figures 2.1-46 to 2.1-53 provided SAGD well cross sections for Patterns A through G within the Phase 1 application area. Provide a similar cross section for the proposed additional Pattern H illustrated in Figure SIR 9-1.

4. **Supplemental Information Response #9, Table 9-1, Tamarack Project Reservoir Properties and OBIP per Pattern, Page ERCB-45.**

Ivanhoe indicates that the area of the proposed drainage patterns range from 360 to 812 ha. The identified areas are very large and appear to be in error. Review the size of drainage patterns A through H stated in Table 9-1 and resubmit the table if necessary.

5. **Supplemental Information Response #11, Page ERCB-48**.

Ivanhoe states, "*for reservoir management purposes, the Wabiskaw D cap rock is the proposed reference cap rock for the Project.*"

a. Discuss Ivanhoe's rationale for defining the Wabiskaw D as the caprock for the proposed project.

b. Discuss the potential impacts on the proposed operations of defining the Wabiskaw A and Clearwater shale as caprock, given that the Wabiskaw A shale is only separated from the Wabiskaw D by approximately four metres.

6. **Supplemental Information Response #14, Figure SIR 14-3, Top Wabiskaw Member Structure Contour (masl), Page ERCB-56.**

Figure SIR 14-3 illustrates 22 metres of structural relief in the Wabiskaw Member over the proposed development area. Ivanhoe states that this structural collapse is "*related to salt dissolution continued on a regional scale after deposition of the Wabiskaw and Clearwater Shale*". SIR 14 requested Ivanhoe to "*comment on how the structural collapse may affect caprock integrity*"; however, Ivanhoe does not appear to have addressed this in its response. Discuss how the salt dissolution related structural collapse may affect caprock integrity in the proposed project area.

7. **Supplemental Information Response #15, Page ERCB-57.**

   As a result of revisions to interpretation of original bitumen in place (OBIP), Ivanhoe has provided an updated “*best case OBIP*” for the Phase 1 development area of 41 million m3. Provide a corresponding updated OBIP calculation for the proposed project area.

8. **Supplemental Information Response #16, Page ERCB-63.**

   In addition to its core analysis of the Wabiskaw D, Ivanhoe has obtained core over the lower sections of the Clearwater Formation. The ERCB considers core over the entire Clearwater interval to be important to the understanding of caprock lithology and fractures, and for the comparison of and calibration with imaging logs. Discuss Ivanhoe’s plans to obtain core over the entire Clearwater interval.

9. **Supplemental Information Response #18d, Page ERCB-67.** Ivanhoe states that it plans to “*complete a 2D seismic program on the Tamarack Lease this winter (2011-2012).*” Supplemental Information Response #**38b, Page ERCB-113.** Ivanhoe states, “*Ivanhoe is aware that karst features may exist in part of the Phase 1 Development Area and will be conducting a 2D seismic program this winter to map any karst features*”.

   The ERCB considers 3D seismic to be critical data for thermal operations at shallow depths in order to understand geological features such as karsting, Quaternary erosion, and faulting where well data or 2D seismic cannot provide this resolution.

   a. Discuss whether Ivanhoe plans to complete a 3D survey to better image structural features and Quaternary erosion, or to establish a baseline for future 4D surveys.

   b. Discuss whether Ivanhoe plans to acquire 4D seismic for the proposed project as a tool for monitoring steam chamber growth, including details on its use in Ivanhoe’s monitoring strategy.

10. **SIR Response 19, Page ERCB-72.**

    Ivanhoe provides a discussion on core photos and other analysis for four wells, including AA/06-35-090-09W4/0 in Appendix B. Oil staining is apparent in the Wabiskaw C in AA/06-35, suggesting that oil migration through the Wabiskaw D has occurred locally, which may be indicative of conduits through the Wabiskaw D. Discuss the possible impacts of this observation on containment.

11. **March 7, 2011, Schlumberger Tamarack Field Fracture Study from FMI Images Report, Section 6, Conclusions and recommendations, Page 19.**

Schulmberger states, "*More analysis is needed to fully understand if fractures observed in these three Tamarack Field wells are local phenomenon or belong to regional fracture sets*."

Response to this comment is important in establishing a pervasive regional fracture set, which could have implications on caprock stability and conductivity. The ERCB considers imaging logs to be a crucial tool in assessing caprock integrity.

a. Provide processed image logs for the remainder of the wells within the proposed project area.

b. Based on the newly processed image logs, provide a fracture analysis for the Clearwater and McMurray Formations that includes examples of fractures, and the impact these fractures may have on reservoir fluid containment.

12. **July 21, 2011, Proposed Operating Pressure Submission, Appendix, Figure: Pad A Heel Observation Well, Page 64, and Figure: Pad B Toe Observation Well, Page 67.**

The temperature profiles indicate significant temperature response in the IHS and in the zone identified as "Upper McMurray Cap Rock".

a. Discuss the temperatures measured from a depth of 370 metres to 405 metres in the Pad A heel observation well, and from 380 metres to 405 metres in the Pad B toe observation well. The discussion should include the lithology of the McMurray, conductive versus convective heating of the interval, and temperatures measured within and above the identified "Upper McMurray Cap Rock".

b. Explain the reason for temperatures in these IHS dominated intervals to be ~100 degrees Celsius.

c. Discuss how the IHS from the Pad A heel observation well and Pad B toe observation well compares to the IHS throughout the proposed project area.

2.3. Reservoir Engineering

13. **Project Update, Figure PU-1, Project Layout.**

Figure PU-1 illustrates three Phase 1 initial observation wells north of the Suncor mineral surface lease boundary, with additional observation wells indicated as potential Phase 1 wells. The figure also illustrates a number of "potential" observation wells within the proposed Phase 1 development area. The ERCB requires submission of information to facilitate review of project impacts and associated monitoring for the entire Phase 1 development area.

a. Ivanhoe has reduced the number of monitoring wells north of the development area. Provide a discussion on the incremental increase in risk associated with decreased monitoring.

b. Discuss whether Ivanhoe considers the initial observation wells to be adequate for monitoring steam chamber growth, caprock integrity, and potential interactions with the Suncor tailings pond.

c. Confirm Ivanhoe's entire Phase 1 observation well plan.

14. **Supplemental Information Response #3b, Table SIR 3-1, Phase 1 Initial Observation Well Locations and Monitoring Type, Page ERCB-20.**

Table SIR 3-1 indicates Ivanhoe's plans to install pressure and temperature monitoring in the Clearwater and Wabiskaw C.

a. Identify the proposed monitoring zone within the Clearwater Formation and provide a log illustrating the zone.

b. Discuss Ivanhoe's rationale for selection of the identified Clearwater zone and the Wabiskaw C as adequate monitoring zones, including but not limited to lithology, permeability, porosity, radius of detection, areal extent, and any tests conducted to evaluate the zones.

c. Ivanhoe states, "*The wells within the steamflood area will be completed to allow periodic temperature logging as appropriate across the McMurray, Wabiskaw and Clearwater formations.*" Indicate how often temperature logging will be conducted and what information Ivanhoe expects to obtain from the identified permanent temperature monitoring installations. Include a discussion on whether Ivanhoe anticipates any access limitations to wells for temperature logging.

15. **Supplemental Information Response #11, Page ERCB-49.** Ivanhoe states that it "*proposes that the maximum operating pressure should vary as a function of time*", and further "*proposes to reduce operating pressure to the lowest pad pressure among the coalesced steam chambers*."
Supplemental Information Response #11, Table SIR 11-1, Recommended Operating Pressures for Each Fully Developed Pad, Page ERCB-49. Ivanhoe provides the proposed maximum operating pressures (MOP) for the first 600 days and at 621 days for Pads A to G.

  a. Provide a detailed discussion on how the coalescence of steam chambers will be determined between each pair of adjacent patterns.

  b. Figure SIR 9-1 indicates eight patterns (A to H). The proposed drainage area H appears to be missing from Table SIR 11-1. Revise and resubmit Table SIR 11-1 and any other material from the SIR responses as necessary.

  c. Among the proposed operating pressures for each of the drainage patterns, Pad G is the lowest. Discuss Ivanhoe's ability to operate drainage patterns A to H at the lowest common pressure.

  d. Discuss Ivanhoe's rationale for providing MOPs for the first 600 days and at 621 days and discuss Ivanhoe's proposed operations between day 600 and day 621.

16. **Supplemental Information Response #21, Page ERCB-75.**

Ivanhoe states that top gas within the project area is discontinuous and is not expected to act as thief zones or interfere with the distribution of steam. Discuss Ivanhoe's monitoring plan for potential steam loss and non-condensable gas migration into these gas caps.

17. **Supplemental Information Response #24c, Page ERCB-79.**

Regarding its operating strategy with respect to on-going drawdown of the Lower McMurray source water zone, Ivanhoe states, "*if significant pressure drawdown was detected…the injection pressure would be adjusted to keep a constant pressure differential between the steamflood steam pressure and the underlying aquifer pressure*."

  a. Provide the current pressure in the underlying aquifer.

  b. Identify the differential pressure between the steamflood steam pressure and the underlying aquifer pressure at which Ivanhoe plans to operate.

  c. Identify the differential pressure between the steamflood steam pressure and the underlying aquifer pressure at which Ivanhoe expects steam loss to the aquifer to begin.

  d. Provide an update or timeline regarding Ivanhoe's progress in selection of make-up water sources.

18. **Supplemental Information Response #28, Pages ERCB-87 and ERCB-88.**

Ivanhoe provides additional information on the well statuses identified in Table 2.1-1 of the application.

a. Ivanhoe states, "*All wells within the steamflood area will be confirmed to be compatible for thermal operations. Any well found deficient will be re-entered and properly*." Discuss the additional steps Ivanhoe will take if well re-completion or re-abandonment to ensure thermal compatibility is unsuccessful.

b. Ivanhoe states that it "*plans on re-entering and using the following cased wells…as observation wells*". Provide a detailed re-completion plan for the eight identified cased wells to ensure compatibility with the proposed thermal operations.

c. Ivanhoe states, "*Remediation will be pursued in those cases where Ivanhoe is unable to reasonably conclude that a well was properly abandoned per ERCB Directive 020 and the well will be in an area expected to be thermally affected by SAGD operations in approximately a one year time frame*." The ERCB requires more information on the wells penetrating the McMurray Formation that could be impacted by thermal operations to ensure fluid containment associated with the proposed thermal operations.

    i. Provide a table that includes the unique well identifiers of all wells that may be impacted by the proposed thermal operations (including wells not owned, licensed or operated by Ivanhoe) and the associated spud date, well licensee, current status, completion details (casing size and grade, casing connection type, cement type, cement top, and cement returns to surface), identification of the presence of surface casing vent flows and gas migration, and thermal compatibility.
    ii. Provide the criteria used to assess the thermal compatibility of the existing wells that may be impacted by the proposed thermal operations.
    iii. For each well not considered to be thermally compatible with the proposed thermal operations, discuss why each well is not considered to be compatible.
    iv. Provide a map showing the location of all wells not considered to be compatible with the proposed thermal operations. This map should include the proposed project and development area boundaries and the Phase 1 subsurface drainage areas and should be annotated with the distance between thermally incompatible wells and the nearest subsurface drainage area.
    v. For each well not considered to be compatible with the proposed Phase 1 thermal operations, provide a risk assessment with respect to fluid containment and provide the mitigation measures, including buffer distances, remediation, and monitoring that Ivanhoe will undertake at each well to ensure fluid containment, both inside and outside of the production casing, before the start of the proposed Phase 1 thermal operations.
    vi. For wells not considered to be compatible with the proposed thermal operations which will not be impacted by the Phase 1 thermal operations, discuss how these wells will be addressed to ensure compatibility with thermal operations beyond Phase 1.

d. Ivanhoe states, "*The wells marked as "Unknown" thermal cement status, and no required remediation plan, listed in Volume 1, Table 2.1-1 are all outside of the steamflood Project area and will not be re-abandoned due to their distance from the steamflood operations.*" Provide the distance in metres to the nearest proposed subsurface drainage area for each of the five identified wells and discuss the minimum safe setback distance considered appropriate for wells of unknown thermal cement status that are outside of proposed drainage areas in relation to the proposed thermal operations.

e. Ivanhoe states that AA/06-26-090-09W4/0 and AA/07-27-090-09W4/0 are within the steamflood area, of unknown thermal cement status, and "*will be re-entered and converted to observations wells with the appropriate thermal cement completion.*" Provide Ivanhoe's plan for recompletion of these two wells.

2.4. Geomechanical Analysis

19. **Volume 1, Section 2.1.6.3, Operating Pressure, Page 2-21.**

Ivanhoe states that it has conducted and analyzed micro-fracture tests in two wells (13-26-090W4M and 14-23-090-09W4M) at four intervals within the proposed Phase 1 development area. These wells are located in the eastern portion of the proposed development area. There is evidence of karsting in the western portion of the proposed project area, and the Athabasca River is located three kilometres west of the proposed project area; both of these occurrences are known stress reduction mechanisms. The ERCB expects that mini-frac locations are selected to represent the stresses in unaffected areas, but also in areas where the in situ stresses may be impacted by geological features, such as karsting and erosion.

a. Discuss the affects that Athabasca River erosion and karsting may have on the in situ stress regime within the proposed project area.

b. Discuss Ivanhoe's plans to conduct a mini-frac test in the western portion of the project area to further evaluate the in situ stress conditions.

20. **Supplemental Information Response #Response 12, Page ERCB-51.**

Ivanhoe states that it is "*currently working with industry suppliers and geomechanical experts in order to determine the required spacing and locations*" for heave monitoring in support of its caprock integrity monitoring program. Ivanhoe also indicates that the initial heave monitoring array will encompass only drainage patterns A, B and C.

a. Provide an update on this work.

b. Ivanhoe has provided information to support development of drainage patterns A through H, but has only indicated an initial heave monitoring array for drainage patterns A, B and C. Discuss Ivanhoe's plan for surface heave monitoring for the proposed drainage patterns D through H.

21. **Appendix E, Geomechanical Input and Output Files.**

    Review of the submitted geomechanical input and output files indicates that the "stress-strain hysteresis" option was turned off in Ivanhoe's models. Comment on the impacts this may have on the calculated changes of stress and strain in the reservoir sands and the caprock shale, given that the unloading Young's modulus is much larger than the loading Young's modulus.

22. **Appendix E, Geomechanical Input and Output Files.**

    A non-linear hyperbolic soil model was used to represent the stress-strain behaviour of the oil sands material, which is unable to model dilations.

    a. Considering that high pressure SAGD operations at shallow depth may cause significant oil sands dilation, comment on the impact this may have on the calculated changes of stress and strain in the reservoir sands and the caprock shale.

    b. Provide all data and analysis used to support the above comments.

23. **Appendix G, Horizontal Stress Profiles and Contour Maps, Total Minimum Horizontal Stress (kPa, Sh) Figure.** The principle of stress equilibrium with respect to earth stresses requires that far-field stresses be equilibrated. This means that horizontal stress in a heated zone cannot increase without having a horizontal stress decrease in the bounding zones. There is no apparent stress reduction in the rocks above or below the reservoir. Therefore, the requirement for equilibrium of total far-field stress has apparently been violated. Explain why stress equilibrium was not satisfied on this vertical plane, and comment on the validity of the geomechanical modeling results.

24. The ERCB requires additional information regarding the potential for reservoir containment loss during SAGD operations once methane (CH4), a non-condensing gas, evolves as free gas when high temperature from steam injection contacts the gas-saturated oil sands. In this scenario, there is the potential for the evolved gas to remain high in the McMurray reservoir and migrate into any induced fractures. Discuss whether this mechanism could increase the driving force to propagate the fracture upwards into the overlying Clearwater caprock formation.

2.5. Geotechnical Analysis

25. **Supplemental Information Response #40, Page ERCB-115.**

    Regarding the assessment of the potential for effects within the Suncor MSL, Ivanhoe states that is has based the peizometric head on a pressure profile "*calibrated to piezometric measurements*". Provide the data from the piezometers used to calibrate the model and indicate the location and depth of the instrument used.

26. **Attachment 2, Section 8.1, Page 28.**

In its report to Ivanhoe, EBA states, "*The ground heave prediction contour lines are parallel to the MSL boundary and the wetland levels. Figures 11, 12 and 13 demonstrate that there should be negligible differential heave in the east to west water flow direction*". In the context of having variable geology overlying the wells, explain why the heave contours illustrated in the referenced figures are parallel to the MSL boundary.

27. **Attachment 2, Section 8.2, Page 34.**

In its report to Ivanhoe, EBA states, "*The EBA analysis and evaluation consisted of three sequential steps described in Section 6.2 of this report. The results of the Step 1 initial case (prior to SAGD effects) slope stability analysis of South Dyke Section K2-K2' and L-L' carried out by EBA were substantially identical to the KCB analysis results presented in the January 2010 Elevation 390 m Design Update Report*."

In Suncor's South Tailings Pond 2011 Performance Report, submitted to Alberta Environment and Water, Water Administration, key observations about elevated foundation pore pressures in the Clearwater Formation are reported, including some readings where pore pressure is higher than the design pore pressure.

a. Update the stability assessment for profile sections K2-K2' and L-L', reflecting any parameter updates based on the Suncor 2011 South Tailings Pond Performance Report.

b. Identify the maximum excess pore pressure in the Clearwater Formation that can trigger instability (i.e., where the factor of safety = 1.0).

2.6. Facilities

28. **Supplemental Information Response #42b, Page ERCB-118.**

Ivanhoe states, "*The vapour recovery unit will recover and recycle any diluent vapours from the product tanks*." However, the proposed project does not include a diluent recovery unit, indicating that any flashed naphthenic diluent will be combusted (lost) with fuel gas. Provide the expected diluent losses to the fuel gas system due to flashing.

29. **Supplemental Information Response #44a, Table SIR 44-1, Phase 1 Total Available Steam, Page ERCB-120.**

Ivanhoe has shown the total available (maximum) steam output from two co-generation units as 98 tonnes per hour, and the normal operation output from the same two units as 198 tonnes per hour. Reconcile the total available steam and normal operation output for the co-generation unit.

30. **Supplemental Information Response #47, Page ERCB-125.**

Ivanhoe has selected a semi-dry scrubbing technology for its flue gas desulphurization (FGD) unit due to the presence of ash in the re-heater overhead flue gas stream, and the limitations on available source water for scrubbing. Ivanhoe has also designed for a sulphur removal rate of 90 per cent.

a. Describe the limitations that prevent the achievement of higher sulphur removal efficiency. Include identification of modifications that could be made to improve the sulphur removal efficiency of the FGD unit.

b. Provide the anticipated composition of total produced gas upstream of the Mixed Fuel Gas Drum at the central processing facility (CPF), effluent gas from the CPF steam generator #1 and co-generator, as well as effluent gas from the HTL™ re-heater.

c. Ivanhoe has stated that because sulphur is carried within the coke combusted in the reheater, only post combustion technology is feasible. Provide the rationale for Ivanhoe's choice to not to incorporate sulphur recovery/removal technology at the CPF where pre-combustion technology could be incorporated.

d. Provide details on the type of unit that will be utilized to remove particulates and ash from flue gas stream.

31. **Supplemental Information Response #48, Table 48-1, Page ERCB-127.**

Ivanhoe has provided expected source water flow rates over the project life.

a. Ivanhoe is utilizing a mechanical vapour compression evaporator system for water treatment, not zero liquid discharge. As such, disposal should be low but not zero. Provide the assumption(s) that was incorporated into Ivanhoe's water use model to give a disposal rate of 0 m^3/day after year three.

b. Provide separate water and hydrocarbon balances for the project that represent the first three years of operation, as well as a second set of balances representing steady-state operations (e.g., years 5 through 19). The balances must be represented using block flow diagrams (i.e., oil treatment, water treatment, HTL™, etc.). All quantities are to be expressed in metric units at standard temperature and pressure. Mass and volumetric flow rates are to be provided on a calendar day and stream day basis.

2.7. Environment

32. **Supplemental Information Response #113a, Page AENV-91.** Ivanhoe states, "*In some cases, the ability to move surface facilities to avoid watercourse buffers is limited by the subsurface geology and well pads are located to exploit the areas of highest quality reservoir*."
Supplemental Information Response #124, Figure SIR 124-1, Project Facilities and Watercourse Buffers, Page AENV-109. Ivanhoe illustrates five pads at which diversions may potentially be implemented.
Supplemental Information Response #133, Table SIR 133-1, Minimum and Average Distances of Project from Watercourses, Page AENV-122. Table SIR 133-1 identifies six of the thirteen well pads for the proposed project area development as within 0 to 92 metres of water bodies.

The ERCB requires additional information to support Ivanhoe's statement that the encroachment of its well pads on water bodies is justified by resource recovery requirements and the mitigations proposed. It appears that alternate siting within short distances or minor re-configuration of well pads could be used to reduce encroachment upon water bodies and eliminate in-stream effects of channel construction.

a. Provide one, or more as necessary, alternate surface locations for Pads 2 and 3 to demonstrate alternative surface locations that would meet the 100 metre water body setback. Note that a constraints mapping approach may be useful to illustrate multiple factors considered.

    i. Provide accompanying well trajectory cross sections, well lengths, and drainage areas, original and developable bitumen in place, and recovery factors for each of the alternatives presented in comparison to the originally proposed layouts.
    ii. Provide a supporting discussion to demonstrate any subsurface geological and/or drilling limitations to surface pad placement.
    iii. Identify environmental impact assessment conclusions that are altered and/or supported by the potential selection of alternative surface locations identified.

b. Discuss similar alternate surface pad placement and outcomes for additional pads outside the development area, such as Pads 6, 7, 10 and 12.

c. Regarding setbacks from water bodies, *Directive 056: Energy Development Applications and Schedules* requires that for any well within 100 metres of a water body, the use of spill prevention measures, automatic controls and shut off valves, berms, trenches, and alternative operating methods be evaluated. Ivanhoe has identified perimeter berms with diversion channels as mitigation for surface run-off, sedimentation, etc. For Phase 1 pads that are unable to maintain a 100 metre setback from water bodies, discuss Ivanhoe's other mitigations and pollution controls that could be implemented for wells, well pads, or other production equipment.

3. General

33. **Volume 4: Supplemental Information Request #1, Response #60, Page AENV 12, Table SIR 60-1.**

Ivanhoe Tamarack's outline of actions for wellhead failure implies that the impact of an event would be limited to the area of the well pad. Such events experienced by other operators have resulted in spill effects well beyond the well pad boundary.

a. What criteria were used to categorize the likelihood of an event as rare, unlikely, possible, likely, or almost certain?

b. Explain why Ivanhoe believes that a wellhead release would not go beyond the area of the well pad.

c. What measures will be in place to limit the effects of such an event? For example, will there be emergency shut down options and procedures to immediately limit the duration of the event?

The discussion of cap rock failure identifies a final impact as low. Other operators have found that cap rock failures can be quite challenging and result in long-term, ongoing spill events.

d. How confident is Ivanhoe in its assessment of the risk of cap rock failure?

e. What mitigation measures are available to reduce the impact to aquatic and terrestrial resources in the event a cap rock failure occurs?

34. **Volume 4: Supplemental Information Request #1, Response 60 e, Page AENV-14 and Question 165 a, Page AENV-174.**

Ivanhoe indicates they have not yet developed a spill response plan. However, to ensure Ivanhoe understands the potential impacts of the project, and to demonstrate that they have considered the requirements of a spill response plan, it is necessary to see that at least a conceptual plan is in place.

a. Provide a conceptual spill response plan, including an assessment and monitoring plan to be used in the event of a spill.

b. Provide a discussion of criteria used in the development of the plan.

35. **Volume 4: Supplemental Information Request #1, Response #61, Page AENV-15.**

Ivanhoe states it understands Alberta Transportation's concerns regarding cumulative traffic impacts associated with future development; however, since Ivanhoe is not the proponent for the CMAR, it is not responsible for a Traffic Impact Assessment for the CMAR Project. Ivanhoe does understand that Ledcor is conducting a TIA, as part of the Federal Environmental Screening Process for the CMAR Project. Once filed, this document will become part of the public record and will be available for review.

Alberta Transportation has recently received confirmation from Ledcor CMI Ltd. (Clearwater Multi-User Access Road Environmental Assessment Screening, Responses to Information Request #1, November 2011) that the Traffic Impact Assessment (TIA) for the Clearwater Multi-User Access Road (CMAR) is currently underway. The TIA should be the combined efforts of all CMAR road users to address transportation issues and any necessary access improvements. Alberta Transportation may have further comments once we receive the TIA.

a. Confirm that Ivanhoe is working with Ledcor to produce the combined TIA.

4. Air

36. **Volume 4: Supplemental Information Request #1, Project Update and Response #49, Page ERCB-128.**

Ivanhoe states in the Project Update, "*It is expected that there will be a reduction of greenhouse gas and sulphur air emission from the project, and a deduction in the amount of energy required to operate the Project facilities.*"

a. Compare in table form SO_2 emissions from each Project source in the original Application and Project Update with the FGD operating and inoperative.

37. **Volume 4: Supplemental Information Request #1, Project Update.**

The Project Update indicates that process improvements are expected to reduce the energy required to operate the Project and the emissions of greenhouse gases. The Project Update also indicates that SCO and liquid hydrocarbon yields will also increase.

a. Provide an update to Table 4.6-19 in Volume 2, Section 4.6.5 of the EIA, which summarizes the GHG emission estimates for the Project. The response should also include a comparison between the updated estimates and the original ones.

b. Provide a comparison of the GHG emission intensity of the original application with the Project Update. Since the Project produces more than one product (SCO and other liquid hydrocarbons), the GHG emission intensity should be in the form of (g CO_2e / MJ refined product).

38. **Volume 4: Supplemental Information Request #1, Response # 67, Pages AENV-23 & 24**

Ivanhoe indicates that the steam generators will burn alternate gaseous fuel, thus the NOx emission limit of 40 g/GJ applies. However, the original application indicates that the Project burns both natural gas and produced gas.

a. Provide the ratio/percentage of produced gas and purchased gas in the final gas mixture that will be used in the steam generators. Based on this information, if the final composition of the gas mixture is still mainly natural gas (e.g. 95% or more), the NOx emission factor of 26 g/GJ should be used to determine compliance with the

Interim NOx BATEA Guidelines, Alberta Environment, 2007. Indicate whether the correct NOx emission limit was used.

b. If the 26 g/GJ compliance limit applies, provide updated calculations and update Table ATT6-3 in Volume 1 of the Integrated Application, for the 26 g/GJ compliance limit.

39. **Volume 4: Supplemental Information Request #1, Response # 67, Page AENV-24 and Volume 3, Section 3.0, Table A2-34, Page A2-63**

Ivanhoe states, "*The co-generation units are rated at 30 MW (power basis).* Ivanhoe also states *Heat generation by the co-generation units is estimated to be 239 G/hr"* for each co-generation unit. Response to SIR 67a, Table SIR 67-1 indicates that the heat input into Co-gen 1 and Co-gen 2 is 90.81 MW each. This means the co-gen is more than 100% efficient. The 239 GJ/h may be the combined heat from both co-gens but the sample calculations appear to be for each co-gen.

a. For the operating conditions on which the Project emission rates are based, what is the amount of fuel energy input into each co-gen unit? What is the electrical power output and heat output for *each* co-gen unit?

b. If the 30 MW of electricity and 239 GJ/h generated are for each co-gen, how does Ivanhoe plan to meet the NOx emission estimate of 0.297 t/d as specified in their AQ modeling?

c. Provide calculations to show how the cogeneration unit will meet the NOx guidelines listed below. Show calculations on a per individual co-gen unit basis. In the calculation of the emission limit include the heat recovery component so a comparison between the NOx emission limit and the estimated NOx emission rate is transparent.

- *National Emission Guidelines for Stationary Combustion Turbines, CCME, December 1992*
- *Alberta Air Emissions Standards for Electricity Generation, December 2005*

40. **Volume 4: Supplemental Information Request #1, Response # 70, Table SIR 70-1 and Table SIR 70-2, Page AENV-27.**

PM emissions for construction appear to be only from diesel combustion sources.

a. Provide an estimate of traffic/road dust emissions associated with construction activities.

The units for the heaters in Tables SIR 70-1 and SIR 70-2 appear to be incorrect as it is not in the form of energy per unit time.

b. Provide revised Tables SIR 70-1 and SIR 70-2 utilizing correct. units for the diesel-fired heaters.

c. Demonstrate that the greenhouse gas emission estimates in Table SIR 70-2 still applicable with the corrected units.

41. **Volume 4: Supplemental Information Request #1, Response # 75a, Page AENV-34.**

Ivanhoe indicates that emission estimates of VOCs and PAHs for the SAGD and HTL components were pro-rated from data on emissions data from two EIAs (Conoco Phillips Surmont, Syncrude Upgrader).

a. Provide sample calculations to show how these emissions were estimated, specifically for benzene and reduced sulphur compounds. The sample calculation should show the original emission estimate from the other project, and the details of the pro-rating calculation (the ratio of fuel consumption estimates for the SAGD component, and the ratio of the bitumen processing rates for the HTL component).

42. **Volume 4: Supplemental Information Request #1, Response # 83b, Pages AENV-44 & 45.**

Ivanhoe compares regional emissions within the AQRSA for all Projects included as of June 2009 and as of August 2011. Table SIR 83-3 indicates relatively large changes in NO_X and CO emissions in the LSA between June 2009 and August 2011.

a. Identify the operations in the LSA that contribute most to the emission changes, and quantify those changes.

b. Reassess NO2 and confirm the additional Baseline emissions do not result in additional exceedances of NO2 AAAQOs.

43. **Volume 4: Supplemental Information Request #1, Response # 84, Page AENV-47.**

Table SIR 84-3 lists uncontrolled road dust emissions for particulate matter based on Mobile 6.2C emission factors. A review of this model indicates only exhaust, tire wear, and brake wear are included in its emission factors, not road dust.

Volume 2, Figure 4.5-10 in indicates that Application case PM2.5 2nd highest 24-h concentrations are already above the AAAQO of 30 ug/m3.

a. Provide complete references for the methodology used to calculate road dust emissions.

b. Provide sample calculations for TPM, PM10 and PM2.5 road dust emissions.

c. Provide Mobile 6.2C input files that show the emissions or emission factors used.

44. **Volume 4: Supplemental Information Request #1, Response # 85, Page AENV-49, and Response #75, Page AENV-34.**

SIR 85a states that RSC emissions are emitted by the Project and refers to Table A4-41 in Volume 3, Appendix A4 for the emission rates. However, Table A4-41 shows RSC emissions from the SAGD component of the Project to be zero, even though recent SAGD air quality assessments (Osum Taiga, Dover Operating Corp. Commercial, Devon Jackfish 3) have indicated there will be some fugitive emissions from leaks in the process area, as well as from storage tanks since not all fugitive emissions are completely recovered from vapour recovery systems.

As well, in Ivanhoe's response to SIR 1 #75, it states that fugitive emissions of VOCs and PAHs from the Project were based on Syncrude measurements, pro-rated on the basis of the bitumen processing rate. Syncrude measurements show there are H_2S emissions from the Syncrude plant process area of 12.38 kg/h (Clearstone et al. 1998), which is greater than Ivanhoe's Project estimates for the HTL component (shown in Table A4-41) by nearly 700,000 times. In fact, emission estimates of Ivanhoe's HTL component for many RSC, VOCs and PAH species are several orders of magnitude lower than the Syncrude measurements.

a. Explain for each operating component (SAGD and HTL) of the Project why Ivanhoe expects such low fugitive emissions of RSCs, VOCs and PAHs from their Project.

b. Provide an explanation why zero fugitive emissions are expected for the SAGD component of the Project. Even if all fugitive vapours are recovered from the vapour recovery system, how does Ivanhoe plan to prevent any fugitive leaks from valves, flanges, and other process fittings?

c. Confirm that the odour thresholds in Table SIR 85-1 for H2S and COS are reversed.

d. If the fugitive emissions are higher than indicated, assess the impacts of these emissions on air quality and odour.

Literature cited:

Clearstone Engineering Ltd., Alberta Research Council and QED Consultants Ltd., 1998. *Syncrude Mildred Lake Site: Assessment of Fugitive Emissions*. Volume 2, Table 143, page 133. Prepared for Syncrude Canada Ltd. Calgary, AB.

45. **Volume 4: Supplemental Information Request #1, Response # 87a, Page AENV-51 and Volume 4, Project Update.**

a. Explain whether predictions of exceedances in Table SIR 87-1 include improvements offered in the Project Update.

b. What additional mitigation can Ivanhoe implement that will eliminate the additional exceedances created by the Project?

46. **Volume 4: Supplemental Information Request #1, Response # 222b, Page AENV-251 and Volume 3, Appendix A4, Table A4-41, Page A4-43.**

Ivanhoe indicates that 1,3-butadiene, acrolein, and acetaldehyde are not emitted by the Project because emission factors for these chemicals are not provided by U.S. EPA AP-42. However, emission factors for all three of these chemicals are provided in Chapter 3.1 of AP-42, which would presumably have been the emission factors used to estimate emissions of VOCs and PAHs from the cogeneration units.

a. Clarify what emission factors were used to estimate emissions of VOCs and PAHs for the cogeneration units if Chapter 3.1 of AP-42 was not used.

b. If 1,3-butadiene, acrolein, and acetaldehyde are emitted by the Project, provide an updated Table A4-41 which includes emission rates for these chemicals.

5. Water

5.1. Hydrogeology

47. **Volume 4: Supplemental Information Request #1, Response # 97c, Page AENV-64 and Figure SIR 97-1, Page AENV-65.**

Ivanhoe identifies the Wabiskaw Member of the Clearwater Formation contains "*interbedded mudstone and very fine grained sandstone*". The ERCB Base of Groundwater Protection Query Tool identifies the Clearwater Formation as the deepest protected geological unit. This geological unit is therefore anticipated to contain non-saline groundwater.

a. Provide mapping illustrating the spatial distribution of any sand units within the Wabiskaw Member and discuss whether this unit represents a potential aquifer, and if so, the direction and velocity of groundwater flow.

b. Provide information regarding the groundwater chemistry within the Wabiskaw Member and identify whether this unit is saline or non-saline.

c. If the Wabiskaw Member contains or could contain non-saline groundwater, discuss appropriate groundwater monitoring for this unit.

d. Discuss the potential hydraulic communication between any Wabiskaw sand units and the underlying McMurray Formation.

48. **Volume 4: Supplemental Information Request #1, Response # 99b, Pages AENV-68 & 69.**

Ivanhoe provides a comparison of the log values of the hydraulic conductivity for the McMurray oil sands from regional information versus the value used in the numerical groundwater model.

a. Discuss how the log value of the hydraulic conductivity is utilized in the analytical calculations of the numerical groundwater model or provide a rationale for the calibrated hydraulic conductivity values used in the numerical groundwater model.

49. **Volume 4: Supplemental Information Request #1, Response # 107, Page AENV-84.**

Information provided by Ivanhoe in Volume 3, Appendix C2 indicates generally higher salinity from the McMurray Formation (2 620 mg/L to 29 790 mg/L) than the Waterways Aquifer/Aquitard (638 mg/L to 5 174 mg/L), suggesting that equilibrium conditions may not have been reached.

a. Discuss whether the Waterways Aquifer/Aquitard could contain non-saline groundwater underlying the Tamarack lease.

b. If uncertainty remains as to whether groundwater from the Waterways Aquifer/Aquitard is saline or non-saline, discuss plans to verify the salinity of the Waterways Formation.

5.2. Surface Water Quality

50. **Volume 4: Supplemental Information Request #1, Response # 108, Page AENV-85, Response # 121b, Page AENV-103 and Response # 123, Pages AENV-106 & 107.**

The project proposes filling 1.65 km^2 (165 ha) of wetlands, which represent about 12% of the existing wetlands in the affected basins. The expected effect of converting wetland areas to dry areas is that evaporation and evapotranspiration will be reduced, and this will in turn will cause runoff volumes to increase compared to baseline conditions. Effects on peak flow are more complicated to assess because of project water management activities. Ivanhoe claims that any effects on runoff volumes and peak flows will be absorbed by the remaining wetlands, without any detrimental effects on those wetlands

Ivanhoe states, "*Given that more than 88% of the wetlands remain undisturbed in the affected watersheds, the wetlands and beaver ponds will be able to absorb much of the increased runoff from the Project-affected areas*". To be credible, this argument requires that the runoff from disturbed areas is distributed over the undisturbed wetland areas. Available mapping indicates that this requirement is not met. Comparison of the project footprint (Volume 4, Page AENV-108, Figure SIR 124-1) and wetland mapping (Volume 2, Page 11-12, Figure 11.4.2) shows that the disturbed wetlands are generally located in or along downstream drainage corridors and that majority of the undisturbed wetlands are located in upper headwater areas where no moderating effect would occur. Ivanhoe's analysis of moderating effects from the unaltered wetlands is inaccurate.

For each of the main basins in which alterations are proposed, provide the following information.

a. Identify the total area of unaltered wetlands downstream of the alterations, which may mitigate project effects on hydrology;

b. Describe the mechanism by which evaporation and/or evapotranspiration increases will occur to offset the filling of other wetlands, specifically (i) will the water depth in closed depressions be increased; and/or (ii) will the areal limits of the wet lands (or open water surface) be increased; and

c. Identify the effects increased water depth or increased area of flooding will have on the existing vegetation in or adjacent to the undisturbed wetlands.

51. **Volume 4: Supplemental Information Request #1, Response # 112 b, Page AENV-90, Response 117 a & b, Page AENV 96 & 97, and Response 121a, Page AENV-103.**

The 112b response indicates that the capacity of the CPF stormwater pond "*would allow a 100-year rainfall to last six days prior to the pond overflowing*" and that "*in a 100-year storm scenario, the well pad ponds would contain the stormwater for 1.4 days.* Response to 117a discusses HEC-HMS model calibration using "*the 100-year precipitation.*" The 121a response indicates that for major (1:100 year storm) events runoff was generated from the pads and CPF areas only "*after the volume of runoff from the event exceeded the available storage volume*". Baseline and projected model curve numbers in Table SIR 117-1 indicate that HEC-HMS modeling may have been done on an aggregate basis which did not explicitly model stormwater storage facilities.

SIR 121a questioned why peak flows in UN1 and UN2 were predicted to increase by up to 18% and 32% respectively when the stormwater systems would detain the event runoff for later release at a time that is not coincident with the storm event.

a. What is the magnitude, duration, and distribution of the 1:100 year precipitation used for calibration of the HEC-HMS baseline model(s)?

b. What is the 100-year rainfall magnitude and duration for the 6-day event discussed in the response to SIR 112b?

c. What is the 100-year storm magnitude and duration for the 1.4 day event discussed in the response to SIR 112b?

d. Were stormwater facilities explicitly modeled in the HEC-HMS models of future conditions? If yes, please provide hydrographs which show stormwater facility outflows in relation to runoff from the remainder of the basin.

52. **Volume 4: Supplemental Information Request #1, Response # 113, Page AENV-91, Response # 115, Pages AENV-115 & 116, Response # 122, Pages AENV-104 & 105, and Response # 124, Pages AENV-108 & 109.**

Ivanhoe clarifies that the disturbance footprint is guided by resource recovery goals and that the final footprint may shift as the reservoir is further delineated. While "*Ivanhoe will make every reasonable effort*" to locate well pads "*in such a way that encroachments on watercourse buffers are minimized*", the possibility exists that the final encroachments could be unchanged or worsened from what is shown in the application documents. The response to SIR 122 clarifies that diversion channels will not replicate the original floodplain dimensions (as stated in the original application) but may instead incorporate narrower floodplain dimensions which are "*hydraulically more efficient*". Figure SIR 124-1 (Volume 4, Page AENV-109) shows five locations where diversions channels may be required. The response to 122d clarifies that these diversions will be permanent.

The diversion channels that are being proposed will increase the project footprint. A preliminary design is needed for each of the diversions to clarify the magnitude of these engineering works and determine if there is a need to consider secondary impacts (vegetation, animal movement, etc.) It is not possible to assess impacts without this basic footprint information. The footprint could be large if well pads fully obstruct floodplain areas and require deep excavation to construct permanent bypass channels (and floodplains) though upland areas.

a. Provide conceptual designs for each of the diversion channels needed to replace existing stream channels and floodplains that will be filled during well pad construction. Details should include: (a) the total length of diversion channel (b) the bottom width of constructed channel including the floodplain; and (c) the maximum depth of cut below existing grade, considering that the diversion may need to be cut through upland terrain.

b. What is the total additional project footprint disturbance (ha) associated with the watercourse diversions?

c. Provide a map of the diversion locations with associated disturbances.

53. **Volume 4: Supplemental Information Request #1, Response # 118, Page AENV-97 and Response # 119, Pages AENV-98 & 99.**

Ivanhoe stated that discharge measurements made at each of the six sites in the Aquatics Local Study Area "*were used to examine watershed yields; i.e., runoff over the course of the year for comparison with yields from larger regional watersheds*" but does not provide the results from this comparison. A comparison of the local measurements made April 30 and Aug 19 2009 (Volume 2, page 7-13) with same day discharges reported by Water Survey of Canada for the regional watersheds, (Beaver, Steepbank, and Hangingstone) show that the unit runoff is reasonably consistent for all basins and that the runoff is independent of the basin size.

In the response to SIR 119, Ivanhoe clarifies that the regional runoff data defined by three stations "*show a trend towards decreasing yields (mm of runoff) with decreasing watershed drainage area*" and this is why the runoff from the local basins is as much as 35% less than the runoff from regional gauged basins. Runoff yields are not normally associated with basin area, and the local stream discharge measurements compared to the large basin data also support a finding that regional basin yields are not dependent on basin size.

Accordingly, the baseline characterization of project area runoff may be inaccurate, with mean annual runoff amounts that are too low. This means that predicted project impacts to runoff volumes will be less than suggested in the existing documents.

a. Discuss the possibility that predicted runoff amounts are too low, and discuss the risk of adverse environmental impacts that this possible increase in runoff may represent.

54. **Volume 4: Supplemental Information Request #1, Response # 126 b, Page AENV-111.**

The table requested, which was to indicate the median base cation concentrations used in modeling, as well as the minimum and maximum values derived from literature, was not provided.

a. Provide the requested table.

55. **Volume 4: Supplemental Information Request #1, Response # 133 c, Page AENV-122.**

Of the 13 well pads listed in the table, six encroach within the 100 metre protective watercourse buffer. The industry (in-situ) standard for well pads is to meet the 100-metre setback requirement.

a. Clarify whether the distances provided are measured to the edge of the proposed pad, or the edge of the planned disturbance (e.g. clearing).

b. Distances from watercourses or waterbodies should be measured from the average annual high water mark for waterbodies and watercourses without defined channels. For watercourses with a defined channel, the setback distance should be measured from the top of the escarpment. If measurements were not made using these criteria, provide a revised table.

c. Provide Ivanhoe's justification for not meeting the 100-metre setback standard in this project.

56. **Volume 4: Supplemental Information Request #1, Response # 136, Pages AENV-136 & 137.**

Ivanhoe describes the field methods used for water quality sampling but does not describe the field methods used for sediment quality sampling. SIR 136 requested Ivanhoe to provide a description of the field methods used for sediment quality sampling including standard sampling procedures.

a. Describe how rinsing equipment before and after each site with stream/lake water would have eliminated cross-contamination of samples by removing metal residues and organic residues from the previous sample.

b. Describe how this method of rinsing sampling equipment is equivalent to using soaps and solvents to remove metal residues and organic residues from sampling equipment for sediments.

57. **Volume 4, Supplemental Information Request #1, Response # 144, Page AENV-140.**

Volume 2, Section 8.4.5, Page 8-14 states, "*As the proportion of surface water to groundwater will increase due to the higher runoff estimates, concentrations of substances dissolved and suspended in Unnamed Tributary 1 and Unnamed Tributary 2 will decrease.*" SIR 144 requested Ivanhoe to provide a detailed description of the mechanisms behind this statement using data and information from the Aquatic Resources Local Study Area, particularly as groundwater contains no substances in suspended form.

a. If Groundwater contains no non-dissolved constituents of water quality (i.e., all non-dissolved constituents of water quality in a watercourse come from other sources: surface runoff, direct atmospheric deposition, or suspension of bottom sediments), provide a description of how concentrations of suspended constituents of water quality will increase with increasing surface runoff relative to groundwater (i.e., "as the proportion of surface water to groundwater will increase due to the higher runoff estimates")

58. **Volume 4, Supplemental Information Request #1, Response # 150, Page AENV-146.**

Ivanhoe did not answer the questions asked but instead referred to sections of the EIA. There is no justification provided for selecting only those lakes in the Air Quality Regional Study Area that were predicted to have a greater than 0.5% difference in deposition from the baseline. A less than 0.5% difference for a given lake may result in a prediction of PAI in the Application Case that that is Greater than the Critical Load of the given lake.

a. Provide either: (i) a rationale for why only lakes which were modeled to have a greater than 0.5% difference in deposition from the baseline were included in the assessment for the Air Quality Regional Study Area; or (i) conduct the acidifying emissions assessment on all 321 lakes in the Air Quality Regional Study Area.

5.3. Aquatics

59. **Volume 4: Supplemental Information Request #1, Response 63 a., Page AENV-18.**

The original question quoted Ivanhoe as stating, "*Year-round access is required to access the basal water source wells, well pads and the CPF and as a result, year-round crossings are required.*" However, in Table SIR 63-1, Id #1 is categorized as Winter Access yet has a Crossing Method of Clear span, while Id #8 is a Year Round Access using an Ice Bridge.

a. Clarify the apparent contradiction in the Table and explain whether Ivanhoe's need for year-round access has changed. Revise the proposed crossing methods for Id #1 and Id #8 to one that is congruent with the access required.

b. Ivanhoe notes that all watercourses that contain or have the potential to contain fish (i.e. fish habitat present) will be crossed with clear-span bridges. Discuss the criteria that Ivanhoe used to determine whether a crossing site functions as fish habitat.

60. **Volume 4: Supplemental Information Request #1, Response 111 b, Page AENV-89.**

The response suggests that "*the created wetland environments would reflect the dominant aquatic environments that are already found within the watershed*." However, there is significant uncertainty around the successful reclamation to bog and fen habitat, which are the dominant aquatic environments in the area.

a. Discuss the potential long-term changes to the watershed and its aquatic biota if bog and fen habitat cannot be successfully reclaimed.

61. **Volume 4: Supplemental Information Request #1, Response 113 a, Page AENV-91 and Question 115 a. Page AENV-93.**

The response indicates that the lease is dominated by poor quality fish habitat with significant movement barriers. Noting that beaver dams are not considered permanent movement barriers,

a. provide further details on the movement barriers.

b. Are the identified barriers topographical and permanent in nature?

c. Would they still function as barriers in high water periods?

62. **Volume 4: Supplemental Information Request #1, Response 114 a. Page AENV-92, Response 124 c, Page AENV 108, and Response 158 c. Page AENV 167.**

SRD is responsible for the management of fish populations in the province. Impacts to fish populations are directly connected to impacts to fish habitat. Given the proposed diversions and the lack of site-specific baseline data, it is difficult to assess the impacts to fisheries as a consequence.

a. When will Ivanhoe make sufficient information available to assess the impact of potential diversions?

b. Has Ivanhoe undertaken the baseline assessment work required to support federal applications related to the diversions and development of well pads 6, 7, and 12? If so, provide these data. If not, provide a schedule for data collection, sampling protocol and timing, and a planned submission date.

63. **Volume 4: Supplemental Information Request #1, Response 135 a, Page AENV-125.**

Ivanhoe provided a list of criteria used in selecting the aquatic regional study area but no indication of how this information was considered.

a. Explain how these criteria were used in the determination of the study area? For example, does the extent of the aquatic regional study are reflect the maximum extent of fish migrations for the species known to inhabit the area?

64. **Volume 4: Supplemental Information Request #1, Response 154 c, Page AENV 155.**

Ivanhoe states, "*fish are not present in the ALSA*", however, based on information provided in the EIA there is insufficient data to establish this.

a. Discuss why Ivanhoe contends that there are no fish present in the ALSA and provide defensible, statistically sound data to support the assertion.

65. **Volume 4: Supplemental Information Request #1, Response 159 c, Page AENV-168.**

Ivanhoe asserts that benthic invertebrate sampling results for two watercourses is representative of three other unsampled watercourses.

a. Provide peer-reviewed literature to support the assertion that sampling results in two watercourses is representative of what would be found in three others.

b. Identify the habitat similarities that must be present for this assertion to hold, and present specific habitat assessment data from the three watercourses that were used to establish sufficient habitat similarity.

66. **Volume 4: Supplemental Information Request #1, Response 160 d, Page AENV 169.**

The Ivanhoe Tamarack project is in an area that is connected to known Arctic grayling habitat. Arctic grayling are ranked federally as a high priority candidate to receive a status assessment and they are designated as a species of special concern provincially.

a. How will Ivanhoe Tamarack contribute to regional data collection to ensure Arctic grayling continue to persist in the oil sands area?

67. **Volume 4: Supplemental Information Request #1, Response 293, Page AENV 375.**

Ivanhoe predicts a potential maximum ground heave of 28 cm at the end of the first 11 years.

a. Where is this predicted to occur and will it result in surface flow changes?

b. If so, discuss implications to local aquatic habitat.

6. Terrestrial

6.1. Land Use and Land Management

68. **Volume 4: Supplemental Information Request #1, Response #168, Page AENV-177**

Ivanhoe states, "*After construction is complete, the camp will be demobilized and removed from site*." Ivanhoe does not state what will happen to the disturbed land associated with the camp.

a. Explain what Ivanhoe intends to do with the disturbed lands once the construction camps are removed.

69. **Volume 4: Supplemental Information Request #1, Response #171, Page AENV-180.**

Ivanhoe states that the proposed product pipeline will likely follow the existing Corridor Pipeline right-of way. According to the Draft *Lower Athabasca Regional Plan*, there is a proposed conservation area along the Clearwater River. The draft plan accounts for the current pipeline right-of-way but does not include additional future pipelines within or adjacent to the ROW.

a. Discuss alternate pipeline right-of-way locations Ivanhoe has considered.

6.2. Conservation and Reclamation

70. **Volume 4, Project Update.**

Ivanhoe states that the number and location of the observation and monitoring wells has changed and that the original well locations will only be utilized if required. This was undertaken to reduce the overall size of the project footprint and locations are shown in Figure PU-1.

a. Given the general approach to reclamation and disturbance amelioration proposed for the project (i.e., use of PDA's and future development of site specific plans) will PDA's be undertaken for all proposed well locations (new and old) before project startup?

b. If not, what is the expected timeline from determination of the need for use of an additional observation well and its construction? Is this sufficient to allow for PDA to be undertaken?

71. **Volume 4: Supplemental Information Request #1, Response # 196, Page AENV-207.**

Ivanhoe refers to their planned adaptive management approach.

a. How, on what schedule, and to who will Ivanhoe's progress in implementing this approach be reported?

72. **Volume 4: Supplemental Information Request #1, Response # 198 a, Page AENV-210.**

Ivanhoe indicates that "*demonstrated progress towards re-establishment of wildlife habitat*" is one of its reclamation objectives.

a. Explain how Ivanhoe will clearly demonstrate that it has made progress towards the re-establishment of wildlife habitat.

b. What will Ivanhoe use as the baseline for existing wildlife habitat and what will be considered successful re-establishment?

73. **Volume 4: Supplemental Information Request #1, Response # 122 d, Page AENV - 105.**

Ivanhoe states, "*during reclamation, the pads will be modified but will not be removed*."

a. Provide the rationale for not fully removing pads and reclaiming to pre-disturbance conditions.

6.3. Terrain and Soils

74. **Volume 4: Supplemental Information Request #1, Response # 201b, e, f & g., Page AENV-213-214**

Ivanhoe states, "*the MIL, FIR, and MAR soils evaluated in …Section 7 …of Abboud et al. (2002) were sampled from areas that have been impacted by forest fires over the last 20 years. The LFH horizons in these soils are thinner (due to forest fires) with low organic matter, cation exchange capacity and base saturation. Critical loads of these fire affected soils are not directly comparable to soils within the Project and were, therefore, left out of the assessment.*"

Whether assessed using older methodology (Holowaychuk and Fessenden 1987) or the more recent critical load approach (Abboud et al. 2002), most studies in the Oil Sands region consider Firebag (FIR), Marguerite (MAR) and Mildred (MIL) soils to be amongst the most sensitive to acidifying inputs.

a. Considering that fire-affected soils are an intrinsic part of the landscape and that FIR, MAR and MIL might be the most acid sensitive soils (50-year Mid CV case critical load <0.1 keq H^+/ha/yr) in the northeast region, re-assess the extent of acidification of soils in the TRSA assuming this "worst case scenario".

Literature Cited:

Abboud, S.A., L.W. Turchenek and L.A. Halsey. 2002. *Critical loads of acid deposition on soils in the Athabasca Oil Sands region, Alberta.* Prepared for NO_x-SO_2 Management Working Group, Cumulative Environmental Management Association by Alberta Research Council, AMEC Earth & Environmental Limited, and University of Alberta. 171 pp.

CASA (Clean Air Strategic Alliance) and AENV (Alberta Environment). 1999. *Application of critical, target, and monitoring loads for the evaluation and management of acid deposition*. Target Loading Subgroup, Clean Air Strategic Alliance and Alberta Environment. 67 pp.

Holowaychuk, N. and R.J. Fessenden. 1987. *Soil sensitivity to acid deposition*. Alberta Research Council, Terrain Sciences Department, Edmonton. 38 pp. + maps.

75. **Volume 4: Supplemental Information Request #1, Response # 204 a, b & c, Page AENV-218 to 220.**

Based on data for at least 4 profiles (87, 81, C78 and C79) provided in Volumes 3 & 4, Winefred-based soils (WNF, WNFxc, WNFxczb and WNFzb variants) appear to be common in the TLSA. Ivanhoe stated in its response to Question 204. b. that "*Coarse textured veneers have been noted in the TLSA and accounted for in the assessments of*

LCCS, soil reclamation suitability or soil erosion potential." Ivanhoe went on to indicate that LCCS, reclamation suitability and soil erosion potential ratings were not changed.

a. Considering the number of probable WNF-like profiles apparent in the datasets, to what extent were such soils noted in the TLSA? Were they considered as dominant, sub-dominant or minor inclusions in existing map units?

b. In other studies in the region, WNF soils (series and related variants) tend to fall into LCCS Class 3 with a final rating (index points) in the low to mid fifties. How does Ivanhoe's LCCS assessment of these soils compare?

76. **Volume 4: Supplemental Information Request #1, Response # 204g, Page AENV-221 and Response # 206a, Page AENV-224.**

In its response to SIR 204g, Ivanhoe indicated that it used additional data from a Suncor project (Suncor Energy 2003) and the soil inventory of the Alberta Oil Sands Environmental Research Program Study Area (Turchenek and Lindsay 1982) in calculating land capability and reclamation suitability. Conversely in the response to SIR 206a, Ivanhoe states, "*Soil profiles used to derive LCCS ratings were carefully selected to represent similar profiles (pedons) or soil series within the TLSA. This approach provided an accurate representation of LCCS ratings for soil series within the TLSA without having to amalgamate several soil profiles*."

a. Clarify this apparent contradiction in the approach to assembling soil data for use in assessing land capability classification and reclamation suitability.

77. **Volume 4, Supplemental Information Request #1, Response # 190, Page AENV-201.**

Ivanhoe states that stockpiles *"will be monitored periodically to prevent any slumping...*" Monitoring of the stockpiles will demonstrate if a stockpile is unstable and if mitigation will be required to prevent loss of soil materials. Monitoring does not ensure that the stockpile will be stable when thawing.

a. What proactive steps will Ivanhoe use to ensure stockpile stability and prevent the loss of soil materials?

78. **Volume 4, Supplemental Information Request #1, Response # 192, Page AENV-203.**

Ivanhoe states that it "*will plan ahead and coordinate with local regional suppliers to ensure stocks are available at the time of reclamation*." With an anticipated increase in the reclamation of oilsand and other energy developments, the demand for nursery stock of suitable species will increase over time.

a. What steps is Ivanhoe planning to take to ensure that planting stock will be available at the time of reclamation?

79. **Volume 4, Supplemental Information Request #1, Response # 210, Page AENV-229.**

Ivanhoe states that the overall impact of the project on hydrology will be low. However, the critical importance of smaller scale changes in surface, and near surface, water levels on fen communities (i.e., interruption of water flow by roads or facilities can greatly extend the disturbance footprint by negatively impacting vegetation, particularly trees) has not been addressed. Actions to maintain drainage in the channels described in the hydrology assessment are not in all cases the same actions that would be required to maintain the fen plant community, particularly in the unnamed stream 1 watershed that includes a large undefined channel and is bisected 4 times (perpendicular to flow direction) by proposed development.

a. Describe what construction techniques/methods will be employed to ensure that the anticipated negative effects on fen communities will not occur, and how this will be monitored.

6.4. Wildlife

80. **Volume 4, Supplemental Information Request #1, Response # 1, Table SIR 1-3.**

Both the Fort McMurray #468 First Nation and Metis Local #1935 have raised concerns about impacts to woodland caribou as a result of the project, noting diminishing woodland caribou in the area around Fort McMurray. Woodland caribou habitat has been identified in the provincial Woodland Caribou Policy in the South ½ of Township 88, Range 8, West of the Fourth Meridian.

a. Given the proximity to woodland caribou habitat, address how Ivanhoe Tamarack will meet the Woodland Caribou Policy in terms of:

i. maintaining and restoring caribou habitat,
ii. managing efforts that will recognize habitat changes through time, and
iii. prudent management of the land base.

81. **Volume 4, Supplemental Information Request #1, Response # 45, Page ERCB-123.**

a. Will there be any process-affected ponds on site, and if so, explain the mitigation measures to be undertaken to ensure wildlife do not come into contact with the process-affected materials.

82. **Volume 4, Supplemental Information Request #1, Response 61, Page AENV - 15, Response 62, Page AENV 17., and Question 171, Page AENV-180.**

It is understood that the Clearwater Multi-Access Road (CMAR) is not part of this EIA. However, it is not clear if there is other access required to the Phase 2 site which would form part of this EIA. For access which Ivanhoe will be building:

a. Discuss how impacts to Aquatic Resources and Wildlife associated with access to the project were considered.

b. If they were not considered, explain why, update the assessment to do so, and provide the findings.

c. Identify mitigation and design commitments associated with the access and its potential impacts on aquatic and terrestrial resources including specifics related to:

i. Road design and maintenance to manage sedimentation
ii. Road monitoring to ensure:
   - surface and shallow groundwater flows are not impeded,
   - changes to vegetation / ecosites as a consequence of altered flow are noted early,
   - watercourse crossings are functioning as designed and fish passage and wildlife movement are not impeded.

83. **Volume 4, Supplemental Information Request #1, Response # 211, Page AENV-230.**

Ivanhoe was asked to validate their models. In the response, Ivanhoe provided a discussion of the development of their HSI models and an explanation of how they were validated, indicating field data were used. However, in the EIA text (Section 12.3.3, Page 12-20), Ivanhoe states, "*Where field data were not sufficient for determining species habitat preferences, Habitat Suitability Index (HSI) models were applied*."

a. These would seem to be contradictory. Provide a discussion.

Muir, et.al. (2011) have recently presented a reference on habitat models.

b. In light of the work by Muir at al. discuss the adequacy of the methods used by Ivanhoe to validate wildlife and aquatic habitat models.

Literature Cited:

Muir, J.E. V.C. Hawkes, K.N. Tuttle, and T. Mochizuki. 2011. Synthesis of Habitat Models used in the Oil Sands Region. LGL Report EA3259. Unpublished report by LGL Limited environmental research associates, Sidney, B.C. for the Cumulative Environmental Management Association (CEMA) – The Reclamation Working Group (RWG), Fort McMurray, AB. 30pp + Appendices.

84. **Volume 4, Supplemental Information Request #1, Response 213 a, Page AENV-232.**

Ivanhoe Tamarack provides a discussion of changes in habitat suitability as a consequence of sensory disturbance. Ivanhoe states, "*No habitat effectiveness distances as a result of sensory disturbance are known to have been proven or recommended for Canadian Toads in the boreal forest*."

a. Clarify whether the lack of proven or recommended effective distances is because no investigative work has actually been done, or whether work has been done but, found to be inconclusive.

85. **Volume 4, Supplemental Information Request #1, Response # 213 b, Page AENV-233.**

Ivanhoe states, "*barrier effects of above-ground pipelines on moose and other species in the TLSA are not expected* "

a. Provide justification for this position based on scientifically defensible data, or published work that was situated in similar habitat with similar above-ground pipeline, road and transmission line schematics. If unpublished data are used to support the position, provide the data.

86. **Volume 4, Supplemental Information Request #1, Response # 213 c, Page AENV-233, and Question 284. Page AENV-351.**

Ivanhoe provided a revised assessment of habitat suitability to account for sensory disturbance. With respect to Mixedwood Forest Bird Community.

a. Ivanhoe indicates in the discussion that a 300 metre buffer was applied around the CPF to account for sensory disturbance. This does not appear to be reflected in Figure 12.5-4. Explain and/or provide an updated figure.

b. Ivanhoe discusses sound, referencing Bayne et al. (2008); but, goes on to indicate that use by mixedwood forest birds is expected to continue around Project facilities (other than the CPF). How do noise levels associated with the pad sites compare to the findings of Bayne, et al. (2008)? Why was a buffer or a modified buffer not applied to the pad sites to account for noise impacts?

c. Ivanhoe states, "*Timing constraints for vegetation clearing will not occur while migratory birds are nesting, rearing young and fledging*." Confirm whether Ivanhoe intended to convey that timing constraints for vegetation clearing would be applied to ensure disturbance of nesting, rearing and fledging migratory birds would not occur.

With respect to Old Growth Forest Bird Community.

d. Ivanhoe indicates in the discussion that a 300 metre buffer was applied around the CPF to account for sensory disturbance. This does not appear to be reflected in Figure 12.5-5. Explain and/or provide an updated figure.

e. Ivanhoe provided a discussion of sound impacts in the mixedwood discussion; but, did not cover the topic similarly in the old growth discussion. Provide this discussion.

87. **Volume 4, Supplemental Information Request #1, Response # 214 a, Page AENV-241.**

Ivanhoe indicates that the minimum above-ground pipeline height will be 0.5 metres and did not provide the maximum and average pipeline heights as measured to the bottom of the pipeline as requested.

Ivanhoe also indicates that the detailed engineering for the above ground pipelines has not yet been completed and therefore the mitigation measures for above ground pipe have not been fully described. Without understanding how above-ground pipeline is being mitigated, it is not possible to understand how the project will affect large ungulates.

a. Provide the maximum and average pipeline heights as measured to the bottom of the pipeline as requested.

b. Provide Ivanhoe's targets for clearance under above ground pipe within each of the following categories: total length (m) and percentage (%) of above ground pipe with clearance greater than 1.4 m, 1.8 m, 2 m and 2.5 m.

c. Provide a map of the above ground pipelines including related project infrastructure, wildlife habitat and areas targeted for mitigation

88. **Volume 4, Supplemental Information Request #1, Response # 214 b, Page AENV-241.**

Ivanhoe states that the distance between above-ground crossing opportunities will be 800 metres. For species which prefer either above-pipe or below-pipe crossings, this could result in functional spacing between crossings, provided the crossing type alternated, of up to 800 metres. In the event of numerous similar crossing types (e.g. four over-pipe ramps in a row); crossing opportunities for species that prefer the other crossing type could be kilometers apart.

a. Why was a maximum distance between crossings of 800 metres chosen? Provide data or studies that support this distance.

b. If over-pipe crossing structures are to be used:

   i. Provide a conceptual engineering drawing of the planned structure, incorporating design features based on published data and recommendations to facilitate over-pipe crossing use.
   ii. Clearly identify sources of information used.

89. **Volume 4, Supplemental Information Request #1, Response # 214 c, Page AENV-241.**

Ivanhoe was asked to discuss the effectiveness of the chosen over-pipe crossing design but simply stated that wildlife species found in the area, including bear, coyote, deer, lynx, moose, and wolf have been documented to use the over-pipe crossings of similar design. This does not clearly indicate effectiveness.

a. Provide a discussion that compares wildlife use of the proposed over-pipe structure to wildlife movement in a non-constrained environment assuming all other habitat factors to be similar.

b. Provide a discussion of wildlife use of the proposed over-pipe structure as compared to an under-pipe crossing opportunity with a 1.8 metre winter clearance along a 20-metre section of pipe assuming all other habitat factors to be similar.

Ivanhoe indicates that all interconnecting infrastructure, including pipelines, transmission lines, and access roads will be routed along a common corridor.

c. Discuss how this would result in an additive effect on permeability of the area for wildlife.

d. Discuss the height of the proposed road grade and its potential effect on wildlife permeability. Discuss options which Ivanhoe could implement to reduce the road height and minimize this effect, and outline Ivanhoe's plans to do so.

e. How is Ivanhoe designing these multiple use corridors to minimize the combined ROW width?

f. What mitigation will Ivanhoe implement to reduce the functional ROW with respect to wildlife movement / permeability? Some examples include: will belowground pipeline ROWs be immediately and actively revegetated with the exception of the ditchline? Will transmission ROWs be immediately revegetated?

g. With respect to bear use of the area discuss:

i. How Ivanhoe will meet the objectives of the provincial BearSmart program.
ii. How Ivanhoe will minimize the potential for bear-human interaction in these areas. Note - Fencing of camps and waste storage areas is a fairly cost-effective way of reducing the potential for bear-human interactions.

90. **Volume 4, Supplemental Information Request #1, Response # 216 a, Page AENV 243.**

Cumulative habitat loss is identified at 6.3% from baseline and an overall disturbance level of 27.9% of the TRSA. This would seem to indicate that a 28% decline in regional wildlife populations could be expected based solely on the loss of habitat.

a. Why is the impact rating for cumulative habitat loss moderate?

b. What quantitative criteria were considered, and how was this modified by qualitative criteria?

c. Explain how professional judgment was factored in. Was a rationale provided for a rating of moderate as opposed to high or low?

d. What scale of habitat loss would warrant a rating of high?

91. **Volume 4: Supplemental Information Request #1, Response # 217 b, Page AENV-244.**

Ivanhoe notes that a 2D seismic program is planned for the winter of 2011-2012. Based on this Ivanhoe will determine the need for 3D and 4D seismic programs to assist in planning and monitoring project performance and steam chamber evolution.

a. How was the planned 2D seismic program considered in the assessment of project impacts?

b. If it was not considered, what additional impacts to fish and wildlife resources would be expected?

c. How were potential 3D and 4D seismic impacts considered in the assessment of project impacts?

d. If they were not considered, what additional impacts to fish and wildlife would be expected?

e. If Ivanhoe uses industry standard grid spacing and periodicity for 3D and 4D seismic, what is the cumulative fragmentation level for the TRSA?

7. Health

92. **Volume 4: Supplemental Information Request #1, Response #70, Page AENV-27.**

In Table SIR 70-1, Ivanhoe provides construction phase emissions

a. Discuss how these emissions compare with the predicted operating emission.

b. Discuss the potential human health impact associated with the construction phase emissions.

93. **Volume 4: Supplemental Information Request #1, Response #225a, Page AENV-254.**

Ivanhoe states, "*Carcinogenic PAH profiles are provided in Appendix L of Volume 3.*" Appendix L2 does not include a toxicity profile for a Carcinogenic PAH group.

a. Provide the TEFs used to assess the carcinogenic PAH group and the calculations used to estimate concentrations for this group.

94. **Volume 4: Supplemental Information Request #1, Response #230a, Page AENV-259.**

Ivanhoe states, "*Those COPCs not discussed in the appendix are provided below.*" A profile for particulate matter was not provided. Other toxicity profiles are not complete.

a. Provide a toxicity profile for particulate matter.

b. Complete the toxicity profile for the aliphatic and aromatic hydrocarbon to include the inhalation TRVs. Include calculations and references.

95. **Volume 4: Supplemental Information Request #1, Response #233a, Page AENV-262.**

Ivanhoe states, "*Risks associated with $PM_{2.5}$ were not re-assessed since the Canada Wide Standards (CWS) TRV used in the application was developed in part on considerations to potential impacts to public health*." The CWS for $PM_{2.5}$ was developed as a target for reduction of air pollutants in areas of concern. The CSW also describes the implementation of "*continuous improvement, pollution prevention, and keeping-clean-areas-clean programs in areas with ambient concentrations below the CWS levels*" The CSW states that for areas with air quality below the CSW "*it would be wrong to convey the impression that no action is required in these areas or that it would be acceptable to allow pollutant levels to rise to the CWS levels.*" This indicates that the CWS may not be the best choice for the assessment of potential human health effects for a new development. More conservative, health based guidelines are available from US EPA (2005), WHO (2005), CARB and NAAQO.

a. Explain why the less conservative CWS was selected for the HHRA instead the more conservative objectives selected by three other jurisdictions for the protection of human health.

b. Provide an assessment of potential human health effects using a TRV more appropriate to the region and justify the TRV chosen.

96. **Volume 4: Supplemental Information Request #1, Response #239a, Page AENV-268.**

Ivanhoe states that the MPOI was not assessed for $PM_{2.5}$ because it is not "*a static location but would change daily depending on emissions and meteorological conditions*." This is true for the predicted air concentrations of all contaminants estimated for the MPOI.

a. Calculate and discuss the potential risk of exposure to $PM_{2.5}$ at the MPOI.

97. **Volume 4: Supplemental Information Request #1, Response #242, Page AENV-271.**

Ivanhoe did not address the $PM_{2.5}$ results which indicated that the highest concentrations were not at the MPOI. Instead they have removed the MPOI location for $PM_{2.5}$ from the HHRA. Thus, information has not been provided for the original SIR.

The MPOI is a hypothetical location designed to represent a highly conservative estimate of potential exposure for each chemical, so as to represent the highest potential risk.

a. Provide results for all receptor locations including the MPOI.

b. Explain and resolve the discrepancy where results of the SUM15 assessment at some receptor locations are greater than the MOPI.

98. **Volume 4: Supplemental Information Request #1, Response #246, Page AENV-285.**

In Table SIR 246-2, carcinogens were ranked with non-carcinogens and the reference sources for the toxicity data were not provided. Some chemicals included in Appendix L1 were not included in the tables provide with the SIR 246 (e.g., 7,12 dimethylbenz[a]anthracence)

a. Screen carcinogens and non-carcinogens separately for chronic inhalation.

b. Provide reference for all toxicity data used.

c. Included all chemicals present in the facility emissions in the screening tables.

99. **Volume 4: Supplemental Information Request #1, Response #251a, Page AENV-294.**

Ivanhoe states, "*COS does not have any potential for binding to soils, remaining in water, or bioaccumulating in vegetation or animals.*" Yet, the chemical screening for persistence and bioaccumulation ranks COS as one of the most potentially bioaccumulative and the most persistent chemical of the emissions list.

a. Explain how COS ranks as more persistent and potentially bioaccumulating than other chemicals known to demonstrate these properties.

100. **Volume 4: Supplemental Information Request #1, Response #252b, Page AENV-295.**

This response does not address the original SIR. The original SIR states, "*the screening methods described in Appendix L1 to identify persistent and bioaccumulative COPC do not identify chemicals known to bioaccumulate and persist (e.g., carcinogenic PAHs, metals) but instead identifies chemicals not usually included due to their volatility (e.g., benzene, carbonyl sulphide).*" The formulas Ivanhoe use to calculate the *Bioaccumulation Potency* and *Persistence Potency* in Appendix L-1, Section 1.2 and 1.3 are unfamiliar. Their accuracy is unsubstantiated and requires scientific proof to support their application.

a. Provide scientific evidence supporting the use and validity of these formulas.

b. Provide references and supporting documentation for the use of these formulas.

101. **Volume 4: Supplemental Information Request #1, Response #253a, Page AENV-297.**

a. Identify whether any of the carcinogenic COPCs have the same carcinogenic endpoints or target organ (e.g., lung, kidney, liver) and calculate the total ILCR for those groups.

102. **Volume 4: Supplemental Information Request #1, Response #256a, Page AENV-300.**

The OEHHA describe a carcinogenic exposure limit for naphthalene for chronic inhalation based on an NTP (2000) study. Neither the US EPA nor HC have included an evaluation of the 2000 NTP study results in the establishment of their chronic inhalation guidelines. Naphthalene is currently under re-assessment by the US EPA which has establish a draft carcinogenic TRV. The International Agency for Research on Cancer (IARC 2002) has concluded that naphthalene is *possibly carcinogenic to humans (Group 2B).* Ivanhoe treats other *Group B* chemicals as carcinogens (e.g., acetaldehyde, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene) in the HHRA.

a. Include an assessment of the potential carcinogenicity of naphthalene following chronic inhalation.

103. **Volume 4: Supplemental Information Request #1, Response #258a, Page AENV-304.**

a. Provide reference sources for data in Table SIR 258-1.

104. **Volume 4: Supplemental Information Request #1, Response #262a, Pages AENV-308 to AENV-315.**

A spot check of the literature sources provided still does not include the correct date of publication of the TRV. For example the RAIS link describes the IRIS TRV for benzene; this data was revised in 2000, not 2010 as indicated. Similarly the RAIS link for B[a]P also used the IRIS TRV which was last revised in 1994, not 2010. Other discrepancies were the OEHHA for benzene and the MDEP reference for carbonyl sulfide. There may be others.

a. Provide accurate reference for all literature/data sources; include publication dates of the TRVs.

105. **Volume 4: Supplemental Information Request #1, Response #270a, Page AENV-323.**

Ivanhoe states, "*The inhalation TRV in mg/m3 was adjusted as a dose (mg/kg-d) for the modelling effort.*"

a. Provide the calculations used to adjust from an air concentration (mg/m^3) to a dose (mg/kg-d).

106. **Volume 4: Supplemental Information Request #1, Response #271 a, d, Page AENV-334.**

In response SIR 271a, Ivanhoe states, "*the predicted 9th highest 1 hour SO_2 concentration arising from the HTL^{TM} flare … is 433.5µg/m^3. This represents the worst flare upset case and all other upset scenarios are within this range. This predicted concentration resulting from the upset scenario remained below AENV Ambient Air Quality Objective* [AAAQO] *of 450µg/m^3 for SO_2.*" However, in the response to SIR 72b, Table SIR 72-1 provided predicted 1 hour maximum SO_2 concentrations due to upset flaring to be higher than 433.5µg/m^3 and the AAAQO.

a. Explain this discrepancy.

b. Provide the potential human health risk associated with all upset conditions.

In response to SIR 271d, Ivanhoe states: *See Response to SIR 61a.* However, an assessment of the potential public health/safety impact associated with project related traffic is not addressed under SIR 61, nor is a Traffic Impact Assessment provided as requested by SIR 61a.

c. Provide an assessment of the potential public health/safety impact of increased traffic in the region due to the project.

8. Approvals

The responses to questions in this Approvals section will not be considered as part of the EIA completeness decision made by Alberta Environment.

8.1. Environmental Protection and Enhancement Act

107. **Volume 4: Supplemental Information Request #1, Response #108, Page AENV-85.**

Ivanhoe provides a table outlining the wetland disturbance areas. The *Water Act* may require that an approval be obtained before undertaking construction activity in a wetland.

a. Clarify if any wetlands are being impacted by the proposed infrastructure and clarify when Ivanhoe will submit a Water Act Application if required for this activity. It is expected that a review of historical aerial photos is completed to ensure that open water bodies are identified in the wet years

108. **Volume 4: Supplemental Information Request #1, Response #113, Page AENV-91.**

Ivanhoe states, "*The watercourses identified on the Constraints Map are generally non-flowing or ephemeral drainage. Encroachments on non fish-bearing watercourse buffers create minimal environmental impact as long as sedimentation is prevented and drainage is maintained.*"

a. Clarify how sedimentation is prevented and drainage is maintained. Specify the type and level of best management practices used to ensure the conveyance of the water and prevention of water quality degradation.

109. **Volume 4: Supplemental Information Request #1, Response #114, Page AENV-92.**

Ivanhoe states, "*Ivanhoe will make application under all applicable legislation for the channel diversions, including applications under the Alberta Water Act and Federal Fisheries Act.*"

a. Clarify when Ivanhoe will submit a Water Act application for the channel diversions.

b. Clarify if any other open bodies of water are being impacted for the construction of Ivanhoe's proposed infrastructure for the Tamarack Integrated Oil Sands Project. It is expected that a review of historical aerial photos is completed to ensure that open water bodies are identified in the wet years. Disturbance of open bodies of water may trigger a Water Act approval.

c. Clarify if Ivanhoe will be seeking a temporary or permanent diversion water licence under the *Water Act* for the potential use of runoff water, if accumulated surface water within runoff ponds or SAGD pads do not meet regulatory requirements for release.

110. **Volume 4: Supplemental Information Request #1, Response #277, Page AENV-330.**

Ivanhoe states, "*The FGD is a dry lime scrubbing technology, which does not produce nor is it designed to capture NOx emissions. Please refer to the NOx emissions data on Table SIR 70-1.*"

Table SIR 70-1, page 27, summarizes the construction phase emissions. The original question was asked in relation to the major air emission sources at the Central Processing Facility, particularly the FGD/HTL units, listed in Table ATT6-3.

a. **Application, Volume 1, Attachment 6- Page 6, Table ATT6-3** shows NOx emissions of 6.04 t/d from each of the two proposed FGD units under Tamarack Phase 1 HTL and Phase 2 HTL, respectively. Based on that, provide the following information:

   i. What is the source of these NOx emissions?
   ii. How were the NOx emissions calculated or estimated?
   iii. If indeed the two FGD unit stacks are the major sources of NOx emissions, discuss what options Ivanhoe is considering or implementing to minimize NOx emissions from these units.

b. Based on Ivanhoe's response to (a), provide a revised Table ATT6-3 if needed.

111. **Volume 4: Supplemental Information Request #1, Response #279, Page AENV-332.**

a. Using the Rational Method as described in *A Guide to Content of Industrial Applications*, Alberta Environment, September 1999, provide the size/volume (m^3) and dimensions (L x W x D) of the proposed runoff pond on the Central Processing Facility.

9. Federal

The responses to questions in this Federal section will not be considered as part of the EIA completeness decision made by Alberta Environment and Water.

112. **Volume 4: Supplemental Information Request #1, Response #282, Page AENV-346**

Federal legislation (*Species at Risk Act*, Section 79(2)) requires that, for projects under federal review, adverse project effects be identified for listed wildlife species. Also, if a project is carried out, measures must be taken to avoid or lessen those effects on listed species and to monitor them. These measures must be taken regardless of the significance of the impact on listed species. This requirement reflects the status of listed species (i.e., declining or low populations) and thus the potential greater risk to populations posed by industrial development. Because of their status, considerable effort and attention should be placed on identifying and mitigating impacts on listed species.

To monitor the effects of the project on listed species, it is necessary to understand the distribution and relative abundance of wildlife prior to project disturbance. This data is crucial for monitoring changes in species distribution and abundance following project development, and validating Environmental Assessment predictions. Currently, the yellow rail surveys completed by Ivanhoe are not adequate to determine the potential presence of yellow rail in the TLSA. Environment Canada (EC) recommends 3 surveys within a season to maximize detection probability of rails (Bazin and Baldwin 2007). There is also some suggestion that detection is greatest during new moon periods when conditions are darkest (Prescott et al. 2002). EC notes that when repeated surveys were conducted in the Imperial Kearl Lake lease, a high number of rails were detected, with the highest numbers detected in late June and mid-July, and the lowest in mid-June (Golder 2008). EC notes that these densities are amongst the highest reported in Canada, illustrating the importance of the oil sands region for this species. Detection probability of yellow rails in the Tamarack lease was likely low, given the timing of the survey (relatively early in the breeding season) and limited survey effort (one survey only).

a. Describe how Ivanhoe plans to monitor the effects of the project on listed species;

b. Describe whether existing data is suitable to characterize baseline distribution and abundance of listed species in the TLSA, including yellow rail (see comments above);

c. Describe whether existing baseline data is suitable for rigorous effects monitoring; and,

d. Given the above information, describe whether additional baseline surveys, including yellow rail surveys, will be conducted to adequately document baseline conditions for monitoring purposes.

Literature Cited:

Golder Associates. 2008. Kearl Oil Sands Project Yellow Rail Surveys. Prepared for Imperial Oil Resources Ventures Limited.

113. **Volume 4: Supplemental Information Request #1, Response #283, Page AENV-347**

Environment Canada (EC) does not accept the use of surrogate or umbrella species to assess project effects on listed species. No two species have identical habitat requirements. Thus, using one species (or guild) to represent the habitat requirements of a listed species may over- or under-estimate the impact of a project on a listed species. It is important to identify impacts as accurately as possible to ensure application of effective mitigation, namely measures to avoid or lessen project effects. As the primary impact of the Tamarack project is habitat loss, it is important to identify measures to avoid species at risk habitat, or to lessen impacts to species at risk habitat. To do so requires understanding the distribution and amount (area) of habitat for listed species in the TLSA, and the extent of direct and indirect habitat loss. This analysis has not been completed.

a. Complete an analysis of project effects on individual listed species that may interact with the project, including quantification of direct and indirect habitat loss for appropriate species.

114. **Volume 4: Supplemental Information Request #1, Response #285, Page AENV-353**

The primary mitigation measure proposed by Ivanhoe for loss of habitat is reclamation. Although considerable effort and research is being directed towards reclamation, it is important to recognize the current uncertainties and limitations with reclamation. Specifically, successful re-colonization of reclaimed habitat by listed species in the oil sands region has not been demonstrated, thus the long-term success of reclamation is unknown. Whether the diversity and density of listed (and other) species in reclaimed habitats will be similar to pre-disturbance conditions is unknown. Also, some habitats such as bogs and fens may not be reclaimed and may be lost permanently (e.g., by conversion to shallow water) or for a long period of time (e.g., loss of old growth forest). These habitats are important for several listed species. Because of these uncertainties and limitations, other measures are warranted to mitigate the effects of habitat loss on listed species. One additional mitigation measure used in the oil sands region is habitat offsets. Offsets have been used as mitigation for oil sands mines, and were proposed by Total E&P Canada for the Joslyn III SAGD project (however, since this project was abandoned, the offsets were applied to the Joslyn North Mine project instead).

a. Based on the species-specific impact analysis requested above, describe how Ivanhoe will mitigate any permanent or long-term loss of habitat for listed species resulting from project exploration, construction and operations. Mitigation should follow a hierarchal approach based on avoidance, minimization and finally restitution of effects, as described in the *Environmental Assessment Best Practice Guide for Wildlife at Risk in Canada* (2010) and *Addressing Species at Risk Act Considerations Under the Canadian Environmental Assessment Act for Species Under the Responsibility of the Minister responsible for Environment Canada and Parks Canada* (2010).

10. Errata

115. **Volume 4, Project update. Figure PU-1.**

a. Year round access appears to be missing from Figure PU-1. Other figures in Volume 4 show the location unchanged for the original submission so it was assumed no change was made. Is this correct?

Ivanhoe Energy

ERCB Responses
ERCB Application No. 1665921

ERCB Responses
ERCB Application No. 1665921

GENERAL

1. Provide an update on the status of stakeholder (public and industry) notification and consultation respecting the subject application, including a discussion on any concerns or objections respecting the subject application (including any objections submitted to the ERCB and statements of concern submitted to Alberta Environment and Water) and the efforts to resolve them.

Volume 4, SIR 1 provided an overview of consultation up to 31 August 2011. Since that time, Ivanhoe has continued to execute the consultation plan outlined in the application, as well as the Strategy and Plan for the Consultation of First Nations and Métis Communities (06 April 2010) approved by AENV (the Aboriginal Consultation Plan).

Volume 4 of the application was filed with the ERCB and AENV on 25 November 2011. Ivanhoe distributed copies of the documents in paper and/or electronic form directly to the stakeholders identified in Table SIR2 1-1.

Statements of Concern

AENV accepted seven Statement of Concerns (SOCs) during the public notification process from the following parties:

- Athabasca Chipewyan First Nation (ACFN);
- Fort McKay First Nation (Fort McKay FN);
- Fort McMurray First Nation (FMFN);
- Mikisew Cree First Nation (MCFN);
- Regional Municipality of Wood Buffalo (RMWB);
- Suncor Energy Inc. (Suncor); and
- Northland Forest Products Ltd. (Northland);

Ivanhoe continues to work with stakeholders to address outstanding concerns with the ultimate goal of mitigating them, where feasible and possible. Formal SOC responses have been provided directly to ACFN, Fort McKay FN, FMFN and MCFN and copied to the regulators, (e.g., AENV and ERCB). Ivanhoe continues to work directly with RMWB, Suncor and Northland to address their concerns. Through the formal responses to the SOCs and through further discussions with stakeholders, Ivanhoe hopes to have all SOCs formally withdrawn.

Table SIR2 1-1: SIR Stakeholder Notifications

Community or Stakeholder Group	Community or Stakeholder	Date of Notification	Contact Type
Local Communities	Anzac	12/09/2011	Letter
	Fort Chipewyan Community	12/09/2011	Letter
	Regional Municipality of Wood Buffalo	12/09/2011	Letter
	Fort McKay	12/09/2011	Letter
Environmental Organizations	Pembina Institute	12/09/2011	Letter
	Fort McMurray Environmental Association	12/09/2011	Letter
	Toxic Watch Society of Alberta	12/09/2011	Letter
Aboriginal Organizations	Northeast Aboriginal Business Association	12/09/2011	Letter
	Wood Buffalo First Nations Elder's Society	12/09/2011	Letter
	Nistawoyou Association Friendship Centre	12/09/2011	Letter
Métis Organizations	Métis Local 125	12/09/2011	Letter
	Métis Local 2020	12/09/2011	Letter
	Willow Lake Métis Local 780	12/09/2011	Letter
	Métis Local 1935	12/09/2011	Letter
	Métis Nation of Alberta	12/09/2011	Letter
	Chard Métis Local 214	12/09/2011	Letter
	Conklin Métis Local 193	12/09/2011	Letter
	Métis Nation of Alberta	12/15/2011	Letter
	Métis Local 63	12/09/2011	Letter
Athabasca Chipewyan First Nation	Athabasca Chipewyan First Nation IRC	12/09/2011	Letter
Chipewyan Prairie Déne First Nation	Chipewyan Prairie Déne First Nation IRC	12/09/2011	Letter
Fort McMurray #468 First Nation	Fort McMurray #468 First Nation IRC	12/09/2011	Letter
Fort McKay First Nation	Fort McKay Sustainability Department	12/09/2011	Letter
Mikisew Cree First Nation	Mikisew Cree First Nation GIR	12/09/2011	Letter
Surface and Mineral Disposition Holders	Northland Forest Products Ltd.	12/09/2011	Letter
	Alberta-Pacific Forest Industries Inc.	12/09/2011	Letter
	Minus Nine	12/09/2011	Letter
	ATCO	12/09/2011	Letter
	Hammerstone Corporation	12/09/2011	Letter
	Enbridge Pipelines Inc.	12/15/2011	Letter
Trappers	Bernice Cree	12/09/2011	Letter
	Richard Golosky (Individual - RLRU)	12/09/2011	Letter
	Doug Golosky (Individual - RLRU)	12/09/2011	Letter
Regional Initiatives	Wood Buffalo Environmental Association	12/09/2011	Letter
	Cumulative Environmental Management Association	12/09/2011	Letter
	Regional Aquatics Monitoring Program	12/15/2011	Letter
	Oil Sands Developers Group	12/09/2011	Letter
	Northern Lights Health Region	12/09/2011	Letter
Trade Organizations	Fort McMurray Chamber of Commerce	12/09/2011	Letter
Oil Sand Operators	Grizzly Oil Sand	12/15/2011	Letter
	Imperial Oil	12/15/2011	Letter
	Nexen Inc.	12/15/2011	Letter
	E-T Energy	12/15/2011	Letter
	Suncor Energy Inc.	12/15/2011	Letter
	Laricina Energy	12/15/2011	Letter
Recreational Organizations	McMurray Sno-Drifters Association)	12/09/2011	Letter
	Wood Buffalo ATV Riders Club	12/09/2011	Letter

A summary of the consultation events with First Nations and Aboriginal stakeholders during the period from October 2011 to May 2012 is provided in Appendix SIR2 E. Ivanhoe continues to provide information on the Tamarack Project (Project) and meets with interested groups to discuss concerns and issues.

Public Stakeholders

Regional Municipality of Wood Buffalo

Ivanhoe continues to work with RMWB to address its concerns and issues identified in its SOC filed on 10 February 2011. Ivanhoe met with the RMWB in February 2012, March 2012 and April 2012 for the purpose of addressing these SOCs and negotiating a mutually agreed-upon Memorandum of Understanding that will manage any outstanding issues.

Suncor Energy Inc.

Ivanhoe continues to work with Suncor to address its concerns and issues identified in its SOC, filed on 11 February 2011. Ivanhoe met with Suncor in August 2011, February 2012 and June 2012 for the purpose of addressing these SOCs. Ivanhoe continues to work with Suncor to address the concerns and have the SOC removed.

Northland Forest Products

Ivanhoe continues to work with Northland to address its concerns and issues identified in its SOC, filed on 09 February 2011. Ivanhoe has had several conversations with Northland and met with Northland in January and March 2012 to specifically discuss and review a draft Memorandum of Understanding that will manage any outstanding issues identified in Northland's SOC.

Registered Fur Management Area 1582

Ivanhoe continues to consult with Registered Fur Management Area (RFMA) Holder 1582, located within the terrestrial local study area (TLSA) of the Project. Ivanhoe met with the trapper in December 2011 and February 2012 to provide an update on its 2012 winter field program.

Registered Fur Management Area 273

Ivanhoe continues to consult with RFMA Holder 273, located within the terrestrial regional study area (TRSA) of the Project. Ivanhoe met with the trapper in May 2012.

Registered Fur Management Area 2422

Ivanhoe continues to consult with RFMA Holder 2422, located within the TRSA of the Project. Ivanhoe met with the trapper in December 2011 to review Ivanhoe's 2012 winter field program. Ivanhoe met again with the trapper in April 2012.

Registered Fur Management Area 2453

Ivanhoe is continuing to engage with the Fort McKay FN Sustainability Department on behalf of RFMA 2543, located within the TRSA for the Project.

Aboriginal Communities

A detailed record of consultation with Aboriginal communities from August 2011 to May 2012 is provided in Appendix SIR2 E.

Athabasca Chipewyan First Nation

Ivanhoe continues to provide funding to the ACFN Industry Relations Corporation (IRC) for Membership at an associate level and provides copies of all records of contact to ACFN through the AENV bi-monthly reporting process.

Ivanhoe met with ACFN IRC in April 2012 to provide an update on the Project and to discuss other matters related to traditional knowledge collection and ongoing consultation. Ivanhoe has formally responded to ACFN's SOCs on 29 June 2012 and copies were provided to AENV and ERCB. Ivanhoe continues to consult with ACFN to address its concerns and identified issues.

Chipewyan Prairie Déne First Nation

Ivanhoe continues to provide funding to the CPDFN IRC for membership at an associate level and provides copies all records of contact to CPDFN, through the AENV bi-monthly reporting process.

Fort McMurray First Nation 468

Ivanhoe is a member of the FMFN 468 IRC and provides copies of all records of contact to FMFN 468, through the AENV bimonthly reporting process.

Ivanhoe met with FMFN 468 in October, November and December 2011 and again in February, March and April 2012. The meeting in March 2012 occurred in Calgary and provided an opportunity for the leadership of FMFN 468 to meet with Senior Management of Ivanhoe to discuss the Project. A follow-up meeting with FMFN 468 is scheduled to occur in the community during the early summer of 2012.

FMFN 468 provided Ivanhoe with additional Traditional Ecological Knowledge information in the report, *FMFN#468 Elders – Wildlife Framework, Ivanhoe Energy's Tamarack Project (March 31 – April 2)*. This information was provided to Ivanhoe on 09 February 2012 and forwarded to AENV on 08 June 2012, for consideration in the regulatory process.

Ivanhoe has formally responded to FMFN 468's SOCs on 27 June 2012 and continues to consult with FMFN 468 to address its concerns and identified issues.

Fort McKay First Nation (includes Fort McKay Métis Community)

Ivanhoe continues to provide funding to the Fort McKay Sustainability Department and provides copies of all records of contact to Fort McKay, through the AENV bi-monthly reporting process.

Ivanhoe met with Fort McKay in:

- November 2011 (twice);
- December 2011;
- February 2012 (twice), including one meeting to specifically discuss and address SOCs that Fort McKay had raised in regards to emissions, odours and air quality; and
- May 2012.

Ivanhoe has also provided funding to Fort McKay to have the Project reviewed during Fort McKay's community consultation sessions. These sessions were conducted in April 2012 and Ivanhoe is awaiting a final report from Fort McKay. Ivanhoe will meet with Fort McKay upon receipt of this report to discuss and review any recommendations on concerns raised by Fort McKay.

Ivanhoe formally responded to Fort McKay's SOCs and copied AENV and ERCB on 15 May 2012. Ivanhoe continues to consult with Fort McKay to address its concerns and identified issues.

Mikisew Cree First Nation

Ivanhoe continues to provide funding to the MCFN Government & Industry Relations Department (GIR) for membership at an associate level. Ivanhoe provides copies of all records of contact to MCFN, through the AENV bi-monthly reporting process.

Ivanhoe met with MCFN GIR in March 2011 and April 2012 to provide an update on the Project.

Ivanhoe is currently funding an Indigenous Knowledge Study on behalf of MCFN and will provide the study report when it is made available.

Ivanhoe is working with MCFN to establish an MCFN-Ivanhoe advisory committee. The committee will give MCFN members the opportunity to provide input on the Project.

Ivanhoe formally responded to MCFN's SOCs on 29 June 2012 and continues to consult with MCFN to address its concerns and identified issues.

Fort McMurray Métis Local 1935 (Local 1935)

Ivanhoe met with Local 1935 staff in November 2011 and February 2012 to provide an update on the Project. In addition to these meetings, Ivanhoe has attended and supported Local 1935 community events in December 2011 and May 2012.

Ivanhoe continues to work with Local 1935 to address its concerns and issues.

2. Supplemental Information Response #6, Figure SIR 6-1, Tamarack Project Area and Phase 1 Development Area, Page ERCB-24. Supplemental Information Response #15, Figure SIR 15-1, Gross SAGD Reservoir Thickness (m) Isopach, Page ERCB-58, and Figure SIR 15-4, Developable SAGD Reservoir Thickness (m) Isopach, Page ERCB-61.

a. The project area illustrated in Figures SIR 6-1 and Figure SIR 15-4 differ in the inclusion of five Legal Subdivisions (LSD) in the eastern portion of Sections 28 and 33-090-09W4M. Clarify the apparent discrepancy and confirm the applied-for project and development area boundaries, using Alberta Township Survey (ATS) grid to a LSD level to define the areas.

The Project Area illustrated in Volume 4, Figure SIR 6-1 is correct. The applied for Project Area is described as follows, using the Alberta Township Survey (ATS) grid: Township 90 N, Range 09W4M: LSDs 1,2,3,6,7,8,9,10,11,14,15 and 16 of Section 22; all of Sections 23,24,25,26 and 27; LSDs 1,8,9 and 16 of Section 28; LSD 1 of Section 33; and LSDs 1,2,3 and 4 of Section 34.

As requested by the ERCB, Ivanhoe has revised the applied for Phase 1 Development Area along LSD boundaries (Figure SIR 6-1 (Rev)). The revised Phase 1 Development Area is described as follows, using the ATS grid: Township 90N, Range 09W4M: LSDs 9,10,11,14,15 and 16 of Section 22, LSDs 11,12,13 and 14 of Section 23, LSDs 2,3,4,5,6,7,10,11,12,13,14 and 15 of Section 26, all of Section 27 and LSDs 1,2,3 and 4 of Section 34.

b. Figure SIR 15-1 illustrates that the southeast quarter of Section 25 and the north half of Section 24 contain no developable McMurray bitumen. The ERCB recognizes that Ivanhoe plans to construct the central processing facility on portions of Sections 24 and 25. Clarify whether bitumen recovery is also planned for this area over the life of the Tamarack Project.

Bitumen recovery is not planned over the life of the Project for the area in the parts of Sections 24 and 25 that underlie the central processing facility (CPF).

GEOLOGY

3. Supplemental Information Response #9, Figure SIR 9-1, Phase 1 Pattern and Pad Development Areas, Page ERCB-44.
Figure SIR 9-1 illustrates an additional drainage pattern, H, beneath Pad 3 that was not previously illustrated in Figure 2.1-3 in the application. In the original application, Figures 2.1-46 to 2.1-53 provided SAGD well cross sections for Patterns A through G within the Phase 1 application area. Provide a similar cross section for the proposed additional Pattern H illustrated in Figure SIR 9-1.

SAGD well cross section for Pattern H is presented in Appendix SIR2 B, Figure SIR2 B-2.

4. Supplemental Information Response #9, Table 9-1, Tamarack Project Reservoir Properties and OBIP per Pattern, Page ERCB-45.
Ivanhoe indicates that the area of the proposed drainage patterns range from 360 to 812 ha. The identified areas are very large and appear to be in error. Review the size of drainage patterns A through H stated in Table 9-1 and resubmit the table if necessary.

Table SIR 9-1 (Rev), provided in the SIR2 Project Update, contains the correct hectare (ha) numbers and additional changes due to revisions in the planned SAGD well-pair drainage areas and patterns, which are discussed in SIR2 6. Project Area results, as requested in SIR2 7, are also included in Table SIR 9-1 (Rev).

5. Supplemental Information Response #11, Page ERCB-48.
Ivanhoe states, "*for reservoir management purposes, the Wabiskaw D cap rock is the proposed reference cap rock for the Project.*"

a. Discuss Ivanhoe's rationale for defining the Wabiskaw D as the caprock for the proposed project.

See SIR2 Project Update. Ivanhoe is proposing Wabiskaw B (described by the ERCB as Wabiskaw A shale) as the cap rock for the Project.

b. Discuss the potential impacts on the proposed operations of defining the Wabiskaw A and Clearwater shale as caprock, given that the Wabiskaw A shale is only separated from the Wabiskaw D by approximately four metres.

See response to SIR2 5a.

6. Supplemental Information Response #14, Figure SIR 14-3, Top Wabiskaw Member Structure Contour (masl), Page ERCB-56.

Figure SIR 14-3 illustrates 22 metres of structural relief in the Wabiskaw Member over the proposed development area. Ivanhoe states that this structural collapse is "*related to salt dissolution continued on a regional scale after deposition of the Wabiskaw and Clearwater Shale*". SIR 14 requested Ivanhoe to "*comment on how the structural collapse may affect caprock integrity*"; however, Ivanhoe does not appear to have addressed this in its response. Discuss how the salt dissolution related structural collapse may affect caprock integrity in the proposed project area.

Ivanhoe has updated its geological interpretation of the timing of structural collapse and the implications to cap rock integrity based on the results of a 16.5 km 2D seismic survey in the Phase 1 Development Area that was acquired in February 2012 (Appendix SIR2 F, Figure SIR2 F-1). Based on this newly acquired data, it is interpreted that there was no significant salt dissolution under the seismic acquisition area and the structural lows on the top of the Pre- Cretaceous Unconformity are due to karsting and valley incision of Basal McMurray channels. In addition, these structural features pre-dated the deposition of the Wabiskaw and Clearwater Shale and the structural relief in the Wabiskaw Member over the proposed development area is the result of a localized post-Clearwater structural uplift.

Uninterpreted black and white seismic sections are presented in SIR2 F, Figures SIR2 F-2 through SIR2 F-7. Interpreted color seismic sections, which have been tied to wells at key horizons, are presented in Appendix SIR2 F, Figures SIR2 F-8 through SIR2 F-13. Seismic results support the interpretation presented in Ivanhoe's application that the McMurray Formation sand and shale sediments filled the uneven Pre-Cretaceous Unconformity (Appendix SIR2 F, Figure SIR2 F-14). The McMurray Formation is approximately twice as thick in the Pre-Cretaceous structural lows as it is above the Pre-Cretaceous highs (Appendix SIR2 F, Figure SIR2 F-15). The Wabiskaw thickness in the Phase 1 Development Area varies by only 2 m (Appendix SIR2 F, Figure SIR2 F-16), indicating that this unit was deposited on a relatively flat surface. Most faults which originate in the Pre-Cretaceous section terminate within the McMurray Formation. Therefore, the effects of karsting, and/or channel cutting, which caused the relief on the Pre-Cretaceous Unconformity, do not affect the Wabiskaw B cap rock horizon, except for small scale adjustments due to differential compaction.

A structural high exists in the southern portion of Section 26 and northern portion of Section 23. This structural high formed after the Clearwater Formation was deposited in an approximately 25 ha-sized area centered near the 1AA/03-26-090-09W4/0 well. This structure contains 22 m of relief at the Wabiskaw B cap rock level (Appendix SIR2 F, Figure SIR2 F-17). This late forming feature may have been caused by rotational movement along a deep seated basement fault that branched upward into the Paleozoic and Cretaceous section as a flower structure, however, this cannot be confirmed with the existing well and seismic data. The Wabiskaw B cap rock is faulted in several places on this high, however, the faults at this level have minor offsets with shale on shale contact across the faults.

Ivanhoe has modified its planned Phase 1 development plans to postpone bitumen development within 100 m of faults affecting the Wabiskaw cap rock zones on the structural high described above (Appendix SIR2 F, Figure SIR2 F-18) until the end of Phase 1 development. Initially, no development is planned within a 100 m perimeter around the local high and, consequently, seven of the 10 well-pairs in Pattern A have been shortened (Appendix SIR2 F, Figure SIR2 F-18). Revised reservoir parameters and volumetric OBIP calculations are shown in Table 9-1 (Rev). See SIR2 Project Update.

Ivanhoe has modified its planned Phase 1 development plans to postpone bitumen development within 100 m of faults on the structural high described above (Appendix SIR2 F, Figure SIR2 F-18) until the end of Phase 1 development. Initially, no development is planned within a 100 m perimeter around the local high and, consequently, seven of the 10 well-pairs in Pattern A have been shortened (Appendix SIR2 F, Figure SIR2 F-18). Revised reservoir parameters and volumetric OBIP calculations are shown in Table 9-1 (Rev). See SIR2 Project Update.

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7. Supplemental Information Response #15, Page ERCB-57.
As a result of revisions to interpretation of original bitumen in place (OBIP), Ivanhoe has provided an updated "*best case OBIP*" for the Phase 1 development area of 41 million m3. Provide a corresponding updated OBIP calculation for the proposed project area.

The updated OBIP calculations for the Project Area are shown in Table SIR 9-1 (Rev). See SIR2 Project Update. The calculated OBIP for the Project Area is 98.7 million m^3.

8. Supplemental Information Response #16, Page ERCB-63.
In addition to its core analysis of the Wabiskaw D, Ivanhoe has obtained core over the lower sections of the Clearwater Formation. The ERCB considers core over the entire Clearwater interval to be important to the understanding of caprock lithology and fractures, and for the comparison of and calibration with imaging logs. Discuss Ivanhoe's plans to obtain core over the entire Clearwater interval.

Ivanhoe concurs with the conclusions stated in the fracture analysis study performed on FMI images from three wells on the Project Lease (Schlumberger Canada Ltd. Data and Consulting Services 2011). Small scale fractures observed in the Clearwater Formation section in this study were noted to be sparse and have random orientation, which implies that they are the result of unloading events related to isostatic rebound of glacial retreat.

Fractures are observed in cores from several Project wells in the Wabiskaw Member, however, these fractures are not observed to extend into the overlying Clearwater Shale Member.

Ivanhoe plans to core and log with the FMI tool across the entire Clearwater Formation as a part of its next OSE program after receipt of approval.

Literature Cited:

Schlumberger Canada Ltd Data and Consulting Services. 2011. *Tamarack Field Fracture Study*. Proprietary Report Prepared for Ivanhoe on March 8, 2011, 29 pp. (Note: This report was transmitted to ERCB).

9. Supplemental Information Response #18d, Page ERCB-67. Ivanhoe states that it plans to "*complete a 2D seismic program on the Tamarack Lease this winter (2011-2012)*." Supplemental Information Response #38b, Page ERCB-113. Ivanhoe states, "*Ivanhoe is aware that karst features may exist in part of the Phase 1 Development Area and will be conducting a 2D seismic program this winter to map any karst features*".
The ERCB considers 3D seismic to be critical data for thermal operations at shallow depths in order to understand geological features such as karsting, Quaternary erosion, and faulting where well data or 2D seismic cannot provide this resolution.

a. Discuss whether Ivanhoe plans to complete a 3D survey to better image structural features and Quaternary erosion, or to establish a baseline for future 4D surveys.

The recently completed 2D seismic survey in the Phase 1 Development Area provided excellent data quality for understanding geological features such as karsting, valley incision of Basal McMurray channels, Quaternary erosion and faulting. These data provided conclusive evidence that no deep Quaternary channels exist and over 50 m of Clearwater and Wabiskaw cap rock are present in the Phase 1 Development Area. The karst and valley incision features observed on the Pre-Cretaceous Unconformity do not impact the Wabiskaw and Clearwater cap rock horizons in the Phase 1 Development Area (see SIR2 6). A faulted structural high at cap rock level was mapped using well data and the 2D seismic lines and Ivanhoe has adjusted its development plans accordingly. The stated issues have been adequately assessed by the 2D seismic program, and therefore, Ivanhoe has no plans at this time to conduct a 3D seismic survey.

b. Discuss whether Ivanhoe plans to acquire 4D seismic for the proposed project as a tool for monitoring steam chamber growth, including details on its use in Ivanhoe's monitoring strategy.

Ivanhoe has no plans to conduct 4D seismic over the Project Area. The Reservoir Monitoring Plan (Appendix SIR2 D) will adequately monitor steam chamber growth.

10. SIR Response 19, Page ERCB-72.
Ivanhoe provides a discussion on core photos and other analysis for four wells, including AA/06-35-090-09W4/0 in Appendix B. Oil staining is apparent in the Wabiskaw C in AA/06-35, suggesting that oil migration through the Wabiskaw D has occurred locally, which may be indicative of conduits through the Wabiskaw D. Discuss the possible impacts of this observation on containment.

After further examination of cores in the 1AA/06-35-090-09W4/0 well, Ivanhoe concurs with the ERCB interpretation that oil staining is present in the Wabiskaw C sand. The AA/06-35-090-09W4/0 well is located outside of the Project Area, where Ivanhoe has no plans for bitumen development. The proposed cap rock of Wabiskaw B over the Project Area addresses concerns relating to potential conduits through the Wabiskaw D shale.

11. March 7, 2011, Schlumberger Tamarack Field Fracture Study from FMI Images Report, Section 6, Conclusions and recommendations, Page 19.
Schulmberger states, "*More analysis is needed to fully understand if fractures observed in these three Tamarack Field wells are local phenomenon or belong to regional fracture sets*."
Response to this comment is important in establishing a pervasive regional fracture set, which could have implications on caprock stability and conductivity. The ERCB considers imaging logs to be a crucial tool in assessing caprock integrity.

a. Provide processed image logs for the remainder of the wells within the proposed project area.

The results of Ivanhoe's recently completed 2D seismic survey and FMI fracture study report are sufficient to document the competence of the Wabiskaw B shale cap rock for steam containment. Therefore, Ivanhoe has no immediate plans to process FMI images from additional wells.

b. Based on the newly processed image logs, provide a fracture analysis for the Clearwater and McMurray Formations that includes examples of fractures, and the impact these fractures may have on reservoir fluid containment.

The combination of existing core, FMI and seismic data is sufficient to demonstrate that the Clearwater and Wabiskaw B shales are competent cap rocks for steam containment.

12. July 21, 2011, Proposed Operating Pressure Submission, Appendix, Figure: Pad A Heel Observation Well, Page 64, and Figure: Pad B Toe Observation Well, Page 67. The temperature profiles indicate significant temperature response in the IHS and in the zone identified as "Upper McMurray Cap Rock".

a. Discuss the temperatures measured from a depth of 370 metres to 405 metres in the Pad A heel observation well, and from 380 metres to 405 metres in the Pad B toe observation well. The discussion should include the lithology of the McMurray, conductive versus convective heating of the interval, and temperatures measured within and above the identified "Upper McMurray Cap Rock".

The lithology of the McMurray in the wells consists of a fining upward sequence in the Middle McMurray that includes basal clean fluvial sands, which grade upward into estuarine sandy and muddy IHS beds. These deposits are overlain by tidal flat mudstones of the Upper McMurray.

Based on the limited information available, the temperatures measured in the intervals listed above indicate both conductive and convective heating into the upper McMurray. The temperature profile is not typical of conductive heating and the temperature stabilizes at about 100°C. This indicates there is some vertical permeability to water to allow the convective heating. It is important to note, however, that the temperatures are far below saturated steam temperatures for the initial or elevated pressures reported for those depths indicating no steam movement into the low quality Upper McMurray.

b. Explain the reason for temperatures in these IHS dominated intervals to be ~100 degrees Celsius.

Ivanhoe is not privy to all of the operating data associated with these wells. It is not clear why temperatures in this interval are approximately 100°C, but this temperature is far below the saturated steam temperatures based on the initial or elevated pressures reported for injection. Temperatures are elevated above the original temperature as heat has been transferred from the steam chamber below.

c. Discuss how the IHS from the Pad A heel observation well and Pad B toe observation well compares to the IHS throughout the proposed project area.

The lithology sequence of the McMurray Formation, including the IHS beds, in the two wells is analogous to the McMurray Formation lithologies observed in wells in the Project Area.

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13. Project Update, Figure PU-1, Project Layout.
Figure PU-1 illustrates three Phase 1 initial observation wells north of the Suncor mineral surface lease boundary, with additional observation wells indicated as potential Phase 1 wells. The figure also illustrates a number of "potential" observation wells within the proposed Phase 1 development area. The ERCB requires submission of information to facilitate review of project impacts and associated monitoring for the entire Phase 1 development area.

a. Ivanhoe has reduced the number of monitoring wells north of the development area. Provide a discussion on the incremental increase in risk associated with decreased monitoring.

Ivanhoe is proposing to reduce the number of observation wells in the Suncor MSL area to lessen the Project's impact in this area. The revised observation well network as part of the proposed Reservoir Monitoring Plan (Appendix SIR2 D) will improve Ivanhoe's ability to monitor surface and subsurface changes due to the Project.

b. Discuss whether Ivanhoe considers the initial observation wells to be adequate for monitoring steam chamber growth, caprock integrity, and potential interactions with the Suncor tailings pond.

See Ivanhoe's Reservoir Monitoring Plan (Appendix SIR2 D). The monitoring plan will adequately monitor steam chamber growth, cap rock integrity and potential interactions with the Suncor tailings pond.

c. Confirm Ivanhoe's entire Phase 1 observation well plan.

See Ivanhoe's Reservoir Monitoring Plan (Appendix SIR2 D).

14. Supplemental Information Response #3b, Table SIR 3-1, Phase 1 Initial Observation Well Locations and Monitoring Type, Page ERCB-20.
Table SIR 3-1 indicates Ivanhoe's plans to install pressure and temperature monitoring in the Clearwater and Wabiskaw C.

a. Identify the proposed monitoring zone within the Clearwater Formation and provide a log illustrating the zone.

Upon further review, the Clearwater shale in the Project Area does not contain any continuous horizons with sufficient permeability that would be acceptable as a pressure monitoring zone. Ivanhoe will monitor the temperature across the Clearwater shale but will not use this zone to measure pressure as a part of the Reservoir Monitoring Plan (Appendix SIR2 D).

b. Discuss Ivanhoe's rationale for selection of the identified Clearwater zone and the Wabiskaw C as adequate monitoring zones, including but not limited to lithology, permeability, porosity, radius of detection, areal extent, and any tests conducted to evaluate the zones.

Ivanhoe will not be using the Clearwater shale for subsurface pressure monitoring. Based on the well data obtained over the Project Area, Ivanhoe considers the Wabiskaw C to be laterally continuous and of sufficient reservoir quality so that pressure and temperature monitoring will be useful in monitoring changes that may occur over the life of the Project.

The Wabiskaw C consists of poorly developed glauconitic, silty sand and varies from 3 to 4 m in thickness over the Project Area. The Wabiskaw C glauconitic sand has been extensively cored within the Project Area and the data from the core analysis supports horizontal permeabilities of up to 75 mD with porosities in the order of 29%. The quality of the Wabiskaw C sand is considered to be of high enough permeability to transmit pressure and temperature across the Phase 1 Development Area. The Wabiskaw C sand was not flow tested in the Project Area.

c. Ivanhoe states, "*The wells within the steamflood area will be completed to allow periodic temperature logging as appropriate across the McMurray, Wabiskaw and Clearwater formations.*" Indicate how often temperature logging will be conducted and what information Ivanhoe expects to obtain from the identified permanent temperature monitoring installations. Include a discussion on whether Ivanhoe anticipates any access limitations to wells for temperature logging.

All of the observation wells will be equipped with permanently installed distributed temperature sensors (DTS), which will record wellbore temperature with depth on a continuous basis. The DTS will be connected (using buried optical cable) to the data collection centre located at the SAGD well pads where the data will be collected, temporary stored and transmitted for review and permanent storage. Since there will be no need to access the observation wells in order to obtain this data, well access does not impose any limitation to the collection of the temperature data. However, well lease access by road will be maintained throughout the well life for inspection and servicing.

15. Supplemental Information Response #11, Page ERCB-49.
Ivanhoe states that it "*proposes that the maximum operating pressure should vary as a function of time*", and further "*proposes to reduce operating pressure to the lowest pad pressure among the coalesced steam chambers*."
Supplemental Information Response #11, Table SIR 11-1, Recommended Operating Pressures for Each Fully Developed Pad, Page ERCB-49. Ivanhoe provides the proposed maximum operating pressures (MOP) for the first 600 days and at 621 days for Pads A to G.

a. Provide a detailed discussion on how the coalescence of steam chambers will be determined between each pair of adjacent patterns.

Wellhead pressures and injection rates will be closely monitored to determine the timing of steam chamber coalescence. If significant coalescence occurs then the local steam chamber pressures of adjacent well-pairs must equilibrate, which will cause either an increase in steam injection in the higher pressure well-pair or a decrease in injection of the lower pressure well-pair. Individual rate fluctuations along with correlation between well-pairs will be used to detect such coalescence. Estimates of the timing of chamber coalescence will be determined from reservoir simulation modelling and monitoring data.

b. Figure SIR 9-1 indicates eight patterns (A to H). The proposed drainage area H appears to be missing from Table SIR 11-1. Revise and resubmit Table SIR 11-1 and any other material from the SIR responses as necessary.

See Table SIR 11-1 (Rev).

Table SIR 11-1 (Rev): Recommended Operating Pressures for Each Fully Developed Pad

	Depth to Base Wabiskaw B (m GL)	First 600 Day MOP (kPaa)	MOP at 621 Days (kPaa)
GeoSim Model Reference	81.5 at Wabiskaw D	1 450	1 250
Pad A	75.0	1 406	1 212
Pad B	72.0	1 352	1 166
Pad C	66.0	1 263	1 089
Pad D	66.0	1 263	1 089
Pad E	60.0	1 174	1 012
Pad F	68.0	1 334	1 150
Pad G	60.0	1 139	982
Pad H	64.0	1 228	1 058

Notes:

As the Project is developed, partial pad development may result in higher MOP for a pad if only wells with deeper referenced cap rock are developed.

Upon coalescence of steam chambers, pressures will be adjusted to the lowest MOP.

c. Among the proposed operating pressures for each of the drainage patterns, Pad G is the lowest. Discuss Ivanhoe's ability to operate drainage patterns A to H at the lowest common pressure.

Pattern G development will be deferred until the end of Phase 1. Ivanhoe plans to develop the patterns at the proposed MOPs in Table SIR 11-1 (Rev) and will operate at the lowest common pressure of the coalesced patterns. As detailed in SIR2 15a, upon coalescence, well operations will be adjusted to achieve the lowest common MOP.

d. Discuss Ivanhoe's rationale for providing MOPs for the first 600 days and at 621 days and discuss Ivanhoe's proposed operations between day 600 and day 621.

The time of 600 days was selected to begin the decrease of operating pressure from the initial higher pressure to the long-term lower pressure. This time was chosen based on estimated steam rise in a very clean McMurray sand description in an attempt to minimize the risk for cap rock failure at the higher pressures. The timing of 600 days is very conservative based on the real heterogeneity of permeability even in the clean McMurray sand. The decrease of the pressure in the steam chamber happens gradually and by 621 days normal SAGD operation (full steam injection) has resumed at the lower operating pressure. The period from 600 days to 621 days is a transition period in the simulation history and is an estimate of the time for the steam chamber to decrease to the lower pressure.

16. Supplemental Information Response #21, Page ERCB-75.
Ivanhoe states that top gas within the project area is discontinuous and is not expected to act as thief zones or interfere with the distribution of steam. Discuss Ivanhoe's monitoring plan for potential steam loss and non-condensable gas migration into these gas caps.

Ivanhoe plans on monitoring the gas zones contained in the continuous bitumen pay in the Project Area (shown in Volume 1, Figure 2.1-55) by introducing dual purpose (i.e., top gas and steam chest) observation wells in these areas. These wells will allow direct pressure and temperature measurement in the gas zones to monitor potential steam and non-condensable gas entry into these zones (see Reservoir Monitoring Plan, Appendix SIR2 D).

17. Supplemental Information Response #24c, Page ERCB-79.
Regarding its operating strategy with respect to on-going drawdown of the Lower McMurray source water zone, Ivanhoe states, "*if significant pressure drawdown was detected…the injection pressure would be adjusted to keep a constant pressure differential between the steamflood steam pressure and the underlying aquifer pressure*."

a. Provide the current pressure in the underlying aquifer.

A total of six pressures have been obtained in the Lower McMurray Basal Water Sand during the testing in 2010. No change in pressure from that time is expected since no further withdrawals have occurred. The results indicate a consistent pressure of 704.5 kPaa at a datum depth of 215.0 masl. A summary of these test are shown in Table SIR2 17-1.

Table SIR2 17-1: Pressures in the Lower McMurray Basal Water Sand

Well ID UWI	GL masl	MD masl	MD mbgl	Pressure kPaa	Datum P kPaa
100/02-35-089-09W4M	364.8	245.8	119.0	391.1	696.3
102/02-35-089-09W4M	364.4	248.0	116.4	363.2	690.5
100/05-26-090-09W4M	365.0	222.3	142.7	639.9	712.7
100/09-27-090-09W4M	362.5	206.3	156.2	784.9	698.5
102/10-26-090-09W4M	370.2	214.4	155.8	736.4	730.2
100/10-26-090-09W4M	370.9	213.7	157.2	732.5	719.8
100/12-26-090-90W4M	364.4	211.2	153.2	740.6	702.7
100/15-27-090-09W4M	360.2	236.4	123.8	472.9	685.3
Average Pressure at datum of 215 masl					704.5

b. Identify the differential pressure between the steamflood steam pressure and the underlying aquifer pressure at which Ivanhoe plans to operate.

The differential pressure will vary by pattern. The pressure differential, using a datum of 215 masl, ranges from a low in Pattern E of 319.5 kPaa to a high of 551.5 kPaa in Pattern A. The pressure differential is based on the data previously supplied and summarized in Volume 4, Table SIR 11-1.

c. Identify the differential pressure between the steamflood steam pressure and the underlying aquifer pressure at which Ivanhoe expects steam loss to the aquifer to begin.

Ivanhoe, due to the nature of the reservoir, does not expect to have steam loss to the aquifer. The setback of 5 m above the tight LKM and MKM boundary and the lack of significant heat below the producing wellbore should not allow the bitumen to slump into the aquifer and, therefore, steam is not expected to have a pathway into the aquifer. Under the proposed operating conditions, the lowest pressure in the SAGD system will be located within the producing wells at 500 kPaa (bottomhole pressure) or less, which when corrected for depth will be within 100 kPaa of the aquifer pressure.

d. Provide an update or timeline regarding Ivanhoe's progress in selection of make-up water sources.

Ivanhoe is pursuing other off-lease water sources. However, Ivanhoe is not in a position to provide any updates at this time.

18. Supplemental Information Response #28, Pages ERCB-87 and ERCB-88. Ivanhoe provides additional information on the well statuses identified in Table 2.1-1 of the application.

a. Ivanhoe states, "*All wells within the steamflood area will be confirmed to be compatible for thermal operations. Any well found deficient will be re-entered and properly.*" Discuss the additional steps Ivanhoe will take if well re-completion or reabandonment to ensure thermal compatibility is unsuccessful.

Ivanhoe will consult with and seek approval from the ERCB on all non-routine re-entry and abandonment plans. If it is determined that a recompletion or re-abandonment is unsuccessful in obtaining a well compatible with the proposed thermal operations, then Ivanhoe will consult with the ERCB to determine the best course of action to monitor and mitigate potential fluid movement due to these wellbores. The potential mitigation measures may include:

- isolation of the area by prescribing a setback distance from the offending wellbore; or
- installing a properly thermally completed observation well as close as possible to the existing well to monitor the temperature and pressure at numerous points and evaluate any movement of fluids along the old wellbore. If data obtained from the continuous "twin" well monitoring suggests fluid movement, then the offset SAGD well-pairs operating conditions may be adjusted in consultation the ERCB.

b. Ivanhoe states that it "*plans on re-entering and using the following cased wells…as observation wells*". Provide a detailed re-completion plan for the eight identified cased wells to ensure compatibility with the proposed thermal operations.

Table SIR2 18-1 provides the current completion for each of the proposed observation wells. After review all of the existing suspended wells, Ivanhoe has identified an additional well (02/05-26-090-07W4) that is available for recompleting as an observation well, bringing the total from eight to nine identified wells. The plans for the conversion to observation wells for each of the nine wells are as follows:

- *02/05-26-090-09W4/0*: the well will be used to monitor the Basal McMurray Aquifer (BMA) through the existing completion. The observation well will be equipped with tubing, vibrating wire (VW) piezometer (or other pressure gauge for pressure data collection) and DTS (for temperature data collection);
- *00/15-22-090-09W4/0*: this well was properly completed for the proposed thermal operations. The well has four VW piezometers located at 145, 119, 91 and 70 mKB. Installation of DTS for temperature data will finish the instrumentation of this well for utilization as an observation well;

Table SIR2 18-1: Tamarack Suspended Well Information and Thermal Compatibility

UWI	Spud Date	License #	Current Licensee	Well Name	Mode	Perfs	TV Depth	KB Elev	Subsea	Surface Casing	Intermediate or Production Casing	Production Casing	Thermal Compatible
02/05-26-090-09W4/0	2010-02-04	417784	Ivanhoe Energy Inc.	Ivanhoe Energy Pw Tamarack 5-26-90-9	Suspended	Screens 142-162.5 mKB	176.3 (PBTD 162.0 mKB)	366.4	190.1	0-43.5 mKB 339.1 mm, 71.43 kg/m, J-55,ST&C, Range 3, New EVRAZ Cement 7.6 m^3 of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3	0-142.0 mKB 177.8 mm, 34.4 kg/m, T-Blue,L-80 Cement 15.0 m^3 of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 6.5 m^3 of good cement returns		Yes
00/04-25-090-09W4/0	2010-02-05	417841	Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 4-25-90-9	Suspended	Yes 413-417 mKB 403-408 mKB	490	409.6	-80.4	0-54.5 mKB 339.7 mm, 71.47 kg/m, H-40,ST&C Cement 10 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 3.0 m^3 of cement returns	0-189.5 mKB 244.5 mm, 48.07 kg/m, H-40, ST&C Cement 14.5 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 6.0 m^3 of returns	0-490 mKB 177.8 mm, 25.30 kg/m, H-40, ST&C Cement 14.5 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 2.5 m^3 of returns	Yes
00/10-26-090-09W4/0	2010-02-21	418554	Ivanhoe Energy Inc.	Ivanhoe Energy Mw Tamarac 10-26-90-9	suspended	Screens 154.5-170.3 mKB	157.5	372	214.5	0-39.37 mKB 339.1 mm, 81.3 kg/m, J-55, 8rd not cemented	0-157.0 mKB 177.8 mm, 34.23 kg/m, L-80, Hydril Cement 8.8 m^3 of Thermal 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 4.0 m^3 of good cement returns		Yes
02/10-26-090-09W4/0	2010-02-11	417829	Ivanhoe Energy Inc.	Ivanhoe Energy Pw Tamarac 10-26-90-9	suspended	Screens 154.5-170.3 mKB	182.5	371.6	189.1	0-26.5 mKB 339.1 mm, 81.3 kg/m, J-55,ST&C Cement 4.5 m^3 of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 1.5 m^3 of good cement returns	0-154.53 mKB 177.8 mm, 34.4 kg/m, L-80, Hydril Cement 15.0 m^3 of Thermal 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 4.5 m^3 of good cement returns		Yes
00/13-26-090-09W4/0	2010-02-13	417974	Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 13-26-90-9	Suspended	none	188.3	365.5	177.2	0-28.5 mKB 177.8 mm, 25.3 kg/m,H-40,ST&C Cement 4.0 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 1.5 m^3 of cement returns	0-188.3 mKB 114.3 mm, 17.3 kg/m,L-80,T-Blue Cement 6.0 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 2.0 m^3 of good cement returns		Yes
AA/15-25-090-09W4/0	2010-02-16	418948	Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 15-25-90-9	Suspended	Screens 43.5-54.5 mKB	77	408	331	0-55 mKB 177.8 mm, 25.3 kg/m,H-40,ST&C Cement 2.7 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3	none		Yes
AA/09-36-090-09W4/0	2010-02-19	418953	Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 9-36-90-9	Suspended	Screens 54-61 mKB	71	403	332	0-54 mKB 50.8 mm, PVC Cement 5.5 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3	none		Yes
00/09-27-090-09W4/0	2010-02-23	417082	Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 9-27-90-9	Suspended	Screens 143.9-152.9 mKB	169.5	364.2	194.7	0-40.17 mKB 177.8 mm, 25.3 kg/m,H-40,ST&C Cement 4.3 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 1.5 m^3 of cement returns	0-152.9 mKB 141.5 mm water well casing with 9.0 m 0.2 slot screens not cemented		No
00/15-22-090-09W4/0	2010-02-25	417098	Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 15-22-90-9	suspended	No	143	363	220	0-41.8 mKB 177.8 mm, 25.3 kg/m,H-40,ST&C Cement 4.0 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 1.5 m^3 of cement returns	0-143.0 mKB 73 mm, tubing w Piezometers at 145, 119, 91,& 70 mKB Cement 6.2 tonnes of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 1.5 m^3 of good cement returns		Yes
00/12-26-090-09W4/0	2010-02-27	417092	Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 12-26-90-9	Suspended	Screens 157.0-173.6 mKB	187.6	367	179.4	none	0-173.6 mKB 141.5 mm, 25.3 kg/m, H-40, 8rd with 0.2 slot screens not cemented		No
00/15-27-090-09W4/0	2010-02-27	417305	Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 15-27-90-9	Suspended	Screens 139-150 mKB	164.4	363	198.6	0- 20.94 mKB 177.8 mm, H-40, 25.3 kg/m, ST&C, Used Not cemented	0-138.9 mKB 114.3 mm, 17.3 kg/m,L-80,T-Blue Cement 5.2 m^3 of Thermal 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 1.5 m^3 of good cement returns		Yes
100/14-22-090-09W4/0	2010-03-03		Ivanhoe Energy Inc.	Ivanhoe Energy Tamarack 14-22-90-9	Suspended		52	361	309	0-42.44 mKB 339.1 mm, 81.2 kg/m, J-55, ST&C, Cement 11.5 m^3 of TML 40 + 1.0% $CACL_2$, 0.35% FL-1, 0.35% CFR-2, 0.1% DFP @ 1885 kg/m^3 4.0 m^3 of good cement returns			Yes

- *00/04-25-090-09W4/0*: this well was properly completed for the proposed thermal operations. Recompletion work is necessary to abandon the existing Keg River perforations by spotting a thermal cement plug from total depth (TD) to a top of 390 mKB and performing a pressure test after the cement has cured. The Wabiskaw C and Middle McMurray intervals will be perforated to allow pressure monitoring. The well will be completed so that pressure and temperature measurements can be collected from both zones;
- *02/10-26-090-09W4/0*: this well was properly completed for the proposed thermal operations. The well will be used to monitor the BMA through the existing completion. The observation well will be equipped with tubing, VW piezometer (or other pressure gauge for pressure data collection) and DTS (for temperature data collection);
- *00/10-26-090-90W4/0*: this well was properly completed for the proposed thermal operations. The Wabiskaw C and Middle McMurray intervals will be perforated to allow pressure monitoring. The well will be completed so that pressure and temperature measurements can be collected from both zones;
- *00/12-26-090-90W4/0*: this well was not properly completed for the proposed thermal operations. To make this well thermally compatible requires removal of existing casing string and the installation of thermally compatible production casing and cementing the casing with thermal cement. The well will be instrumented as an observation well by installing VW piezometers for pressure data collection on the outside of the casing prior to cementing. A tubing string and DTS for temperature data collection will also be installed;
- *00/13-26-090-90W4/0*: this well was properly completed for the proposed thermal operations. Perforation work to establish communication with the Wabiskaw C and Middle McMurray will be preformed. The well will be completed so that pressure and temperature measurements can be collected from both zones;
- *00/09-27-090-90W4/0*: this well was not properly completed for the proposed thermal operations. To make this well thermally compatible requires removal of existing casing string and the installation of thermally compatible production casing and cementing the casing with thermal cement. The well will be instrumented as an observation well by installing VW piezometers for pressure data collection on the outside of the casing prior to cementing. A tubing string and DTS for temperature data collection will also be installed; and
- *00/15-27-090-90W4/0*: this well was properly completed for the proposed thermal operations. The well will be used to monitor the BMA through the existing completion. The observation well will be equipped with tubing, VW piezometer (or other pressure gauge for pressure data collection) and DTS (for temperature data collection).

c. Ivanhoe states, "*Remediation will be pursued in those cases where Ivanhoe is unable to reasonably conclude that a well was properly abandoned per ERCB Directive 020 and the well will be in an area expected to be thermally affected by SAGD operations in approximately a one year time frame*." The ERCB requires more information on the wells penetrating the McMurray Formation that could be impacted by thermal operations to ensure fluid containment associated with the proposed thermal operations.

i. Provide a table that includes the unique well identifiers of all wells that may be impacted by the proposed thermal operations (including wells not owned, licensed or operated by Ivanhoe) and the associated spud date, well licensee, current status, completion details (casing size and grade, casing connection type, cement type, cement top, and cement returns to surface), identification of the presence of surface casing vent flows and gas migration, and thermal compatibility.

Table SIR2 18-1 identifies the requested information for suspended wells on the Project Lease. Abandoned wells are identified in Table SIR2 18-2.

ii. Provide the criteria used to assess the thermal compatibility of the existing wells that may be impacted by the proposed thermal operations.

Ivanhoe has reviewed all wells on the Tamarack Lease to assess each well's thermal compatibility under the proposed thermal operations. The criteria for determining thermal compatibility include successful abandonment or completion with thermal cement with reported cement returns to surface.

Wells on the Project Area are of three vintages. The first exploratory wells were drilled by Husky Oil in 1973 through 1975 (a total of 11 wells). These legacy wells were abandoned by pulling surface casing and cementing the wellbore with non-thermal cement, a common oilfield practice at the time. These wells would not be considered as thermally compatible under existing practices because of the use of non-thermal cement. Of the 11 wells, four are directly impacted by Phase 1 of the Project.

The second wave of drilling was undertaken by Talisman Energy in 2007 with the drilling of a further thirty delineation wells within the lease. These wells were all abandoned using up-to-date methods, including the use of thermally compatible cement and cement returns to surface. Ivanhoe considers all of the wells to have been abandoned properly and to be thermally compatible with the proposed thermal operations.

The latest round of drilling on the Tamarack Lease was conducted by Ivanhoe in 2010, which included the drilling of 29 delineation wells and three Quaternary water evaluation wells. Of the delineation wells drilled, 20 were abandoned using thermal cement with cement returns to surface and are considered thermally compatible with the proposed thermal operations.

Table SIR2 18-2: Tamarack Abandoned Well Information and Thermal Compatibility

UWI	Spud Date	License #	Current Licensee	Well Name	Mode	Perfs	TV Depth	KB Elev	Subsea	Surface Casing	Casing Size (m)	Depth of Casing (m)	Cement	Type	Additional Comments	Thermal Compatible
AA/11-23-090-09W4/0	1973-03-11	0045008F	Husky Oil Operations Limited	Husky 4 McMurray Ov 11-23-90-9	Abnd	No	143.0	369.7	226.7	none	n/a	n/a	returns to surface	Non-Thermal Cement	No well history report	No
AA/06-26-090-09W4/0	1973-03-14	0045008G	Husky Oil Operations Limited	Husky 6 McMurray Ov 6-26-90-9	Abnd	No	145.1	367.9	222.8	none	n/a	n/a	returns to surface	Non-Thermal Cement	Surface casing pulled prior to cementing	No
AA/07-34-090-09W4/0	1973-03-15	0045008K	Husky Oil Operations Limited	Husky 7 McMurray Ov 7-34-90-9	Abnd	No	137.2	360.0	222.8	none	n/a	n/a	returns to surface	Non-Thermal Cement	Surface casing pulled prior to cementing	No
AA/06-35-090-09W4/0	1973-03-16	0045008L	Husky Oil Operations Limited	Husky 5 McMurray Ov 6-35-90-9	Abnd	No	153.0	363.0	210.0	none	n/a	n/a	returns to surface	Non-Thermal Cement	Surface casing pulled prior to cementing	No
AA/07-33-090-09W4/0	1973-03-19	0045008J	Husky Oil Operations Limited	Husky 8 McMurray Ov 7-33-90-9	Abnd	No	126.2	354.5	228.3	none	n/a	n/a	returns to surface	Non-Thermal Cement	Surface casing pulled prior to cementing	No
AA/07-27-090-09W4/0	1973-03-22	0045008H	Husky Oil Operations Limited	Husky 10 McMurray Ov 7-27-90-9	Abnd	No	150.0	360.9	210.9	none	n/a	n/a	returns to surface	Non-Thermal Cement	Surface casing pulled prior to cementing	No
AA/07-28-090-09W4/0	1973-03-23	0045008I	Husky Oil Operations Limited	Husky 9 McMurray Ov 7-28-90-9	Abnd	No	124.1	356.0	231.9	none	n/a	n/a	returns to surface	Non-Thermal Cement	Surface casing pulled prior to cementing	No
AA/07-22-090-09W4/0	1973-03-24	0045008E	Husky Oil Operations Limited	Husky 11 McMurray Ov 7-22-90-9	Abnd	No	126.8	364.2	237.4	none	n/a	n/a	returns to surface	Non-Thermal Cement	Surface casing pulled prior to cementing	No
AA/11-24-090-09W4/0	1974-01-24	0048584I	Husky Oil Operations Limited	Husky 10 McMurray Ov 11-24-90-9	Abnd	No	170.1	404.5	234.4	none	n/a	n/a	returns to surface	Non-Thermal Cement	No well history report	No
AA/06-25-090-09W4/0	1974-01-27	0048584J	Husky Oil Operations Limited	Husky 12 McMurray Ov 6-25-90-9	Abnd	No	164.0	414.8	250.8	none	n/a	n/a	returns to surface	Non-Thermal Cement	No well history report	No
AA/06-36-090-09W4/0	1975-02-03	0052371L	Husky Oil Operations Limited	Husky 16 McMurray Ov 6-36-90-9	Abnd	No	191.7	410.3	218.6	none	n/a	n/a	returns to surface	Non-Thermal Cement	No well history report	No
AA/04-28-090-09W4/0	2007-02-02	370942	Talisman Energy Inc.	Talisman Ov McMurray 4-28-90-9	Abnd	No	127.6	352.2	224.6	none	177.8	0-41.0	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/01-28-090-09W4/0	2007-02-04	370948	Talisman Energy Inc.	Talisman Ov McMurray 1-28-90-9	Abnd	No	150.0	356.2	206.2	none	177.8	0-32.0	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/11-28-090-09W4/0	2007-02-06	370943	Talisman Energy Inc.	Talisman Ov McMurray 11-28-90-9	Abnd	No	133.5	352.2	218.7	none	177.8	0-33.8	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/16-28-090-09W4/0	2007-02-07	370947	Talisman Energy Inc.	Talisman Ov McMurray 16-28-90-9	Abnd	No	129.8	355.7	225.9	none	177.8	0-20.0	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/14-27-090-09W4/0	2007-02-08	370950	Talisman Energy Inc.	Talisman Ov McMurray 14-27-90-9	Abnd	No	160.5	358.2	197.7	none	177.8	0-20.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/03-27-090-09W4/0	2007-02-10	370949	Talisman Energy Inc.	Talisman Ov McMurray 3-27-90-9	Abnd	No	144.5	359.5	215.0	none	177.8	0-20.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/01-27-090-09W4/0	2007-02-11	370952	Talisman Energy Inc.	Talisman Ov McMurray 1-27-90-9	Abnd	No	156.5	362.7	206.2	none	n/a	n/a	returns to surface	Thermal Cement	n/a	n/a
AA/16-22-090-09W4/0	2007-02-13	370956	Talisman Energy Inc.	Talisman Ov McMurray 16-22-90-9	Abnd	No	128.5	363.5	235.0	none	177.8	0-27.1	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/15-23-090-09W4/0	2007-02-14	370955	Talisman Energy Inc.	Talisman Ov McMurray 15-23-90-9	Abnd	No	133.5	379.0	245.5	none	177.8	0-20.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/01-26-090-09W4/0	2007-02-15	370954	Talisman Energy Inc.	Talisman Ov McMurray 1-26-90-9	Abnd	No	142.4	385.2	242.8	none	177.8	0-27.1	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/16-27-090-09W4/0	2007-02-17	370951	Talisman Energy Inc.	Talisman Ov McMurray 16-27-90-9	Abnd	No	157.5	361.2	203.7	none	177.8	0-20.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/11-26-090-09W4/0	2007-02-18	372936	Talisman Energy Inc.	Talisman Ov McMurray 11-26-90-9	Abnd	No	166.7	368.2	201.5	none	177.8	0-20.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/03-26-090-09W4/0	2007-02-20	370953	Talisman Energy Inc.	Talisman Ov McMurray 3-26-90-9	Abnd	No	124.4	370.7	246.3	none	177.8	0-27.1	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/09-26-090-09W4/0	2007-02-21	372937	Talisman Energy Inc.	Talisman Ov McMurray 9-26-90-9	Abnd	No	187.5	386.7	199.2	none	177.8	0-27.1	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/04-33-090-09W4/0	2007-02-22	370944	Talisman Energy Inc.	Talisman Ov McMurray 4-33-90-9	Abnd	No	102.5	351.4	248.9	none	177.8	0-24.8	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/03-36-090-09W4/0	2007-02-23	372935	Talisman Energy Inc.	Talisman Ov McMurray 3-36-90-9	Abnd	No	178.6	407.7	229.1	none	177.8	0-20.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/11-33-090-09W4/0	2007-02-23	370941	Talisman Energy Inc.	Talisman Ov McMurray 11-33-90-9	Abnd	No	115.5	351.4	235.9	none	177.8	0-34.2	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/16-33-090-09W4/0	2007-02-25	372926	Talisman Energy Inc.	Talisman Ov McMurray 16-33-90-9	Abnd	No	121.0	353.7	232.7	none	177.8	0-13.5	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/01-33-090-09W4/0	2007-02-25	370945	Talisman Energy Inc.	Talisman Ov McMurray 1-33-90-9	Abnd	No	145.5	355.9	210.4	none	177.8	0-27.5	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/12-34-090-09W4/0	2007-02-26	372930	Talisman Energy Inc.	Talisman Ov McMurray 12-34-90-9	Abnd	No	115.0	355.2	240.2	none	177.8	0-33.8	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/04-34-090-09W4/0	2007-02-26	370946	Talisman Energy Inc.	Talisman Ov McMurray 4-34-90-9	Abnd	No	148.4	356.4	208.0	none	177.8	0-20.7	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/10-34-090-09W4/0	2007-02-27	372929	Talisman Energy Inc.	Talisman Ov McMurray 10-34-90-9	Abnd	No	151.6	356.7	205.1	none	177.8	0-20.8	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/03-34-090-09W4/0	2007-02-27	372927	Talisman Energy Inc.	Talisman Ov McMurray 3-34-90-9	Abnd	No	163.5	357.4	193.9	none	177.8	0-34.3	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/16-35-090-09W4/0	2007-02-28	372938	Talisman Energy Inc.	Talisman Ov McMurray 16-35-90-9	Abnd	No	159.5	381.7	222.2	none	177.8	0-27.1	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/01-34-090-09W4/0	2007-02-28	372928	Talisman Energy Inc.	Talisman Ov McMurray 1-34-90-9	Abnd	No	148.5	360.2	211.7	none	177.8	0-27.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/03-35-090-09W4/0	2007-03-01	372931	Talisman Energy Inc.	Talisman Ov McMurray 3-35-90-9	Abnd	No	151.5	366.4	214.9	none	177.8	0-27.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/14-36-090-09W4/0	2007-03-02	372934	Talisman Energy Inc.	Talisman Ov McMurray 14-36-90-9	Abnd	No	169.5	402.2	232.7	none	177.8	0-27.1	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/01-35-090-09W4/0	2007-03-02	372932	Talisman Energy Inc.	Talisman Ov McMurray 1-35-90-9	Abnd	No	154.5	384.9	230.4	none	177.8	0-27.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/12-36-090-09W4/0	2007-03-03	374045	Talisman Energy Inc.	Talisman Ov McMurray 12-36-90-9	Abnd	No	150.5	390.2	239.7	none	177.8	0-27.1	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AA/12-35-090-09W4/0	2007-03-03	372933	Talisman Energy Inc.	Talisman Ov McMurray 12-35-90-9	Abnd	No	135.5	359.4	223.9	none	177.8	0-27.4	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/04-26-090-09W4/0	2010-02-01	417094	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 4-26-90-9	Abnd	No	142.0	365.5	223.5	none	177.8	0-42.0	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/08-27-090-09W4/0	2010-02-01	417294	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 8-27-90-9	Abnd	No	188.5	363.6	175.1	yes	177.8	0-28.0	returns to surface	Thermal Cement	n/a	Yes
AB/13-27-090-09W4/0	2010-02-06	417080	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 13-27-90-9	Abnd	No	170.0	359.5	189.5	yes	177.8	0-41.8	returns to surface	Thermal Cement	n/a	Yes
AB/12-27-090-09W4/0	2010-02-09	417296	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 12-27-90-9	Abnd	No	179.3	359.5	180.2	yes	177.8	0-41.6	returns to surface	Thermal Cement	n/a	Yes

UWI	Spud Date	License #	Current Licensee	Well Name	Mode	Perfs	TV Depth	KB Elev	Subsea	Surface Casing	Casing Size (m)	Depth of Casing (m)	Cement	Type	Additional Comments	Thermal Compatible
AB/11-27-090-09W4/0	2010-02-10	417081	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 11-27-90-9	Abnd	No	156.0	360.5	204.5	yes	177.8	0-40.1	returns to surface	Thermal Cement	n/a	Yes
AB/10-27-090-09W4/0	2010-02-11	417295	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 10-27-90-9	Abnd	No	164.3	362.6	198.3	yes	177.8	0-40.4	returns to surface	Thermal Cement	n/a	Yes
00/14-23-090-09W4/0	2010-02-15	417767	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 14-23-90-9	Abd Zone	yes	141.0	370.0	229.0	yes	177.8	0-19.6	returns to surface	Thermal Cement	n/a	Yes
AB/08-28-090-09W4/0	2010-02-17	417079	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 8-28-90-9	Abnd	No	155.8	358.5	202.7	none	n/a	n/a	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/05-27-090-09W4/0	2010-02-18	417292	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 5-27-90-9	Abnd	No	173.0	359.6	186.6	none	n/a	n/a	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/14-22-090-09W4/0	2010-02-19	417830	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 14-22-90-9	Abnd	No	147.0	361.4	214.4	yes	339	0-42.4	returns to surface	Thermal Cement		Yes
AB/04-27-090-09W4/0	2010-02-20	417091	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 4-27-90-9	Abnd	No	145.6	360.0	214.4	yes	177.8	0-41.8	returns to surface	Thermal Cement	n/a	Yes
AB/06-27-090-09W4/0	2010-02-21	417089	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 6-27-90-9	Abnd	No	161.3	361.0	199.7	yes	177.8	0-41.8	returns to surface	Thermal Cement	n/a	Yes
AB/11-22-090-09W4/0	2010-02-22	417142	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 11-22-90-9	Abnd	No	134.0	362.0	228.0	none	n/a	n/a	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/09-22-090-09W4/0	2010-02-23	417144	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 9-22-90-9	Abnd	No	138.0	367.0	229.0	none	177.8	0-41.7	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/10-22-090-09W4/0	2010-02-23	417143	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 10-22-90-9	Abnd	No	141.0	365.8	224.8	none	177.8	0-41.8	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/07-26-090-09W4/0	2010-02-25	417093	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 7-26-90-9	Abnd	No	154.2	373.2	219.0	none	177.8	0-42.0	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
00/02-27-090-09W4/0	2010-03-01	418557	Ivanhoe Energy Inc.	Ivanhoeenergy Mw Tamarack 2-27-90-9	Cancelled	No	0.0	0.0	0.0	none	n/a	n/a	n/a	n/a	n/a	Yes
AB/02-27-090-09W4/0	2010-03-01	417827	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 2-27-90-9	Abnd	No	162.0	362.5	200.5	none	177.8	0-38.8	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/13-23-090-09W4/0	2010-03-02	417096	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 13-23-90-9	Abnd	No	138.8	366.5	227.7	none	177.8	0-38.8	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes
AB/12-23-090-09W4/0	2010-03-03	417097	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 12-23-90-9	Abnd	No	136.6	368.5	231.9	none	177.8	0-38.8	returns to surface	Thermal Cement	n/a	Yes
AB/13-24-090-09W4/0	2010-03-04	417095	Ivanhoe Energy Inc.	Ivanhoeenergy Tamarack 13-24-90-9	Abnd	No	196.7	408.5	211.8	none	177.8	0-38.8	returns to surface	Thermal Cement	Surface casing pulled prior to cementing	Yes

The remaining nine McMurray delineation wells are suspended and will be recompleted as needed to ensure thermal compatibility for use as observation wells for the proposed thermal operations as discussed in SIR2 18b.

iii. For each well not considered to be thermally compatible with the proposed thermal operations, discuss why each well is not considered to be compatible.

There are two Husky wells directly within the proposed thermal operation area:

- AA/06-26-090-90W4/0; and
- AA/07-27-090-90W4/0.

There are two Husky wells adjacent to the proposed thermal operation area:

- AA/07-22-090-90W4/0; and
- AA/11-23-090-90W4/0.

As discussed in SIR2 18c ii, these four wells were completed with non-thermal cement and no casing. All wells, except AA/11-23-090-90W4/0, were reported to have had cement returns to surface. Data on AA/11-23-090-90W4/0 was not available.

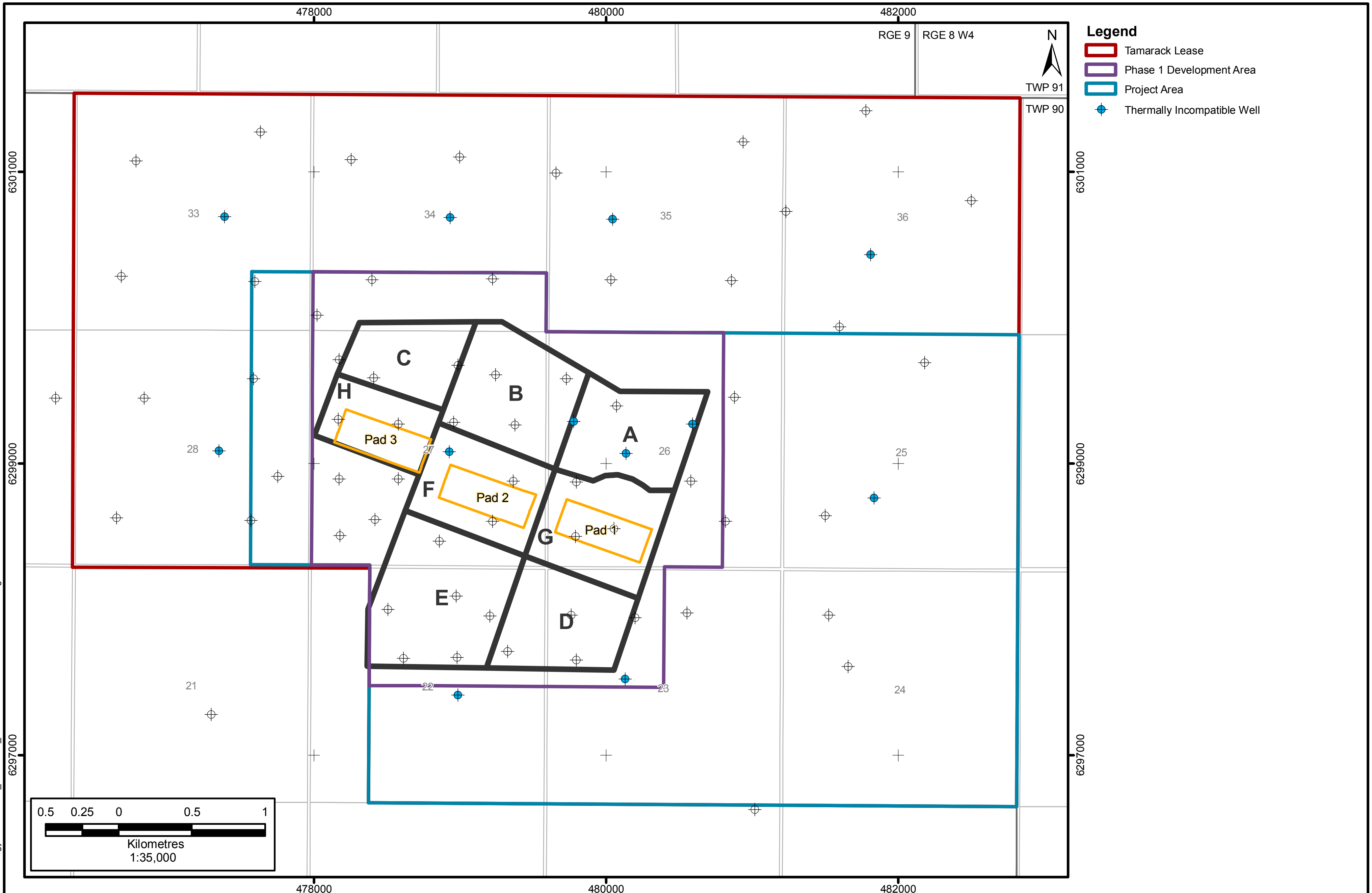
There are two additional wells currently listed as suspended (Table SIR2 18-1) that require further work to ensure thermal compatibility:

- 00/10-26-090-09W4; and
- 00/12-26-090-09W4.

These six wells are scheduled to be converted to thermally compatible observation wells as outlined in SIR2 18b and SIR2 18e.

iv. Provide a map showing the location of all wells not considered to be compatible with the proposed thermal operations. This map should include the proposed project and development area boundaries and the Phase 1 subsurface drainage areas and should be annotated with the distance between thermally incompatible wells and the nearest subsurface drainage area.

See Figure SIR2 18-1.



Sources: Ivanhoe, Spatial Data Warehouse Ltd.

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Ivanhoe Energy
Tamarack Project

Thermally Incompatible Wells

DATE: June 2012		SIR2-Fig018-01 12-06-29		**Figure SIR2 18-1**
PROJECT: CE0374601		PROJECTION/DATUM: UTM Zone 12 NAD83		
ANALYST: TM	QA/QC: TJR MAJ EH	DRAWN BY: AMEC	PREPARED BY: AMEC	

v. For each well not considered to be compatible with the proposed Phase 1 thermal operations, provide a risk assessment with respect to fluid containment and provide the mitigation measures, including buffer distances, remediation, and monitoring that Ivanhoe will undertake at each well to ensure fluid containment, both inside and outside of the production casing, before the start of the proposed Phase 1 thermal operations.

The risk of thermal degradation of the existing cement plugs compromising fluid containment outside of the McMurray intervals is small. The temperature profile modelling completed to date indicates that the portion of the existing cement plug across the cap rocks will not be subjected to temperatures that would cause thermal degradation over the life of the Project. However, in order to remove the risk associated with fluid containment in the thermally incompatible wells listed in SIR2 18c iii, Ivanhoe intends to re-enter these wells as discussed in SIR2 18e and complete them as observations wells using thermal cement. The wells will be equipped to measure pressure and temperature.

The two suspended wells, listed in SIR2 18b iii are currently incompatible with the proposed thermal operation and will need to be re-worked to make them compatible. After these wells are re-completed they will no longer pose any risk associated with fluid containment.

vi. For wells not considered to be compatible with the proposed thermal operations which will not be impacted by the Phase 1 thermal operations, discuss how these wells will be addressed to ensure compatibility with thermal operations beyond Phase 1.

The wells located outside of the Phase 1 Development Area but within the Phase 2 Development Area will be properly abandoned for thermal operations prior to commencing Phase 2 operations, in a similar method as those within Phase 1, in consultation with the ERCB using the best available methods at that time.

d. Ivanhoe states, "The wells marked as "Unknown" thermal cement status, and no required remediation plan, listed in Volume 1, Table 2.1-1 are all outside of the steamflood Project area and will not be re-abandoned due to their distance from the steamflood operations." Provide the distance in metres to the nearest proposed subsurface drainage area for each of the five identified wells and discuss the minimum safe setback distance considered appropriate for wells of unknown thermal cement status that are outside of proposed drainage areas in relation to the proposed thermal operations.

Table SIR2 18-3 provides the wells outside of the proposed thermal operations and their distance from those operations.

Table SIR2 18-3: Husky Well Locations and Distance to Proposed Thermal Operations

Wells	Distance to Nearest Subsurface Drainage Area
AA/06-25-090-90W4/0	1 362 m
AA/07-28-090-90W4/0	680 m
AA/07-33-090-90W4/0	1 105 m
AA/07-34-090-90W4/0	600 m
AA/06-35-090-90W4/0	910 m
AA/06-36-090-90W4/0	1 330 m

All of these well are setback significantly further than the anticipated 40 m radius of influence for the proposed thermal operation (as shown in Figure SIR2 18-1) and no influence from the proposed thermal operation is expected at these locations.

e. Ivanhoe states that AA/06-26-090-09W4/0 and AA/07-27-090-09W4/0 are within the steamflood area, of unknown thermal cement status, and “will be re-entered and converted to observations wells with the appropriate thermal cement completion.” Provide Ivanhoe’s plan for recompletion of these two wells.

Ivanhoe, in consultation with the ERCB, intends to re-enter the Husky wells AA/06-26-090-09W4/0, AA/07-27-090-09W4/0, AA/07-22-090-09W4/0 and AA/11-23-090-09W4/0) to drill out the non-thermal cement to the existing well TD. If successful at reaching TD, Ivanhoe will run casing, thermally cement and equip the wells for temperature and pressure monitoring in a similar fashion to the other observation wells. If the cement can only be partially removed to the base of the Wabiskaw B then Ivanhoe will abandon the well following the recommendations of the ERCB for a non-routine well abandonment.

GEOMECHANICAL ANALYSIS

19. Volume 1, Section 2.1.6.3, Operating Pressure, Page 2-21.
Ivanhoe states that it has conducted and analyzed micro-fracture tests in two wells (13-26-090W4M and 14-23-090-09W4M) at four intervals within the proposed Phase 1 development area. These wells are located in the eastern portion of the proposed development area. There is evidence of karsting in the western portion of the proposed project area, and the Athabasca River is located three kilometres west of the proposed project area; both of these occurrences are known stress reduction mechanisms. The ERCB expects that mini-frac locations are selected to represent the stresses in unaffected areas, but also in areas where the in situ stresses may be impacted by geological features, such as karsting and erosion.

a. Discuss the affects that Athabasca River erosion and karsting may have on the in situ stress regime within the proposed project area.

Geological events such as karsting and erosion will impact the *in situ* stress regime. The magnitude, timing and region of influence of such events have not been quantified. Other geological events such as tectonics, glaciation and large scale surface erosion may have much larger magnitudes of influence and dominate the regional stress state. Karsting and erosion will impact the stress state most significantly at the location of those events. The distance from those events that is impacted has not been quantified. Minifrac tests that have been conducted in locations expected to show a stress decrease due to karsting have not consistently shown the behavior expected. Minifrac tests conducted at Ivanhoe's Well 14-23 were aimed at investigating the stress change around such a geologic feature. No significant stress decrease was observed compared to the other minifrac well located in the middle of the main Phase 1 Development Area.

b. Discuss Ivanhoe's plans to conduct a mini-frac test in the western portion of the project area to further evaluate the in situ stress conditions.

A minifrac test may be conducted in the western portion of the Project Area at a future date. The goal of this test would be to investigate potential stress reduction associated with the river valley near the western Project Area boundary.

20. Supplemental Information Response #Response 12, Page ERCB-51.
Ivanhoe states that it is "currently working with industry suppliers and geomechanical experts in order to determine the required spacing and locations" for heave monitoring in support of its caprock integrity monitoring program. Ivanhoe also indicates that the initial heave monitoring array will encompass only drainage patterns A, B and C.

a. Provide an update on this work.

Ivanhoe plans to use tiltmeters, GPS and InSAR for heave monitoring. The updated Reservoir Monitoring Plan is provided in Appendix SIR2 D.

b. Ivanhoe has provided information to support development of drainage patterns A through H, but has only indicated an initial heave monitoring array for drainage patterns A, B and C. Discuss Ivanhoe's plan for surface heave monitoring for the proposed drainage patterns D through H.

The updated Reservoir Monitoring Plan (Appendix SIR2 D) includes the surface heave monitoring for the entire Phase 1 Development Area.

21. Appendix E, Geomechanical Input and Output Files. Review of the submitted geomechanical input and output files indicates that the "stress strain hysteresis" option was turned off in Ivanhoe's models. Comment on the impacts this may have on the calculated changes of stress and strain in the reservoir sands and the caprock shale, given that the unloading Young's modulus is much larger than the loading Young's modulus.

Geomaterials typically exhibit two types of hysteresis, shear related or compactive related. Materials in the Project Area have been affected by glaciation. This results in an overconsolidation of the materials far beyond the current or expected effective stresses during the SAGD operation. Therefore, compaction related hysteresis is not expected. The reservoir sand is the only material expected to undergo shear failure. However, SAGD is not a cyclic process; therefore, shear-induced hysteresis is not expected.

Figure SIR2 21-1 show stress-strain results from the Wabiskaw D and Clearwater Shale showing both mudstone zones exhibit typical overconsolidated clay behavior; that is peak and residual shear strength and associated pore pressure increase then decrease with dilation.

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT CU 10-6

Stress/Strain Plots @ σ_3 = 600 kPa

TAMARACK PROJECT: Advance Lab Testing for Cap Rock

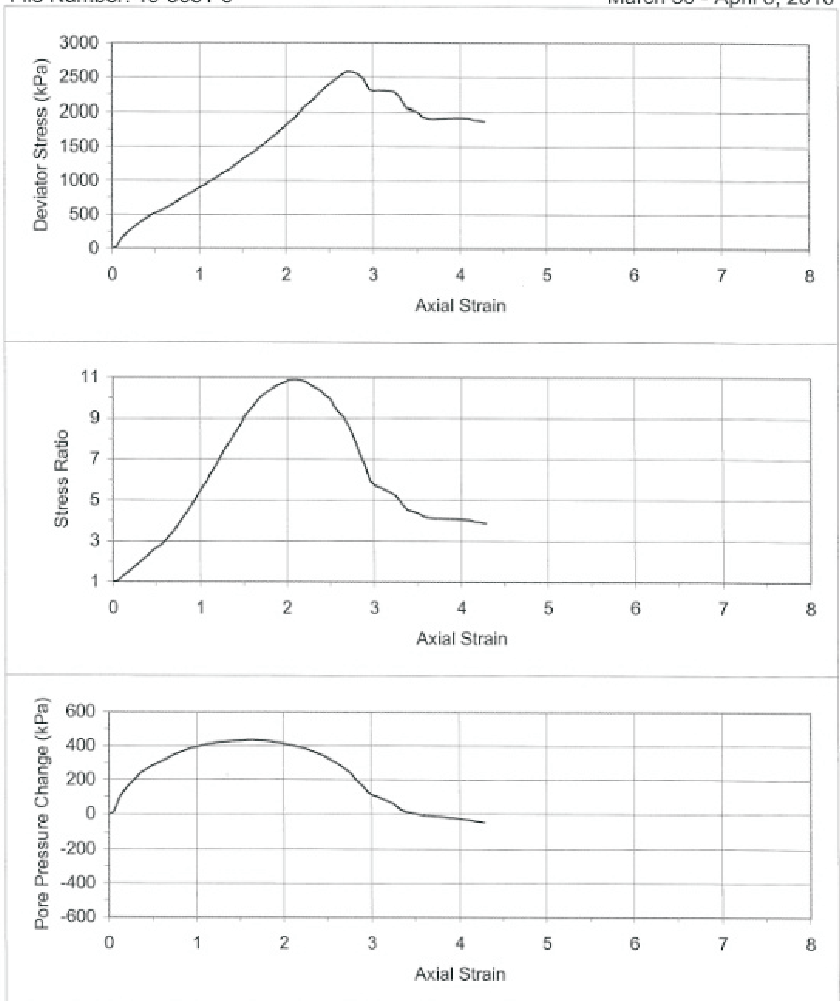
Well #1, 1AA/13-26-09-9-W4M, Run 21, 82.75 - 82.89 mKb

IVANHOE ENERGY INC.

File Number: 19-5651-0

Date of Testing

March 30 - April 8, 2010

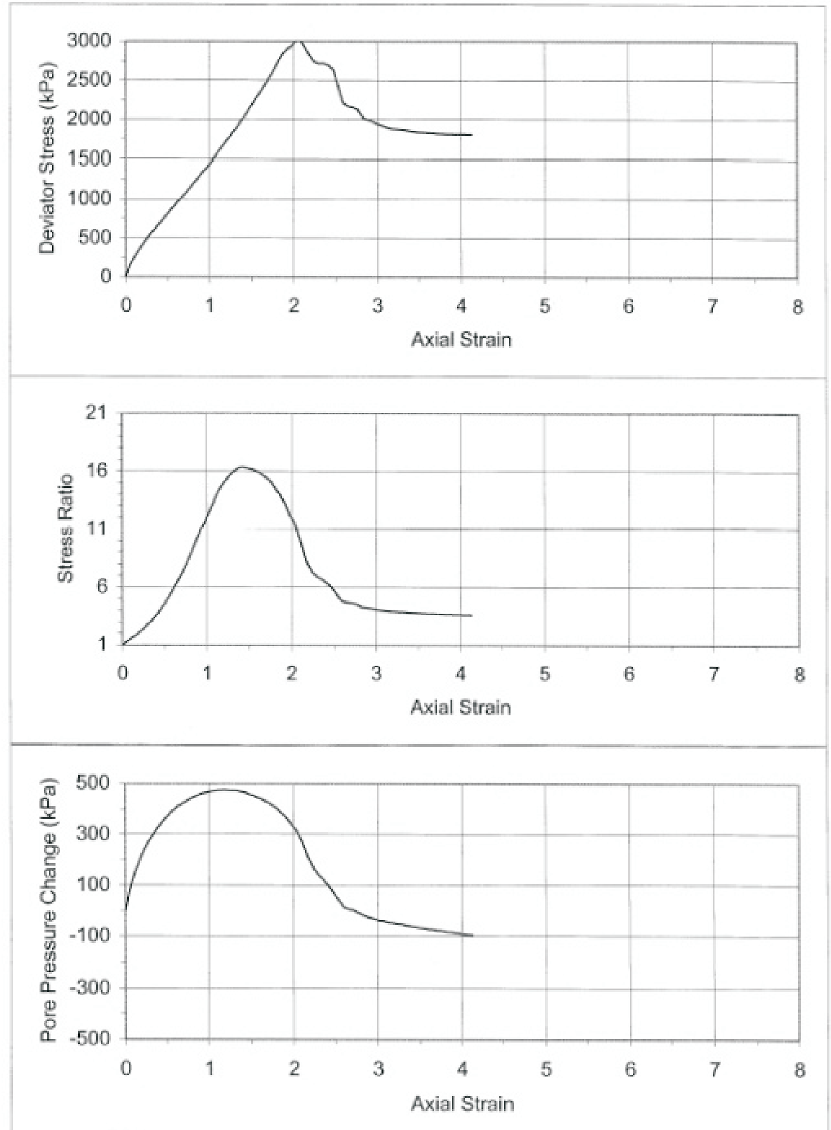


CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT CU 10-2

IVANHOE ENERGY INC. Well #1, 1AA/13-26-09-9-W4M, Run 13, 63.43 - 63.60 mKb

TAMARACK PROJECT: Advance Lab Testing for Cap Rock March 16 - 28, 2010

File Number: 19-5651-0



Source: Ivanhoe.

Ivanhoe Energy

Tamarack Project

Undrained Triaxial Compression Trest Results Showing Stress-strain, Stress Ratio and Shear Induced Pore Water Pressure Behavior for (a) Wabiskaw D Mudstone and (b) Clearwater Shale Mudstone

DATE: June 2012		SIR2-Fig021-01 12-06-29	Figure SIR2 21-1
PROJECT: CE0374601		DRAWN BY: AMEC	
ANALYST: TM	QA/QC: TJR MJ EH	PREPARED BY: Ivanhoe	

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22. Appendix E, Geomechanical Input and Output Files. A non-linear hyperbolic soil model was used to represent the stress-strain behaviour of the oil sands material, which is unable to model dilations.

a. Considering that high pressure SAGD operations at shallow depth may cause significant oil sands dilation, comment on the impact this may have on the calculated changes of stress and strain in the reservoir sands and the caprock shale.

Our understanding is that non-linear elastic (NLE) models can include dilation. The supporting documentation illustrating NLE model can include dilation are provided in the references cited below.

There are two types of dilation expected: 1) Effective stress induced; and 2) Shear induced. Dilation results in an expansion of the solid matrix thus increasing horizontal stresses and potential shear stresses of the surrounding material as the material attempts to expand by deforming the surrounding material. The NLE material parameters used in this study have been calibrated to mature SAGD projects (underground test facility) Phase B (UTF 2007) and Suncor's MacKay River (Walters *et al.* 2012) where surface heave and reservoir level strains have been measured. The magnitude of the dilation and expansion of the sand is important as it is the driving force that deforms the cap rock and potentially pushes it closer to failure.

Shear dilation was not included for the NLE model, as previous experience has shown the dilation associated with effective stress decrease (and nonlinear compressibility of the material, as observed in initial Young's modulus for triaxial tests as different minimum effective stresses) is sufficient to generate the expected reservoir level and surface level deformations. Also, subsequent modelling of the previously mentioned projects with an elasto-plastic material capable of and calibrated to lab data showing significant shear dilations indicated that the shear dilation observed in the lab is difficult to obtain in the field scale models. The results from these models suggest it is reasonable to not include an assumption of shear dilation in the NLE model, since the shear dilation in a SAGD environment is usually small compared to the effective stress induced dilation.

b. Provide all data and analysis used to support the above comments. 23. Appendix G, Horizontal Stress Profiles and Contour Maps, Total Minimum Horizontal Stress (kPa, Sh) Figure. The principle of stress equilibrium with respect to earth stresses requires that far-field stresses be equilibrated. This means that horizontal stress in a heated zone cannot increase without having a horizontal stress decrease in the bounding zones. There is no apparent stress reduction in the rocks above or below the reservoir. Therefore, the requirement for equilibrium of total far-field stress has apparently been violated. Explain why stress equilibrium was not satisfied on this vertical plane, and comment on the validity of the geomechanical modeling results.

McMurray and Wabiskaw core from the Project Area has been tested and is comparable to analog projects (UTF 2007, Walters *et al.* 2012); therefore, we should expect similar geomechanical behavior. For example, the Project Area McMurray sand direct shear tests yielded a peak friction angle of about 40 degrees. This is typical of a dense McMurray sand behavior.

Literature Cited:

Settari, et al. *Geotechnical Aspects of Recovery Processes in Oil Sands*. Can. Geotech. J. 30, 22-33 (1993).

UTF Phase B Geomechanics Consortium (UTF). 2007. *Coupled Geomechanical and Reservoir Simulation of the UTF Phase B Pilot Project*. Prepared by Taurus Reservoir Solutions Ltd., Calgary, AB.

Vaziri, H. 1989. *A New Constitutive Stress Strain Model for Describing the Geomechanical Behavior of Oil Sands*. Proceedings, 40th Annual Meeting of Petroleum society of the Canadian Institute of mining and Metallurgy, Banff, Alta., pp. 67-1-67-16.

Vaziri, H. 1986. *Finite Element Analysis of Oil Sands Subjected to Thermal Effects*. Proceedings, 37th Annual Technical Meeting of Petroleum society of the Canadian Institute of Mining and Metallurgy, Calgary, pp. 497-518.

Walters, D., J. Wang and A. Settari. 2012. *A Geomechanical Methodology for Determining Maximum Operating Pressure in SAGD Reservoirs*. SPE 157855, presented at the SPE Heavy Oil Conference Canada held in Calgary, Alberta, Canada, 12–14 June 2012.

23. Appendix G, Horizontal Stress Profiles and Contour Maps, Total Minimum Horizontal Stress (kPa, Sh) Figure. The principle of stress equilibrium with respect to earth stresses requires that far-field stresses be equilibrated. This means that horizontal stress in a heated zone cannot increase without having a horizontal stress decrease in the bounding zones. There is no apparent stress reduction in the rocks above or below the reservoir. Therefore, the requirement for equilibrium of total far-field stress has apparently been violated. Explain why stress equilibrium was not satisfied on this vertical plane, and comment on the validity of the geomechanical modeling results.

The above statements are valid only for a constant stress boundary condition. Reservoirs do not exhibit this behavior except at the free surface (ground level or an erosional event (river valley)). Boundary conditions used for modelling were uniaxial strain (no normal deformation at side and bottom boundaries). A uniaxial strain boundary condition was used because it is the most applicable boundary condition and results in a dynamic stress boundary condition illustrated below. Figure SIR2 23-1 shows the change in normal total stress in the X direction on both sides (boundaries) of the model. The plot shows this altered stress boundary condition as a function of depth for the entire model boundary. The results demonstrate that force balance is satisfied as the sum of the incremental forces on both sides are equal and in equilibrium.

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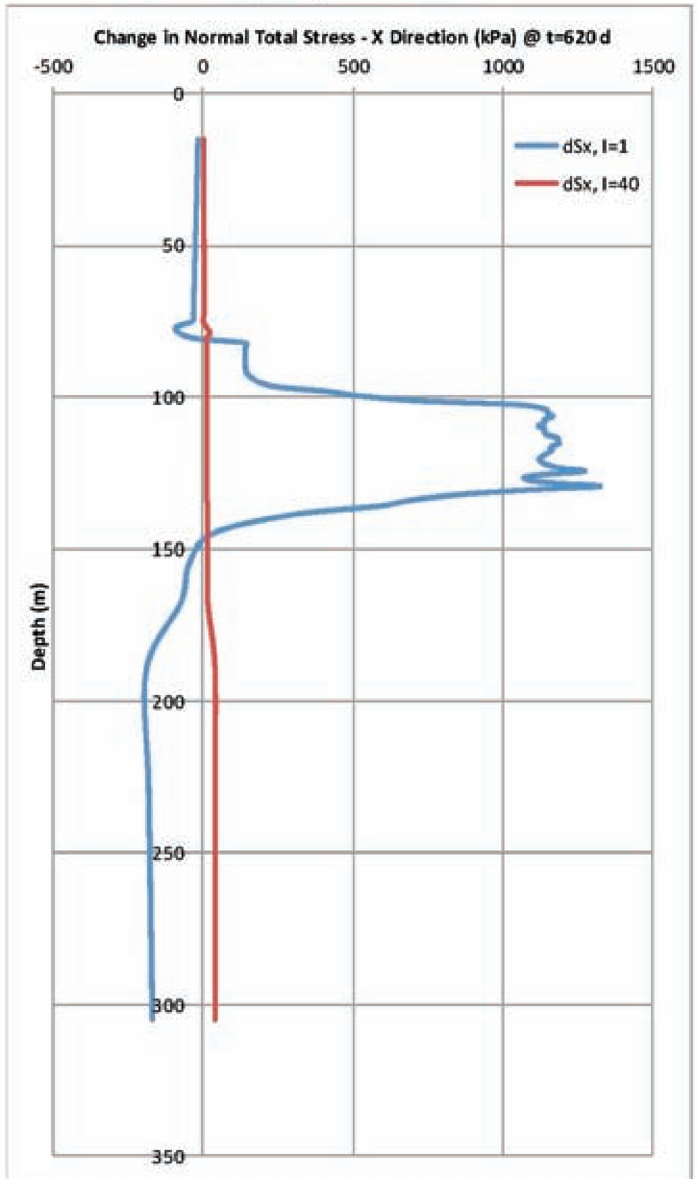
I=1 Sum(dSx*A)=ΣFx 8826.209
I=40 Sum(dSx*A)=ΣFx 8826.186



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Ivanhoe Energy
Tamarack Project

Change in Normal Total Stress in X Direction at Left (I=1) and Right (I=40) Boundaries of the Model

DATE: June 2012		SIR2-Fig023-01 12-06-29	Figure SIR2 23-1
PROJECT: CE0374601		DRAWN BY: AMEC	
ANALYST: TM	QA/QC: KW MJ EH	PREPARED BY: Ivanhoe	

24. The ERCB requires additional information regarding the potential for reservoir containment loss during SAGD operations once methane (CH4), a non-condensing gas, evolves as free gas when high temperature from steam injection contacts the gas saturated oil sands. In this scenario, there is the potential for the evolved gas to remain high in the McMurray reservoir and migrate into any induced fractures. Discuss whether this mechanism could increase the driving force to propagate the fracture upwards into the overlying Clearwater caprock formation.

The mechanism of exsolved solution gas migrating to the top of the McMurray and decreasing the pressure gradient from the steam chamber to the top of the McMurray sand is theoretically possible. This scenario has been simulated by investigating two assumptions:

- constant initial permeability representative of core measurements from the Project: and
- modelled enhanced permeability pathways due to shear dilation (1.5 to 2.5 times the original permeability).

The simulation results show the pressure profile, accounting for vertical gas migration, alters the horizontal stresses of the pressurized zone due to poroelastic effects. Although the pressure moves upward more rapidly, the total horizontal stress changes adjust with it and the potential for tensile fracturing is low. Also, the volume of solution gas expected to evolve is relatively low, its mobility for leak-off is high, and therefore, the driving force to propagate a vertical fracture is expected to be quite low. The steam vapour below cannot necessarily follow the same path as the solution gas due to temperature effects and the tendency for the vapour to condense with cooling. Therefore, steam is not expected to be an additional drive mechanism.

The only exception to the above conclusion is the presence of a tensile fracture originating from the steam chamber, acting as a conduit for solution gas, without altering the stresses significantly. The proposed safe MOP mitigates against this risk by maintaining the injection pressure below the minimum total stress of the sand. Assuming the worst case scenario for the proposed MOP, the minimum factor of safety against tensile failure is 1.7 at the base of the Wabiskaw B (Figure SIR2 24-1). In combination with the Reservoir Monitoring Plan (Appendix SIR2 D), the risk of a driving force to propagate a fracture upwards into the overlying cap rock formation is effectively mitigated.

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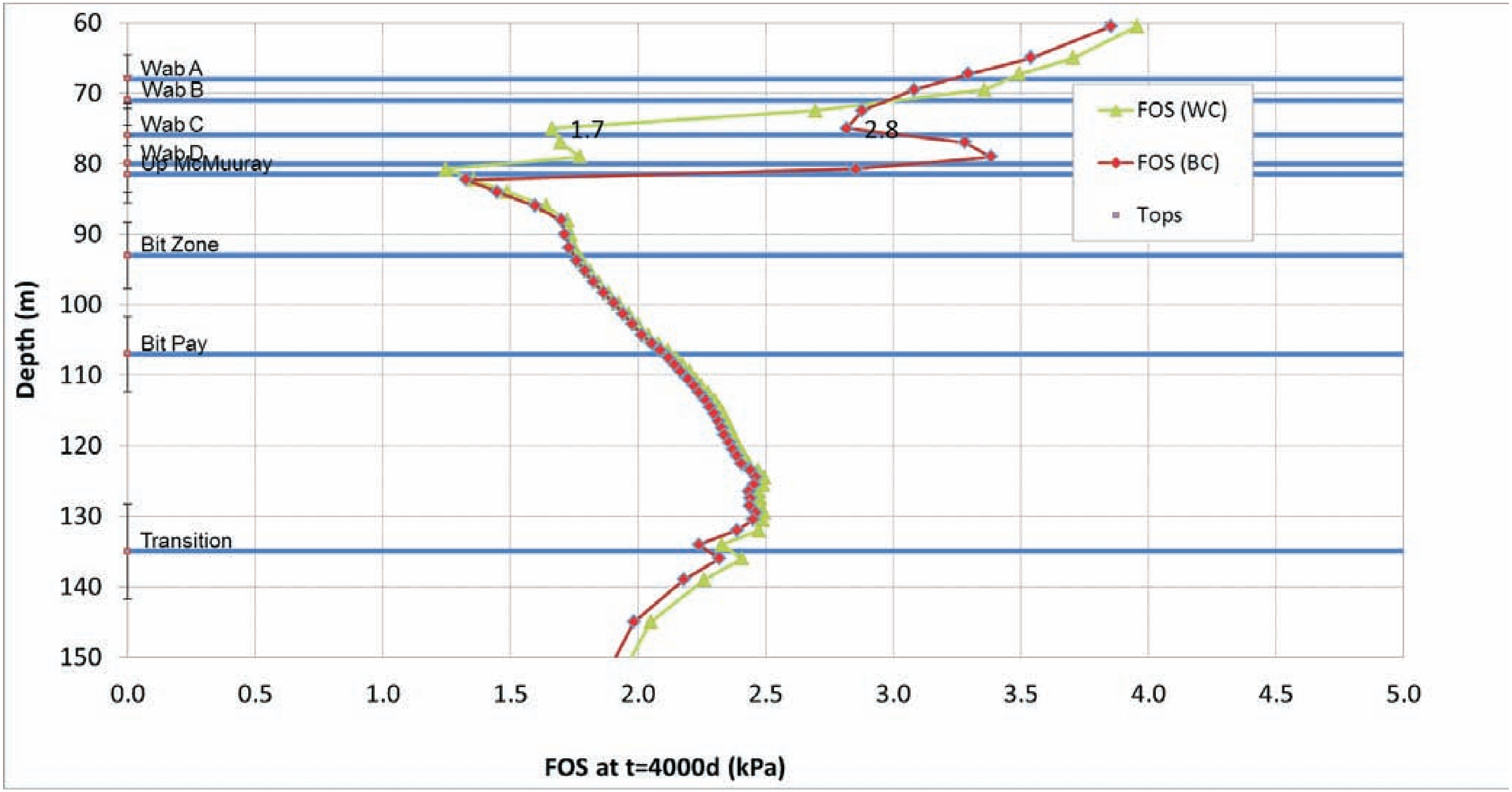

Source: Ivanhoe.

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Ivanhoe Energy
Tamarack Project

Factor of Safety vs. Depth

DATE: June 2012			SIR2-Fig024-01 12-06-29	**Figure SIR2 24-1**
PROJECT: CE0374601			DRAWN BY: AMEC	
ANALYST: TR	QA/QC: TM	MJ EH	PREPARED BY: Ivanhoe	

GEOTECHNICAL ANALYSIS

25. Supplemental Information Response #40, Page ERCB-115.
Regarding the assessment of the potential for effects within the Suncor MSL, Ivanhoe states that is has based the piezometric head on a pressure profile "*calibrated to piezometric measurements*". Provide the data from the piezometers used to calibrate the model and indicate the location and depth of the instrument used.

The EBA analysis was conducted before Ivanhoe's piezometric data were available. The EBA analysis and pressures used were made consistent with the Geosim model at that time. The pressure gradient in the Geosim model was consistent with the accepted regional pressure behavior that typically gives an underpressured McMurray sand. However, once piezometric data was gathered for the Project Area, those pressures were used to update the Geosim model.

The EBA analysis and updated Geosim results showed minimal changes in pressure and the change in initial pressure description was not considered important to the conclusion of the EBA analysis. A lower initial pressure would result in a higher factor of safety for the EBA stability analysis of the dyke. The updated Geosim simulations showed no difference in the change in pressure at the base of the Clearwater shale below the dyke location. Therefore, the EBA stability analysis is still considered valid.

26. Attachment 2, Section 8.1, Page 28. In its report to Ivanhoe, EBA states, "*The ground heave prediction contour lines are parallel to the MSL boundary and the wetland levels. Figures 11, 12 and 13 demonstrate that there should be negligible differential heave in the east to west water flow direction*". In the context of having variable geology overlying the wells, explain why the heave contours illustrated in the referenced figures are parallel to the MSL boundary.

The heave contours are parallel to the MSL boundary because the EBA ground heave map assumed the Geosim element-of-symmetry (EOS) model (valid for a specific location) could be used to populate the expected heave for the entire Phase 1 Development Area. The EOS model heave results were positioned such that the well toes all lined up with the MSL boundary. Therefore, the heave contours of the resulting pattern aligned with the MSL boundary. The heave associated with EOS model used the maximum thickness of the development area giving an estimate of the maximum heave potential. This approach results in a worst case scenario and, therefore, variable geology (McMurray thickness and overburden thickness) would be expected to result in lower heaves than presented.

27. Attachment 2, Section 8.2, Page 34.

In its report to Ivanhoe, EBA states, "*The EBA analysis and evaluation consisted of three sequential steps described in Section 6.2 of this report. The results of the Step 1 initial case (prior to SAGD effects) slope stability analysis of South Dyke Section K2-K2' and LL' carried out by EBA were substantially identical to the KCB analysis results presented in the January 2010 Elevation 390 m Design Update Report*."

In Suncor's South Tailings Pond 2011 Performance Report, submitted to Alberta Environment and Water, Water Administration, key observations about elevated foundation pore pressures in the Clearwater Formation are reported, including some readings where pore pressure is higher than the design pore pressure.

a. Update the stability assessment for profile sections K2-K2' and L-L', reflecting any parameter updates based on the Suncor 2011 South Tailings Pond Performance Report.

In Suncor (2011) where pore pressure is higher than the design pore pressure in the Clearwater Formation, presented in Table 8.2 and discussed in Section 8.1.2, are for the North Dyke. The Project is located south of the South Dyke, several kilometres distance from the North Dyke.

Pore pressure measurements in the Clearwater Formation underlying the West Dyke and South Dyke are presented in Table 8.6 and discussed in Section 8.2.3 of Suncor (2011). The text for Section 8.2.3 comprises only two sentences: "The vibrating wire piezometer data for the piezometers in the Clearwater Formation units along the West and the South dyke are summarized in Table 8.6. The (B-bar) values range between 0.06 and 0.46 which are below the design value of 0.8."

Furthermore, regarding performance monitoring of the South Dyke, Section 8.2.1 of Suncor (2011) states:

> "None of the thirteen slope inclinometers along the South Dyke have recorded foundation movements to date."

The design value of 0.8 corresponds with a 1.5 Factor of Safety. The 2011 actual values ranged from 0.06 to 0.46. Based on our updated stability analysis, the value of 0.46 corresponds with a 1.7 factor of safety. The lowest (deepest) portion of the critical failure surface was at an elevation of 320 m, within the Clearwater Formation.

b. Identify the maximum excess pore pressure in the Clearwater Formation that can trigger instability (i.e., where the factor of safety = 1.0).

Based on our updated stability analyses, the pore pressures along that critical failure surface would need to increase by an additional 250 to 300 kPa from the measured 2011 pore pressures, in order to reduce the factor of safety to 1.0 (from the pore pressures associated with the highest 2011 value of 0.46). The total excess pore pressure would need to be approximately 450 to 500 kPa at the 320 m elevation (critical failure surface elevation), which is approximately 35 m above the top of the McMurray Formation.

Literature Cited:

Suncor. 2011. *South Tailings Pond 2011 Annual Performance Report.*

FACILITIES

28. Supplemental Information Response #42b, Page ERCB-118.
Ivanhoe states, "*The vapour recovery unit will recover and recycle any diluent vapours from the product tanks*." However, the proposed project does not include a diluent recovery unit, indicating that any flashed naphthenic diluent will be combusted (lost) with fuel gas. Provide the expected diluent losses to the fuel gas system due to flashing.

To clarify the response to Volume 4, SIR 42b, diluent vapours recovered by the VRU system will be cooled and any condensed liquids will be recovered and recycled to the diluent tank. Any diluent vapour that does not condense will be sent to the fuel gas system and will be combusted.

During the early phase of the Project, before the HTL™ upgrader is running, a total of 19 000 kg/hr of diluent will be injected, which equates to a loss of 95 kg/hr of diluent to the fuel system. In this case, there will be a loss of diluent to the fuel of up to 0.5 wt%.

Once the HTL™ upgrader is in operation, part of the operation will recover diluent and recycle it to the upstream process. In this case, 20 500 kg/hr of diluent will be used in the process and less than 10 kg/hr of diluent will be consumed as fuel. This is because the recycled diluent has already been stripped of light end gas during the first pass through the diluent recovery column, and will not contain light ends which are present in imported diluent. Once steady state recycling operations have been established and the stored volume of diluent has been stripped of light ends, the amount of diluent consumed as fuel will drop to below 0.05 wt% of the operating volume.

29. Supplemental Information Response #44a, Table SIR 44-1, Phase 1 Total Available Steam, Page ERCB-120.
Ivanhoe has shown the total available (maximum) steam output from two co-generation units as 98 tonnes per hour, and the normal operation output from the same two units as 198 tonnes per hour. Reconcile the total available steam and normal operation output for the co-generation unit.

There is an error in the steam output of the co-generation units. Table SIR 44-1 (Rev) presents the corrected information. The maximum output is 98 t/hr and the normal output is also 98 t/hr.

Table SIR 44-1 (Rev): Phase 1 Total Available Steam

	Steam Generation per Unit (t/hr)	Quantity	Total Available Steam (t/hr)	% of Total Available Steam	Normal Operation 3.0 SOR (t/hr)	% of Normal Operation
Steam Generators	139	3	417	57.6%	114	27.1%
Co-generation	49	2	98	13.6%	98	23.3%
HTL™	208	1	208	28.8%	208	49.5%
Total			**723**	**100%**	**420**	**100%**

30. Supplemental Information Response #47, Page ERCB-125.
Ivanhoe has selected a semi-dry scrubbing technology for its flue gas desulphurization (FGD) unit due to the presence of ash in the re-heater overhead flue gas stream, and the limitations on available source water for scrubbing. Ivanhoe has also designed for a sulphur removal rate of 90 per cent.

Revisions to Question 30 were received by email on June 28, 2012. Answers to this revised question are forthcoming.

a. Describe the limitations that prevent the achievement of higher sulphur removal efficiency. Include identification of modifications that could be made to improve the sulphur removal efficiency of the FGD unit.

A flue gas desulphurization (FGD) vendor has not been selected, but vendor data and open source literature suggest it should be possible to achieve at least 90% instantaneous sulphur removal efficiency on a stream day basis using the dry lime sorbent based FGD technology. This is a limitation of the chemistry/chemical reaction equilibrium that is used in the process, but the process chemistry is the standard for this type of application, (i.e., fluid bed combusters). Once FGD availability has been considered, the annualized recovery efficiency is estimated to be 85% on a calendar day basis.

In order to achieve higher FGD sulphur recovery factors, Ivanhoe would need to add a secondary wet FGD system, which according to some vendors' data, could achieve a 98+% instantaneous capture efficiency on a stream day basis. Once FGD availability has been considered, the annualized recovery efficiency will be lower than 98+%, depending on technology and vendor selected. Wet systems were not considered at this location due to the high volumes of fresh water used, wastewater produced and evaporative losses of water to the atmosphere, which would only achieve a low incremental rate of sulphur recovery above the dry system design.

b. Provide the anticipated composition of total produced gas upstream of the Mixed Fuel Gas Drum at the central processing facility (CPF), effluent gas from the CPF steam generator #1 and co-generator, as well as effluent gas from the HTL™ reheater.

Table SIR2 30-1 provides anticipated composition of total produced gas upstream of the mixed fuel gas drum at the CPF, effluent gas from the CPF steam generator #1 and co-generator, as well as effluent gas from the HTL™ reheater.

Table SIR2 30-1: Gas Streams

		Combusted Gases		Flue Gases			
		Blended Fuel (HTL™ + SAGD Produced Gas)[1]	HTL™ Vacuum Distillation Non-Condensable (VDN) Gas[2]	Reheater[3]	HTL™ Heaters[4]	Steam Generator[5]	Co-Generation[6]
Compound	**Formula**	**Mol Frac.**	**Mol Frac.**	**Mol Frac.**	**Mol Frac.**	**Mol Frac.**	**Mol Frac.**
Hydrogen	H_2	0.3974	0.0297	0.0000	0.0000	0.0000	0.0000
Helium	He	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	N_2	0.0751	0.1097	0.6990	0.6940	0.7027	0.7490
Carbon Monoxide	CO	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000
Carbon Dioxide	CO_2	0.0308	0.0002	0.1302	0.0965	0.0887	0.0252
Hydrogen Sulphide	H_2S	0.0010	0.1576	0.0000	0.0000	0.0000	0.0000
Methane	CH_4	0.2976	0.2094	0.0000	0.0000	0.0000	0.0000
Ethane	C_2H_6	0.0246	0.0739	0.0000	0.0000	0.0000	0.0000
Ethylene	C_2H_4	0.0623	0.0206	0.0000	0.0000	0.0000	0.0000
Propane	C_3H_8	0.0053	0.0726	0.0000	0.0000	0.0000	0.0000
Propylene	C_3H_6	0.0411	0.0310	0.0000	0.0000	0.0000	0.0000
Butane	C_4H_{10}	0.0009	0.0282	0.0000	0.0000	0.0000	0.0000
Butylene	C_4H_8	0.0124	0.0208	0.0000	0.0000	0.0000	0.0000
C5+		0.0250	0.1280	0.0000	0.0000	0.0000	0.0000
Water	H_2O	0.0245	0.0893	0.1516	0.2092	0.1883	0.0758
Sulphur Oxides	SO_x	0.0004	0.0000	0.0063	0.0002	0.0012	0.0000
Nitrogen Oxides	NO_x	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Oxygen	O_2	0.0014	0.0290	0.0127	0.0000	0.0192	0.1500
Total		**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**

Notes:
[1] Sent to steam gens, co-gens and HTL™ heaters. Pipeline gas added at combustors.
[2] Sent to steam gen only.
[3] From burning coke. **No gas combusted**. Sent to FGD.
[4] Blended fuel + pipeline gas.
[5] Blended fuel + VDN gas sent to FGD.
[6] Blended fuel + pipeline gas.

c. Ivanhoe has stated that because sulphur is carried within the coke combusted in the reheater, only post combustion technology is feasible. Provide the rationale for Ivanhoe's choice to not to incorporate sulphur recovery/removal technology at the CPF where pre-combustion technology could be incorporated.

Sulphur originates as part of the overall organic molecular structure of the bitumen. It is carried into the HTL™ reactor as part of the liquid reactor feed, where some sulphur is carried forward with the compounds in the reactor vapour product and the rest is condensed with the heaviest hydrocarbon compounds into the coke. Extracting sulphur from the chemical structure of the HTL™ reactor feed is not feasible in the CPF or HTL™, because technology does not exist for doing this processing commercially in a way which would reduce atmospheric sulphur emissions from the HTL™ reheater.

d. Provide details on the type of unit that will be utilized to remove particulates and ash from flue gas stream.

In the current design, particulate matter (PM) from both the HTL™ reheater units and from the CPF flue gases, are removed in the FGD unit. The current design of the FGD unit encompasses a fabric filter baghouse for particulate controls and targets particulate emissions (PM_{10}) to be 7.2 kg/hr, which equates to 10.92 g of particulate per/GJ of heat input.

31. Supplemental Information Response #48, Table 48-1, Page ERCB-127. Ivanhoe has provided expected source water flow rates over the project life.

a. Ivanhoe is utilizing a mechanical vapour compression evaporator system for water treatment, not zero liquid discharge. As such, disposal should be low but not zero. Provide the assumption(s) that was incorporated into Ivanhoe's water use model to give a disposal rate of 0 m^3/day after year three.

After year three, all wastewater from the evaporator system and inlet softening systems will be used in the FGD system that will be installed with the HTL™. This water loss is shown in the FGD water vapour stream in the water mass balance (Volume 4, Table SIR 48-1). This loss of water is accounted for in the "brackish water make-up" volumes.

b. Provide separate water and hydrocarbon balances for the project that represent the first three years of operation, as well as a second set of balances representing steadystate operations (e.g., years 5 through 19). The balances must be represented using block flow diagrams (i.e., oil treatment, water treatment, HTL™, etc.). All quantities are to be expressed in metric units at standard temperature and pressure. Mass and volumetric flow rates are to be provided on a calendar day and stream day basis.

See Appendix SIR2 G.

ENVIRONMENT

32. Supplemental Information Response #113a, Page AENV-91. Ivanhoe states, "*In some cases, the ability to move surface facilities to avoid watercourse buffers is limited by the subsurface geology and well pads are located to exploit the areas of highest quality reservoir*."

Supplemental Information Response #124, Figure SIR 124-1, Project Facilities and Watercourse Buffers, Page AENV-109. Ivanhoe illustrates five pads at which diversions may potentially be implemented.

Supplemental Information Response #133, Table SIR 133-1, Minimum and Average Distances of Project from Watercourses, Page AENV-122. Table SIR 133-1 identifies six of the thirteen well pads for the proposed project area development as within 0 to 92 metres of water bodies.

The ERCB requires additional information to support Ivanhoe's statement that the encroachment of its well pads on water bodies is justified by resource recovery requirements and the mitigations proposed. It appears that alternate siting within short distances or minor re-configuration of well pads could be used to reduce encroachment upon water bodies and eliminate in-stream effects of channel construction.

a. Provide one, or more as necessary, alternate surface locations for Pads 2 and 3 to demonstrate alternative surface locations that would meet the 100 metre water body setback. Note that a constraints mapping approach may be useful to illustrate multiple factors considered.

Unnamed Tributary 1 was originally classified as a non-flowing or ephemeral drainage (Volume 4, SIR 113a). However, ground investigations of the subject watercourse undertaken in May 2012, as discussed in the SIR2 Project Update reveal that there is no defined channel in the areas near Pads 1, 2 and 3. Photos taken from helicopter during the site visit include the proposed pad locations and are provided in the SIR2 Project Update. This drainage area is, therefore, not a water body under AENV's Code of Practice for Watercourse Crossings, so no encroachment will take place. Stream diversions will not be required, resulting in no in-stream effects of channel construction.

i. Provide accompanying well trajectory cross sections, well lengths, and drainage areas, original and developable bitumen in place, and recovery factors for each of the alternatives presented in comparison to the originally proposed layouts.

See response to SIR2 32a.

ii. Provide a supporting discussion to demonstrate any subsurface geological and/or drilling limitations to surface pad placement.

See response to SIR2 32a.

iii. Identify environmental impact assessment conclusions that are altered and/or supported by the potential selection of alternative surface locations identified.

See response to SIR2 32a.

b. Discuss similar alternate surface pad placement and outcomes for additional pads outside the development area, such as Pads 6, 7, 10 and 12.

The south fork of Unnamed Tributary 1 and the south fork of Unnamed Tributary 2 were originally classified as a 'non-flowing or ephemeral drainage" (Volume 4, SIR 113a). However, ground investigations of the subject watercourses undertaken in May 2012, as discussed in the SIR2 Project Update reveal that there are no defined channels in the areas near Pads 6, 7, 10 or 12. Photos taken from helicopter during the site visit include the proposed pad locations and are provided in the SIR2 Project Update. The drainage areas near Pads 10 and 12 are, therefore, not considered water bodies under AENV's Code of Practice for Watercourse Crossings, so no encroachment will take place. Stream diversions will not be required, resulting in no in-stream effects of channel construction.

The original location of Pads 6 and 7 are within 100 m of active beaver ponds, which would be considered a water body. Therefore, Ivanhoe has amended the pad locations to maintain the 100 m setback (see SIR2 Project Update, Figure SIR2 PU-10).

c. Regarding setbacks from water bodies, Directive 056: Energy Development Applications and Schedules requires that for any well within 100 metres of a water body, the use of spill prevention measures, automatic controls and shut off valves, berms, trenches, and alternative operating methods be evaluated. Ivanhoe has identified perimeter berms with diversion channels as mitigation for surface run-off, sedimentation, etc. For Phase 1 pads that are unable to maintain a 100 metre setback from water bodies, discuss Ivanhoe's other mitigations and pollution controls that could be implemented for wells, well pads, or other production equipment.

There are no Phase 1 well pads that are within 100 m of a water body (see SIR2 Project Update).

Ivanhoe Energy

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GENERAL

33. Volume 4: Supplemental Information Request #1, Response #60, Page AENV 12, Table SIR 60-1.
Ivanhoe Tamarack's outline of actions for wellhead failure implies that the impact of an event would be limited to the area of the well pad. Such events experienced by other operators have resulted in spill effects well beyond the well pad boundary.

a. What criteria were used to categorize the likelihood of an event as rare, unlikely, possible, likely, or almost certain?

The following criteria were used to identify likelihood for Volume 4, Table SIR 60-1:

- *Rare* – highly unlikely but may occur under exceptional circumstances;
- *Unlikely* – not expected but there is a slight possibility it may occur at some time;
- *Possible* – the event might occur at some time as there is a history of occurrence within industry;
- *Likely* – there is a strong possibility that the event will occur as there is a history within industry; and
- *Almost Certain-Very Likely* – the event is expected to occur in most circumstances as there is a history of regular occurrence in industry.

b. Explain why Ivanhoe believes that a wellhead release would not go beyond the area of the well pad.

In the original response, Ivanhoe did not mean to imply that all wellhead failures would be limited to the area of the well pad. Volume 4, Table SIR 60-1 was developed to encompass a large range of upset scenarios from leaking gaskets to valve and equipment failures; with the majority of these failures to be contained within well pad boundaries as per site runoff design, and limited in volume due to control system, alarms and emergency shutdown valves, and regular site visits. There are conditions and events that could result in releases to the environment off-site, such as catastrophic failures or high pressure releases; if these events occur, they will be managed under Ivanhoe's Emergency Response Plan (ERP) and the Spill Response Plan, discussed in SIR2 34, in order to minimize and mitigate any impact.

In Table SIR 60-1, Ivanhoe also differentiates between a wellhead release and a well blowout. A wellhead release is an event that will be limited to the well pad and can be controlled through mechanical means, whereas a blowout is an uncontrolled release that could potentially impact beyond the well pad (i.e., air). These events are identified separately in Table SIR 60-1 to account for the differences in potential likelihood and magnitude.

In reviewing Table SIR 60-1, Ivanhoe suggests three revisions to the well blowout spill hazard assessment:

- Likelihood of a well blowout is currently identified as Possible. After further review and based upon the criteria identified in SIR2 33a, Ivanhoe suggests the likelihood of a well blowout is Rare;
- Potential Magnitude of a well blowout is currently identified as Moderate. After further review and based upon the criteria identified in SIR2 33a, Ivanhoe suggests the magnitude of a well blowout is High; and
- Preventative Actions have been expanded to include the total life cycle of the well from drilling through abandonment.

The final impact rating, which considers likelihood, magnitude and preventative actions, does not change (Table SIR2 33-1).

Table SIR2 33-1: Job Safety Analysis and Risk Register – Spill Hazard Assessment

Description of Risk	Description of Impact	Likelihood[1]	Potential Magnitude[2]	Preventative Actions	Final Impact[3]
Well Blowout	Localized medium - contamination of air, soil, surface water. Minimal potential for contamination of subsurface. No permanency effect on the environment.	Rare	High – a single SAGD well blowout would release bitumen	Wells drilled, completed and abandoned as per approved procedures. Routine preventative maintenance program will be implemented	Low

Notes:

[1] Likelihood was rated as Rare, Unlikely, Possible, Likely, Almost Certain.

[2] Magnitude was rated as described in Volume 2, Section 3.5.3.

[3] Final impact was rated based on the Likelihood, Magnitude and, where applicable, the implementation of mitigation measures and monitoring plans. Final impact was rated as Low, Moderate, High.

c. What measures will be in place to limit the effects of such an event? For example, will there be emergency shutdown options and procedures to immediately limit the duration of the event?

The injection and production wells will be equipped with emergency shutdown valves that in the case of a wellhead failure will isolate the injection system or the production system to contain a release.

In the event of a well blowout, the ERP will be implemented. This plan will identify the major issues and provide a cohesive response that deals with safety, emergency notification, mobilization of necessary personnel and equipment and an environmental mitigation plan to deal with the event.

The discussion of cap rock failure identifies a final impact as low. Other operators have found that cap rock failures can be quite challenging and result in long-term, ongoing spill events.

d. How confident is Ivanhoe in its assessment of the risk of cap rock failure?

Ivanhoe is very confident in its assessment of the risk of cap rock failure. The final impact rating is a qualitative rating, which is a function of Likelihood and Potential Magnitude and for cap rock, failure is rated as Rare and High, respectively. Preventative actions of a cap rock failure will include:

- recommended operating pressures as outlined in Volume 4, Appendix C, identifies pad-specific MOPs with appropriate factors of safety;
- a comprehensive Reservoir Monitoring Plan (Appendix SIR2 D);
- based on the information obtained from the Reservoir Monitoring Plan, Ivanhoe will be able to detect cap rock failure in advance of a surface breach and implement corrective actions to prevent such an event. Corrective actions may include:
  - ❑ reducing injection or shutting-in of steam injection wells;
  - ❑ continuation or increase in production from well patterns to reduce formation pressure;
  - ❑ implementation of Ivanhoe's ERP; and
  - ❑ other actions, as necessary.

Given the information currently available, the contingencies in place and the adaptive management approach that Ivanhoe has adopted, Ivanhoe is confident of its assessment of the risk of cap rock failure and of its ability to manage that risk.

e. What mitigation measures are available to reduce the impact to aquatic and terrestrial resources in the event a cap rock failure occurs?

The Reservoir Monitoring Plan (Appendix SIR2 D) will allow for early detection of subsurface problems and operations will be modified in a timely manner to avoid a surface breach. The ERP will provide for the mitigation of environmental impacts to aquatic and terrestrial resources due to a cap rock failure and breach at surface, including:

- mobilizing equipment, including mutual aid from WCSS Area Y members to provide support;
- containing and capturing any released bitumen or condensed water through the use of absorbents, booms, vacuum trucks or other equipment;
- removing and disposing of all visible oily liquids or impacted soil;
- preventing contaminants from reaching potentially impacted water bodies using berms, ditches, booms or other techniques;
- identifying areas of impact and contamination through soil and water sampling and analysis; and
- developing a remediation plan to remove and dispose of or treat any remaining contaminated soil or water.

34. Volume 4: Supplemental Information Request #1, Response 60 e, Page AENV-14 and Question 165 a, Page AENV-174.
Ivanhoe indicates they have not yet developed a spill response plan. However, to ensure Ivanhoe understands the potential impacts of the project, and to demonstrate that they have considered the requirements of a spill response plan, it is necessary to see that at least a conceptual plan is in place.

a. Provide a conceptual spill response plan, including an assessment and monitoring plan to be used in the event of a spill.

A Conceptual Spill Response Plan is provided in Appendix SIR2 H.

b. Provide a discussion of criteria used in the development of the plan.

See response to SIR2 34a. The Conceptual Spill Response Plan includes a discussion of criteria used to develop the plan.

35. Volume 4: Supplemental Information Request #1, Response #61, Page AENV-15. Ivanhoe states it understands Alberta Transportation's concerns regarding cumulative traffic impacts associated with future development; however, since Ivanhoe is not the proponent for the CMAR, it is not responsible for a Traffic Impact Assessment for the CMAR Project. Ivanhoe does understand that Ledcor is conducting a TIA, as part of the Federal Environmental Screening Process for the CMAR Project. Once filed, this document will become part of the public record and will be available for review.

Alberta Transportation has recently received confirmation from Ledcor CMI Ltd. (Clearwater Multi-User Access Road Environmental Assessment Screening, Responses to Information Request #1, November 2011) that the Traffic Impact Assessment (TIA) for the Clearwater Multi-User Access Road (CMAR) is currently underway. The TIA should be the combined efforts of all CMAR road users to address transportation issues and any necessary access improvements. Alberta Transportation may have further comments once we receive the TIA.

a. Confirm that Ivanhoe is working with Ledcor to produce the combined TIA.

Information from the Project was provided to Ledcor to include in the Clearwater Multi-User Access Road (CMAR) Traffic Impact Assessment (TIA). To Ivanhoe's knowledge, the TIA was completed in December 2011 and was provided to Alberta Transportation in January 2012, as part of the environmental screening process.

AIR

36. Volume 4: Supplemental Information Request #1, Project Update and Response #49, Page ERCB-128.
Ivanhoe states in the Project Update, "*It is expected that there will be a reduction of greenhouse gas and sulphur air emission from the project, and a deduction in the amount of energy required to operate the Project facilities.*"

a. Compare in table form SO_2 emissions from each Project source in the original Application and Project Update with the FGD operating and inoperative.

Table SIR2 36-1 provides a comparison of the SO_2 emissions from Project sources as assessed in the application, and as described in the Volume 4, Project Update. It should be noted that the environmental impact assessment (EIA) assumed, for conservatism, that the steam generators operated as independent emission sources from the FGD stack. This does not reflect an actual operating case, as whenever the HTL™ is operational the effluent from the steam generators is routed to the FGD stack. However, in the event that the HTL™ is not operational, the SAGD components may continue to operate, in which case, the steam generators are independent sources. This conservative assessment captures a worst-case scenario by assuming that normal SAGD-only and normal HTL™ emissions occur simultaneously. The information provided in the table reflects the actual operating case where the HTL™ is operational in order to be comparable to the Volume 4, Project Update. Therefore, the emissions presented for the application design will appear to be lower than the assessed scenario in the EIA.

Table SIR2 36-1: Project SO_2 Emission Comparison Between Application and Volume 4, Project Update

Facility	Emission Source	SO_2 with FGD Operational (t/d)		SO_2 with FGD Inoperative (t/d)	
		Application Design	Project Update[6] Design	Application Design	Project Update[6] Design
Phase 1 SAGD	Steam Generator 1	0.00[1]	0.00[1]	0.00[1]	0.00[1]
	Steam Generator 2	0.00[1]	0.00[1]	0.00[1]	0.00[1]
	Glycol Heater	0.00	0.00	0.00	0.00
	Steam Generator 3	0.00[1]	0.00[1]	0.00[1]	0.00[1]
	HP Flare	0.00	0.00	0.00	0.00
	LP Flare	0.00	0.00	0.00	0.00
	Co-gen 1	0.00	0.22	0.00	0.22
	Co-gen 2	0.00	0.22	0.00	0.22
Phase 1 HTL™	FGD	6.46[2]	5.94[3]	65.43[4]	59.40[5]
	DRU Heater	0.06	0.11	0.06	0.11
	Pre-Frac Heater	0.12	0.23	0.12	0.23
	HTL™ Flare	0.00	0.00	0.00	0.00
Phase 2 SAGD	Steam Generator 1	0.00[1]	0.00[1]	0.00[1]	0.00[1]
	Steam Generator 2	0.00[1]	0.00[1]	0.00[1]	0.00[1]
	Glycol Heater	0.00	0.00	0.00	0.00
	Steam Generator 3	0.00[1]	0.00[1]	0.00[1]	0.00[1]
	HP Flare	0.00	0.00	0.00	0.00
Phase 2 HTL™	FGD	6.46[2]	5.94[3]	65.43[4]	59.40[5]
	DRU Heater	0.06	0.11	0.06	0.11
	Pre-Frac Heater	0.12	0.23	0.12	0.23
	HTL™ Flare	0.00	0.00	0.00	0.00

Notes:

[1] During HTL™ operation, emissions from the steam generators are routed to the FGD.

[2] Includes approximately 0.41 t/d from the steam generators and 6.05 t/d from the HTL™ reheater.

[3] Includes approximately 0.44 t/d from the steam generators and 5.50 t/d from the HTL™ reheater.

[4] Includes approximately 4.13 t/d from the steam generators and 61.3 t/d from the HTL™ reheater.

[5] Includes approximately 4.40 t/d from the steam generators and 55.0 t/d from the HTL™ reheater.

[6] Based on information provided in Volume 4, Project Update.

37. Volume 4: Supplemental Information Request #1, Project Update.
The Project Update indicates that process improvements are expected to reduce the energy required to operate the Project and the emissions of greenhouse gases. The Project Update also indicates that SCO and liquid hydrocarbon yields will also increase.

a. Provide an update to Table 4.6-19 in Volume 2, Section 4.6.5 of the EIA, which summarizes the GHG emission estimates for the Project. The response should also include a comparison between the updated estimates and the original ones.

Table SIR2 37-1 provides a comparison of the GHG emissions, and emissions intensity as described in the EIA and as revised following the Volume 4, Project Update.

Table SIR2 37-1: Comparison of GHG Emissions Between EIA and Volume 4, Project Update

Ivanhoe GHG Emissions Comparison	**As Reported in EIA**	**As Revised following Volume 4, Project Update**
Alberta's GHG Emissions (2007) (kt CO_2E/yr)	245 700	245 700
Canada's GHG Emissions (2007) (kt CO_2E/yr)	747 000	747 000
Ivanhoe Estimated GHG Emissions (kt CO_2E/yr)	1 398	1 308
Ivanhoe Emissions Intensity (g CO_2E/MJ refined product)	33.9	29.0
Ivanhoe GHG Emissions as a Percentage	**Percent of Total GHG Emissions (%)**	**Percent of Total GHG Emissions (%)**
Percent of Alberta Total	0.57	0.53
Percent of Canada Total	0.19	0.18

b. Provide a comparison of the GHG emission intensity of the original application with the Project Update. Since the Project produces more than one product (SCO and other liquid hydrocarbons), the GHG emission intensity should be in the form of (g CO_2e/MJ refined product).

See response to SIR2 37a.

38. Volume 4: Supplemental Information Request #1, Response # 67, Pages AENV-23 & 24

Ivanhoe indicates that the steam generators will burn alternate gaseous fuel, thus the NOx emission limit of 40 g/GJ applies. However, the original application indicates that the Project burns both natural gas and produced gas.

a. Provide the ratio/percentage of produced gas and purchased gas in the final gas mixture that will be used in the steam generators. Based on this information, if the final composition of the gas mixture is still mainly natural gas (e.g. 95% or more), the NOx emission factor of 26 g/GJ should be used to determine compliance with the Interim NOx BATEA Guidelines, Alberta Environment, 2007. Indicate whether the correct NOx emission limit was used.

During normal operations, with the HTL™ operational, the steam generators will be fired entirely on produced gas either from the formation, or gas produced by the HTL™ process. Under these conditions, there will be no purchased gas sent to the steam generators. When the HTL™ is not operational, the steam generators will burn a mixture containing approximately 95% purchased natural gas.

Ivanhoe will be using alternate fuel gas under normal operations and, therefore, the 40 g/GJ compliance limit does apply.

b. If the 26 g/GJ compliance limit applies, provide updated calculations and update Table ATT6-3 in Volume 1 of the Integrated Application, for the 26 g/GJ compliance limit.

See response to SIR2 38a.

39. Volume 4: Supplemental Information Request #1, Response # 67, Page AENV-24 and Volume 3, Section 3.0, Table A2-34, Page A2-63

Ivanhoe states, "The co-generation units are rated at 30 MW (power basis). Ivanhoe also states Heat generation by the co-generation units is estimated to be 239 G/hr" for each co-generation unit. Response to SIR 67a, Table SIR 67-1 indicates that the heat input into Co-gen 1 and Co-gen 2 is 90.81 MW each. This means the co-gen is more than 100% efficient. The 239 GJ/h may be the combined heat from both co-gens but the sample calculations appear to be for each co-gen.

a. For the operating conditions on which the Project emission rates are based, what is the amount of fuel energy input into each co-gen unit? What is the electrical power output and heat output for each co-gen unit?

Fuel input to each co-gen unit is estimated at 339 GJ/h. The electrical power output is 30 MW and the heat output is 119.5 GJ/h for each co-gen unit.

b. If the 30 MW of electricity and 239 GJ/h generated are for each co-gen, how does Ivanhoe plan to meet the NOx emission estimate of 0.297 t/d as specified in their AQ modeling?

The 239 GJ/h of heat generated stated in the response to Volume 4, SIR 67 is the combined total for both co-gen units. The NO_X emission estimate of 0.297 t/d is based on 119.5 GJ/h heat output for each co-gen unit.

c. Provide calculations to show how the cogeneration unit will meet the NOx guidelines listed below. Show calculations on a per individual co-gen unit basis. In the calculation of the emission limit include the heat recovery component so a comparison between the NOx emission limit and the estimated NOx emission rate is transparent.

- ***National Emission Guidelines for Stationary Combustion Turbines, CCME, December 1992***
- ***Alberta Air Emissions Standards for Electricity Generation, December 2005***

The co-generation units are rated at 30 MW (power basis). The National Emission Guidelines permit an emission rate equal to:

$$(\text{Power Output} \times A) + (\text{Heat Output} \times B) = NO_X \text{ Limit}$$

where: A = 140 g/GJ; and
B = 40 g/GJ.

The power output of each co-generation unit is 30 MW (108 GJ/h). The heat output of each unit is 119.5 GJ/h. Therefore, the National NO_x emission limit is then given by:

$$\text{National } NO_X \text{ Limit} = \left[\left(108\frac{\text{GJ}}{\text{h}}\right) \times \left(\frac{140\text{g}}{\text{GJ}}\right)\right] + \left[\left(119.5\frac{\text{GJ}}{\text{h}}\right) \times \left(\frac{40\text{g}}{\text{GJ}}\right)\right]$$
$$= 19.9 \text{ kg/h}$$

Estimated emissions from each co-generation unit are 12.37 kg/h. Therefore, the turbines meet the National Emission Guidelines for NO_x.

Similarly, the Alberta Air Emissions Standards for Electricity Generation specify a NO_x emission limit of 0.4 kg/MWh (0.11 kg/GJ) where the energy unit includes both electrical and thermal generation. Heat generation by the co-generation units is estimated to be 119.5 GJ/h (per unit), and electrical generation is 108 GJ/h. Therefore, the total production of each unit is 227.5 GJ/h.

The Alberta NO_x emission limit is then given by:

$$\text{Alberta } NO_X \text{ Limit} = \left[\left(0.11\frac{\text{kg}}{\text{GJ}}\right) \times \left(\frac{227.5 \text{ GJ}}{\text{h}}\right)\right]$$
$$= 25.3 \text{ kg/h}$$

Estimated emissions from each co-generation unit are 12.37 kg/h. Therefore, the turbines meet the Alberta Air Emissions Standards for Electricity Generation for NO_x.

40. Volume 4: Supplemental Information Request #1, Response # 70, Table SIR 70-1 and Table SIR 70-2, Page AENV-27.
PM emissions for construction appear to be only from diesel combustion sources.

a. Provide an estimate of traffic/road dust emissions associated with construction activities.

The parameters for peak daily construction traffic and emissions are provided in Tables SIR2 40-1 and 40-2. Emissions from road dust are estimated as described in the response to SIR2 43. Emissions from vehicles are estimated using MOBILE6.2C.

Table SIR2 40-1: Total Road Dust Emissions

Total VKT per day (km)	Emission (kg/day)			Number of Dry Days per Year	Emissions (tonnes/year)		
	TPM	PM_{10}	$PM_{2.5}$		TPM	PM_{10}	$PM_{2.5}$
4 400	8 992.5	2 569.4	256.9	149	1 340	383	38

Table SIR2 40-2: Total Vehicle Emissions

	Traffic Type	Distribution		Average Distance Travelled Per Day		Emission Factor	Emissions per Day	Total Emissions	Total Emissions
		(Vehicle Class)	(%)	(VKT km)	(mi)	(g/mi)	(g/d)	(g/d)	(t/y)
PM_{10}	Construction Workers	HDDV	25%	660	410	0.183	75	326	0.12
		LDGT	60%	1 584	984	0.030	30		
		LDDT	15%	396	246	0.069	17		
	Equipment and Materials	HDDV	100%	900	559	0.183	102		
	Drilling Crew and Equipment	HDDV	100%	900	559	0.183	102		
$PM_{2.5}$	Construction Workers	HDDV	25%	660	410	0.145	59	248	0.09
		LDGT	60%	1 584	984	0.015	15		
		LDDT	15%	396	246	0.052	13		
	Equipment and Materials	HDDV	100%	900	559	0.145	81		
	Drilling Crew and Equipment	HDDV	100%	900	559	0.145	81		

Notes:

HDDV – Heavy duty diesel vehicle.

LDGT – Light duty gas truck.

LDDT – Light duty diesel truck.

The units for the heaters in Tables SIR 70-1 and SIR 70-2 appear to be incorrect as it is not in the form of energy per unit time.

b. Provide revised Tables SIR 70-1 and SIR 70-2 utilizing correct units for the diesel fired heaters.

See Tables SIR 70-1 (Rev) and SIR 70-2 (Rev).

Table SIR 70-1 (Rev): Construction Phase Emissions

Emission Source	Size	Units	Fuel Type	Quantity	Ave Time hr/day	SO_2 kg/d	NO_x kg/d	PM kg/d	CO kg/d	VOC kg/d	CO_2e t/d
Generators	100	HP	Diesel	11	24	0.00	156.00	8.40	66.00	8.40	17.53
Generators	35	HP	Diesel	18	12	0.00	44.67	2.41	18.90	2.41	5.02
Welders	15	HP	Diesel	30	12	0.00	31.91	1.72	13.50	1.72	3.58
Light Towers	2	HP	Diesel	66	12	0.00	9.36	0.50	3.96	0.50	1.05
Heater	350 000	BTU/h	Diesel	15	6	0.00	27.20	1.43	12.17	1.69	3.52
Heater	750 000	BTU/h	Diesel	3	6	0.00	11.66	0.61	5.22	0.72	1.51
Total						**0.00**	**280.81**	**15.07**	**119.75**	**15.40**	**32.31**

Table SIR 70-2 (Rev): Estimated Fuel Usage and GHG Emissions for Construction Phase Sources

Emission Source	Size	Units	Fuel Type	Quantity	Ave Time hr/day	Fuel Usage per Unit L/hr	CO_2e per Unit kg/hr	Total CO_2e t/d
Generators	100	HP	Diesel	11	24	23.1	66.38	17.53
Generators	35	HP	Diesel	18	12	8.09	23.23	5.02
Welders	15	HP	Diesel	30	12	3.47	9.96	3.58
Light Towers	2	HP	Diesel	66	12	0.46	1.33	1.05
Heater	350 000	BTU/h	Diesel	15	6	13.6	39.13	3.52
Heater	750 000	BTU/h	Diesel	3	6	29.2	83.86	1.51
Total						**77.98**	**223.89**	**32.31**

c. Demonstrate that the greenhouse gas emission estimates in Table SIR 70-2 still applicable with the corrected units.

Tables SIR 70-1 (Rev) and SIR 70-2 (Rev) provide the correct units for the heater ratings. The calculations of emissions estimates are unaffected as this was simply a typo in the table. Average fuel usage for the heaters is given by:

$$Fuel\ Usage\left(\frac{L}{h}\right) = 350000\frac{BTU}{h} \times 1.055 \times 10^{-3}\frac{MJ}{BTU} \times \frac{1}{38.7}\frac{L}{MJ} \times \frac{1}{70\%}$$

$$= 13.63\ \mathrm{L/h\ per\ unit}$$

Emissions of CO_2e are then calculated based on the referenced value of 2 871 t CO_2e/e^3m^3 fuel.

41. Volume 4: Supplemental Information Request #1, Response # 75a, Page AENV-34. Ivanhoe indicates that emission estimates of VOCs and PAHs for the SAGD and HTL components were pro-rated from data on emissions data from two EIAs (Conoco Phillips Surmont, Syncrude Upgrader).

a. Provide sample calculations to show how these emissions were estimated, specifically for benzene and reduced sulphur compounds. The sample calculation should show the original emission estimate from the other project, and the details of the pro-rating calculation (the ratio of fuel consumption estimates for the SAGD component, and the ratio of the bitumen processing rates for the HTL component).

Table SIR2 41-1 provides the emissions estimates for benzene and reduced sulphur compound (RSC) from the Surmont and Syncrude EIAs, as well as the scaling factors used to generate the emissions estimates for the Project. As an example, benzene emissions are calculated as follows:

$$\text{Project SAGD Benzene} = \text{Surmont Benzene} \times \frac{\text{Surmont Fuel Usage}}{\text{Project SAGD Fuel Usage}}$$

$$= 1.40 \times 10^{-3}\,\frac{g}{s} \times \frac{1436\,\frac{e^3m^3}{d}}{3592\,\frac{e^3m^3}{d}}$$

$$= 5.59 \times 10^{-4}\,\mathrm{g/s}$$

$$\text{Project HTL}^{\text{TM}}\text{ Benzene}\left(\frac{\mathrm{g}}{\mathrm{s}}\right) = \text{Syncrude Benzene}\left(\frac{\mathrm{g}}{\mathrm{s}}\right) \times \frac{\text{Syncrude Fuel Usage}}{\text{Project HTL}^{\text{TM}}\text{ Fuel Usage}}$$

$$= 4.84 \times 10^{-1}\,\frac{g}{s} \times \frac{10850\,\frac{e^3m^3}{d}}{768\,\frac{e^3m^3}{d}}$$

$$= 3.42 \times 10^{-2}\,\mathrm{g/s}$$

$$\text{Project Benzene} = \text{Project SAGD Benzene} + \text{Project HTL}^{\text{TM}}\text{ Benzene}$$

$$= 5.59 \times 10^{-4}\,\mathrm{g/s} + 3.42 \times 10^{-2}\,\mathrm{g/s}$$

$$= 3.48 \times 10^{-2}\,\mathrm{g/s}$$

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Table SIR2 41-1: Scaling of Emissions Estimates for the Project

Substance/Parameter	ConocoPhillips Surmont	Syncrude Upgrader	Project SAGD	Project HTL™
Fuel Consumption (e^3m^3/d)	3 592	10 850	1 436	768
Bitumen Production (m^3/d)[1]	15 900	89 835	6 360	6 360
Benzene (g/s)	1.40E-03	4.84E-01	5.59E-04	3.42E-02
H_2S (g/s)	0.00	4.86E-02	0.00	3.44E-03
CS_2 (g/s)	0.00	6.28E-03	0.00	4.45E-04
COS (g/s)	0.00	6.86E-03	0.00	4.86E-04
Mercaptans (g/s)	0.00	1.39E-04	0.00	9.84E-06
Thiophenes (g/s)	0.00	2.82E-02	0.00	2.00E-03

Note:

[1] Values for the upgrading facilities (Syncrude Upgrader and Project HTL™) represent bitumen input.

42. Volume 4: Supplemental Information Request #1, Response # 83b, Pages AENV-44 & 45.
Ivanhoe compares regional emissions within the AQRSA for all Projects included as of June 2009 and as of August 2011. Table SIR 83-3 indicates relatively large changes in NO_X and CO emissions in the LSA between June 2009 and August 2011.

a. Identify the operations in the LSA that contribute most to the emission changes, and quantify those changes.

The operations in the air quality local study area that contribute most to the emission changes and the quantification of those changes are shown in Table SIR2 42-1.

Table SIR2 42-1: Comparison of Air Quality Local Study Area Emission Sources Since Modelling Cutoff Date

Facility	NO_x (t/d)			CO (t/d)		
	EIA Reported Emissions	SIR Reported Emissions	Difference (%)	EIA Reported Emissions	SIR Reported Emissions	Difference
Northlands Forest Products	0.19	0.19	<1%	25.00	6.79	-73%
Suncor Baseplant, Millenium, Voyageur	90.70	90.70	<1%	54.55	54.55	<1%
Syncrude Mildred Lake	64.09	77.51	+21%	70.94	70.97	<1%
Williams FMM Chemical Plant	0.02	0.02	<1%	0.02	0.06	+151%
Community and Highway Emissions	2.68	3.36	+25%	14.07	17.52	+25%
Total	**157.68**	**171.79**	**+8.9%**	**164.58**	**149.90**	**-8.9%**

b. Reassess NO2 and confirm the additional Baseline emissions do not result in additional exceedances of NO2 AAAQOs.

As shown in Table SIR2 42-2, the additional baseline emissions do result in additional exceedances of the NO_2 ambient air quality objectives (AAAQOs) in the Baseline Case. The addition of the Project to these estimates (i.e., the Application Case) results in an additional small increase in the number of exceedances over the Baseline Case. The absolute increase in contribution at each receptor for each hour has not changed for the Project. The increased baseline emissions causes an overall increase at each receptor for each hour and for a number of these the Project contribution now pushes them over the AAAQO. In the context of the overall assessment this increase is not significant (0.1% increase in number of exceedences from Revised Baseline Case to Revised Application Case). Therefore, the conclusions reached in the EIA are unchanged with respect to NO_2, despite the additional baseline emissions.

Table SIR2 42-2: Summary of Exceedances of the NO_2 AAAQO

	Number of Exceedances	
	1-hour	**Annual**
EIA Baseline Case	1 980	5
EIA Application Case	1 980	5
Increase between EIA Baseline and Application Cases	<1%	<1%
Revised Baseline Case	4 478	5
Revised Application Case	4 483	5
Increase between Revised Baseline and Application Cases	<1%	<1%

43. Volume 4: Supplemental Information Request #1, Response # 84, Page AENV-47. Table SIR 84-3 lists uncontrolled road dust emissions for particulate matter based on Mobile 6.2C emission factors. A review of this model indicates only exhaust, tire wear, and brake wear are included in its emission factors, not road dust. Volume 2, Figure 4.5-10 in indicates that Application case $PM_{2.5}$ 2nd highest 24-h concentrations are already above the AAAQO of 30 μg/m^3.

a. Provide complete references for the methodology used to calculate road dust emissions.

The uncontrolled road dust emissions were calculated according to the methodology outlined in the Unpaved Roads section of US EPA (1995).

b. Provide sample calculations for TPM, PM10 and PM2.5 road dust emissions.

It was assumed that the silt content of the road was represented by the mean silt content for service roads at mining operations (8.5%). The daily PM, PM_{10} and $PM_{2.5}$ emissions were calculated assuming the average number of vehicles making one round-trip per day. The mean vehicle weight was estimated to be 8.08 tons, a weighted average based upon the total vehicle kilometres travelled (VKT) for each vehicle class.

The annual dust emissions, for each particle size, were then estimated by multiplying the average daily emissions by the number of dry days per year (days without 0.2 mm of rainfall and without snow cover). To determine the number of dry days per year, six years of meteorological data were obtained from Environment Canada for the Fort McMurray airport. The 2001 to 2006 time period was chosen as it was the most complete data set for snow cover. During this six year period, there was an average of 149 dry days per year. A summary of the meteorological data is provided in Table SIR2 43-1.

Table SIR2 43-1: Meteorological Data from the Fort McMurray Airport

Year	Number of Days with Rain > 0.2 mm	# of Days with Snow on Ground > 0 cm
2001	60.0	128.0
2002	64.0	178.0
2003	82.0	126.0
2004	56.0	139.0
2005	82.0	146.0
2006	61.0	175.0
Average	67.5	148.7
Average Wet Days	216.2	
Average Dry Days	148.8	

It was assumed for these estimates that no dust control measures (other than natural precipitation) were in place.

Following the guidance in US EPA (1995), the following equation can be used to estimate road dust emissions from unpaved surfaces:

$$E = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

where:

E = size-specific emission factor (lb/VMT)
s = surface mean silt content (%)
W = mean vehicle weight (tons)
k, a and b are empirical constants given by Table SIR2 43-2 (MRI 1998)

Table SIR2 43-2: Constants for Road Dust Estimation Equation

Constant	Expressed Units	TPM	PM_{10}	$PM_{2.5}$
k	lb/VMT[1]	4.9	1.5	0.15
a	-	0.7	0.9	0.9
b	-	0.45	0.45	0.45

[1] Pounds per vehicle mile travelled.

The calculated emission factors are provided in Table SIR2 43-3 and the resulting emissions are provided in Table SIR2 43-4.

Table SIR2 43-3: Emission Factors for Road Dust Calculations

Mean Vehicle Weight (tons)	Silt Content (%)	Emission Factor (lb/VMT)			Emission Factor (kg/VKT)		
		TPM	PM_{10}	$PM_{2.5}$	TPM	PM_{10}	$PM_{2.5}$
58.45	8.5	14.6	4.2	0.4	4.13	1.18	0.12

Table SIR2 43-4: Total Road Dust Emissions

Total VKT per day (km)	Emission (kg/day)			Number of Dry Days per Year	Emissions (tonnes/year)		
	TPM	PM_{10}	$PM_{2.5}$		TPM	PM_{10}	$PM_{2.5}$
194	799.7	228.5	22.8	149	119.2	34.0	3.4

c. Provide Mobile 6.2C input files that show the emissions or emission factors used.

Volume 4, Table SIR 84-3 provides estimates for uncontrolled road dust emissions, however, these estimates were not generated using MOBILE6.2C. Therefore, input files are not provided.

Literature Cited:

United States Environmental Protection Agency (US EPA). 1995. *Compilation of Air Pollutant Emission Factors (AP-42), Volume 1: Stationary Point and Area Sources.* Office of Air Quality Planning and Standards, Office of Air and Radiation. Research Triangle Park, NC.

Midwest Research Institute (MRI). 1998. *Emission Factor Documentation for AP-42, Section 13.2.2, Unpaved Roads, Final Report.* Kansas City, Missouri.

44. Volume 4: Supplemental Information Request #1, Response # 85, Page AENV-49, and Response #75, Page AENV-34.

SIR 85a states that RSC emissions are emitted by the Project and refers to Table A4-41 in Volume 3, Appendix A4 for the emission rates. However, Table A4-41 shows RSC emissions from the SAGD component of the Project to be zero, even though recent SAGD air quality assessments (Osum Taiga, Dover Operating Corp. Commercial, Devon Jackfish 3) have indicated there will be some fugitive emissions from leaks in the process area, as well as from storage tanks since not all fugitive emissions are completely recovered from vapour recovery systems. As well, in Ivanhoe's response to SIR 1 #75, it states that fugitive emissions of VOCs and PAHs from the Project were based on Syncrude measurements, pro-rated on the basis of the bitumen processing rate. Syncrude measurements show there are H_2S emissions from the Syncrude plant process area of 12.38 kg/h (Clearstone et al. 1998), which is greater than Ivanhoe's Project estimates for the HTL component (shown in Table A4-41) by nearly 700,000 times. In fact, emission estimates of Ivanhoe's HTL component for many RSC, VOCs and PAH species are several orders of magnitude lower than the Syncrude measurements.

Literature cited:

Clearstone Engineering Ltd., Alberta Research Council and QED Consultants Ltd., 1998. *Syncrude Mildred Lake Site: Assessment of Fugitive Emissions*. Volume 2, Table 143, page 133. Prepared for Syncrude Canada Ltd. Calgary, AB.

a. Explain for each operating component (SAGD and HTL) of the Project why Ivanhoe expects such low fugitive emissions of RSCs, VOCs and PAHs from their Project.

Emissions of RSC, VOC and PAH are estimated based on a combined approach of using US EPA combustion emission factors and scaling emissions from the SAGD and HTL™ Project components based on reported emissions from Devon and Syncrude, respectively.

Volume 3, Appendix A4, Table A4-41 contained an error in the units of measurement for VOC and PAH emissions. The table indicated units of kg/d, however, the emission rates were provided in units of g/s. Emissions of some substances were also updated based on corrected emission factors. Table A4-41 (Rev) provides the correct emission rates as applied in modelling. The revised emissions are about 100x higher than provided in the EIA. It is confirmed that the correct (higher) emissions were used in modelling. The most recent Syncrude EIA (Syncrude 2009) reports total RSC emissions from the plant process areas of 1.08 t/yr (0.12 kg/hr). This is more 100x lower than quoted in the 1998 Clearstone report above. Syncrude nominal inlet capacity is also about 8x larger than Ivanhoe. This correction and emission update show that Syncrude emissions are comparable to Ivanhoe emissions

Further, it is noted that the Syncrude process area includes many activities that are not present at Ivanhoe. Therefore fugitive emissions would be expected to be higher at Syncrude than Ivanhoe and the use of Syncrude for estimating emissions from the HTL™ component of the Project is conservative.

Recent reported EIA emissions (Devon 2010) indicate process area emissions of H_2S of 1.2 kg/d for a similar sized SAGD facility to the Project. This estimate includes a conservative assumption regarding the performance of the vapour recovery unit on plant storage tanks and may, therefore, overstate the actual emissions significantly. Even if it is assumed that emissions from the Project are comparable to Devon, the increase in H_2S emissions will not change the conclusions regarding odour provided in Volume 2, Section 4.5.1.3 and Volume 4, SIR 85.

It is noted that SAGD emissions of RSC, including H_2S, are still shown as zero in Table A4-41 (Rev), but due to the conservativeness in estimating HTL emissions using Syncrude data, the overall project emission estimate (SAGD + HTL) is reasonable.

Estimated VOC and PAH emissions are provided in Table A4-41 (Rev).

b. Provide an explanation why zero fugitive emissions are expected for the SAGD component of the Project. Even if all fugitive vapours are recovered from the vapour recovery system, how does Ivanhoe plan to prevent any fugitive leaks from valves, flanges, and other process fittings?

Ivanhoe recognizes that even with the best fugitive emission control, these emissions cannot be reduced to zero. However, at this point in the design process, the exact amount of fugitive emissions cannot be quantified. Ivanhoe anticipates that this source is insignificant compared to the total VOC, RSC and PAH emissions from the facility and these emissions will not change the assessment conclusions.

Table A4-41 (Rev): Project VOC and PAH Air Emissions Used for the Application and Planned Development Scenarios

	Emission Source	
	Tamarack SAGD	**Tamarack HTL™**
UTM North - NE	6 298 400	6 298 400
UTM East - NE	482 253	482 253
UTM North - SE	6 297 608	6 297 608
UTM East - SE	482 253	482 253
UTM North - SW	6 297 608	6 297 608
UTM East - SW	481 461	481 461
UTM North - NW	6 298 400	6 298 400
UTM East - NW	481 461	481 461
Area (km^2)	1.0	1.0
Elevation (m)	390	390
1,3-Butadiene (kg/d)	3.47E-03	0.00E+00
2-MethylNaphthalene (kg/d)	5.52E-04	2.95E-04
3-Methylcholanthrene (kg/d)	4.14E-05	2.21E-05
7,12-Dimethylbenz(a)anthracene (kg/d)	3.68E-04	1.97E-04
Acenaphthene (kg/d)	4.14E-05	2.21E-05
Acenaphthylene (kg/d)	4.14E-05	2.21E-05
Acetaldehyde (kg/d)	3.22E-01	0.00E+00
Acrolein (kg/d)	5.18E-02	0.00E+00
Aliphatic and C_{19}-C_{34} (kg/d)	5.52E-05	8.67E-01
Aliphatic and C_5-C_8 (kg/d)	0.00E+00	5.96E+01
Aliphatic and C_9-C_{18} (kg/d)	5.52E-04	3.52E+01
Anthracene (kg/d)	4.14E-05	2.95E-05
Aromatic (kg/d)	0.00E+00	1.64E+01
Benzene (kg/d)	5.59E-04	2.96E+00
Benzo(a)anthracene (kg/d)	4.14E-05	2.21E-05
Benzo(a)pyrene (kg/d)	2.76E-05	1.48E-05
Benzo(b)fluoranthene (kg/d)	4.14E-05	2.21E-05
Benzo(g,h,i)perylene (kg/d)	2.76E-05	1.48E-05
Benzo(k)fluoranthene (kg/d)	4.14E-05	2.21E-05
Carbon Disulphide (kg/d)	0.00E+00	3.84E-02
Carbonyl Sulphide (kg/d)	0.00E+00	4.19E-02
Chrysene (kg/d)	4.14E-05	2.21E-05
Dibenzo(a,h)anthracene (kg/d)	2.76E-05	1.48E-05
Dichlorobenzene (kg/d)	2.76E-02	1.48E-02
Ethylbenzene (kg/d)	2.58E-01	1.39E+00
Fluoranthene (kg/d)	6.91E-05	3.69E-05
Fluorene (kg/d)	6.44E-05	3.45E-05
Formaldehyde (kg/d)	1.73E+00	9.23E-01
Hydrogen Sulphide (kg/d)	0.00E+00	2.97E-01
Indeno(1,2,3-cd)pyrene (kg/d)	4.14E-05	2.21E-05
Mercaptans (kg/d)	0.00E+00	8.50E-04
Naphthalene (kg/d)	1.63E-04	7.51E-03
n-hexane (kg/d)	4.14E+01	2.21E+01
n-pentane (kg/d)	5.98E+01	3.20E+01
Phenanthrene (kg/d)	3.91E-04	2.09E-04
Pyrene (kg/d)	1.15E-04	6.15E-05
Thiophenes (kg/d)	0.00E+00	1.72E-01
Toluene (kg/d)	9.06E-03	8.40E+00
Xylenes (kg/d)	5.14E-01	3.30E+00

c. Confirm that the odour thresholds in Table SIR 85-1 for H2S and COS are reversed.

Table SIR 85-1 (Rev), which has been revised to correct the reversal of the odour thresholds for H_2S and carbonyl sulphide (COS), compares the maximum predicted ground-level concentrations of RSC to published odour thresholds and the AAAQO.

Table SIR 85-1 (Rev): Predicted RSC Maximum Ground-level Concentrations

Pollutant	1-h Maximum (ppm)[3]	Odour Threshold (ppm)	AAAQO (ppm)
H_2S	1.87E-06	4.10E-04	1.00E-02
COS	2.33E-05	5.50E-02	-
CS_2	1.35E-06	2.10E-01	1.00E-02
Thiophenes[1]	5.46E-06	5.60E-04	-
Mercaptans[2]	4.73E-08	7.00E-05	-

Notes:
[1] Assumed to be predominantly thiophene.
[2] Assumed to be predominantly methyl mercaptan.
[3] Although the AAAQO should be compared to the 99.9th percentile prediction, the overall maximum is presented to be conservative.

d. If the fugitive emissions are higher than indicated, assess the impacts of these emissions on air quality and odour.

The results indicate that the maximum concentrations are two orders of magnitude lower than the odour thresholds (and further still below the AAAQO). Therefore, even if the additional emissions were assumed for the Project, it is unlikely that any of the conclusions reached regarding odour or air quality concerns will be affected. This conclusion is likely representative of other VOCs as well.

Literature Cited:

Syncrude Canada Ltd. (Syncrude). 2009. *Application for Approval of the Southwest Sand Storage Conversion Project.* Submitted to the Alberta Energy and Utilities Board and Alberta Environment. Air Quality Section Prepared by AMEC Environment & Infrastructure Ltd., Calgary, Alberta.

Devon ARL Corp. (Devon). 2010. Application for Approval of the Devon Jackfish 3 Project. Submitted to the Alberta Energy and Utilities Board and Alberta Environment. Air Quality Section Prepared by Stantec Consulting Ltd., Calgary, Alberta.

45. Volume 4: Supplemental Information Request #1, Response # 87a, Page AENV-51 and Volume 4, Project Update.

a. Explain whether predictions of exceedances in Table SIR 87-1 include improvements offered in the Project Update.

Volume 4, Project Update does not provide for any improvement in overall facility emissions, but rather an improvement in efficiency and product yield, which is an improvement in emission intensity. Therefore, the predictions provided in Volume 4, Table SIR 87-1 do not include the potential improvements described in Volume 4, Project Update and reflect a conservative assessment of the potential impacts.

b. What additional mitigation can Ivanhoe implement that will eliminate the additional exceedances created by the Project?

Ivanhoe has proposed the following emission mitigation measures during construction and operation of the Project:

- process optimization described in the Volume 4, Project Update that reduces energy use/unit of product;
- low-NO_x burners on gas fired equipment;
- fuel system and combustion equipment designed for sour service that allows for the use of produced gas for fuel;
- heat integration that eliminates purchased natural gas usage when the HTL™ process it operating;
- FGD to remove SO_2 from almost all combustion emissions;
- high efficiency fabric filter system for capturing PM from the FGD effluent; and
- bussing of staff to site to minimize vehicle emissions.

46. Volume 4: Supplemental Information Request #1, Response # 222b, Page AENV-251 and Volume 3, Appendix A4, Table A4-41, Page A4-43.
Ivanhoe indicates that 1,3-butadiene, acrolein, and acetaldehyde are not emitted by the Project because emission factors for these chemicals are not provided by U.S. EPA AP- 42. However, emission factors for all three of these chemicals are provided in Chapter 3.1 of AP-42, which would presumably have been the emission factors used to estimate emissions of VOCs and PAHs from the cogeneration units.

a. Clarify what emission factors were used to estimate emissions of VOCs and PAHs for the cogeneration units if Chapter 3.1 of AP-42 was not used.

Emission rates for VOC and PAHs from the co-generation units were mistakenly estimated using emission factors for heaters and boilers. Table A4-41 (Rev), provided in response to SIR2 44 provides the revised emission rates from the Project.

b. If 1,3-butadiene, acrolein, and acetaldehyde are emitted by the Project, provide an updated Table A4-41 which includes emission rates for these chemicals.

Table A4-41 (Rev), provided in response to SIR2 44 provides the revised emission rates of 1,3-butadiene, acrolein, acetaldehyde and ethylbenzene from the Project.

WATER

HYDROGEOLOGY

47. Volume 4: Supplemental Information Request #1, Response # 97c, Page AENV-64 and Figure SIR 97-1, Page AENV-65.
Ivanhoe identifies the Wabiskaw Member of the Clearwater Formation contains "*interbedded mudstone and very fine grained sandstone*". The ERCB Base of Groundwater Protection Query Tool identifies the Clearwater Formation as the deepest protected geological unit. This geological unit is therefore anticipated to contain nonsaline groundwater.

a. Provide mapping illustrating the spatial distribution of any sand units within the Wabiskaw Member and discuss whether this unit represents a potential aquifer, and if so, the direction and velocity of groundwater flow.

As provided in Volume 1, Section 2.1.3.3, the Wabiskaw is subdivided into the D, C, B and A units (in ascending order). The D unit in the Project Area consists of mudstone and has a consistent thickness of approximately 1 m. The C unit consists of poorly developed glauconitic, silty sand and averages approximately 3 m thick. The B unit is a dark grey mudstone with a consistent thickness of approximately 5 m. In Volume 1, Section 2.1.3.3, the A unit is identified as a slightly glauconitic silty sand, which averages 3 m thick. After examination of cores from wells on the lease, Ivanhoe has revised the interpretation of the Wabiskaw A unit as a silty mudstone.

Wabiskaw C unit is a poor quality, silty sand aquifer. Isopach map for the C unit is presented in Volume 1, Figure 2.1-24.

The horizontal direction of groundwater flow in the C unit is westerly towards the Athabasca River valley (the regional groundwater discharge area). This unit (the lower part of the Clearwater Formation), crops out approximately 50 m above the river as indicated in Volume 2, Figure 6.4-20.

Hydraulic conductivity (permeability) values derived from lab tests on Wabiskaw C samples are available for three wells within the lease (Table SIR2 47-1). The average water permeability value for the three samples is 4.4×10^{-7} m/s, which is at the low end of the expected range of 10^{-7} to 10^{-3} m/s for silty sand (Freeze and Cherry 1979). A typical porosity value from porosity well logs for the lease is 30%. The horizontal hydraulic gradient value for an aquifer generally is in the order of 0.5% (range from 0.1 to 1%). Based on these values, the estimated velocity of horizontal groundwater flow in the Wabiskaw C unit is 0.2 m/yr.

Table SIR2 47-1: Summary of Mercury Injection Capillary Pressure Results

Well	Sample	Depth (m)	Ambient Porosity (fraction)	Swanson Air Permeability (mD)	Swanson Water Permeability	
					(mD)	(m/s)
Talisman OV McMurray 1-27-90-9 W4M	1	73.05	0.286	74.0	48.1	4.6×10^{-7}
Talisman OV McMurray 16-27-90-9 W4M	1	77.63	0.281	88.9	59.8	5.8×10^{-7}
Ivanhoe Energy Tamarack 10-26-90-9 W4M	1	87.20	0.290	47.7	28.6	2.8×10^{-7}

Note:
Results provided by Core Laboratories Canada Ltd.

b. Provide information regarding the groundwater chemistry within the Wabiskaw Member and identify whether this unit is saline or non-saline.

Based upon the formation's marine environment of deposition, Ivanhoe assumes the formation water to be saline. However, groundwater chemistry information for the Wabiskaw Member is not available so this assumption cannot be confirmed.

c. If the Wabiskaw Member contains or could contain non-saline groundwater, discuss appropriate groundwater monitoring for this unit.

As discussed in SIR2 47b, Ivanhoe does not expect the Wabiskaw member to contain non-saline groundwater, therefore, groundwater monitoring of this unit is not proposed.

d. Discuss the potential hydraulic communication between any Wabiskaw sand units and the underlying McMurray Formation.

The Wabiskaw C unit is overlain and underlain by aquitards (i.e., the B and D units). The entire Wabiskaw Member is underlain by the McMurray Aquitard, which, in turn, is underlain by the BMA (Volume 2, Section 6.4.3.1). The vertical hydraulic conductivity derived for the McMurray Aquitard from the calibrated groundwater flow model is 6.7×10^{-11} m/s (Volume 3, Appendix C1, Table C1-1). In light of this very low vertical hydraulic conductivity value, hydraulic communication between the Wabiskaw C unit and the underlying McMurray Formation is limited.

Literature Cited:

Freeze, R.A. and J.A. Cherry. 1979. *Groundwater*. Prentice Hall Inc., Englewood Cliffs, New Jersey. 604 pp.

48. Volume 4: Supplemental Information Request #1, Response # 99b, Pages AENV-68 & 69.
Ivanhoe provides a comparison of the log values of the hydraulic conductivity for the McMurray oil sands from regional information versus the value used in the numerical groundwater model.

a. Discuss how the log value of the hydraulic conductivity is utilized in the analytical calculations of the numerical groundwater model or provide a rationale for the calibrated hydraulic conductivity values used in the numerical groundwater model.

The groundwater model does not apply logarithmic values for hydraulic conductivity. The hydraulic conductivity values listed in Volume 3, Appendix C1, Table C1-1 are the actual values applied in the groundwater model. Logarithmic values cited in the response to Volume 4, SIR 99b were provided as a literature example of why the McMurray Oil Sands conductivity value in the Ivanhoe model compares very closely to that of the Suncor Voyager model. Logarithmic values were not used in any part of the numerical model input for the Ivanhoe model.

49. Volume 4: Supplemental Information Request #1, Response # 107, Page AENV-84. Information provided by Ivanhoe in Volume 3, Appendix C2 indicates generally higher salinity from the McMurray Formation (2 620 mg/L to 29 790 mg/L) than the Waterways Aquifer/Aquitard (638 mg/L to 5 174 mg/L), suggesting that equilibrium conditions may not have been reached.

a. Discuss whether the Waterways Aquifer/Aquitard could contain non-saline groundwater underlying the Tamarack lease.

If the Waterways Aquifer/Aquitard is fractured and hydraulically connected to the BMA, the Waterways water would be saline (Volume 4, SIR 107). If non-saline Waterways water is present within the Project Area, then it would be in a fracture zone that is not hydraulically connected to the BMA (i.e., not part of active groundwater flow in the BMA). In this case, the non-saline Waterways water (if it exists) would not be affected by bitumen recovery operations.

In addition, using the ERCB Base of the Groundwater Protection Query Tool, the Waterways Aquifer is not considered for protection.

b. If uncertainty remains as to whether groundwater from the Waterways Aquifer/Aquitard is saline or non-saline, discuss plans to verify the salinity of the Waterways Formation.

In view of the response to SIR2 49a, Ivanhoe does not plan to verify the salinity of the Waterways Formation.

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SURFACE WATER QUALITY

50. Volume 4: Supplemental Information Request #1, Response # 108, Page AENV-85, Response # 121b, Page AENV-103 and Response # 123, Pages AENV-106 & 107.
The project proposes filling 1.65 km2 (165 ha) of wetlands, which represent about 12% of the existing wetlands in the affected basins. The expected effect of converting wetland areas to dry areas is that evaporation and evapotranspiration will be reduced, and this will in turn will cause runoff volumes to increase compared to baseline conditions. Effects on peak flow are more complicated to assess because of project water management activities. Ivanhoe claims that any effects on runoff volumes and peak flows will be absorbed by the remaining wetlands, without any detrimental effects on those wetlands Ivanhoe states, "*Given that more than 88% of the wetlands remain undisturbed in the affected watersheds, the wetlands and beaver ponds will be able to absorb much of the increased runoff from the Project-affected areas".* To be credible, this argument requires that the runoff from disturbed areas is distributed over the undisturbed wetland areas.
Available mapping indicates that this requirement is not met. Comparison of the project footprint (Volume 4, Page AENV-108, Figure SIR 124-1) and wetland mapping (Volume 2, Page 11-12, Figure 11.4.2) shows that the disturbed wetlands are generally located in or along downstream drainage corridors and that majority of the undisturbed wetlands are located in upper headwater areas where no moderating effect would occur. Ivanhoe's analysis of moderating effects from the unaltered wetlands is inaccurate.
For each of the main basins in which alterations are proposed, provide the following information.

a. Identify the total area of unaltered wetlands downstream of the alterations, which may mitigate project effects on hydrology;

Volume 4, Table SIR 108-1 presented known wetland areas within the TLSA. The 12% of wetlands that are affected represent the percentage affected within the TLSA not the percentage affected in the aquatic local study area (ALSA), which is larger than the TLSA (refer to Volume 2, Section 3.2.1). Since the Alberta Wetland Inventory data does not cover the entire ALSA, Alberta Ground Cover Classification data was used instead to map the wetlands in the ALSA (Table SIR2 50-1). Wetlands were defined as graminoid wetland, open water, shrubby wetland, treed bog and disturbed.

Table SIR2 50-1: Alberta Ground Cover Classification Wetland Disturbances Within the ALSA

Watershed	Watershed Area (km^2)	Baseline Wetlands Area (km^2)	Application Case Wetlands Disturbed Area (km^2)	Percentage of Wetlands Disturbed by Project (%)
Upper Donald Creek	14.9	3.25	0.09	2.9
Lower Donald Creek	3.1	0.58	0.00	0.0
Unnamed Tributary 1	5.8	2.87	0.21	7.3
Unnamed Tributary 2	16.9	5.69	0.66	11.6
Unnamed Tributary 3	2.9	1.84	0.01	0.3
Upper McLean Creek	16.3	8.14	0.00	0.0
Lower McLean Creek	21.4	5.55	0.09	1.6
Direct Drainage to Athabasca River	8.8	2.04	0.00	0.0
Totals	**90.2**	**30.00**	**1.10**	**3.5**

Wetland disturbance within the ALSA is a total of 3.5% ranging in the subcatchments from 0% to 11.6 %. The Project footprint (Volume 2, Section 7.5, Figure 7.5-1), occurs in the upper parts of each catchment, hence the remaining 96.5% of the undisturbed wetlands occur downstream.

b. Describe the mechanism by which evaporation and/or evapotranspiration increases will occur to offset the filling of other wetlands, specifically (i) will the water depth in closed depressions be increased; and/or (ii) will the areal limits of the wet lands (or open water surface) be increased; and

Minor increases in mean annual runoff will result in an increase average wetness of downstream beaver ponds and wetlands. This will result in greater average depths or surface areas of these wetted areas, depending on topography. This runoff will increase outflow, which along with increased evaporation and evapotranspiration, will offset potential for increased water depth or flooding.

c. Identify the effects increased water depth or increased area of flooding will have on the existing vegetation in or adjacent to the undisturbed wetlands.

Depending on the level of increased water depth and the degree to which it is sustained, species composition could change, or vegetation dieback could occur at wetland margins. A degree of water level fluctuation is part of the natural variability to which wetlands are adapted, therefore, water level changes would have to exceed this natural range of variability and be sustained over the long term to have negative effects on the biota. It is not expected that the changes resulting from the Project will exceed the natural range of variability in the ALSA.

51. Volume 4: Supplemental Information Request #1, Response # 112 b, Page AENV-90, Response 117 a & b, Page AENV 96 & 97, and Response 121a, Page AENV-103. The 112b response indicates that the capacity of the CPF stormwater pond "*would allow a 100-year rainfall to last six days prior to the pond overflowing*" and that "*in a 100-year storm scenario, the well pad ponds would contain the stormwater for 1.4 days.* Response to 117a discusses HEC-HMS model calibration using "*the 100-year precipitation.*" The 121a response indicates that for major (1:100 year storm) events runoff was generated from the pads and CPF areas only "*after the volume of runoff from the event exceeded the available storage volume"*. Baseline and projected model curve numbers in Table SIR 117-1 indicate that HEC-HMS modeling may have been done on an aggregate basis which did not explicitly model stormwater storage facilities.

SIR 121a questioned why peak flows in UN1 and UN2 were predicted to increase by up to 18% and 32% respectively when the stormwater systems would detain the event runoff for later release at a time that is not coincident with the storm event.

a. What is the magnitude, duration, and distribution of the 1:100 year precipitation used for calibration of the HEC-HMS baseline model(s)?

For the Baseline and the Application Case, HEC-HMS modelling the 1:100 year 24-hr precipitation event from the Fort McMurray Airport climate station was used. This precipitation event has a magnitude of 96.9 mm and a duration of 24 hrs. The HEC-HMS frequency precipitation event distribution was used.

b. What is the 100-year rainfall magnitude and duration for the 6-day event discussed in the response to SIR 112b?

The response to Volume 4, SIR 112b mistakenly stated the CPF stormwater pond capacity to be 422 000 m^3. The CPF stormwater pond will have a capacity of 55 556 m^3 and will be designed to contain a 1:100 year 24-hr precipitation event as identified in SIR2 51a. SIR2 111a provides CPF stormwater pond sizing calculations.

c. What is the 100-year storm magnitude and duration for the 1.4 day event discussed in the response to SIR 112b?

The 100-year storm magnitude and duration for the 1.4 day event is an error. The magnitude of a 100-year 24-hr precipitation event is presented in SIR2 51a (96.9 mm). The well pads are designed so that a 1:10 year 24-hr precipitation event can be contained in the pond and a 1:25 year 24-hr precipitation event can be contained in the pond and the surrounding ditches and bermed areas on a well pad.

d. Were stormwater facilities explicitly modeled in the HEC-HMS models of future conditions? If yes, please provide hydrographs which show stormwater facility outflows in relation to runoff from the remainder of the basin.

HEC-HMS modelling was completed for the Baseline and the Application Case, for the 1:100 and 1:10 year 24-hr precipitation events. CPF and well pad stormwater facilities will be sized to accommodate the 1:100 year and 1:25 year precipitation events, respectively, however, were modelled to the 1:25 year precipitation event as part of the Application Case. Figure SIR2 51-1 shows the modelled hydrograph for the Unnamed Tributary 2 watershed during the 1:100 year 24-hr precipitation event. Delay between the beginning of the pond outflow and the increase in flow at the assessment node is caused by the time that the flow takes to reach the assessed location on Unnamed Tributary 2.

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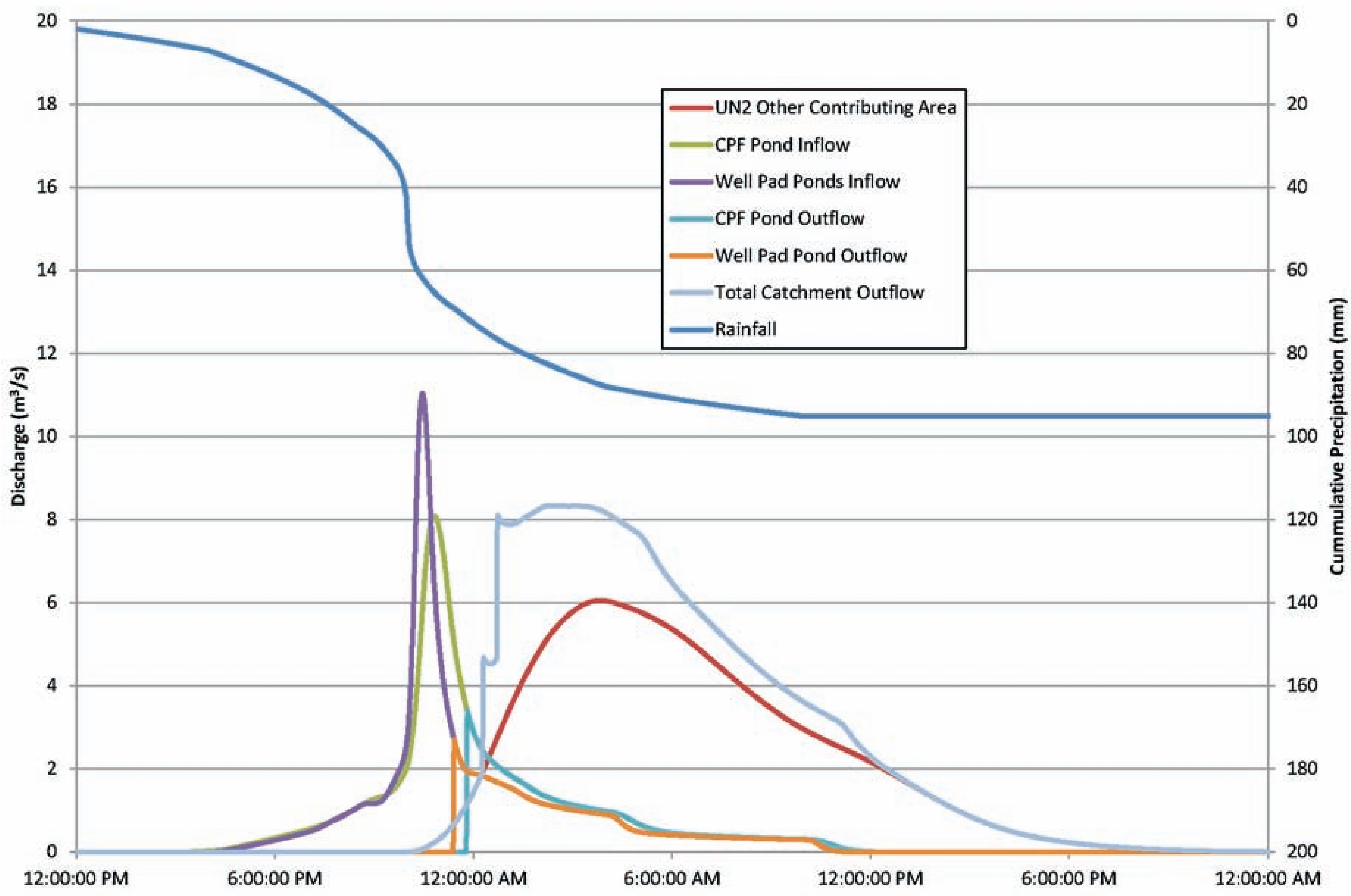

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Ivanhoe Energy

Tamarack Project

Unnamed Tributary 2 Hydrograph

DATE: June 2012	SIR2-Fig051-01 12-06-29	Figure SIR2 51-1
PROJECT: CE0374601	DRAWN BY: AMEC	
ANALYST: KW / QA/QC: KW MAJ EH	PREPARED BY: Ivanhoe	

52. Volume 4: Supplemental Information Request #1, Response # 113, Page AENV-91, Response # 115, Pages AENV-115 & 116, Response # 122, Pages AENV-104 & 105, and Response # 124, Pages AENV-108 & 109.

Ivanhoe clarifies that the disturbance footprint is guided by resource recovery goals and that the final footprint may shift as the reservoir is further delineated. While "*Ivanhoe will make every reasonable effort*" to locate well pads "*in such a way that encroachments on watercourse buffers are minimized",* the possibility exists that the final encroachments could be unchanged or worsened from what is shown in the application documents. The response to SIR 122 clarifies that diversion channels will not replicate the original floodplain dimensions (as stated in the original application) but may instead incorporate narrower floodplain dimensions which are "*hydraulically more efficient".* Figure SIR 124-1 (Volume 4, Page AENV-109) shows five locations where diversions channels may be required. The response to 122d clarifies that these diversions will be permanent.

The diversion channels that are being proposed will increase the project footprint. A preliminary design is needed for each of the diversions to clarify the magnitude of these engineering works and determine if there is a need to consider secondary impacts (vegetation, animal movement, etc.) It is not possible to assess impacts without this basic footprint information. The footprint could be large if well pads fully obstruct floodplain areas and require deep excavation to construct permanent bypass channels (and floodplains) though upland areas.

a. Provide conceptual designs for each of the diversion channels needed to replace existing stream channels and floodplains that will be filled during well pad construction. Details should include: (a) the total length of diversion channel (b) the bottom width of constructed channel including the floodplain; and (c) the maximum depth of cut below existing grade, considering that the diversion may need to be cut through upland terrain.

Unnamed Tributaries 1 and 2 were originally classified as non-flowing or ephemeral drainage (Volume 4, SIR 113a) within the 100 m buffer area of Well Pads 12 and 2, 3, 6, 7 and 10, respectively. However, ground investigations of the subject watercourses undertaken in May 2012, as discussed in the SIR2 Project Update, revealed that there are no defined channels in the areas near Pads 2, 3, 10 and 12. Well Pads 6 and 7, previously shown to encroach on Tributary to Unnamed Creek, were also determined to be outside the 100 m buffer from a defined water channel (though these pads were within 100 m of beaver impoundments). These pads have been adjusted to maintain the 100 m buffer from the impoundments (Table SIR2 PU-1). For these reasons, stream diversions will not be required.

b. What is the total additional project footprint disturbance (ha) associated with the watercourse diversions?

Not applicable. See response to SIR2 52a.

c. Provide a map of the diversion locations with associated disturbances.

Not applicable. See response to SIR2 52a.

53. Volume 4: Supplemental Information Request #1, Response # 118, Page AENV-97 and Response # 119, Pages AENV-98 & 99.

Ivanhoe stated that discharge measurements made at each of the six sites in the Aquatics Local Study Area "*were used to examine watershed yields; i.e., runoff over the course of the year for comparison with yields from larger regional watersheds"* but does not provide the results from this comparison. A comparison of the local measurements made April 30 and Aug 19 2009 (Volume 2, page 7-13) with same day discharges reported by Water Survey of Canada for the regional watersheds, (Beaver, Steepbank, and Hangingstone) show that the unit runoff is reasonably consistent for all basins and that the runoff is independent of the basin size.

In the response to SIR 119, Ivanhoe clarifies that the regional runoff data defined by three stations "*show a trend towards decreasing yields (mm of runoff) with decreasing watershed drainage area"* and this is why the runoff from the local basins is as much as 35% less than the runoff from regional gauged basins. Runoff yields are not normally associated with basin area, and the local stream discharge measurements compared to the large basin data also support a finding that regional basin yields are not dependent on basin size.

Accordingly, the baseline characterization of project area runoff may be inaccurate, with mean annual runoff amounts that are too low. This means that predicted project impacts to runoff volumes will be less than suggested in the existing documents.

a. Discuss the possibility that predicted runoff amounts are too low, and discuss the risk of adverse environmental impacts that this possible increase in runoff may represent.

A sensitivity analysis was undertaken to assess the risks to the assessment if baseline runoff amounts were predicted to be too low. Since baseline volumes and mean annual discharges were also calculated using the predicted runoff versus drainage area relationship, a higher mean annual runoff is shown to be similar to or lower than the predicted Application Case impacts as shown in Table SIR2 53-1.

Volume 2, Section 7.5.2.1 notes that "Mean annual total discharges in UN1 and UN2 are projected to increase by 18% and 38%, respectively, as a result of the Project (Volume 2, Section 7.0, Table 7.5-3). Although the increases in UN1 and UN2 are proportionately large, the estimated sizes of the mean annual discharge increases are minor at 0.002 m^3/s and 0.016 m^3/s, respectively." Because of the small size of these watercourses, the proportionate change to the discharge is high, but any potential increase in erosion caused by such a small increase in mean annual discharge will be minor. This small increase in erosion is likely to be mitigated by the frequent beaver dams upstream of the escarpment and self-armouring of the creeks downstream of the escarpment (Figure SIR2 53-1).

Table SIR2 53-1: Mean Annual Runoff Sensitivity Analysis

Drainage	Drainage Area (km^2)	Variable Runoff (Original)			75 mm			85 mm			95 mm		
		Volume (dam^3)	Mean Annual Discharge (m^3/s)	Change (%)	Volume (dam^3)	Mean Annual Discharge (m^3/s)	Change (%)	Volume (dam^3)	Mean Annual Discharge (m^3/s)	Change (%)	Volume (dam^3)	Mean Annual Discharge (m^3/s)	Change (%)
Lower Donald Creek	17.7	1 367	0.043	-1.2%	1 337	0.042	-1.2%	1 514	0.048	-1.3%	1 690	0.054	-1.3%
Lower McLean Creek	37.4	3 085	0.098	-0.3%	2 825	0.090	-0.2%	3 198	0.101	-0.3%	3 570	0.113	-0.4%
UN1	5.9	475	0.015	18.3%	505	0.016	16.3%	559	0.018	13.6%	612	0.019	11.4%
UN2	17.4	1 784	0.057	38.3%	1 765	0.056	39.3%	1 909	0.061	32.9%	2 054	0.065	28.0%
UN3	2.9	192	0.006	0.5%	221	0.007	0.4%	251	0.008	0.3%	280	0.009	0.3%

Ivanhoe Energy

Unnamed Tributary 2
Self-Armouring

PROJECT:	Tamarack Project
DATE:	June 2012
JOB No.:	CE0374601

Figure SIR2 53-1

As noted in Volume 2, Section 7.5.2.5 "The morphology of the creek channels could be affected by the altered channel flow regime that could result from the Project, principally on the steep channel sections on the Athabasca River escarpment. Because the channel beds are self-armoured, the potential for downcutting is reduced, but local bank erosion and channel widening could occur during extreme flood events. These effects are qualitatively predicted to be low based on the existing self-armoured channel beds." Volume 2, Table 7.5-4 shows the magnitude of the impact of peak flow increases is predicted to be high, but given the small size of the effected creeks, the natural mitigation in the form of beaver dams and self-armouring, the nearby downstream attenuation by the Athabasca River, and the minimal value of these creeks as fish habitat, the geomorphological impact is expected to be low.

Standard mitigation measures to be taken by the Project are discussed in Volume 2, Section 7.5.3, and monitoring for erosion is outlined in Volume 2, Section 7.5.5.

54. Volume 4: Supplemental Information Request #1, Response # 126 b, Page AENV-111.
The table requested, which was to indicate the median base cation concentrations used in modeling, as well as the minimum and maximum values derived from literature, was not provided.

a. Provide the requested table.

A table of all minimum and maximum values derived from the literature is provided in Appendix SIR2 I.

55. Volume 4: Supplemental Information Request #1, Response # 133 c, Page AENV-122.
Of the 13 well pads listed in the table, six encroach within the 100 metre protective watercourse buffer. The industry (in-situ) standard for well pads is to meet the 100-metre setback requirement.

a. Clarify whether the distances provided are measured to the edge of the proposed pad, or the edge of the planned disturbance (e.g. clearing).

The distances provided are to the edge of the planned disturbance (see SIR2 Project Update).

b. Distances from watercourses or waterbodies should be measured from the average annual high water mark for waterbodies and watercourses without defined channels. For watercourses with a defined channel, the setback distance should be measured from the top of the escarpment. If measurements were not made using these criteria, provide a revised table.

The setback distances are identified for watercourses with a defined channel (see Table SIR2 PU-1). Escarpments were not present within the TLSA. Valley breaks were also not present within the TLSA; therefore, distances were measured using the ordinary high water mark. The ordinary high water mark, as defined by Fisheries and Oceans Canada, is:

> *"the usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the "active channel/bank-full level" which is often the 1:2 year flood flow return level.*
>
> *In inland lakes or wetlands, it refers to those parts of the water body bed and banks that are frequently flooded by water so as to leave a mark on the land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation (excepting water tolerant species)."*

c. Provide Ivanhoe's justification for not meeting the 100-metre setback standard in this project.

Refer to SIR2 Project Update. All Project facilities are outside of the 100 m watercourse buffer.

56. Volume 4: Supplemental Information Request #1, Response # 136, Pages AENV-136 & 137.
Ivanhoe describes the field methods used for water quality sampling but does not describe the field methods used for sediment quality sampling. SIR 136 requested Ivanhoe to provide a description of the field methods used for sediment quality sampling including standard sampling procedures.

a. Describe how rinsing equipment before and after each site with stream/lake water would have eliminated cross-contamination of samples by removing metal residues and organic residues from the previous sample.

Volume 4, SIR 136 provided the standard operating procedure specific to sediment sampling and did not include the procedure for cleaning equipment.

The procedure for cleaning equipment, complies with *Aquatic Ecosystems Field Sampling Protocols* (AENV 2006), which provides that sampling equipment is rinsed with lake/stream water prior to sampling and immediately after. However, between sites or sampling days, the following procedure is used:

- a non-phosphate, laboratory-grade detergent (e.g., Liquinox) should be used to soap-wash equipment. Use a 0.1 to 2.0% v/v solution when cleaning between field trips (higher when required) and use a 0.1 to 0.2% v/v solution for field-cleaning. Clean equipment with brushes to remove all visible particulate matter and residual oils and grease;
- rinse with water to remove detergent residues;
- rinse with organic solvents (e.g., acetone, hexane) when sampling for trace organics. First rinse with hexane and allow to air dry, and then rinse with acetone and allow to air dry;
- after solvent rinses, rinse three times with de-ionized water;
- air dry in a clean area and on a clean surface, cover the surface with new, clean aluminum foil (rinsed wit solvents if to be used for sampling trace organics). Wrap equipment in clean foil and store in new, clean Ziploc® plastic bag if possible. Mark the date of cleaning and your initials;
- discard waste hexane/acetone into a clearly marked waste jug for organic solvents and store in hazardous waste area for proper disposal;
- consult the MSDS sheets for all chemicals used in the cleaning procedures for information regarding personnel protection, and spill clean-up; and
- all containers or equipment for trace organic work must be stainless steel, glass or Teflon®.

b. Describe how this method of rinsing sampling equipment is equivalent to using soaps and solvents to remove metal residues and organic residues from sampling equipment for sediments.

See response to SIR2 56a.

Literature Cited:

Alberta Environment (AENV). 2006. *Aquatic Ecosystems Field Sampling Protocols*. Environmental Monitoring and Evaluation Branch, Environmental Assurance Division, Edmonton, AB.

57. Volume 4, Supplemental Information Request #1, Response # 144, Page AENV-140.
Volume 2, Section 8.4.5, Page 8-14 states, "*As the proportion of surface water to groundwater will increase due to the higher runoff estimates, concentrations of substances dissolved and suspended in Unnamed Tributary 1 and Unnamed Tributary 2 will decrease.*" SIR 144 requested Ivanhoe to provide a detailed description of the mechanisms behind this statement using data and information from the Aquatic Resources Local Study Area, particularly as groundwater contains no substances in suspended form.

a. If Groundwater contains no non-dissolved constituents of water quality (i.e., all nondissolved constituents of water quality in a watercourse come from other sources: surface runoff, direct atmospheric deposition, or suspension of bottom sediments), provide a description of how concentrations of suspended constituents of water quality will increase with increasing surface runoff relative to groundwater (i.e., "as the proportion of surface water to groundwater will increase due to the higher runoff estimates")

The proportion of surface water to groundwater will not have an effect on the concentration of substances suspended in Unnamed Tributary 1 and Unnamed Tributary 2. The concentration of non-dissolved (suspended) constituents may increase following higher stream flows due to increased erosion. However, as described in Volume 2, Section 8.4.5, Page 8-14, the effects of increased flows on water quality will be attenuated by the flat terrain conditions, numerous beaver dams, and wetlands along the existing channels, thereby naturally mitigating potential impacts on water quality. This is particularly true of suspended constituents, which will settle out in the beaver ponds along the channels.

58. Volume 4, Supplemental Information Request #1, Response # 150, Page AENV-146.
Ivanhoe did not answer the questions asked but instead referred to sections of the EIA. There is no justification provided for selecting only those lakes in the Air Quality Regional Study Area that were predicted to have a greater than 0.5% difference in deposition from the baseline. A less than 0.5% difference for a given lake may result in a prediction of PAI in the Application Case that that is Greater than the Critical Load of the given lake.

a. Provide either: (i) a rationale for why only lakes which were modeled to have a greater than 0.5% difference in deposition from the baseline were included in the assessment for the Air Quality Regional Study Area; or (i) conduct the acidifying emissions assessment on all 321 lakes in the Air Quality Regional Study Area.

An acidifying emissions assessment is provided for all lakes in the AQRSA in (Appendix SIR2 J). No additional lakes are receiving acidifying emissions greater than critical loads in the Application Case or Planned Development Case (PDC).

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AQUATICS

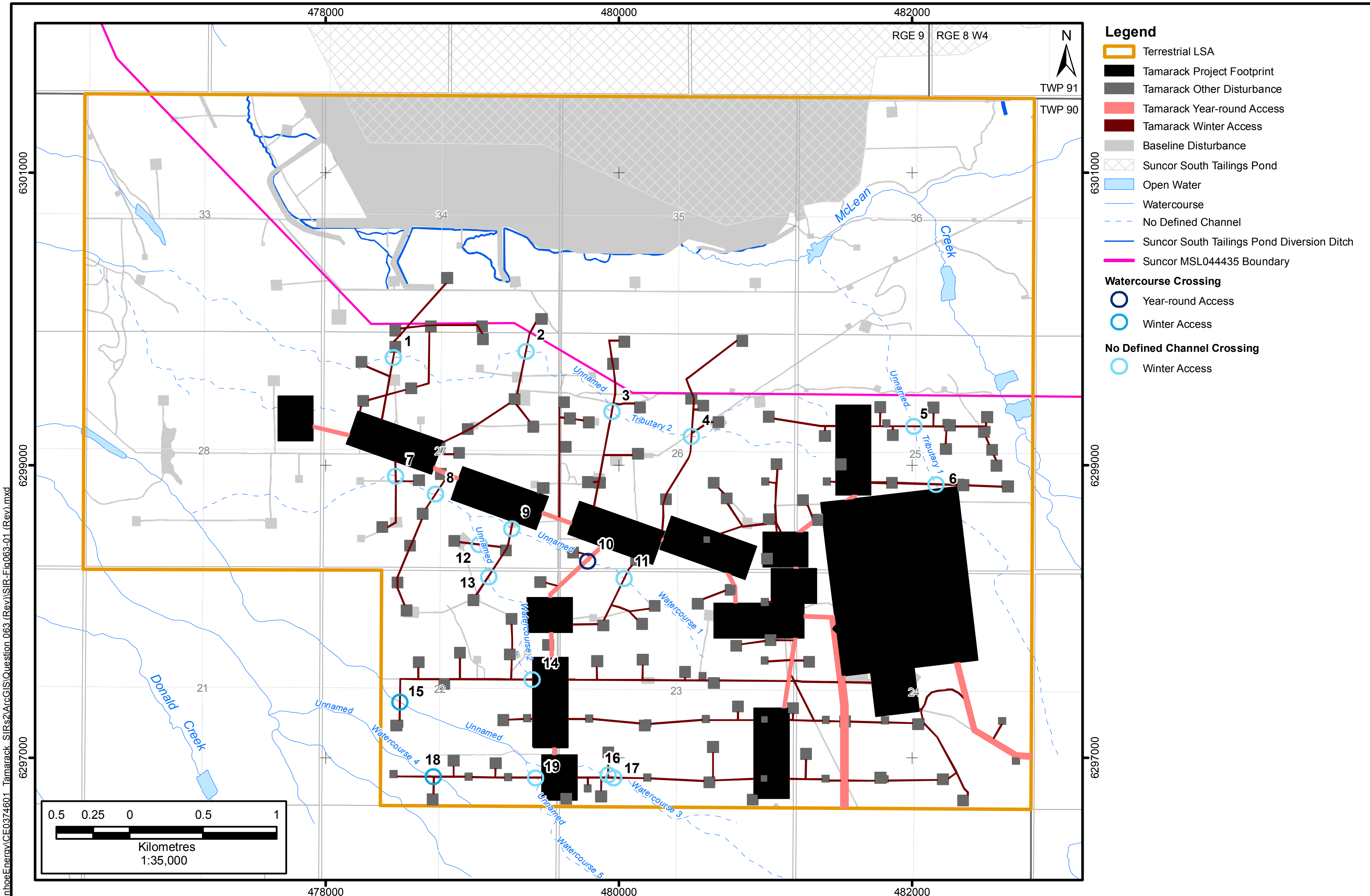
59. Volume 4: Supplemental Information Request #1, Response 63 a., Page AENV-18. The original question quoted Ivanhoe as stating, "*Year-round access is required to access the basal water source wells, well pads and the CPF and as a result, year-round crossings are required.*" However, in Table SIR 63-1, Id #1 is categorized as Winter Access yet has a Crossing Method of Clear span, while Id #8 is a Year Round Access using an Ice Bridge.

a. Clarify the apparent contradiction in the Table and explain whether Ivanhoe's need for year-round access has changed. Revise the proposed crossing methods for Id #1 and Id #8 to one that is congruent with the access required.

Volume 4, Table SIR 63-1 contained an error. Table SIR 63-1 (Rev) has been revised to account for footprint revisions and updated watercourse information (see SIR2 Project Update). Figure SIR 63-1 (Rev) identifies the current crossing locations.

Table SIR 63-1 (Rev): Watercourse Crossings Required for the Project

Id	Easting	Northing	Watercourse	Channel	Access Type	Crossing Method
1	478462	6299738	Unnamed Tributary 2	No Defined Channel	Winter Access	Ice-bridge
2	479368	6299781	Unnamed Tributary 2	No Defined Channel	Winter Access	Ice-bridge
3	479952	6299368	Unnamed Tributary 2	No Defined Channel	Winter Access	Ice-bridge
4	480496	6299198	Unnamed Tributary 2	No Defined Channel	Winter Access	Ice-bridge
5	482012	6299267	Unnamed Tributary 1	No Defined Channel	Winter Access	Ice-bridge
6	482163	6298872	Unnamed Tributary 1	No Defined Channel	Winter Access	Ice-bridge
7	478478	6298926	Unnamed Watercourse 1	No Defined Channel	Winter Access	Ice-bridge
8	478750	6298804	Unnamed Watercourse 1	No Defined Channel	Winter Access	Ice-bridge
9	479270	6298568	Unnamed Watercourse 1	No Defined Channel	Winter Access	Ice-bridge
10	479788	6298346	Unnamed Watercourse 1	No Defined Channel	Year-round Access	Culvert
11	480037	6298226	Unnamed Watercourse 1	No Defined Channel	Winter Access	Ice-bridge
12	479047	6298460	Unnamed Watercourse 2	No Defined Channel	Winter Access	Ice-bridge
13	479113	6298241	Unnamed Watercourse 2	No Defined Channel	Winter Access	Ice-bridge
14	479410	6297536	Unnamed Watercourse 2	No Defined Channel	Winter Access	Ice-bridge
15	478506	6297382	Unnamed Watercourse 3	Watercourse	Winter Access	Ice-bridge
16	479926	6296884	Unnamed Watercourse 3	No Defined Channel	Winter Access	Ice-bridge
17	479964	6296864	Unnamed Watercourse 3	No Defined Channel	Winter Access	Ice-bridge
18	478735	6296872	Unnamed Watercourse 4	Watercourse	Winter Access	Ice-bridge
19	479434	6296864	Unnamed Watercourse 5	No Defined Channel	Winter Access	Ice-bridge



Sources: Ivanhoe, Spatial Data Warehouse Ltd.

Path: S:\Gis\Projects\CE\IvanhoeEnergy\CE0374601_Tamarack_SIRs2\ArcGIS\Question 063 (Rev)\SIR-Fig063-01 (Rev).mxd

Ivanhoe Energy
Tamarack Project

Watercourse Crossings

DATE: June 2012		SIR-Fig063-01 (Rev) 12-06-27	**Figure SIR 63-1(Rev)**
PROJECT: CE0374601		PROJECTION/DATUM: UTM Zone 12 NAD83	
ANALYST: TM	QA/QC: KW RF EH	DRAWN BY: AMEC / PREPARED BY: AMEC	

b. Ivanhoe notes that all watercourses that contain or have the potential to contain fish (i.e. fish habitat present) will be crossed with clear-span bridges. Discuss the criteria that Ivanhoe used to determine whether a crossing site functions as fish habitat.

During detailed design, Ivanhoe will conduct crossing assessments in accordance with the AENV Guide to the Code of Practice for Watercourse Crossings (AENV 2001), at proposed crossings over water bodies with defined beds and banks. During these assessments, a qualified aquatic environment specialist will assess fish habitat potential and provide crossing type recommendations.

Literature Cited:

Alberta Environment (AENV). 2001. *Guide to the Code of Practice for Watercourse Crossings*. Alberta Environment. Edmonton, AB.

60. Volume 4: Supplemental Information Request #1, Response 111 b, Page AENV-89. The response suggests that "*the created wetland environments would reflect the dominant aquatic environments that are already found within the watershed*." However, there is significant uncertainty around the successful reclamation to bog and fen habitat, which are the dominant aquatic environments in the area.

a. Discuss the potential long-term changes to the watershed and its aquatic biota if bog and fen habitat cannot be successfully reclaimed.

If bog and fen habitat cannot be successfully reclaimed, the watershed will be composed of more open water, marsh and swamp habitat in the long-term. In these modified habitats, the aquatic biota will be more diverse and abundant due to the wetter moisture regime and increased nutrients.

61. Volume 4: Supplemental Information Request #1, Response 113 a, Page AENV-91 and Question 115 a. Page AENV-93.
The response indicates that the lease is dominated by poor quality fish habitat with significant movement barriers. Noting that beaver dams are not considered permanent movement barriers,

a. Provide further details on the movement barriers.

Movement barriers referred to drainage sections without defined channels or water. Details on movement barriers, as a result of the ground investigations of the subject watercourses undertaken in May 2012, are discussed in the SIR2 Project Update and are summarized below.

The south fork of Unnamed Tributary 1 does not have a discernable water channel with defined bed and banks along its length and there is no evidence of deposition or scour.

The larger watercourse that occupies the middle of the Unnamed Tributary 2 watershed had sections of defined and undefined channel intersperse with large beaver impoundments. Short, defined sections of channel were typically associated with impoundments as water spilled over or through the dams causing scour and deposition downstream. The upper reaches of the watercourses had little to no beaver activity and, therefore, no sections of defined channel were observed.

Ivanhoe stands by its conclusion that the lease is dominated by poor quality fish habitat with significant movement barriers.

b. Are the identified barriers topographical and permanent in nature?

The identified barriers are topographical and permanent in nature.

c. Would they still function as barriers in high water periods?

The identified barriers would still function as barriers in high water periods.

62. Volume 4: Supplemental Information Request #1, Response 114 a. Page AENV-92, Response 124 c, Page AENV 108, and Response 158 c. Page AENV 167.
SRD is responsible for the management of fish populations in the province. Impacts to fish populations are directly connected to impacts to fish habitat. Given the proposed diversions and the lack of site-specific baseline data, it is difficult to assess the impacts to fisheries as a consequence.

a. When will Ivanhoe make sufficient information available to assess the impact of potential diversions?

Further to SIR2 52a, stream diversions are no longer required for the Project, therefore, impacts associated with potential diversions will not occur.

b. Has Ivanhoe undertaken the baseline assessment work required to support federal applications related to the diversions and development of well pads 6, 7, and 12? If so, provide these data. If not, provide a schedule for data collection, sampling protocol and timing, and a planned submission date.

See response to SIR2 62a.

63. Volume 4: Supplemental Information Request #1, Response 135 a, Page AENV-125.
Ivanhoe provided a list of criteria used in selecting the aquatic regional study area but no indication of how this information was considered.

a. Explain how these criteria were used in the determination of the study area? For example, does the extent of the aquatic regional study are reflect the maximum extent of fish migrations for the species known to inhabit the area?

The following describes how the criteria were used in the determination of the aquatics regional study area (ARSA):

- likely spatial extent of potential impacts from the Project in relation to other developments in the region – the section of the Athabasca River was selected to account for upstream effects as well as effects from projects that may impact watersheds discharging to the Athabasca River in the vicinity of the Project (i.e., Clarke Creek, Poplar Creek/Beaver Creek, Steepbank River);
- review of information regarding fish species composition, distribution, relative abundance, and migrations in the region – this information was reviewed to determine the species that may be impacted by the Project. The maximum extent of fish migrations for species known to inhabit the area were not considered because the migration extent for some fish species may be hundreds of kilometres away from the Project, not in the potential zone of impact. Therefore, this did not factor into the final selection of the ARSA; and
- review of information regarding critical areas of known special status fish species in Alberta – this included a review of AENV Code of Practice Fort McMurray map to determine if any areas in the vicinity of the Project are designated as Class A or Class B. If these areas were in the vicinity of the Project, they would have been included as part of the ARSA (or ALSA as appropriate). None of these areas have been identified in the vicinity of the Project, therefore this did not factor into the final selection of the ARSA.

Additional criteria not referenced in the response to Volume 4, SIR 135a included:

- *Available Surface Water Quantity Data* – delineation of the ARSA was also chosen based on the availability of data from regional monitoring stations. The location of these stations assisted with the selection of the downstream extent of the ARSA along the Athabasca River (see Volume 2, Figure 7.1-1).

64. Volume 4: Supplemental Information Request #1, Response 154 c, Page AENV-155.
Ivanhoe states, "*fish are not present in the ALSA",* however, based on information provided in the EIA there is insufficient data to establish this.

a. Discuss why Ivanhoe contends that there are no fish present in the ALSA and provide defensible, statistically sound data to support the assertion.

Fish are present within the downstream portions of the ALSA (i.e., downstream of the Athabasca River escarpment). Within the Project Area, no fish have been captured in studies conducted to support the EIA. Ivanhoe is confident stating that there is limited fish habitat within the Project Area and where it does exist, it is of poor quality, because:

- field-truthing investigations undertaken in May 2012, and discussed in the SIR2 Project Update, have confirmed that most watersheds within the Project Area do not contain defined watercourse channels. Where they did occur, short, defined sections of channel were typically associated with impoundments as water spilled over or through the beaver dams causing scour and deposition downstream. The upper reaches of the watersheds had little to no beaver activity and therefore no sections of defined channel;
- where channels do exist, the habitat is characterized by low gradient ephemeral drainages lacking basic habitat parameters to support all life stages of fish (e.g., low dissolved oxygen);
- the escarpment from the Athabasca River prevents fish from moving into the Project Area (Table SIR2 64-1); and
- no fish were captured or observed during three seasons of sampling (i.e., spring, fall and winter).

Table SIR2 64-1: Summary of Channel Gradients up the Athabasca River Escarpment

Tributary	Length of Channel Up the Escarpment (m)	% Slope Min	% Slope Max	% Slope Mean
McLean Creek	2 550	0.4	63.06	17.75
Unnamed Trib #1	1 200	2.83	72.31	20.91
Unnamed Trib #2	1 600	0.96	82.47	18.52
Unnamed Trib #3	1 100	1.77	78.49	19.77
Donald Creek	1 200	1.96	86.83	25.69

The assertion that the Project Area contains poor quality habitat is consistent with the baseline assessment. Therefore, the assessment of potential Project impacts to fisheries and aquatic resources does not change from the information presented in Volume 2, Section 9.5.

65. Volume 4: Supplemental Information Request #1, Response 159 c, Page AENV-168.
Ivanhoe asserts that benthic invertebrate sampling results for two watercourses is representative of three other unsampled watercourses.

a. Provide peer-reviewed literature to support the assertion that sampling results in two watercourses is representative of what would be found in three others.

The initial response that habitat along the watercourses above the escarpment was homogenous in nature and that the two benthic sampling sites provide sufficient information to assess and characterize the benthic invertebrate community for the three other watercourses was an overgeneralization. The sampling sites characterized the benthic community of the watercourse areas where they were collected, but the information cannot be extrapolated to characterize other watercourses not sampled.

The benthic sites were chosen on a second order section of McLean Creek and a third order section of UN2. Within the Project Area, there were no sections of watercourse higher than third order. UN1 and tributaries of UN2 (upstream of the benthic sampling site location) were not chosen for benthic sampling due to lack of channel development within the Project Area, which precluded benthic invertebrate sampling. Donald Creek was not chosen as a sampling site since the Project Area does not encroach on this watercourse.

Two benthic invertebrate sites provided adequate baseline information of the benthic community. The purpose of the benthic sampling was also to provide general information on the quality of fish habitat in the Project Area, e.g., fish food availability. Information from two sites was adequate to conservatively assess fish rearing/feeding potential in the Project Area watercourses, i.e., food was available and not a limiting factor for fish presence.

The EIA assessment predicted that there would be no residual effects from Project development on the benthic invertebrate communities. This conclusion was based on construction mitigation (e.g., watercourse buffers, well pad placement, no instream watercourse crossing structures). Based on the revised Project footprint to maintain a 100 m buffer from defined watercourses, potential impacts to benthic invertebrate communities are further reduced (see SIR2 Project Update).

b. Identify the habitat similarities that must be present for this assertion to hold, and present specific habitat assessment data from the three watercourses that were used to establish sufficient habitat similarity.

See response to SIR2 65a.

66. Volume 4: Supplemental Information Request #1, Response 160 d, Page AENV-169.
The Ivanhoe Tamarack project is in an area that is connected to known Arctic grayling habitat. Arctic grayling are ranked federally as a high priority candidate to receive a status assessment and they are designated as a species of special concern provincially.

a. How will Ivanhoe Tamarack contribute to regional data collection to ensure Arctic grayling continue to persist in the oil sands area?

Ivanhoe does not believe that further contribution to regional data collection is justified based on potential Project impacts to Arctic grayling because:

- *Loss of Habitat:* Arctic grayling habitat will not be impacted as a result of Project development. The Project footprint is outside of any defined watercourses (see SIR2 Project Update). Additionally, habitat above the Athabasca River escarpment is characterized by low gradient, discontinuous ephemeral drainages with fine and organic substrates lacking basic habitat parameters to support all life stages of Arctic grayling (i.e., low dissolved oxygen). Arctic grayling prefer cold, clear water streams with abundant pools and riffles. Overhanging vegetation, high quality of pools and diverse pool types (i.e., debris pools, lateral-scour pools, Class 4 pools) typically support a relatively high abundance of Arctic grayling. Furthermore, Arctic grayling have only been documented near the mouth of the Athabasca River below the escarpment and the escarpment acts a permanent barrier to fish movement into the Project Area;
- *Changes in Flow:* As identified in Volume 4, SIR 160a, the impact of changes in flow to Arctic grayling below the escarpment is predicted to be negligible; and
- *Increased Fishing Pressure:* Ivanhoe will have a policy that prohibits employees, contractors and subcontractors from bringing recreational fishing equipment onto site or camp and from accessing the natural environment for recreational fishing from the Project Area.

Ivanhoe will participate in regional monitoring programs as directed by the regulators and as a condition of approval.

67. Volume 4: Supplemental Information Request #1, Response 293, Page AENV 375. Ivanhoe predicts a potential maximum ground heave of 28 cm at the end of the first 11 years.

a. Where is this predicted to occur and will it result in surface flow changes?

The modelled predicted maximum ground heave of 28 cm will occur over the well-pairs.

Surface flow changes are not anticipated because surface flow will maintain existing drainage patterns and flow rates, even with a gradual surface rise. Deeper organic soils can compress which will help prevent raising the vegetative mat above the wetland water level. For shallower organic soils, there may be cases where the vegetative mat may not have sufficient compressibility and may result in raising portions of the mat above the wetland water level. It is anticipated that the referenced local changes in vegetation are likely to be small in area and discontinuous in extent.

The slow rate of deformation will allow existing drainages to maintain current patterns and flow rates. The rate of deformation is expected to be slow because heave will occur gradually over the well-pair operating life due to reservoir heating. Suncor (2009) demonstrated typical annual displacements were approximately 5 cm and the maximum observed heave over the five year duration 2004 to 2009 was 17.9 cm. JACOS (2010) documented a single year heave in a core area of 3.0 cm while the heave over a 10-year period was 25.3 cm.

Additionally, displacement due to heave is predicted to be within the range of variability in the Project Area and is considered small relative to the size of most local landforms and topographic relief. Based on Collins (2005), ground heave will taper from 28 to 2.8 cm at a distance of 240 m away from the well-pairs. Within the Project Area, surface elevations range from 350 to 410 m with the area around most of the well pads being between 360 and 390 m.

b. If so, discuss implications to local aquatic habitat.

As described in SIR2 67a, surface flow changes are not anticipated therefore aquatic habitat is not predicted to change. Additionally, most well pads are located more than 1 000 m away from a defined watercourse (see Table SIR2 PU-1). Well Pads 6 and 7 are just over 100 m away from the southern fork of Unnamed Tributary 2 but this is the upstream extent of the watercourse, it is currently impounded by beaver dams, and aquatic habitat is generally of poor quality.

Literature Cited:

Collins, P.A. 2005. *SPE/PS-CIM/CHOA 97905, Geomechanical Effects on the SAGD Process*. 2005 SPE/PS-CIM/CHOA International Thermal Operations and Heavy Oil Symposium, Calgary, Alberta, Canada.

JACOS. 2010. *Japan Canada Oil Sands Limited, Annual ERCB Update Presentation; JACOS Hangingstone Demonstration Project 2009, Thermal In-Situ Scheme Progress Report*. Feb. 10, 2010.

Suncor. 2009. *Suncor Energy Limited, Annual ERCB Update Presentation; Suncor Firebag, 2009 ERCB Performance Presentation*, May 5 and 6, 2009.

TERRESTRIAL

LAND USE AND LAND MANAGEMENT

68. Volume 4: Supplemental Information Request #1, Response #168, Page AENV-177 Ivanhoe states, "*After construction is complete, the camp will be demobilized and removed from site*." Ivanhoe does not state what will happen to the disturbed land associated with the camp.

a. Explain what Ivanhoe intends to do with the disturbed lands once the construction camps are removed.

The lands disturbed by the construction camp will be reclaimed as described for the central facilities (Volume 1, Section 3.4.8.1).

69. Volume 4: Supplemental Information Request #1, Response #171, Page AENV-180. Ivanhoe states that the proposed product pipeline will likely follow the existing Corridor Pipeline right-of way. According to the Draft *Lower Athabasca Regional Plan,* there is a proposed conservation area along the Clearwater River. The draft plan accounts for the current pipeline right-of-way but does not include additional future pipelines within or adjacent to the ROW.

a. Discuss alternate pipeline right-of-way locations Ivanhoe has considered.

Ivanhoe has not yet identified pipeline access for the Project. Specific markets for the upgraded bitumen will be determined at a later date and this information will be used to determine the best option for transportation. At that time, transportation routes will be identified and Ivanhoe will follow the current regulatory process for pipeline development. When the draft Lower Athabasca Regional Plan becomes official, Ivanhoe will consider and follow linear development requirements that are finalized and set out by the Lower Athabasca Regional Plan.

CONSERVATION AND RECLAMATION

70. Volume 4, Project Update.
Ivanhoe states that the number and location of the observation and monitoring wells has changed and that the original well locations will only be utilized if required. This was undertaken to reduce the overall size of the project footprint and locations are shown in Figure PU-1.

a. Given the general approach to reclamation and disturbance amelioration proposed for the project (i.e., use of PDA's and future development of site specific plans) will PDA's be undertaken for all proposed well locations (new and old) before project startup?

Ivanhoe will provide all necessary data at a sufficient level of detail to meet the requirements of the pre-disturbance assessment (PDA) under the *Environmental Protection and Enhancement Act* (EPEA) Approval. In accordance with PDA requirements outlined in the AENV 2009 publication *Guidelines for Submission of a Pre-disturbance Assessment and C&R Plan,* Ivanhoe does not plan to undertake PDAs for observation and monitoring wells

b. If not, what is the expected timeline from determination of the need for use of an additional observation well and its construction? Is this sufficient to allow for PDA to be undertaken?

Ivanhoe has provided its updated Reservoir Monitoring Plan in Appendix SIR2 D. The need and use for additional observation wells and their construction will be determined as part of the detailed design process. As discussed in SIR2 70a, PDAs are not required for observation wells.

Literature Cited:

Alberta Environment (AENV). 2009. *Guidelines for Submission of a Pre-Disturbance Assessment and Conservation & Reclamation Plan (PDA/C&R Plan) Under an Environmental Protection and Enhancement Act Approval for an Enhanced Recovery In Situ Oil Sands and Heavy Oil Processing Plant and Oil Production Site*. Edmonton, Alberta.

71. Volume 4: Supplemental Information Request #1, Response # 196, Page AENV-207.
Ivanhoe refers to their planned adaptive management approach.

a. How, on what schedule, and to who will Ivanhoe's progress in implementing this approach be reported?

As indicated in Volume 4, SIR 196, the adaptive management plan will be tracked by conducting annual site monitoring programs to determine whether land use objectives have been met. Results of monitoring programs and any adaptive management responses will be reported in the annual Conservation and Reclamation (C&R) reports.

72. Volume 4: Supplemental Information Request #1, Response # 198 a, Page AENV-210.
Ivanhoe indicates that "*demonstrated progress towards re-establishment of wildlife habitat*" is one of its reclamation objectives.

a. Explain how Ivanhoe will clearly demonstrate that it has made progress towards the re-establishment of wildlife habitat.

Ivanhoe will implement progressive reclamation and will periodically monitor reclaimed areas to demonstrate the establishment of self-sustaining ecosystems in areas impacted by the Project. This monitoring will include, but is not limited to: vegetation species, bird species and mammal species, both in undisturbed and developed sites. Monitoring programs will be designed and implemented in accordance with the EPEA Approval and will include data collection to establish baseline monitoring conditions.

b. What will Ivanhoe use as the baseline for existing wildlife habitat and what will be considered successful re-establishment?

See response to SIR2 72a. As defined in the Alberta Conservation & Reclamation Regulation (AR 115, 1993), successful reclamation means that reclaimed lands are restored to equivalent land capability, and that reclaimed lands provide for a maintenance-free, self sustaining ecosystems including wildlife habitat. Ivanhoe will consider the receipt of a reclamation certificate for areas impacted by the Project as successful re-establishment of wildlife habitat.

73. Volume 4: Supplemental Information Request #1, Response # 122 d, Page AENV-105.
Ivanhoe states, "during reclamation, the pads will be modified but will not be removed."

a. Provide the rationale for not fully removing pads and reclaiming to pre-disturbance conditions.

The above statement provided in Volume 4, SIR 122d is in contradiction to the original EIA and was made in error. In Volume 1, Section 3.3.4, Ivanhoe states that general reclamation procedures will include:

> "removal of fill material in upland areas to expose native subsoil. In peatlands, fill and geotextile will be removed to expose the native peat surface".

Ivanhoe confirms that well pads will be removed during reclamation.

TERRAIN AND SOILS

74. Volume 4: Supplemental Information Request #1, Response # 201b, e, f & g., Page AENV-213-214

Ivanhoe states, "the MIL, FIR, and MAR soils evaluated in …Section 7 …of Abboud et al. (2002) were sampled from areas that have been impacted by forest fires over the last 20 years. The LFH horizons in these soils are thinner (due to forest fires) with low organic matter, cation exchange capacity and base saturation. Critical loads of these fire affected soils are not directly comparable to soils within the Project and were, therefore, left out of the assessment."

Whether assessed using older methodology (Holowaychuk and Fessenden 1987) or the more recent critical load approach (Abboud et al. 2002), most studies in the Oil Sands region consider Firebag (FIR), Marguerite (MAR) and Mildred (MIL) soils to be amongst the most sensitive to acidifying inputs.

Literature Cited:

Abboud, S.A., L.W. Turchenek and L.A. Halsey. 2002. Critical loads of acid deposition on soils in the Athabasca Oil Sands region, Alberta. Prepared for NO_x-SO_2 Management

Working Group, Cumulative Environmental Management Association by Alberta Research Council, AMEC Earth & Environmental Limited, and University of Alberta. 171 pp.

CASA (Clean Air Strategic Alliance) and AENV (Alberta Environment). 1999. Application of critical, target, and monitoring loads for the evaluation and management of acid deposition. Target Loading Subgroup, Clean Air Strategic Alliance and Alberta Environment. 67 pp.

Holowaychuk, N. and R.J. Fessenden. 1987. Soil sensitivity to acid deposition. Alberta Research Council, Terrain Sciences Department, Edmonton. 38 pp. + maps.

a. Considering that fire-affected soils are an intrinsic part of the landscape and that FIR, MAR and MIL might be the most acid sensitive soils (50-year Mid CV case critical load <0.1 keq H^+/ha/yr) in the northeast region, re-assess the extent of acidification of soils in the TRSA assuming this "worst case scenario".

The extent of areas in the TRSA rated as sensitive, moderate and of low sensitivity to acidification has been re-assessed based on the 50-year Mid CV case critical load value of <0.1 keq H^+/ha/yr for Firebag (FIR), Marguerite (MAR) and Mildred (MIL) soils. The revised assessment results in 4.2% more sensitive soils within the TRSA, with a corresponding reduction in moderate sensitivity soils (Table SIR2 74-1). This change in soil sensitivity does not alter the results of the assessment.

Table SIR2 74-1: Extent of Acidification Sensitivity of Soils in the TRSA

Provincial Soil Acidification Sensitivity Rating	Excluding Fire Affected Soils		Fire Affected Soils	
	Area (ha)	**Proportion of TRSA (%)**	**Area (ha)**	**Proportion of TRSA (%)**
Sensitive	5 168.7	0.8	31 575.8	5.0
Moderate	51 335.4	8.2	24 928.4	4.0
Low	407 475.1	65.0	407 475.1	65.0
Disturbed Land (Baseline Disturbance)	119 146.0	19.0	119 146.0	19.0
Non-Soil Units (RB, IR, Water)	43 451.3	6.9	43 451.3	6.9
Total	**626 576.4**	**100.0**	**626 576.4**	**100.0**

Source: CASA and AENV (1999).

75. Volume 4: Supplemental Information Request #1, Response # 204 a, b & c, Page AENV-218 to 220.
Based on data for at least 4 profiles (87, 81, C78 and C79) provided in Volumes 3 & 4, Winefred-based soils (WNF, WNFxc, WNFxczb and WNFzb variants) appear to be common in the TLSA. Ivanhoe stated in its response to Question 204. b. that "Coarse textured veneers have been noted in the TLSA and accounted for in the assessments of LCCS, soil reclamation suitability or soil erosion potential." Ivanhoe went on to indicate that LCCS, reclamation suitability and soil erosion potential ratings were not changed.

a. Considering the number of probable WNF-like profiles apparent in the datasets, to what extent were such soils noted in the TLSA? Were they considered as dominant, sub-dominant or minor inclusions in existing map units?

Ivanhoe has reviewed Profiles 87, 81, C78, C79, in order to identify WNF-based soil types and the complete soils dataset as presented in Volume 3, Appendix F, Table F2-1 and to further identify WNF and other soil types that were misclassified at the soil series level. The re-classification of KNS to WNF, MIL to SUT, KNS to DOV and KNS to HRR are presented in Table SIR2 75-1 for profiles C74, C109, C79-1, 81, C83, C90 and C101. There were no changes to soil profiles C78, 105, C79 and 87. A typographical error in Profile 87 appears in Volume 3, Appendix F3 (p. F3-6). Horizon Ae and Bt should both be SiL. Therefore, Profile 87 in Volume 3, Appendix F2, Table F2-1 is correct. Also in profile C79-1, horizons Bm and BC of Volume 3, Appendix F3 (p. F3-18) should be Bm1 and BC1, respectively. Therefore, Profile C79-1 in Volume 3, Appendix F2, Table F2-1 is correct.

The information presented in Table SIR2 75-1 for WNF, WNFzb, WNFxc, WNFxczb, SUT and HRR soil series indicates that these soil types are few in the dataset and do not cover a large extent of the TLSA to be mapped as the dominant or subdominant soil series in existing mapping units.

b. In other studies in the region, WNF soils (series and related variants) tend to fall into LCCS Class 3 with a final rating (index points) in the low to mid fifties. How does Ivanhoe's LCCS assessment of these soils compare?

The changes in the series classification of the soil types as provided in SIR2 75a do not affect the Land Capability Classification (LCCS) ratings or the interpretation of surface or subsurface reclamation suitability ratings as both parameters are based on the dominant soil series of the soil mapping unit. As indicated above, WNF, SUT, HRR are limited in the soils dataset and not representative of dominant or subdominant mapping units in the TLSA. Therefore, no changes are made to land capability classes based on the dominant soil series.

Table SIR2 75-1: Revised Soil Series

Site ID	Soil Subgroup	Soil Series Classification based on Table F2-1 - Soil Profile Descriptions	Revised Soil Series Name	Comments
C78	O.GL	KNS	KNS	No change in soil series classification. Soils developed on medium textured parent till.
C74	O.GL	KNSzb	WNFzb	Glaciofluvial veneer over moderate fine textured parent till.
105	O.GL	WNF	WNF	No change in soil series classification. Soils are developed on medium textured till overlain by a thin glaciofluvial veneer.
C109	O.GL	KNS	WNFxc	Glaciofluvial veneer over moderate fine textured till.
8	E.DYB	MIL	SUT	Glaciofluvial veneer over moderately fine textured till.
C79-1	E.DYB	MIL	SUT	Glaciofluvial veneer over moderately fine textured till.
C79	O.GL	KNSzb	KNSzb	No change in soil series classification. 43 cm of FSL at the soil surface; although Ck is present, calcareousness is generally weak in these soils, and texture aligns with KNS more so than HRR.
87	O.GL	DOV	DOV	No change in soil series classification. Soils developed on fine glaciolacustrine sediments.
81	O.GL	DOVzb	WNFxczb	Glaciofluvial veneer over fine textured glaciolacustrine.
C83	O.GL	KNS	DOV	Soils developed on fine textured glaciolacustrine sediments.
C90	O.GL	KNS	HRR	Soils developed on moderately fine textured till.
C101	O.GL	KNS	HRR	Soils developed on moderately fine textured till.

76. Volume 4: Supplemental Information Request #1, Response # 204g, Page AENV-221 and Response # 206a, Page AENV-224.
In its response to SIR 204g, Ivanhoe indicated that it used additional data from a Suncor project (Suncor Energy 2003) and the soil inventory of the Alberta Oil Sands Environmental Research Program Study Area (Turchenek and Lindsay 1982) in calculating land capability and reclamation suitability. Conversely in the response to SIR 206a, Ivanhoe states, "Soil profiles used to derive LCCS ratings were carefully selected to represent similar profiles (pedons) or soil series within the TLSA. This approach provided an accurate representation of LCCS ratings for soil series within the TLSA without having to amalgamate several soil profiles."

a. Clarify this apparent contradiction in the approach to assembling soil data for use in assessing land capability classification and reclamation suitability.

When deriving LCCS ratings and reclamation suitability, approximately 90 to 95% of soils data were obtained from soil profiles sampled within the TLSA and about 5 to 10% from the Suncor project (Suncor Energy 2003) and AOSERP study (Turchenek and Lindsay 1982).

Literature Cited:

Suncor Energy Inc. (Suncor). 2003. *South Tailings Pond Project. A*pplication submitted to Alberta EUB and AENV, December, 2003: 3 volumes.

Turchenek, L.W. and J.D. Lindsay. 1982. *Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area*. AOSERP Report 122 and Appendix 9.4. Alberta Oil Sands Environmental Research Program (AOSERP). Alberta Environment, Research Management Division. Edmonton, AB.

77. Volume 4, Supplemental Information Request #1, Response # 190, Page AENV-201.
Ivanhoe states that stockpiles "will be monitored periodically to prevent any slumping..." Monitoring of the stockpiles will demonstrate if a stockpile is unstable and if mitigation will be required to prevent loss of soil materials. Monitoring does not ensure that the stockpile will be stable when thawing.

a. What proactive steps will Ivanhoe use to ensure stockpile stability and prevent the loss of soil materials?

Ivanhoe will undertake the following proactive steps to ensure stockpile stability and prevent the loss of soil materials as discussed in the C&R Plan (Volume 1, Section 3.4.6.3):

- a soil or reclamation specialist present on location will ensure that soil salvage will minimize admixture of the LFH/peat and topsoil with the subsoil and preserve salvage soil quality;
- volumes and locations of stored salvaged soil will be recorded for future reference;
- unless otherwise authorized in writing by a Conservation and Reclamation Inspector, topsoil and subsoil salvage will be suspended if wet and/or frozen conditions exists or if high wind velocities will result in degradation of topsoil or subsoil quality;
- where practicable, saturated peat on organic soils will be salvaged under frozen conditions;
- topsoil, peat, and subsoil salvaged for reclamation will be stockpiled on the site of origin where feasible. Stockpiles will be located such that they are:
  - ❑ outside all areas of potential disturbance so that they do not interfere with on-site activities;
  - ❑ outside treed areas;
  - ❑ accessible and retrievable for reclamation;
  - ❑ on a stable surface where surface runoff from surrounding areas does not impinge on the base of the stockpiles;
- a minimum separation of three metres will be maintained between separately salvaged stockpiles of different materials to ensure no soil mixing occurs;
- to minimize erosion, the stockpiles will be contoured to a stable slope gradient and erosion mitigation measures undertaken as needed (e.g., seeded with a certified weed-free ASRD-approved seed mix, use of tackifier or erosion matting); and
- weed control measures will be undertaken as required for the soil stockpiles.

78. Volume 4, Supplemental Information Request #1, Response # 192, Page AENV-203.
Ivanhoe states that it "will plan ahead and coordinate with local regional suppliers to ensure stocks are available at the time of reclamation." With an anticipated increase in the reclamation of oilsand and other energy developments, the demand for nursery stock of suitable species will increase over time.

a. What steps is Ivanhoe planning to take to ensure that planting stock will be available at the time of reclamation?

Reclamation of the initial well pads will not occur until at least 8 to 10 years into Project development. A detailed Conservation, Reclamation and Closure plan will be submitted as part of the EPEA Approval requirements. Seed mix composition and planting stock requirements will be reviewed with ASRD to ensure that recent recommendations appropriate (in terms of suitability and availability) for the Project Area are incorporated. Ivanhoe will cooperate with other industry proponents and stakeholders in the area to identify synergies in the production of planting and seedlings. Orders will be placed with nurseries and seed suppliers well in advance of reclamation, so that planting stock will be available when required.

79. Volume 4, Supplemental Information Request #1, Response # 210, Page AENV-229.
Ivanhoe states that the overall impact of the project on hydrology will be low. However, the critical importance of smaller scale changes in surface, and near surface, water levels on fen communities (i.e., interruption of water flow by roads or facilities can greatly extend the disturbance footprint by negatively impacting vegetation, particularly trees) has not been addressed. Actions to maintain drainage in the channels described in the hydrology assessment are not in all cases the same actions that would be required to maintain the fen plant community, particularly in the unnamed stream 1 watershed that includes a large undefined channel and is bisected 4 times (perpendicular to flow direction) by proposed development.

a. Describe what construction techniques/methods will be employed to ensure that the anticipated negative effects on fen communities will not occur, and how this will be monitored.

The undefined channel in the Unnamed Tributary 1 watershed will be crossed by winter access routes required to install and access observation wells. Vegetation clearing will consist of the removal of trees and shrubs, however the organic mat will remain intact and soil will not be excavated. This winter access is anticipated to have a negligible effect on the surface drainage in these areas. The access clearings are expected to naturally return to pre-disturbance conditions over time.

Negative effects to wetlands including fens will be minimized through the use of the following mitigation measures during construction and operation of all season roads and facilities:

- culverts will be provided at all defined surface channels, at all low points along the alignment and at regular intervals through wetland areas to provide cross-drainage;
- culvert structures will be long enough to ensure that road grading operations do not result in the deposition of road gravel into any channels;
- appropriate sediment control techniques will be utilized to prevent sediments from entering watercourses or wetlands;
- well pads will be bermed or graded to a collection pond or perimeter ditching to manage stormwater runoff;
- stormwater ponds or collection points will be constructed to capture and detain stormwater runoff in order to attenuate peak flows and allow for sediment settlement; and
- water quality testing will be conducted prior to release. Contaminated runoff will be treated prior to release or recycled to the plant water system.

Fen communities will be monitored in accordance with the anticipated terms and conditions of Approval. These monitoring conditions may include species composition and cover, water levels and water quality at selected sites up and downstream of the proposed facilities.

WILDLIFE

80. Volume 4, Supplemental Information Request #1, Response # 1, Table SIR 1-3. Both the Fort McMurray #468 First Nation and Metis Local #1935 have raised concerns about impacts to woodland caribou as a result of the project, noting diminishing woodland caribou in the area around Fort McMurray. Woodland caribou habitat has been identified in the provincial Woodland Caribou Policy in the South ½ of Township 88, Range 8, West of the Fourth Meridian.

a. Given the proximity to woodland caribou habitat, address how Ivanhoe Tamarack will meet the Woodland Caribou Policy in terms of:

i. maintaining and restoring caribou habitat,

ii. managing efforts that will recognize habitat changes through time, and

iii. prudent management of the land base.

The Project is not within, or in close proximity to, caribou habitat as stated in the Woodland Caribou Policy of Alberta (Government of Alberta 2011; Figure SIR2 80-1). Woodland caribou herds with ranges closest to the Project are the East Side Athabasca River, West Side Athabasca River and Richardson herds. The closest of these herds, the East Side Athabasca River herd, is situated over 17 km south of the Project and on the opposite side of the Clearwater River. As such, woodland caribou are unlikely to interact with the Project.

Although the Project is not located within a caribou range, Ivanhoe supports the principle of developing science-based guidelines to facilitate movement of caribou in *in situ* development areas. Ivanhoe will implement the following mitigation measures:

- line of sight will be reduced and off-road travel will be discouraged by placing slash berms where cleared corridors intersect Project access roads;
- Project employees and contractors will receive environmental awareness training to support wildlife conservation, including minimization of impacts to caribou, during construction and operation;
- if caribou are observed, Project employees and contractors will be requested to record the sighting and report it to an Ivanhoe representative. Any caribou observations will be submitted to Fish and Wildlife for entry into the provincial wildlife database; and
- no legumes will be seeded for revegetation.

Literature Cited:

Government of Alberta. 2011. *A Woodland Caribou Policy for Alberta.* Available at website: http://www.srd.alberta.ca/FishWildlife/WildlifeManagement/CaribouManagement/documents/WoodlandCaribouPolicy-Alberta-Jun2011.pdf.

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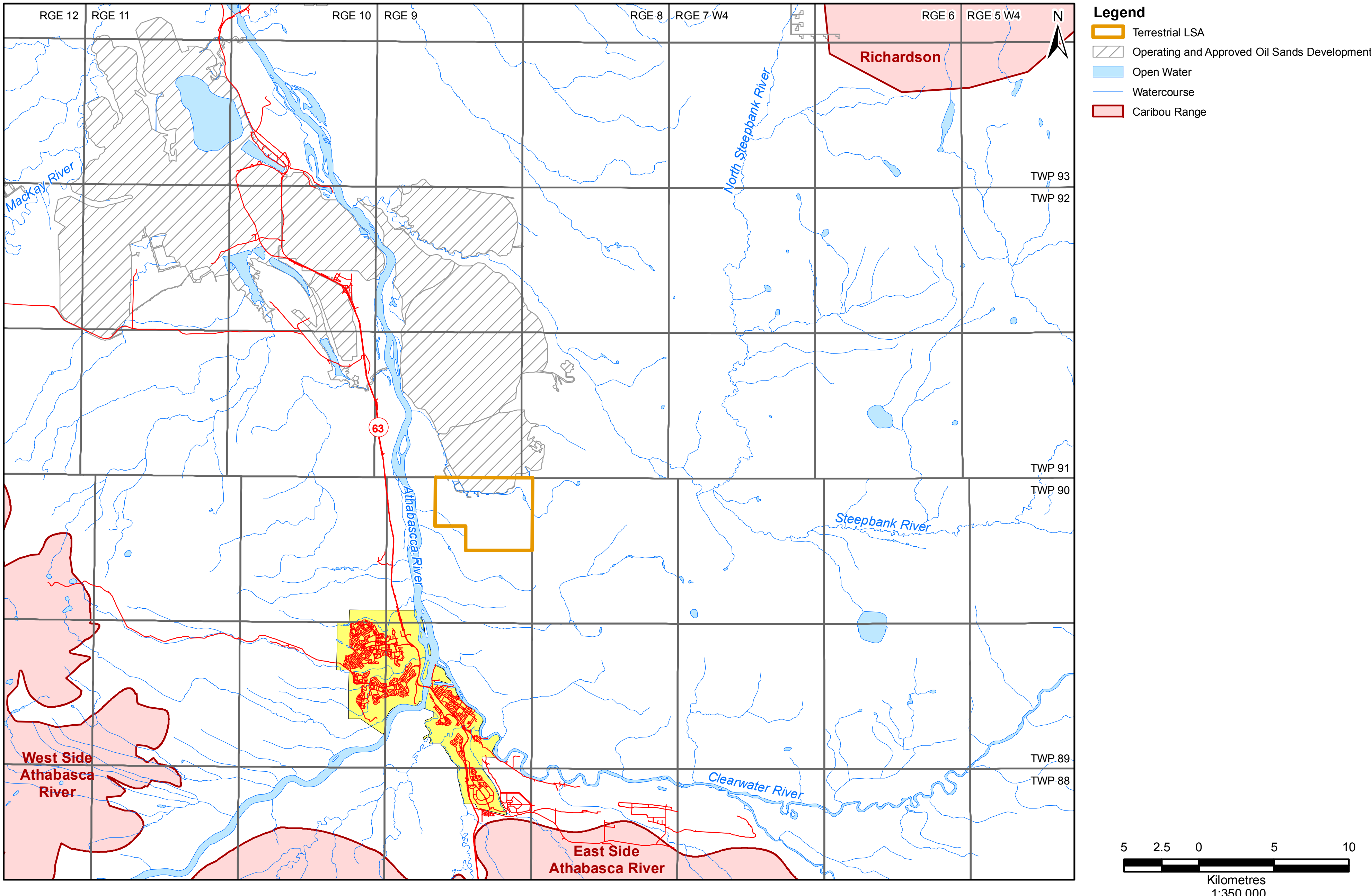

Sources: Al-Pac, Ivanhoe, Spatial Data Warehouse Ltd.
Note: Environment Canada. 2011. Recovery Strategy for the Woodland Caribou, Boreal population (Rangifer tarandus caribou) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vi + 55 pp.

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Ivanhoe Energy
Tamarack Project

Caribou Ranges Identified in the Woodland Caribou Policy of Alberta (2011)

DATE: June 2012		SIR-2 Question 080 Caribou 12-06-21	
PROJECT: CE0374601		PROJECTION/DATUM: UTM Zone 12 NAD83	
ANALYST: TM	QA/QC: KW CT EH	DRAWN BY: AMEC	PREPARED BY: AMEC

Figure SIR2 80-1

81. Volume 4, Supplemental Information Request #1, Response # 45, Page ERCB-123.

a. Will there be any process-affected ponds on site, and if so, explain the mitigation measures to be undertaken to ensure wildlife do not come into contact with the process-affected materials.

There will be no process-affected ponds on-site.

82. Volume 4, Supplemental Information Request #1, Response 61, Page AENV - 15, Response 62, Page AENV 17, and Question 171, Page AENV-180.
It is understood that the Clearwater Multi-Access Road (CMAR) is not part of this EIA. However, it is not clear if there is other access required to the Phase 2 site which would form part of this EIA. For access which Ivanhoe will be building:

a. Discuss how impacts to Aquatic Resources and Wildlife associated with access to the project were considered.

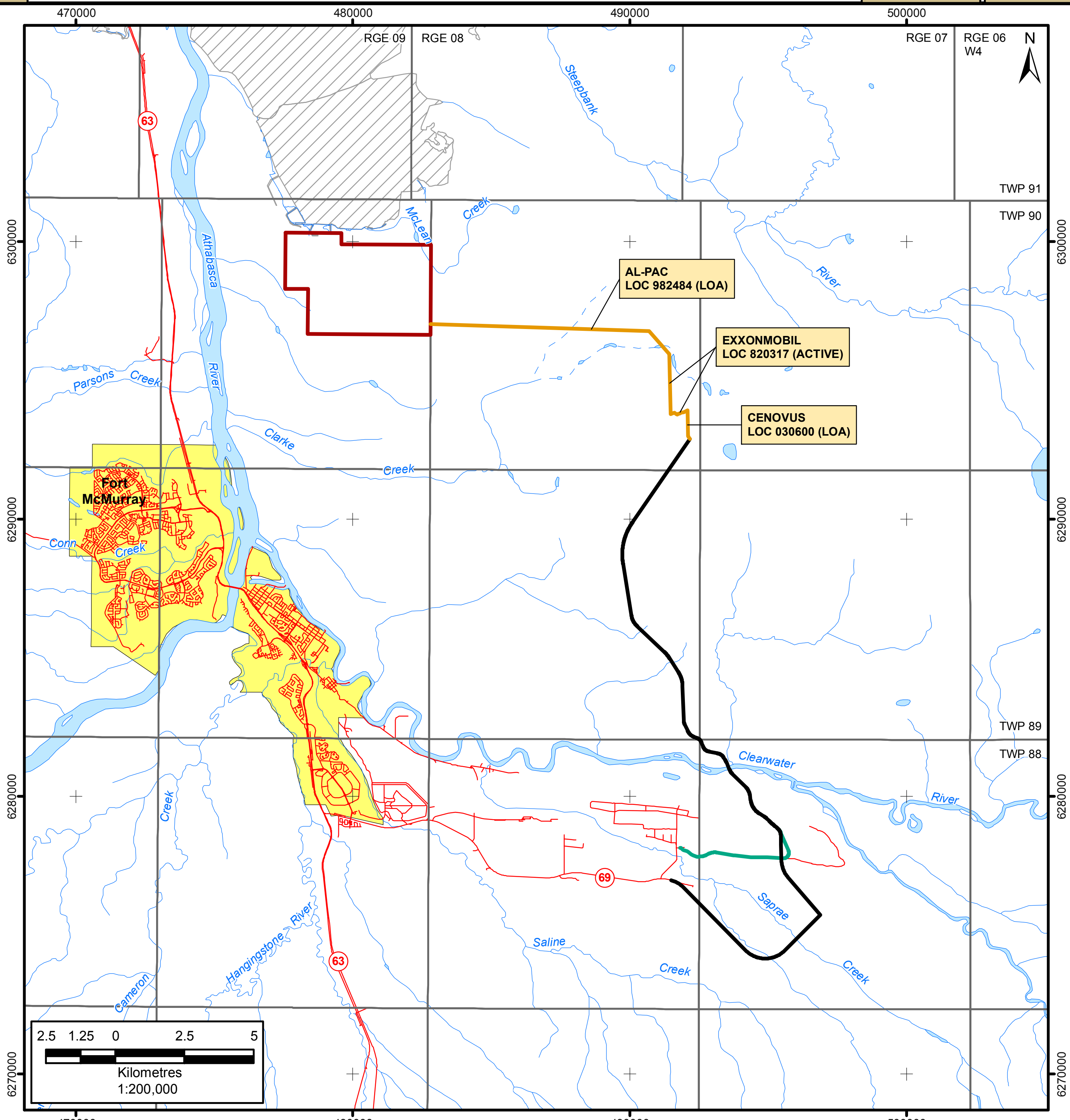
Impacts to fisheries, aquatic resources and wildlife associated with the access road from the CMAR to the Project were not considered.

b. If they were not considered, explain why, update the assessment to do so, and provide the findings.

Impacts were not considered because the CMAR had not been finalized and, as of June 2012, is still pending regulatory approval. Because of this uncertainty, one access route could not be determined and was not included in the assessment of fisheries, aquatic resources and wildlife. The access road to the Project will be considered under a separate regulatory application upon approval of the CMAR. If the CMAR is not approved, Ivanhoe will seek alternate routes.

Assuming the CMAR is approved and follows the currently proposed route, Ivanhoe plans to work with road lease holders to follow existing LOCs from the CMAR to the Project site over a length of approximately 13 km (Figure SIR2 82-1). Aligning the road with existing disturbance will minimize new disturbance and reduce the impacts associated with the access road.

The impacts to fisheries, aquatic resources and wildlife associated with this potential access route are presented below.



Legend

- Project Area
- Operating and Approved Oil Sands Development
- Open Water
- Watercourse
- No Defined Channel
- Proposed Access Road
- Clearwater Multi-user Access Road
- Ledcor Temporary Construction Access

Ivanhoe Energy

Tamarack Project

Proposed Access Road

DATE: June 2012	**Figure SIR2 82-1**
PROJECT: CE0374601	SIR2-Fig082-01 12-06-22
ANALYST: TM; QA/QC: TJR EH EH	DRAWN BY: AMEC
PROJECTION/DATUM: UTM Zone 12 NAD83	PREPARED BY: AMEC

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Fisheries and Aquatic Resources

Effects to fisheries and aquatic resources associated with access to the Project are limited to watercourse crossing locations. The proposed access road crosses the headwaters of Clarke Creek, a tributary to the Athabasca River. Clarke Creek is a mapped Class C watercourse (AENV 2006) but the potential crossing locations are not mapped. Therefore, according to the AENV Code of Practice for Watercourse Crossings (AENV 2007), these portions are also considered Class C with a restricted activity period from 16 April to 15 July.

Based on the analysis of aerial imagery, the Clarke Creek crossings consist of ephemeral drainages with discontinuous channel development and impoundments created by beaver dams. Channels that are present are generally small (i.e., <5 m).

All watercourses will be crossed using clear span bridge structures unless it is determined that there is no potential fish habitat present at the crossing location. Where a clear span bridge is used, it will be installed in accordance with the Fisheries and Oceans Canada Alberta Operational Statement Clear-Span Bridges and the Alberta Environment Code of Practice for Watercourse Crossings. Where it is determined that potential fish habitat is not present at the crossing location, a culvert will be installed in accordance with the Alberta Environment Code of Practice for Watercourse Crossings (AENV 2007). During detailed design, Ivanhoe will conduct crossing assessments in accordance with the AENV Guide to the Code of Practice for Watercourse Crossings (AENV 2007), at proposed crossings over water bodies with defined beds and banks. During these assessments, a qualified aquatic environment specialist will assess fish habitat potential and provide crossing type recommendations.

All crossings will be designed in accordance with the Code of Practice for Watercourse Crossings (AENV 2007). During the installation and operation of the road crossing structures, best management practices specified by Alberta Transportation (AT 2009), the Code of Practice for Watercourse Crossings (AENV 2007), and the federal Fisheries Act will be followed. Best management practices will include:

- the construction of clear span bridges, which does not require instream construction activities;
- ensure that road grading does not result in deposition of road gravel into the channel;
- installation and maintenance of appropriate erosion control measures such as silt fences around riparian disturbance areas, and rights-of-way (ROWs) until disturbed natural vegetation (e.g., muskeg) is returned or becomes re-established by seeding; and
- implementation of post-construction monitoring programs.

The potential effects the proposed access road may have on fisheries and aquatic resources include:

- the release of sediment and deleterious substances;
- the disruption of fish migration and passage;
- changes in channel morphology;

- habitat alteration or loss; and
- increased fishing pressure.

The release of sediment and deleterious substances will be mitigated through bridge design, avoiding instream construction during high flow periods, the controlled removal of beaver dams, isolated construction techniques, use of erosion and sediment control measures, proper storage and handling of hazardous materials, reclamation, and post-construction monitoring. The potential effects of the sedimentation and contaminants on fisheries and aquatic resources caused by the construction and operation of stream crossings are predicted to be low (Table SIR2 82-1).

Table SIR2 82-1: Summary of Access Road Impacts to Fisheries and Aquatic Resources

Activity	Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversible	Confidence	Final Impact Rating
Change in sediment loading	Negative	Local	Low	Short-term	Low	Yes	High	Low
Changes to channel morphology	Neutral	N/A	N/A	N/A	N/A	N/A	High	N/A
Disruption of fish passage and migration	Neutral	N/A	N/A	N/A	N/A	N/A	High	N/A
Alteration or loss of fish habitat	Neutral	N/A	N/A	N/A	N/A	N/A	High	N/A
Change in fishing pressure	Neutral	N/A	N/A	N/A	N/A	N/A	High	N/A

Changes to channel morphology will be controlled through proper bridge and culvert design, avoiding sediment releases and regular maintenance during operation. The potential effect on fisheries and aquatic resources caused by the changes in channel morphology is predicted to be neutral.

The disruption of fish migration and passage will be mitigated by constructing clear span bridges across fish-bearing stream and following bridge design and construction specifications to eliminate any instream work that could potential impede fish passage. The potential effects on fisheries and aquatic resources caused by the blockage to fish passage are predicted to be neutral.

Alteration or loss of fish habitat can occur from the construction of new stream crossings. However, all fish-bearing stream clear span bridges will be constructed in accordance with the Department of Fisheries and Oceans' (DFO's) Operational Statement for Clear Span Bridges (DFO 2007a). The bridge structures will completely span the watercourse without altering the stream bed or banks. The potential effects on fisheries and aquatic resources caused by the direct alteration and removal of fish habitat are predicted to be neutral.

The construction of the access road will only provide access to the headwaters of Clarke Creek, which have a low potential to support sport-fish. In addition, Ivanhoe will have a policy that prohibits employees, contractors and subcontractors from bringing recreational fishing equipment onto site or camp. The potential effects on fisheries and aquatic resources caused by the increased fishing pressure are predicted to be neutral.

Further details regarding the mitigation that Ivanhoe will employ to minimize the effects to fisheries and aquatic resources are presented in the response to SIR2 82c.

Wildlife

Effects to wildlife resources associated with access to the Project are dependent on wildlife species distribution, habitat use, reproductive potential, and population size. Potential impacts to wildlife are discussed as they relate to habitat loss, decreased habitat effectiveness, disruption to movement, and mortality risk. These potential impacts have been assessed for both the construction and operation phases of the access road.

Construction

Habitat Availability

Habitat is used by wildlife for foraging, denning, breeding, and to provide cover from predators and extreme weather conditions. Vegetation removal and alteration changes the landscape and directly alters the amount and type of habitat available for use by wildlife species. The direct effects of habitat loss are obvious, and indirect effects may also occur, including territorial disputes, reduced foraging opportunities, and reduced fitness, primarily for those species with small breeding territories. The majority of habitat alteration will occur as vegetation is removed during construction.

The number of mammals affected varies by species population densities and overlapping home ranges, though adjacent habitats will continue to support mammal populations. Vegetation clearing will reduce nesting and foraging habitat for forest bird species, and removal of habitats will potentially impact bird species communities within those affected habitat types (i.e., mixedwood forest birds). Habitat fragmentation resulting from the habitat loss may negatively impact interior bird species while benefiting edge-associated species and invasive species (Banks-Leite *et al.* 2010; St-Laurent *et al.* 2009). The removal of wetland habitat and associated uplands may also potentially impact amphibian breeding, dispersal, and overwintering habitat, and may result in some amphibian displacement. Ecologically, some wildlife populations may be sensitive to the loss of habitat; however, due to the presence of existing cleared ROW along the LOCs, the habitat loss impacts are expected to be low (Table SIR2 82-2).

Table SIR2 82-2: Summary of Access Road Construction Impacts to Wildlife

Indicator	Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversible	Confidence	Final Impact Rating
Habitat availability	Negative	Local	Low	Long-term	High	Reversible	Low	Low
Habitat effectiveness	Negative	Local	Low	Short-term	High	Reversible	High	Low
Disruption of movement patterns	Negative	Local	Low	Short-term	High	Reversible	High	Low
Wildlife mortality	Negative	Local	Low	Short-term	High	Reversible	High	Low

Habitat Effectiveness

Increases in human disturbance, particularly related to sensory disturbances, will likely have an adverse effect on wildlife and their willingness to use preferred habitat during road construction. Disturbance can have both direct and indirect effects, as animals may experience changes in foraging behaviours and interactions with other animals in a territory or home range. The effects of noise on wildlife will vary depending on the wildlife species affected and the nature of the disturbance, and individual species will demonstrate unique reactions to the same noise disturbance (Parris *et al.* 2009; Bayne *et al.* 2008). Habitat conditions will affect wildlife species' response to noise, with areas having greater vegetation cover resulting in fewer impacts from noise disturbance.

A variety of factors may influence the response of mammals to noise, and most will likely avoid construction activities and habitats adjacent to the road construction. Mammal species, such as moose, deer and lynx, will typically avoid areas with high human activity throughout the day and return during periods of inactivity, such as at dusk and dawn. Bears are more sensitive to disturbance during the fall and winter denning periods and construction activities may reduce habitat use adjacent to the road or disturb den sites. Female bears with cubs are also more likely to alter habitat use as a result of development activities (Pelton 2000).

Birds will usually flee in response to noise. Loud noises can result in short- or long-term effects and may change the flight orientation of migratory birds (Bayne *et al.* 2008). Songbird species may experience a reduction in habitat effectiveness up to 100 m from the disturbed edge (Bayne *et al.* 2008; Jalkotzy *et al*. 1997), and noise may also reduce the foraging efficiency and intra-specific communication in owls (Delaney *et al*. 1999).

Amphibians are generally not affected by sensory disturbances unless approached. However, during the breeding season, extended periods of loud noise related to construction activities and vehicle traffic adjacent to breeding ponds may disrupt breeding if the noise is loud enough such that the calls of amphibians cannot be heard by conspecifics (Parris *et al.* 2009).

Though wildlife may experience some loss of habitat effectiveness during active construction activities, these effects will not be constant and wildlife will return at periods of inactivity. The final impact is low (Table SIR2 82-2).

Disruption of Movement Patterns

The movement patterns of mammal species may be temporarily altered by disturbances due to construction activities and traffic. Mammals will not experience any barriers to movement during construction.

Because of the highly mobile nature of birds, construction activities are not anticipated to affect bird movement. Disturbance may cause birds to avoid some areas, but they will not experience barriers to movement.

Wetland and riparian habitats are important for amphibian breeding, and adjacent upland habitats are important for dispersal and hibernation for some amphibian species (Constible *et al.* 2010). Juvenile amphibians typically disperse in July and August. Timing constraints during vegetation clearing will avoid the breeding and early dispersal period for amphibians.

Construction activities will influence the ability of wildlife to cross the road corridor during active work periods. As construction proceeds, some sections of the road will be completed while others will remain under construction. As a result, animals will not experience substantial barriers to movement from construction traffic or other disturbance and impacts are anticipated to be low (Table SIR2 82-2).

Wildlife Mortality

Wildlife mortality may occur as a result of direct and indirect construction activities. Direct sources of mortality include vehicle-wildlife collisions and destruction of den sites and nests during vegetation clearing. Indirect mortality may occur as a result of habitat loss and displacement. The risk of wildlife mortality is species-specific and depends on the likelihood that species will encounter sources of potential mortality. Wildlife mortality as a result of construction activities is expected to be low (Table SIR2 82-2).

Direct mammal mortality may occur from collisions with construction traffic; however, construction typically involves the use of large slow moving vehicles and will be isolated to active sections of the road. Indirect mortality during construction may occur as a result of improved access to hunting, poaching, and/or trapping of mammal species. No direct mortality is expected for bat species due to timing constraints, though indirect mortality may result from habitat loss and the reduced availability of suitable summer roosting locations.

Due to vegetation clearing timing constraints, direct mortality of bird species is expected to be low during the construction phase. Indirect mortality may occur from the loss of nesting habitat during vegetation clearing. Indirect mortality may also be associated with competition for nesting and foraging resources as a result of crowding in adjacent habitats. The introduction of opportunistic predator species along forest edges, such as the gray jay, may increase the risk of nest predation (Newton 1998).

Amphibians are susceptible to increased mortality risk from changes in surface water conditions within breeding habitats and the removal of over-wintering sites. Potential breeding habitat is located within several small wetlands and drainages within the corridor.

Operations

Habitat Availability

No additional wildlife habitat loss will occur post-construction. Therefore, habitat availability impacts to wildlife during the operation phase will be neutral (Table SIR2 82-3).

Table SIR2 82-3: Summary of Access Road Operation Impacts to Wildlife

Indicator	Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversible	Confidence	Final Impact Rating
Habitat availability	Neutral	N/A	N/A	N/A	N/A	N/A	High	N/A
Habitat effectiveness	Negative	Local	Low	Long-term	High	Reversible	High	Low
Disruption of movement patterns	Negative	Local	Low	Long-term	High	Reversible	High	Low
Wildlife mortality	Negative	Local	Low	Long-term	High	Reversible	High	Low

Habitat Effectiveness

Road operation will transform the environment at and adjacent to the access road, creating edge effects with consequences that will extend past the construction phase (Trombulak and Frissell 2000). The ecological effect of road avoidance may be greater than that of vehicle collisions, depending on the species affected (Forman and Alexander 1998). Noise and visual disturbance from traffic will likely discourage most species from using habitat within and immediately adjacent to the road. Headlights from vehicles at night have also been known to deter some wildlife species, even more so than vehicle noise (Blackwell *et al.* 2009; Darrow and Shivik 2009). Wildlife may avoid using habitats that are otherwise preferred because of the presence of human activity, potentially resulting in increased energy expenditure and lost foraging opportunities (Bayne *et al.* 2008; Jalkotzy *et al*. 1997); as a result, habitat in the vicinity of a development is effectively lost. The duration and magnitude of human disturbance and the behavioural response of a species will determine whether the extent of the effective habitat loss will be complete or partial, temporary or permanent (Bromley 1985). Effective habitat loss may be greatest in areas of high quality habitat, critical reproductive habitats (i.e., nest and den sites), and important overwintering areas. Wildlife in the area have already been impacted by operational activities along the existing winter road, and therefore additional habitat effectiveness impacts are anticipated to be low (Table SIR2 82-3).

Some mammal species, such as black bear and moose, may initially seek shelter further away from development activities but return to the area as they become habituated (Franzmann and Schwartz 1998). Other mammal species, such as the Canada lynx, are known to avoid suitable habitat in the vicinity of high levels of human activity and traffic volumes (Kansas and Collister 1999). Moose avoid access corridors based on the associated level of human activity, and disturbance reactions are highest in hunted populations (Rolley and Keith 1980). In addition, predators such as wolves will use cleared corridors to increase their hunting efficiency (Bowman *et al.* 2010; James 1999). Therefore, road traffic is expected to reduce mammal habitat use adjacent to the roadway throughout its operational life.

Noise effects on songbirds may include reduced ability to hear male breeding vocalizations by conspecifics (Richardson *et al*. 1995), lower species richness (Stone 2000), stress, changes in behaviour, and deleterious effects on food supply or other habitat attributes (Wasser *et al*. 1997; Andrews 1990). Noise created by traffic is typically of low frequency and less likely to interfere with high-pitched songs from species such as the common yellowthroat and least flycatcher (Slabbekoorn and Peet 2003), and therefore these species may be less affected. The productivity of most raptor species declines with proximity to major roadways and they preferentially nest away from roads (Martinez-Abrain *et al.* 2010). However, some raptors may habituate to traffic and will tolerate considerable noise (about 80 dB) close to their nests if it becomes familiar, especially if humans are not visible (White and Thurow 1985). Common species such as the red-tailed hawk will frequently nest near human disturbance.

Road operation may result in an increase in noise disturbance to amphibians. The resulting effects may include disruptions to breeding amphibians, reduced recruitment, early emergence from overwintering burrows, impaired movement, and increased predation (Parris *et al.* 2009; Wollerman and Wiley 2002; Richardson *et al*. 1995). Measurable effects to amphibians from reduced habitat use are not expected beyond the impacts associated with habitat removal. Amphibians will continue to persist in areas adjacent to the road where suitable habitat exists.

Disruption of Movement Patterns

Wildlife movement through the landscape is accomplished by balancing foraging requirements and cover from predators and human disturbance. Movement corridors include habitats that provide suitable vegetative cover and valleys along watercourses. Where movement is disrupted, the habitat can become fragmented. The proposed access road will follow existing disturbance as much as possible and includes a number of LOCs currently used for winter access (Figure SIR2 82-1). Wildlife movement will be negatively impacted and road operation will constitute a semi-permeable barrier to the movement of some wildlife species. Impacts on wildlife are species-specific and will depend on home range and territory sizes, as well as food and cover requirements. The existing winter road has already impacted wildlife movement in the area, and additional impacts are expected to be low (Table SIR2 82-3).

Roads with high traffic volumes restrict wildlife movement (Underhill and Angold 2000) and the movement patterns of mammals will be altered as a result of the access road. Seasonal dispersal may increase the frequency of movement across roads (Putman 1997), and ungulates are typically more susceptible to vehicle collisions in the spring and fall (AT 2008). Although moose may use roads as travel corridors, they have been found to avoid roads by up to 500 m in low quality habitat and they are four times more likely to cross roads at night, when traffic volumes are lower (Laurian *et al.* 2008).

Although habitat use may be altered, fragmentation of local songbird populations is not expected since these species will remain connected to other nearby populations. Some species, such as owls, may use the road as a travel corridor, whereas interior forest songbird species will avoid forest edges (Machtans 2006; Bayne *et al.* 2005). Most bird species will readily cross forest openings of the size expected with the roadway.

Roads may act as partial or complete barriers to amphibian movement, potentially altering gene flow in small populations (Reh and Seitz 1990), and may disrupt the movement and dispersal patterns of amphibians. Sensory barriers may also alter movement patterns. Drainage culverts installed across the road will provide opportunities for amphibian movement along the watercourses and ephemeral drainages.

Wildlife Mortality

The risk of wildlife mortality is species-specific and has been assessed qualitatively based on the likelihood of a species encountering sources of potential mortality. Mortality may be caused directly by humans by vehicle-wildlife collisions and destruction of den sites, hibernacula and nests. Indirect mortality occurs when the development contributes to other sources of mortality, such as increased hunting and trapping pressure, poaching, and management actions associated with the removal of nuisance animals. Loss of habitat, through decreased habitat effectiveness or removal, may also contribute to indirect mortality due to increased intra-specific competition for available food and nesting resources, as well as increased predation risk (Thompson *et al*. 2008). Predation risk is higher along cleared linear corridors as it may improve the hunting efficiency of carnivores (e.g., wolves, birds of prey).

Ungulates, carnivores and small mammals are susceptible to vehicle collisions and this source of mortality can have a negative effect on some populations (Roger *et al.* 2011; Bowman *et al.* 2010). Major wildlife routes where collisions occur most frequently include wildlife movement corridors such as river valleys and smaller drainage courses (Forman and Deblinger 1998; Romin and Bissonette 1996). Wildlife, such as moose and deer, will be attracted to areas where salt substances (i.e., calcium chloride) is applied to the road surface for road de-icing and dust control, which may lead to more vehicle-wildlife collisions. New forage along ditches may also attract wildlife to the road. Large mammal species, such as moose, black bear, and deer, are important species for both recreational and subsistence hunting and are typically hunted in close proximity to access corridors (Boer 1990; Rolley and Keith 1980).

Birds are susceptible to vehicle collisions (Evink *et al*. 1996) and high traffic volumes will potentially result in bird-vehicle collisions. Species that will likely be the most affected include juvenile owls and songbirds that favour open and edge habitats. Areas with trees and shrubs alongside roadways have been known to directly increase the mortality of avian species that prefer edge habitats (Orlowski 2008). Songbird species of concern that favour these habitats include the least flycatcher and eastern phoebe. Losses among birds due to vehicle traffic may be reduced by removing shrubby vegetation in the immediate vicinity of the roadway.

Amphibians are susceptible to road kills because of their movements between wetland breeding sites and upland foraging habitat, and individuals may be inconspicuous and slow-moving (Trombulak and Frissell 2000). Road kill rates are typically highest near ponds and wetlands as juveniles and adults disperse (Forman and Alexander 1998). Though amphibians are likely to avoid roads, mortality from vehicles can have a negative impact on some populations (Ashley and Robinson 1996; deMaynadier and Hunter 1995; Fahrig *et al*. 1995). Amphibian species present in the region are expected to continue to persist in adjacent areas where suitable habitat exists.

Wildlife mortality will potentially increase as a result of the access road operation; however, wildlife mortality will be lessened through mitigation measures such as maintaining visibility and line-of-sight along the roadside through wide ditches with low vegetative growth, re-vegetating with native and non-palatable vegetation species, enforced speed limits, and discouraging off-road travel on intersecting lines through the development of doglegs and placement of slash berms. With the implementation of mitigation measures such as these, the final impact rating is low (Table SIR2 82-3).

c. Identify mitigation and design commitments associated with the access and its potential impacts on aquatic and terrestrial resources including specifics related to:

i. Road design and maintenance to manage sedimentation

ii. Road monitoring to ensure:
- **surface and shallow groundwater flows are not impeded,**
- **changes to vegetation/ecosites as a consequence of altered flow are noted early,**
- **watercourse crossings are functioning as designed and fish passage and wildlife movement are not impeded.**

<u>Fisheries and Aquatic Resources Mitigation</u>

The following standard mitigation measures will be implemented to minimize effects to the aquatic environment.

- minimize the clearing of vegetation to provide access to the work area. The removal of stumps, roots and downed (non-merchantable) or buried logs will not be undertaken in any areas not required for road construction, ditchlines or culvert or bridge installation;
- stabilize all disturbed areas by:
    - ❑ immediately installing temporary erosion control measures, at the crossing site and the developed road allowance sloping to the water body, that remain in place until vegetation or other long-term erosion control methods are fully established and functioning, and

- ❑ installing and placing long-term erosion control measures at the crossing site and the developed road allowance sloping to the water body, including, but not limited to, slope stabilization, revegetation, soil coverings, riprap and armouring, silt fences, check dams, sediment traps, brush barriers and vegetation filters;
- divert runoff or water from the work site or area disturbed by the crossing construction that contains sediment to a setting pond, sediment trap, or through a vegetated area to minimize erosion and sedimentation of the water body;
- dispose of all excavated material in a location above the high water mark and located such that it does not re-enter the watercourse;
- implement revegetation and seeding of disturbed areas as soon as possible after construction. All disturbed areas at the watercourse crossing site that are sloping to the water body must be permanently stabilized within one growing season of the completion of construction;
- clean and free equipment of all external grease, oil and other potential contaminants prior to the equipment entering the water body or area adjacent to the water body;
- clean and free equipment of mud and dirt prior to the equipment entering the water body or area adjacent to the water body, and before the equipment exits areas adjacent to the water body to prevent the transfer of biota (i.e., weeds, larvae) not indigenous to the crossing site;
- service equipment and conduct other activities with the potential for accidental spills (i.e., oil changes, hydraulic repair, hazardous waste storage) in a safe designated area at least 100 m from the stream channel; and
- conduct post-construction monitoring to assess the conditions of the crossing structure and effectiveness of the mitigation and to identify any problems that require remedial action.

Clear span bridges will be constructed in accordance with the DFO's Operational Statement for Clear Span Bridges (DFO 2007a). The bridge structures will completely span the watercourse without altering the stream bed or banks. The following conditions will be met to protect fish and fish habitat when constructing clear span bridges under DFO's Operational Statement:

- use existing trails, roads or cut lines wherever possible, as access routes to avoid disturbance to the riparian vegetation;
- avoid building on any area that is inherently unstable (meander bends, braided streams, alluvial fans, active flood plains) that may result in the alteration of natural stream functions or erosion and scouring of the bridge structure;
- bridge will be designed to properly address river and channel processes at flows above the high water mark;
- design and construct bridge perpendicular to the watercourse to minimize riparian vegetation disturbance;

- machinery fording the watercourse to bring equipment required for construction to the opposite side is limited to a one-time event (over and back) and should occur only if an existing crossing at another location is not available or practical to use;
- operate machinery on land above the ordinary high water mark and in a manner that minimizes disturbance to the banks of the watercourse; and
- installation and maintenance of appropriate erosion control measures such as silt fences around riparian disturbance areas, and ROWs until disturbed natural vegetation (e.g., muskeg) is returned or becomes re-established by seeding.

Culvert installation will involve instream work and to reduce sediment mobilization, isolated construction techniques will be implemented so instream work can proceed under dry conditions. Isolation may include cofferdams, flumes and bypass pumps and will be used during installation of the culvert structures and placement of bank protection. Temporary stream diversions will not be used during construction to divert creek flow. Under Section 8(4) of the Code of Practice, where a water body is dry or frozen to the bottom at the time of carrying out the works, the requirement to isolate the location of the construction or works does not have to be met.

If bypass pumps are used, they will be sized to handle maximum expected discharge. Discharge water will be directed to prevent erosion of the area surrounding the outlet and allow settlement/removal of sediment prior to return to the watercourse. The energy of the discharge from the bypass pump will be dissipated using devices that include, but are not limited to tarps, flip buckets, or appropriately sized granular materials. Sediment traps or discharge through a vegetated area will be utilized in conjunction with an energy dissipater, where bypassed water is heavily sediment laden.

Beaver dams at select sites may need to be removed or breached to lower water levels within the channel to support culvert or bridge construction and channel isolation. The removal of beaver dams will be carefully planned, localized and completed in a manner that avoids substantial drainage of upstream areas to avoid effects to fish habitat.

All beaver dam removal activities will comply with the provincial Code of Practice and federal Fisheries Act, including DFO Operational Statement for Beaver Dam Removal (DFO 2007b). DFO will be contacted regarding the removal of beaver dams, if there is potential for effects to fish and fish habitat. There are no provincial approvals required, although the ASRD Fish and Wildlife office in Fort McMurray will be notified prior to the disturbance of beaver dams.

Wildlife Mitigation

The following strategies will be employed to reduce potential impacts to wildlife species and their habitats as a result of construction and operation activities:

- ***Construction***:
  - Overlap road alignment with existing disturbance consistent with integrated land management principles, to reduce need for additional vegetation clearing and habitat loss;
  - Vegetation clearing will be scheduled outside of the migratory bird nesting and rearing period, generally from April to August, consistent with regulatory expectations;
  - If an occupied den or nest site is encountered, vegetation clearing and construction activities will be suspended pending consultation with Fish and Wildlife officials;
  - Where cleared corridors intersect the road (i.e., on cleared seismic and pipeline ROWs), lines-of-sight will be reduced and off-road travel discouraged through the development of doglegs and the placement of slash berms;
  - Culverts will be kept clear of debris to allow for movement of amphibians and small mammals;
  - Dust control measures will be implemented as needed to prevent impacts to adjacent breeding and foraging habitat;
  - Noise reduction mechanisms on construction vehicles, such as properly maintained construction equipment and noise bafflers such as mufflers, will be used to reduce noise;
  - A no firearms/no hunting policy will be implemented for Project personnel, including contractors, both on-site and while traveling to and from the Project;
  - Harassment of animals will not be permitted by Project personnel. It will be the responsibility of the contractor to ensure compliance with this condition;
  - All food wastes will be stored to prevent access by wildlife and trucked off-site for disposal;
  - Environmental awareness programs will be included during site orientations to all project personnel to ensure staff awareness of the hazards associated with feeding wildlife and vehicle-wildlife collisions, thereby reducing the potential for harm to both humans and wildlife; and
  - During construction, speed limits of 50 km/hr will be enforced and construction personnel will be encouraged to reduce vehicle speeds in areas with high potential for wildlife-collisions while traveling to and from the work site.
- ***Operation:***
  - Speed limits of 80 km/hr will be posted and enforced;
  - Dust control measures will be implemented as needed to prevent impacts to adjacent breeding and foraging habitat;

- Wide ditches with low vegetative growth will be maintained along the roadside to improve visibility and line-of-sight, and to avoid providing forage and/or cover for wildlife;
- Ditches will be re-vegetated with native, non-palatable vegetation species; and
- Shrub and vegetative cover will be planted at culvert entrances and under bridges to encourage wildlife passage and use of these crossings.

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83. Volume 4, Supplemental Information Request #1, Response # 211, Page AENV-230.

Ivanhoe was asked to validate their models. In the response, Ivanhoe provided a discussion of the development of their HSI models and an explanation of how they were validated, indicating field data were used. However, in the EIA text (Section 12.3.3, Page 12-20), Ivanhoe states, "*Where field data were not sufficient for determining species habitat preferences, Habitat Suitability Index (HSI) models were applied*."

Literature Cited:

Muir, J.E. V.C. Hawkes, K.N. Tuttle, and T. Mochizuki. 2011. Synthesis of Habitat Models used in the Oil Sands Region. LGL Report EA3259. Unpublished report by LGL Limited environmental research associates, Sidney, B.C. for the Cumulative Environmental Management Association (CEMA) – The Reclamation Working Group (RWG), Fort McMurray, AB. 30pp + Appendices.

a. These would seem to be contradictory. Provide a discussion. Muir, et.al. (2011) have recently presented a reference on habitat models.

The original statement in the EIA text (Volume 2, Section 12.3.3) was written in a different context from the statement in the Volume 4, SIR 211.

The statement in the EIA refers to the use of HSI models to determine habitat preferences for species that were not frequently detected in the TLSA, and as such, habitat preferences for these species cannot be devised purely from field data.

The statement in the SIR response refers to using the field data that are collected to help validate and determine the effectiveness of the models.

b. In light of the work by Muir at al. discuss the adequacy of the methods used by Ivanhoe to validate wildlife and aquatic habitat models.

The recent work by Muir *et al.* (2011) discusses the subjective nature of HSI model development and the fact that "statistical validation methods used with RSF models to assess variable selection and model fit do not apply to HSI models and alternate methods must be used to validate the model structure" (Page 6). However, the report also highlights a four step process that can be used to validate HSI models, as originally recommended by the US Fish and Wildlife Service (USFWS 1981). Ivanhoe validated the wildlife habitat models using a process similar to that proposed by Muir *et al.* (2011), which was published subsequent to the completion of the EIA. Following the four steps in Muir *et al.* (2011), Ivanhoe's validation methods are as follows:

> *Step 1: Author review - "The model documentation should be reviewed to ensure that all model assumptions and limitations are clearly and correctly stated" (Page 6).*

HSI models that were developed for previous EIAs in the Athabasca region were reviewed. From these, ten species or species communities were selected to reflect CEMA priority species and the interests of stakeholders (Volume 2, Table 12.2-1). The HSI equations were defined and provided for each of the ten species, or species communities and modelled in Volume 2, Section 12.4.5.

> *Step 2: Model calibration - "Model calibration is performed by applying the model to a sample data set and calculating HSI values for each habitat polygon" (Page 7).*

The field data was not designed to conduct a statistical model calibration. The most recent oil sands models were used and modified as needed based on professional judgment and expert opinion as outlined in AENV (2011).

> *Step 3: External review of model - "… increase the reliability of the model by having an independent expert review the model documentation and results of the model calibration (Page 7).*

The HSI model methods and results presented throughout Volume 2, Section 12.0 were reviewed by a senior wildlife biologist who has created HSI models in the past and is considered an expert in the field.

> *Step 4: Test with field data - "Validation of the model with empirical data enables the modeler to assess the model's performance and refine the model as needed" (Page 7).*

Since the program was not designed to collect sufficient data for calibration, the models could not be refined. However, data collected during Ivanhoe field programs were mapped, and the modelling performance was assessed.

Literature Cited:

Alberta Environment (AENV). 2011. *2010 Reclamation Criteria for Wellsites and Associated Facilities Application Guidelines*. Alberta Environment, Edmonton, Alberta. 52 pp.

Muir, J.E. V.C. Hawkes, K.N. Tuttle, and T. Mochizuki. 2011. *Synthesis of Habitat Models used in the Oil Sands Region*. LGL Report EA3259. Unpublished report by LGL Limited environmental research associates, Sidney, B.C. for the Cumulative Environmental Management Association (CEMA) – The Reclamation Working Group (RWG), Fort McMurray, AB. 30pp + Appendices.

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84. Volume 4, Supplemental Information Request #1, Response 213 a, Page AENV-232.
Ivanhoe Tamarack provides a discussion of changes in habitat suitability as a consequence of sensory disturbance. Ivanhoe states, "*No habitat effectiveness distances as a result of sensory disturbance are known to have been proven or recommended for Canadian Toads in the boreal forest*."

a. Clarify whether the lack of proven or recommended effective distances is because no investigative work has actually been done, or whether work has been done but, found to be inconclusive.

The lack of proven or recommended effective distances is because no investigative work has actually been done. Available research has not considered sensory disturbances for the boreal Canadian toad population. Most Canadian toad research has been conducted in the prairies and Canadian toad research in the boreal forest is limited. These populations differ in their habitat use and movement patterns, and therefore, conservation strategies applied in the prairies are not appropriate for the boreal population (Constible *et al.* 2010).

Literature Cited:

Constible, J.M., P.T. Gregory, and K.W. Larsen. 2010. *The Pitfalls of Extrapolation in Conservation: Movements and Habitat Use of a Threatened Toad are Different in the Boreal Forest*. Animal Conservation 13 (2010) 43-52.

85. Volume 4, Supplemental Information Request #1, Response # 213 b, Page AENV-233.
Ivanhoe states, "*barrier effects of above-ground pipelines on moose and other species in the TLSA are not expected* "

a. Provide justification for this position based on scientifically defensible data, or published work that was situated in similar habitat with similar above-ground pipeline, road and transmission line schematics. If unpublished data are used to support the position, provide the data.

Ivanhoe amends the statement in its application upon which this question is based. The statement should read "*barrier effects of above-ground pipelines on moose and other species in the TLSA are predicted to be low".*

Wildlife preferences for over-pipe versus under-pipe crossing structures differ by species. Underpass crossings can provide a preferred passageway for a number of wildlife species, whereas overpass crossings are typically designed for larger mammals such as large carnivores and ungulates (Glista *et al.* 2009). Moose have been known to exhibit a preference to use over-pipe crossing structures more frequently than crossing underneath elevated pipelines, and also to become habituated to where the crossings are located (Dunne and Quinn 2009). Deer will use both overpasses and underpasses and will also frequently cross under pipelines with minimum clearances of 1.00 m. Carnivores have been documented using over-pipe crossings, but more frequently cross pipeline clearances of less than 0.91 m far more than was available; further research is required to determine if carnivores avoid sections of elevated pipeline (Dunne and Quinn 2009).

Literature Cited:

Dunne, B.M. and M.S. Quinn. 2009. *Effectiveness of Above-ground Pipeline Mitigation for Moose (Alces alces) and Other Large Mammals*. Biological Conservation 142(2): 332-343.

Glista, D.J., T.L. DeVault and J.A. DeWoody. 2009. *A Review of Mitigation Measures for Reducing Wildlife Mortality on Roadways*. Landscape and Urban Planning 91: 1-7.

86. Volume 4, Supplemental Information Request #1, Response # 213 c, Page AENV-233, and Question 284. Page AENV-351.
Ivanhoe provided a revised assessment of habitat suitability to account for sensory disturbance. With respect to Mixedwood Forest Bird Community.

a. Ivanhoe indicates in the discussion that a 300 metre buffer was applied around the CPF to account for sensory disturbance. This does not appear to be reflected in Figure 12.5-4. Explain and/or provide an updated figure.

A 300 m buffer around the CPF and revised habitat suitability calculations were applied in Figure 12.5-4 (Rev), as provided in Volume 4, to account for sensory disturbances. Figure 12.5-4 (Rev2) includes an outline of the 300 m buffer applied to the CPF and the well pads. Please refer to Volume 2, Figure 12.5-4 for comparison to the original model.

b. Ivanhoe discusses sound, referencing Bayne et al. (2008); but, goes on to indicate that use by mixedwood forest birds is expected to continue around Project facilities (other than the CPF). How do noise levels associated with the pad sites compare to the findings of Bayne, et al. (2008)? Why was a buffer or a modified buffer not applied to the pad sites to account for noise impacts?

Operational noise levels on well pads are not expected to exceed 65 dBA, which is lower than the threshold identified in Bayne *et al.* (2008), and therefore impacts to the mixedwood forest bird community are not anticipated. Chronic anthropogenic noise from compressor stations typically range from 75 to 100 decibels (dBA), and songbirds have been found to be 1/3 less abundant within 300 m of noisy areas such as these (Bayne *et al.* 2008). The CPF for the Project is expected to operate at noise levels ranging from approximately 60 to 95 dBA (Volume 2, Section 5.0), which may lower the abundance and reproductive success of some songbird species in the vicinity of the CPF. In order to be conservative, Ivanhoe applied a 300 m buffer to all well pads. The addition of the 300 m buffer around the well pads results in a loss of 50 ha of high quality habitat (Figure 12.5-4 (Rev2)). No good quality habitat will be lost. Impacts to the mixedwood forest bird community due to the loss of habitat from the well pads are not anticipated.

c. Ivanhoe states, "*Timing constraints for vegetation clearing will not occur while migratory birds are nesting, rearing young and fledging*." Confirm whether Ivanhoe intended to convey that timing constraints for vegetation clearing would be applied to ensure disturbance of nesting, rearing and fledging migratory birds would not occur.

Ivanhoe confirms that timing constraints for vegetation clearing would be applied to ensure disturbance of nesting, rearing and fledging migratory birds will not occur.

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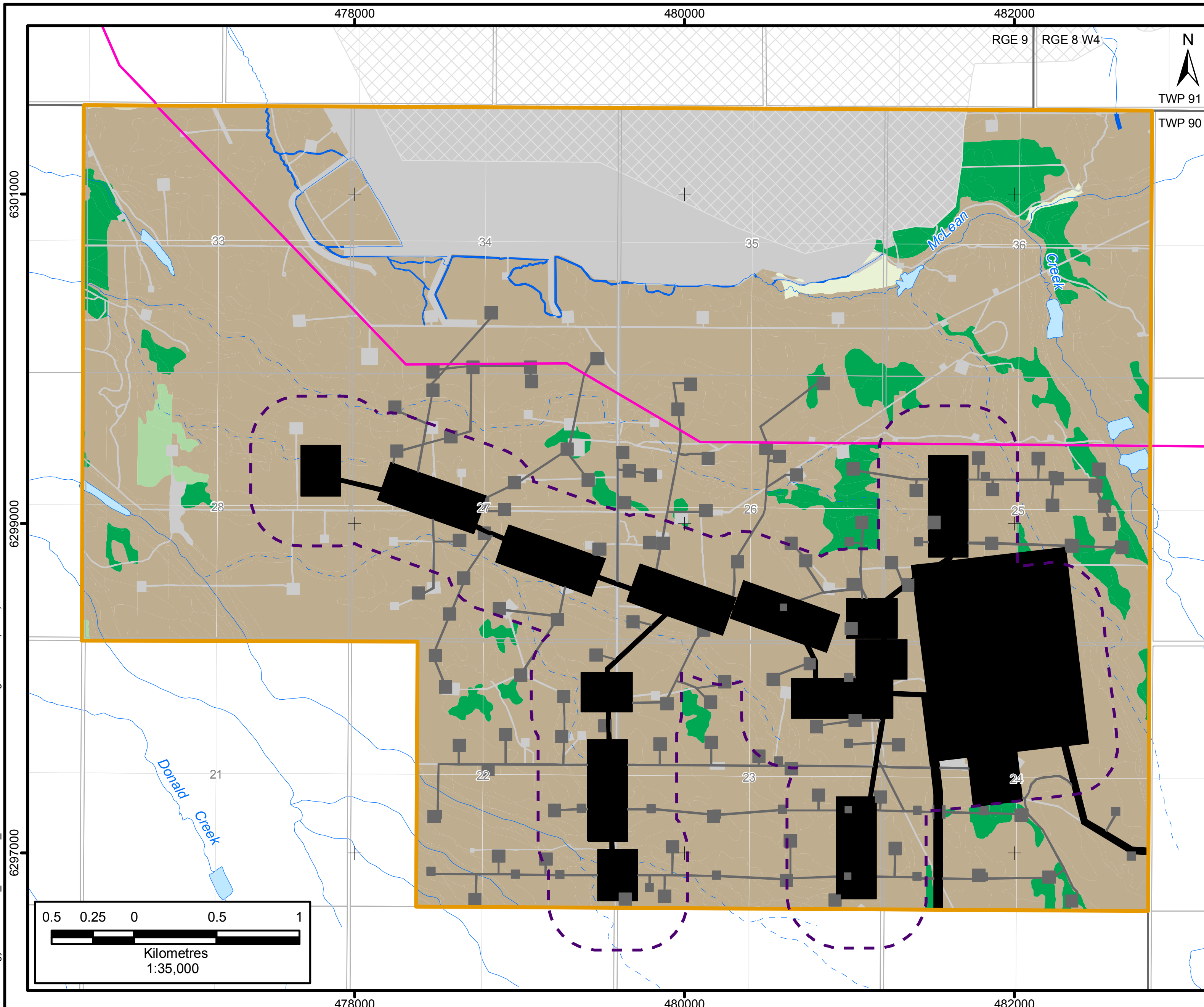

Legend

- Terrestrial LSA
- Tamarack Project Footprint
- Tamarack Other Disturbance
- Baseline Disturbance
- Suncor South Tailings Pond
- Open Water
- Watercourse
- No Defined Channel
- Suncor South Tailings Pond Diversion Ditch
- Suncor MSL044435 Boundary
- 300m Buffer

Habitat Suitability

- High Quality
- Good Quality
- Moderate Quality
- Marginal Quality
- Poor Quality

Habitat Suitability	Application Case	
	Area (ha)	% of LSA
High Quality	139	4.9
Good Quality	13	0.5
Moderate Quality	9	0.3
Marginal Quality	1	0.0
Poor Quality	1 862	66.1
Baseline Disturbance	420	14.9
Tamarack Project Footprint	375	13.3
Total	**2 819**	**100.0**

Sources: Al-Pac, Ivanhoe, Spatial Data Warehouse Ltd.

Path: S:\Gis\Projects\CE\IvanhoeEnergy\CE0374601_Tamarack_SIRs2\ArcGIS\Question 086\Fig12.05-04 (Rev2) MWF Bird.mxd

Ivanhoe Energy

Tamarack Project

Mixedwood Forest Birds Habitat Suitability Application Case

DATE: June 2012	Fig12.05-04 (Rev2) MWF Bird 12-06-27	
PROJECT: CE0374601	PROJECTION/DATUM: UTM Zone 12 NAD83	
ANALYST: TM	QA/QC: TJR MAJ EH	DRAWN BY: AMEC
		PREPARED BY: AMEC

Figure 12.5-4 (Rev2)

With respect to Old Growth Forest Bird Community.

d. Ivanhoe indicates in the discussion that a 300 metre buffer was applied around the CPF to account for sensory disturbance. This does not appear to be reflected in Figure 12.5-5. Explain and/or provide an updated figure.

A 300 m buffer around the CPF and revised habitat suitability calculations were applied in Figure 12.5-5 (Rev), as provided in Volume 4, to account for sensory disturbances. Figure 12.5-5 (Rev2) includes an outline of the 300 m buffer applied to the CPF and the well pads. Please refer to Volume 2, Figure 12.5-5 for comparison to the original model.

e. Ivanhoe provided a discussion of sound impacts in the mixed wood discussion; but, did not cover the topic similarly in the old growth discussion. Provide this discussion.

Habitat use by forest birds is greatly dependent on species-specific tolerances to disturbance. Project facilities such as the CPF, the construction camp, and the main access road will experience high levels of human activity. Old growth habitat that may be impacted by sensory disturbance occurs in the northeast corner of the CPF, which will operate at noise levels up to 95 dBA.

Operational noise levels on well pads are not expected to exceed 65 dBA, which is lower than the threshold identified in Bayne *et al.* (2008), and therefore impacts to the old growth forest bird community are not anticipated. In order to be conservative, Ivanhoe applied a 300 m buffer to all well pads in addition to the 300 m buffer applied to the CPF in Volume 4, Figure 12.5-5 (Rev). The addition of the 300 m buffer around the well pads results in a loss of 14 ha of high quality habitat and 59 ha of good quality habitat (Figure 12.5-4 (Rev2)). The loss of habitat effectiveness is expected to be low for the old growth bird community as the majority of old growth habitat present in the TLSA is located outside of the 300 m buffer for the CPF and well pads. All other Project facilities will experience lower levels of noise and human activity and use of old growth forest habitats by specialist old growth bird species in these areas is expected to continue where suitable foraging and nesting sites are available as avoidance is not usually associated with small or narrow forest clearings or where human activity levels remain low (Dellasala 1986).

Literature Cited:

Bayne, E.M., L. Habib and S. Boutin. 2008. *Impacts of Chronic Anthropogenic Noise from Energy-Sector Activity on Abundance of Songbirds in the Boreal Forest*. Conservation Biology 22(5): 1186-1193.

Dellasala, D.A. 1986*. Response of Three Songbird Species to Forest Disturbances in Large Tracts of Northern Hardwoods*. Ph.D. thesis, University Of Michigan.

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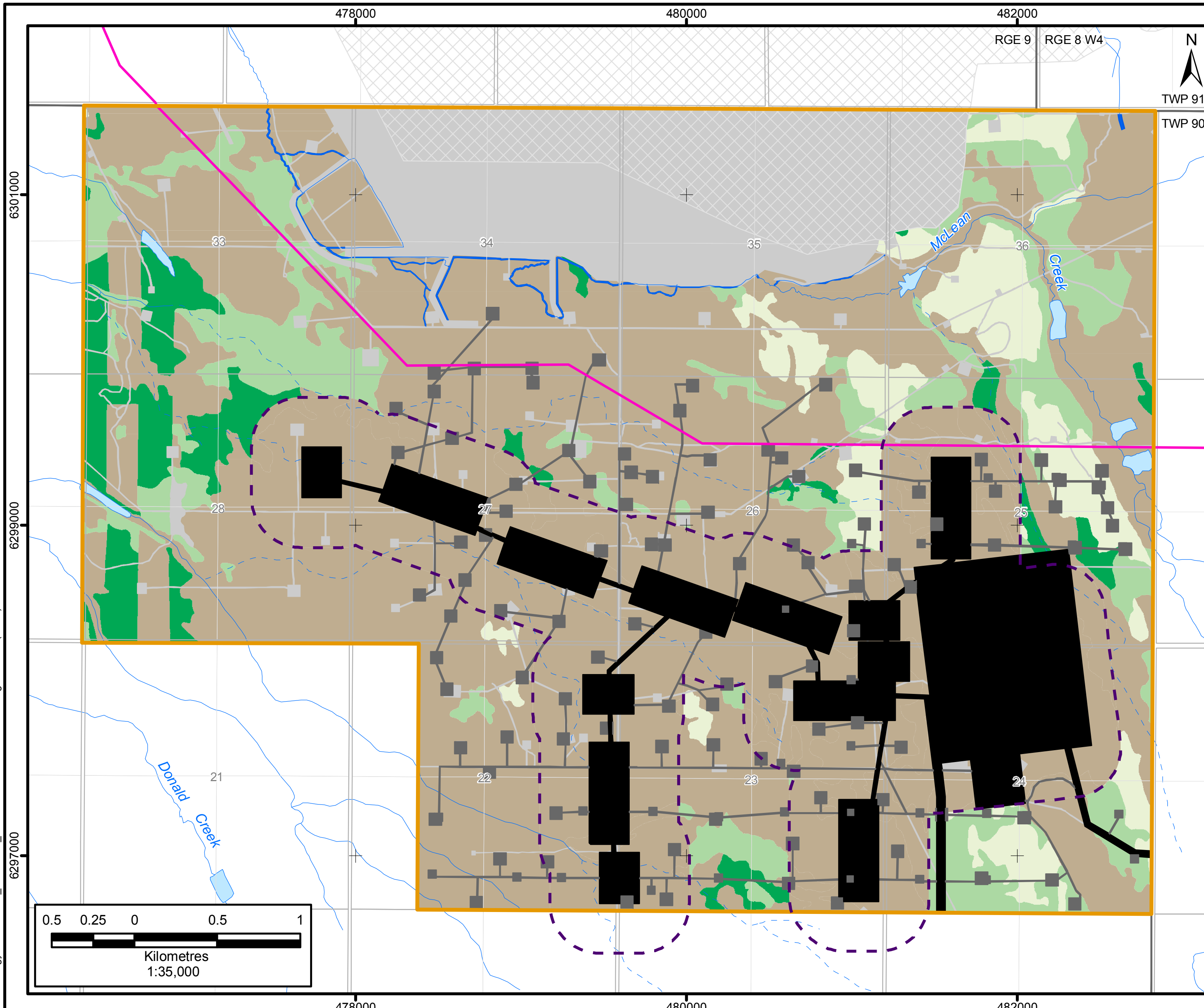

Sources: Al-Pac, Ivanhoe, Spatial Data Warehouse Ltd.

Legend

- Terrestrial LSA
- Tamarack Project Footprint
- Tamarack Other Disturbance
- Baseline Disturbance
- Suncor South Tailings Pond
- Open Water
- Watercourse
- No Defined Channel
- Suncor South Tailings Pond Diversion Ditch
- Suncor MSL044435 Boundary
- 300m Buffer

Habitat Suitability

- High Quality
- Good Quality
- Moderate Quality
- Marginal Quality
- Poor Quality

Habitat Suitability	Application Case	
	Area (ha)	% of LSA
High Quality	119	4.2
Good Quality	260	9.2
Moderate Quality	147	5.2
Marginal Quality	0	0.0
Poor Quality	1 499	53.2
Baseline Disturbance	420	14.9
Tamarack Project Footprint	375	13.3
Total	**2 819**	**100.0**

Path: S:\Gis\Projects\CE\IvanhoeEnergy\CE0374601_Tamarack_SIRs2\ArcGIS\Question 086\Fig12.05-05 (Rev2) OGF Bird.mxd

Ivanhoe Energy
Tamarack Project

Old Growth Forest Birds Habitat Suitability Application Case

DATE: June 2012
Fig12.05-05 (Rev2) OGF Bird 12-06-27
PROJECT: CE0374601
PROJECTION/DATUM: UTM Zone 12 NAD83
ANALYST: TM
QA/QC: TJR MAJ EH
DRAWN BY: AMEC
PREPARED BY: AMEC

Figure 12.5-5 (Rev2)

87. Volume 4, Supplemental Information Request #1, Response # 214 a, Page AENV-241.
Ivanhoe indicates that the minimum above-ground pipeline height will be 0.5 metres and did not provide the maximum and average pipeline heights as measured to the bottom of the pipeline as requested.
Ivanhoe also indicates that the detailed engineering for the above ground pipelines has not yet been completed and therefore the mitigation measures for above ground pipe have not been fully described. Without understanding how above-ground pipeline is being mitigated, it is not possible to understand how the project will affect large ungulates.

a. Provide the maximum and average pipeline heights as measured to the bottom of the pipeline as requested.

Using LiDAR and map analysis, the maximum pipeline height and the average height, as measured to the bottom of the pipeline, is 2.32 m and 1.07 m, respectively.

b. Provide Ivanhoe's targets for clearance under above ground pipe within each of the following categories: total length (m) and percentage (%) of above ground pipe with clearance greater than 1.4 m, 1.8 m, 2 m and 2.5 m.

Table SIR2 87-1 provides the requested information.

Table SIR2 87-1: Clearance Under Above Ground Pipe

Height (Ground to Bottom of Pipeline) (m)	Total Length (m)	% of Above Ground Pipe with Clearance > Height
<1.4	1 260.3	65.5%
1.4 to <1.8	548.6	28.5%
1.8 to <2.0	106.6	5.5%
2.0 to <2.5	8.2	0.4%
>2.5	0.0	0.0%
Total	**1 923.6**	**100.0%**

c. Provide a map of the above ground pipelines including related project infrastructure, wildlife habitat and areas targeted for mitigation.

Ivanhoe undertook a review of proposed pipeline heights in relation to the corridor topography using LiDAR data to assist in determining wildlife crossing locations in accordance with the *DRAFT Aboveground Pipelines Wildlife Crossing Design Standards April 26, 2012* currently under development by ASRD with input from industry. Figure SIR2 87-1 provides conceptual locations for above-ground pipeline crossing structure locations for wildlife. The figure has been plotted on the Habitat Suitability model for moose since moose is the largest mammal in the TLSA. The crossing locations are approximate and conceptual as the Project footprint may change, at which time suitable locations for crossing structures will be re-evaluated based on the new Project footprint. The crossing structure locations will allow for wildlife movement either underneath or over top of the pipeline. Of the seven pipeline crossing identified for Phase 1, five are expected to be under pipe crossings (Crossings #1, 3, 5, 6, and 7) and two are expected to be above pipe crossings (Crossings #2 and 4).

Final locations will be determined following detailed pipeline design and site specific reconnaissance surveys.

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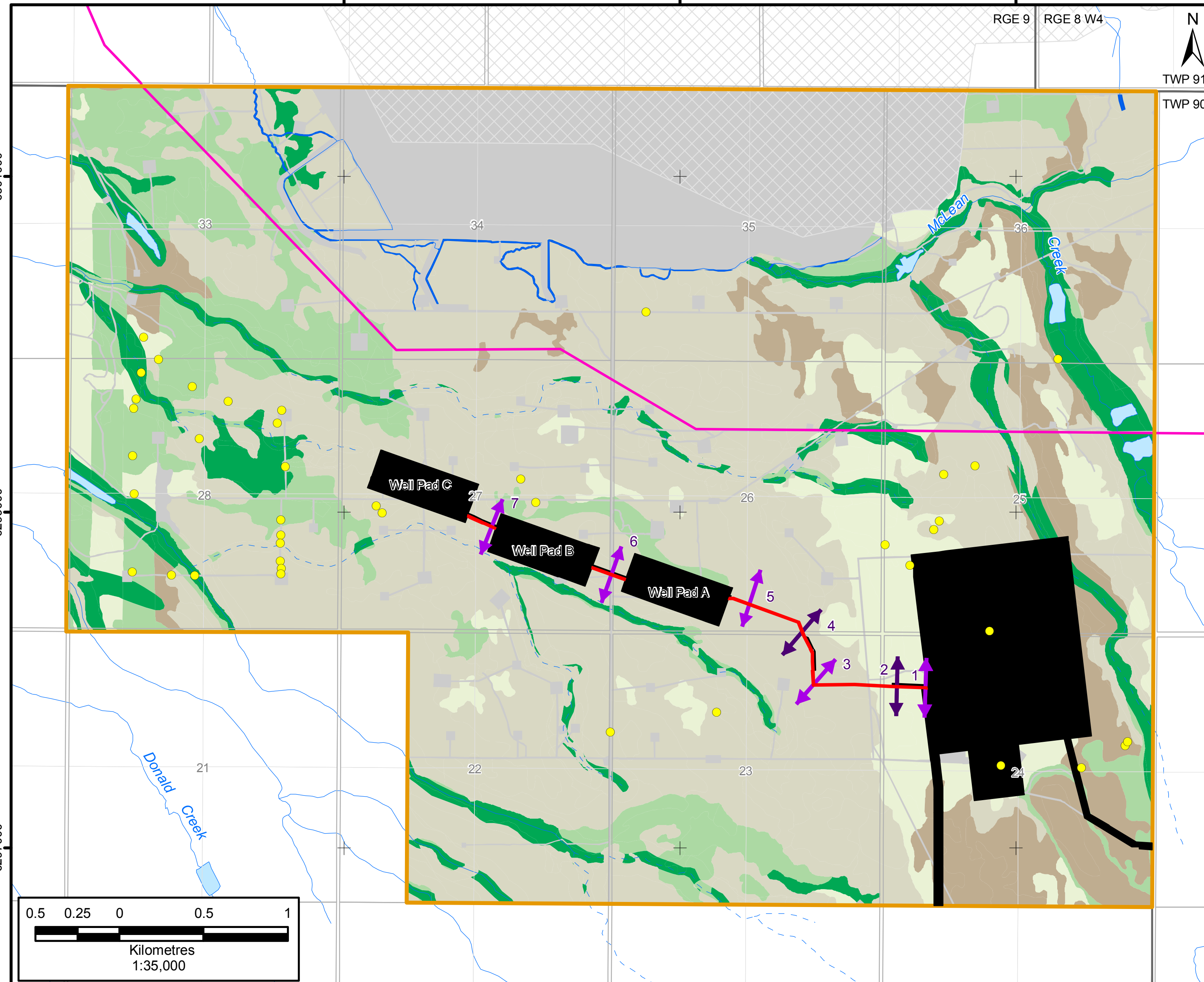

Legend

- Terrestrial LSA
- Tamarack Project Above Ground Pipeline
- Tamarack Project Footprint
- Baseline Disturbance
- Suncor South Tailings Pond
- Open Water
- Watercourse
- No Defined Channel
- Suncor South Tailings Pond Diversion Ditch
- Suncor MSL044435 Boundary

Habitat Suitability

- High Quality
- Good Quality
- Moderate Quality
- Marginal Quality
- Poor Quality
- Moose

Conceptual Pipeline Crossing Structure Location

- Above Ground
- Below Ground

Habitat Suitability	Application Case	
	Area (ha)	% of LSA
High Quality	191	6.8
Good Quality	301	10.7
Moderate Quality	202	7.1
Marginal Quality	1 134	40.2
Poor Quality	200	7.1
Baseline Disturbance	420	14.9
Tamarack Project Footprint	371	13.2
Total	**2 819**	**100.0**

Sources: Al-Pac, Ivanhoe, Spatial Data Warehouse Ltd.

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Ivanhoe Energy

Tamarack Project

Locations of Conceptual Wildlife Pipeline Crossings - Phase 1

DATE: June 2012			SIR-2 Question 087 Moose 12-06-29			
PROJECT: CE0374601			PROJECTION/DATUM: UTM Zone 12 NAD83			
ANALYST: TM	QA/QC: KW	CT	EH	DRAWN BY: AMEC	PREPARED BY: AMEC	

Figure SIR2 87-1

88. Volume 4, Supplemental Information Request #1, Response # 214 b, Page AENV-241.
Ivanhoe states that the distance between above-ground crossing opportunities will be 800 metres. For species which prefer either above-pipe or below-pipe crossings, this could result in functional spacing between crossings, provided the crossing type alternated, of up to 800 metres. In the event of numerous similar crossing types (e.g. four over-pipe ramps in a row); crossing opportunities for species that prefer the other crossing type could be kilometers apart.

a. Why was a maximum distance between crossings of 800 metres chosen? Provide data or studies that support this distance.

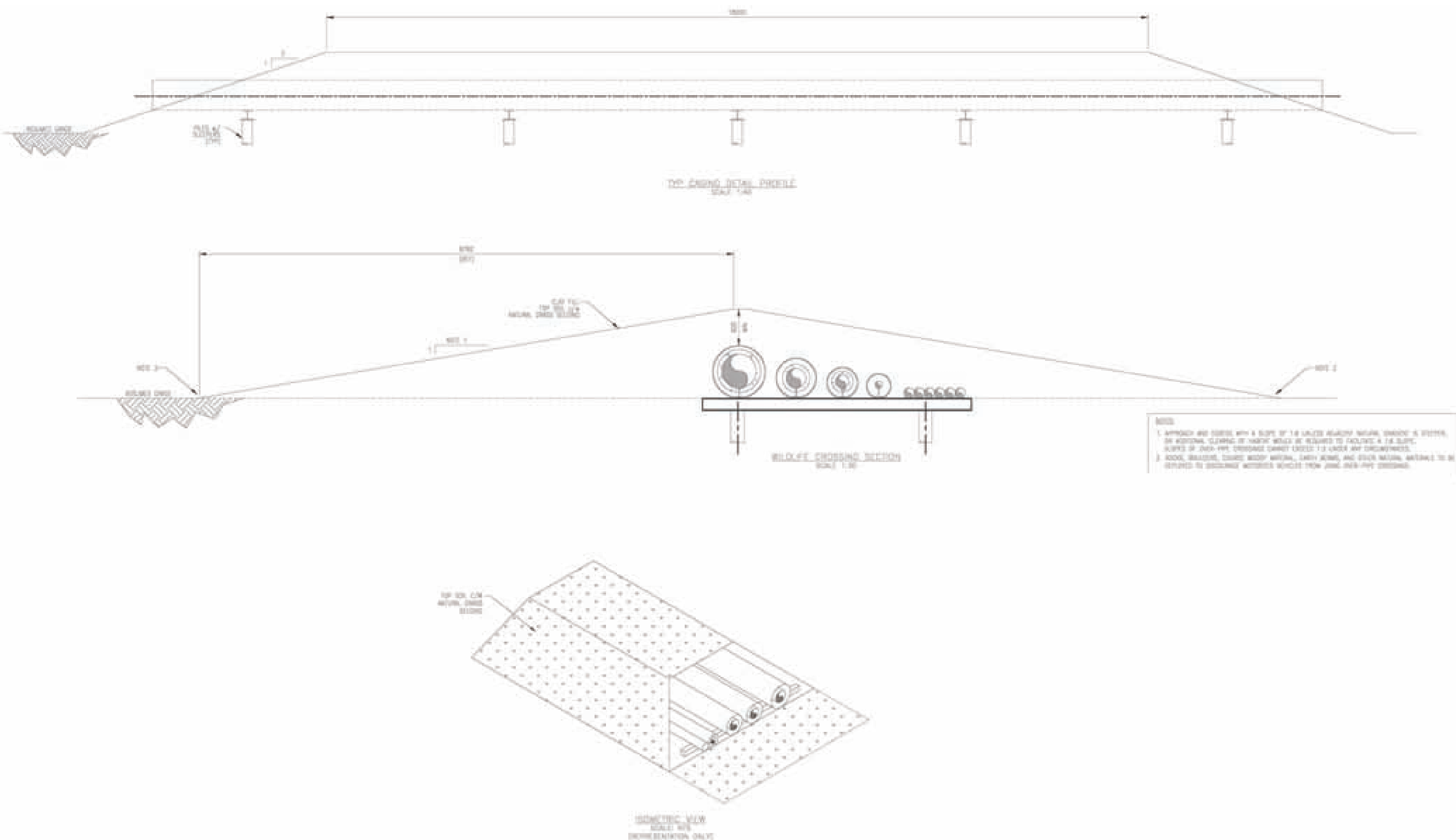
Ivanhoe has revised the pipeline crossing spacing for Phase 1 to be in accordance with the *DRAFT Aboveground Pipelines Wildlife Crossing Design Standards April 26, 2012*. Current design, provided in Figure SIR2 87-1, contemplates three crossings for every 1,000 m of continuous segment of pipeline.

b. If over-pipe crossing structures are to be used:

i. Provide a conceptual engineering drawing of the planned structure, incorporating design features based on published data and recommendations to facilitate overpipe crossing use.

A conceptual drawing of a wildlife overpipe crossing is shown on Figure SIR2 88-1. The following will be implemented for wildlife overpasses:

- *Location of Overpasses:* Overpass crossings will be strategically placed in areas of topographic highs, which are relatively consistent with natural grade, resulting in lower crossing heights and higher wildlife crossing success, as the crossing will be at an elevation relatively consistent with the surrounding environment. The structures will be located in areas where suitable wildlife habitat occurs on both sides of the crossing and oriented so wildlife are directed away from developed areas (i.e., CPF, well pads);
- *Intended Function*: The intended function of the overpipe crossings will be exclusively for wildlife;
- *Corrugated Steel Open-Culvert Design:* Strong corrugated steel culverts will be used to construct the overpasses to ensure the crossings are capable of handling the predicted total soil, vegetation and wildlife loads. The culvert material will be engineered for the intended purpose and will be resistant to corrosion. Providing the base is well constructed, a corrugated open culvert is less prone to differential settlement and will provide suitable stability to promote and establish vegetation growth;
- *Crossing Settlement Considerations:* Steel screw piles will be installed with precast concrete footings on both sides of the proposed crossings to secure the steel culvert in place. This will ensure that the crossing does not settle or slough over time and will reduce the potential for soil erosion;



Source: Ivanhoe. Taken from drawing titled “Typical Wildlife Pipeline Over-Crossing Sketch” dated June 22, 2012

Ivanhoe Energy

Tamarack Project

Conceptual Wildlife Overpipe Crossing Diagram

DATE: June 2012		SIR2-Fig088-01 12-06-29	**Figure SIR2 88-1**
PROJECT: CE0374601		DRAWN BY: AMEC	
ANALYST: TR	QA/QC: TM MJ EH	PREPARED BY: Ivanhoe	

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- *Width of Overpasses:* The overpass design will incorporate a minimum width of 8 m at the crest of the crossing. This proposed width will not deter wildlife from using the crossing and will be sufficient to allow wildlife movement over the above-ground pipeline;
- *Shape of Overpasses:* A parabolic shaped overpass design will be used to allow for uninterrupted line of sight for approaching wildlife;
- *Gently Sloped Access/Egress Approaches:* The crossing will incorporate a gentle slope (<1:6) on the access and egress approaches unless adjacent natural gradient is steeper or additional clearing of habitat would be required. Slopes for overpipe crossings cannot exceed 1:3 under any circumstances. This will allow wildlife to easily cross the overpasses and allow vegetation to be established on the slopes of the crossings;
- *Stabilization of Soils:* The overpasses will be vegetated with an approved ASRD seed mix to minimize soil erosion and promote soil stability. Established vegetation at the overpasses will also enhance wildlife crossing success, as the crossing will closely resemble that of the surrounding environment; and
- *Incorporate Additional Natural Attributes:* In addition to vegetating the crossings with species consistent with native plant communities, Ivanhoe proposes to place a limited amount of both deadfall and rocks directly on and surrounding the immediate overpass locations. The placement of deadfall and rocks will assist in making the crossings more natural and hopefully enhance wildlife crossing success.

ii. Clearly identify sources of information used.

Sources used for the conceptual crossing structure design include:

Clevenger, A., C. Apps, T. Lee, M. Quinn, D. Paton, D. Poulton, and R. Ament. 2010. *Appendix B: Mitigation Measure Information Sheets, Sheet J: Wildlife Overpasses.* In, Highway 3: Transportation Mitigation for Wildlife and Connectivity in the Crown of the Continent Ecosystem. 136 pp.;

DRAFT Aboveground Pipelines Wildlife Crossing Design Standards April 26, 2012;

Dunne, B.M. 2007. *Effectiveness of Above-ground Pipeline Mitigation for Moose (Alces alces) and Other Large Mammals*. Master's thesis, Faculty of Environmental Design, University of Calgary, Alberta. 146 pp.; and

Dunne, B.M. and M.S. Quinn. 2009. Effectiveness of Above-ground Pipeline Mitigation for Moose (*Alces alces*) and Other Large Mammals. *Biological Conservation* 142(2): 332-343.

89. Volume 4, Supplemental Information Request #1, Response # 214 c, Page AENV-241.

Ivanhoe was asked to discuss the effectiveness of the chosen over-pipe crossing design but simply stated that wildlife species found in the area, including bear, coyote, deer, lynx, moose, and wolf have been documented to use the over-pipe crossings of similar design. This does not clearly indicate effectiveness.

a. Provide a discussion that compares wildlife use of the proposed over-pipe structure to wildlife movement in a non-constrained environment assuming all other habitat factors to be similar.

Wildlife movement in any environment (constrained or non-constrained) is species-specific and varies based on the ability of an animal to traverse the landscape as well as by season (Monkkonen and Reunanen 1999; Tischendorf and Fahrig 2000). How a species responds to the different elements of a landscape will define movement patterns, as well as reactions to barriers. Ivanhoe relies on the research cited in SIR2 88b regarding the effectives of wildlife crossing to mitigate the potential impacts of wildlife movement across its Project Area. Ivanhoe has amended the wildlife crossing strategy to increase the frequency of crossings and to incorporate under-pipe crossings in accordance with the *DRAFT Aboveground Pipelines Wildlife Crossing Design Standards April 26, 2012* (see Figure SIR2 87-1). The effectiveness of this approach will be monitored as a condition of approval. Ivanhoe will prepare a long-term plan to monitor the responses of wildlife to above-ground pipelines and features associated with these pipelines.

b. Provide a discussion of wildlife use of the proposed over-pipe structure as compared to an under-pipe crossing opportunity with a 1.8 metre winter clearance along a 20-metre section of pipe assuming all other habitat factors to be similar.

See response to SIR2 85a.

Ivanhoe indicates that all interconnecting infrastructure, including pipelines, transmission lines, and access roads will be routed along a common corridor.

c. Discuss how this would result in an additive effect on permeability of the area for wildlife.

A wide common corridor will lessen the permeability of the area for wildlife as the wider the corridor, the more reluctant many wildlife species may be to cross (Clevenger *et al.* 2010; Tremblay and St. Clair 2009). However, the use of a common corridor results in less vegetation clearing and a minimized overall corridor widths due to the overlap of ROWs (see SIR2 89e).

d. Discuss the height of the proposed road grade and its potential effect on wildlife permeability. Discuss options which Ivanhoe could implement to reduce the road height and minimize this effect, and outline Ivanhoe's plans to do so.

The conceptual design of the proposed road includes a road embankment approximately 1.2 m high and 2:1 side slopes. In addition, culverts will be installed at all low points along the alignment and at regular intervals through wetland areas to provide cross-drainage. Breaks and crossing points in spoil piles as well as open ditches will be provided where possible. These design considerations will facilitate wildlife movement, particularly at sites where well established game trails have been observed. Roads with these characteristics have been used in the oil sands region and annual monitoring for other regional oil sands developments has shown limited road effects on interference with wildlife movement (Devon 2010). The detailed road design characteristics will be determined during the final engineering process.

e. How is Ivanhoe designing these multiple use corridors to minimize the combined ROW width?

The combined ROW, which is 44 m wide, requires separate corridors for transmission lines, a road, sales bitumen pipeline line, fuel gas and diluent pipelines and topsoil storage (see Volume 1, Section 3.3, Figure 3.3-7). To minimize the combined ROW width from multiple corridors, pipelines (i.e., fuel gas and diluent supply pipelines) have been placed in the same ROW and together on elevated pipe-racks.

f. What mitigation will Ivanhoe implement to reduce the functional ROW with respect to wildlife movement/permeability? Some examples include: will belowground pipeline ROWs be immediately and actively revegetated with the exception of the ditchline? Will transmission ROWs be immediately revegetated?

Ivanhoe will implement the following mitigation measures for wildlife movement and permeability to the ROW:

- linear corridor widths for access to well pads and other low use facilities will be minimized to the extent possible;
- existing linear corridors will be followed whenever possible in the design of access road and pipeline ROWs to minimize vegetation clearing and habitat fragmentation effects;
- 100 m riparian buffers around defined watercourses were established during constraints mapping and will be maintained to the extent practical to minimize impacts to riparian habitat;
- following construction, the pipeline ROWs will be re-vegetated immediately and actively with native vegetation species;
- on transmission lines, only trees and shrubs will be removed, however, the ground cover and root mat will remain intact;
- wildlife crossing of linear developments will be facilitated by the provision of crossings;

- wildlife crossings will be constructed under or over pipelines at regular intervals. Pipeline design will take advantage of existing terrain elevations for locations of wildlife crossings.; and
- speed limits will be 50 km/hr along well pad access roads in the Project Area.

g. With respect to bear use of the area discuss:

i. How Ivanhoe will meet the objectives of the provincial BearSmart program.

ii. How Ivanhoe will minimize the potential for bear-human interaction in these areas. Note - Fencing of camps and waste storage areas is a fairly cost-effective way of reducing the potential for bear-human interactions.

Ivanhoe will implement the recommendations and standard management practices for industry and industrial camps as outlined in the Alberta BearSmart Program Manual (Government of Alberta 2011). The following practices will be implemented to reduce the potential for bear-human interactions:

- all food wastes will be stored in bear-proof containers and fenced-off areas to prevent wildlife access to food wastes;
- all food wastes will be trucked off-site for disposal;
- speed limits on lease roads will be set at 50 km/hr;
- “no hunting” and “no fire arms” policies will be implemented for the Project;
- develop a “bear encounter” procedures for Ivanhoe employees and contractors and provide employees and other field personal with appropriate noise and physical non-lethal deterrents;
- work with the RFMA’s and local outfitters to educate them of Ivanhoe’s policies and procedures and coordinate efforts to reduce human-bear interactions;
- implement a Wildlife Siting Program for all employees and contractors and provide that information to AENV; and
- bear awareness will also be included in site orientations for all Project personnel.

Literature Cited:

Clevenger, A., C. Apps, T. Lee, M. Quinn, D. Paton, D. Poulton, and R. Ament. 2010. *Highway 3: Transportation Mitigation for Wildlife and Connectivity in the Crown of the Continent Ecosystem*. Calgary, Alberta. 136 pp.

Devon NEC Corporation (Devon). 2010. *Application for Approval of the Devon Jackfish 3 Project*. Submitted to the Alberta Energy Utilities Board and Alberta Environment. Calgary, Alberta.

Government of Alberta. 2011. *Alberta BearSmart Program Manual*. Pub No. I/307. Available at website: http://srd.alberta.ca/RecreationPublicUse/AlbertaBearSmart/documents/AlbertaBearSmart-ProgramManual-May2011.pdf.

Monkkonen, M. and P. Reunanen. 1999. *On Critical Thresholds in Landscape Connectivity: A Management Perspective*. Oikos. 84(2):302-305.

Tischendorf, L. and L. Fahrig. 2000. *On the Usage and Measurement of Landscape Connectivity*. Oikos. 90:7-19.

Tremblay, M.A. and C.C. St. Clair. 2009. *Factors Affecting the Permeability of Transportation and Riparian Corridors to the Movements of Songbirds in an Urban Landscape*. Journal of Applied Ecology 46: 1314-1322.

90. Volume 4, Supplemental Information Request #1, Response # 216 a, Page AENV-243.
Cumulative habitat loss is identified at 6.3% from baseline and an overall disturbance level of 27.9% of the TRSA. This would seem to indicate that a 28% decline in regional wildlife populations could be expected based solely on the loss of habitat.

a. Why is the impact rating for cumulative habitat loss moderate?

The cumulative habitat loss rating of moderate is incorrect. Based on baseline disturbance on 21.6% and a PDC addition of 6.3% of TRSA habitat loss, the increase in habitat loss from baseline is 29.2%. Using the assessment criteria for magnitude of the impact (Volume 2, Section 3.5.3), this change in habitat from baseline results in a high magnitude (i.e., measured or estimated impact represents a 10% or greater change in the receptor from baseline conditions) increase. The Project contribution to the cumulative effect remains low in magnitude (i.e., <1%).

b. What quantitative criteria were considered, and how was this modified by qualitative criteria?

Quantitative criteria that were considered included expected regional changes in habitat conditions (see Volume 2, Table 12.6-1) and habitat loss thresholds for wildlife (see Volume 2, Section 12.6.1 for discussion). The expected regional changes in habitat conditions were calculated using existing and planned disturbances for the region (habitat loss in hectares and in percent of TRSA). Habitat loss thresholds for a variety of wildlife species or species groups were extracted from scientific literature available at the time of application preparation. These quantitative criteria were not modified in any way by qualitative criteria.

c. Explain how professional judgment was factored in. Was a rationale provided for a rating of moderate as opposed to high or low?

Professional judgment was used in the subjective criteria for the identification and evaluation of impacts, as outlined in Volume 2, Section 3.5. Subjective criteria used in the assessment included the following:

- direction of the impact (i.e., positive, negative, or neutral);
- geographic extent of the impact (i.e., local or regional);
- duration of the impact (i.e., short-term, mid-term, or long-term);
- likelihood (i.e., low or high);
- reversibility (i.e., reversible or irreversible); and
- confidence (i.e., low, moderate, or high).

The final impact rating incorporated both objective (i.e., habitat loss, magnitude of the impact and habitat loss thresholds) and subjective (outlined above) criteria.

d. What scale of habitat loss would warrant a rating of high?

See SIR2 90a.

91. Volume 4: Supplemental Information Request #1, Response # 217 b, Page AENV-244.
Ivanhoe notes that a 2D seismic program is planned for the winter of 2011-2012. Based on this Ivanhoe will determine the need for 3D and 4D seismic programs to assist in planning and monitoring project performance and steam chamber evolution.

a. How was the planned 2D seismic program considered in the assessment of project impacts?

The 2D seismic program was completed in February – March 2012 so it was not contemplated or explicitly considered at the time that the assessment of Project impacts was completed. However, the Alberta Government has an established and defined process for the approval and management of seismic programs, which includes an environmental screening process to ensure that environmental impacts are assessed and managed, prior to approval. Ivanhoe, and its seismic contractor, complied with environmental screening as part of the regulatory approval process for the 2D seismic program.

b. If it was not considered, what additional impacts to fish and wildlife resources would be expected?

Low impact 2D seismic technology was used during the 2012 Winter Seismic Program. This technology resulted in a minimal disturbance that is quickly reclaimed back into the adjacent vegetation community.

There were no expected impacts to fish from the 2012 Winter Seismic Program, since no Code of Practice (AENV 2007) water crossings were required. Impacts to wildlife are expected to be negligible based on the adherence to the conditions of approval. Mitigation measures included:

- eliminating continuous lines of sight at approaches to road, pipeline and powerline ROW;
- allowing the land to revegetate through natural processes without seeding;
- no energy sources allowed on watercourses or water bodies;
- fulfill requirements of program reclamation and apply for a letter of clearance within two full growing seasons, unless an extension is applied for;
- conducting the program outside of buffer zones, including watercourses or water bodies, riparian areas and wildlife corridors;
- seismic lines were cut to a 2.75 m width using mulching equipment to minimize footprint;
- recording was helicopter assisted with no new cut pads were constructed;
- garbage was taken to an approved landfill; and
- no campsites were constructed.

c. How were potential 3D and 4D seismic impacts considered in the assessment of project impacts?

Ivanhoe has no plans to conduct a 3D or 4D seismic program.

d. If they were not considered, what additional impacts to fish and wildlife would be expected?

See response to SIR2 91c.

e. If Ivanhoe uses industry standard grid spacing and periodicity for 3D and 4D seismic, what is the cumulative fragmentation level for the TRSA?

See response to SIR2 91c.

Literature Cited:

Alberta Environment (AENV). 2007. *Code of Practice for Watercourse Crossings*. Alberta Environment, Edmonton, Alberta.

Bayne, E.M., S. Van Wilgenburg, S. Boutin, and K.A. Hobson. 2005. *Modeling and Field-Testing of Ovenbird (Seiurus Aurocapillus) Responses to Boreal Forest Dissection by Energy Sector Development at Multiple Spatial Scales*. Landscape Ecology 20: 203-216.

Houle, M., D. Fortin, C. Dussault, R. Courtois, and J-P. Ouellet. 2010. *Cumulative Effects of Forestry on Habitat Use by Gray Wolf (Canus Lupus) in the Boreal Forest*. Landscape Ecology 25: 419-433.

Linke, J., S.E. Franklin, F. Huettmann, and G.B. Stenhouse. 2005. *Changing Landscape Metrics and Grizzly Bear Landscape use in Alberta*. Landscape Ecology 20: 811-826.

Linke, J., S.E. Franklin, F. Huettmann, and G.B. Stenhouse. 2008. *Effects of Cut Line Density and Land-Cover Heterogeneity on Landscape Metrics in Western Alberta*. Canadian Journal of Remote Sensing 34: 390-404.

HEALTH

92. Volume 4: Supplemental Information Request #1, Response #70, Page AENV-27. In Table SIR 70-1, Ivanhoe provides construction phase emissions

a. Discuss how these emissions compare with the predicted operating emission.

Table SIR2 92-1 provides a comparison of the construction phase and operating phase emissions. The construction phase emissions range from 0% to 52% of the operations phase emissions. The operating phase emissions for NO_x reflect the conservative values assessed in the EIA.

Table SIR2 92-1: Comparison of Construction Phase and Operating Phase Emissions

Pollutant	Operating Phase Emissions (t/d)	Construction Phase Emissions (t/d)	Construction Emissions as a Percentage of Operating Phase Emissions
SO_2	12.99	0.00	0.0
NO_x	14.40	0.28	1.9
CO	5.18	0.12	2.3
PM	0.42	0.02	4.8
VOC	0.29	0.15	51.7
CO_2e	3 830	32.30	0.8

b. Discuss the potential human health impact associated with the construction phase emissions.

It is expected that the emissions due to the construction phase of the Project will be less than the emissions from the operational phase. The construction phase of the Project will involve vegetation clearing and grading of the CPF area and the individual injection/extraction pads. After clearing, the facilities will be constructed as described in the application:

> *"Process equipment enclosures will consist of prefabricated self supporting enclosures or rigid frame field installed enclosures. Prefabricated enclosures will be installed and shipped as a complete skid package to site. This will reduce the field construction time required for building assembly (Volume 1, Section 2.3)."*

Because of these activities, construction equipment on the site will be a limited amount of heavy equipment, which will be utilized for site clearing and grading or for moving of the prefabricated enclosures into place. This will also decrease the amount of time that the equipment will be operating on the site. Therefore, the emissions from construction should be markedly lower by comparison to those from the operational Project facility. Human health impacts will be reduced proportionally from the operational phase.

93. Volume 4: Supplemental Information Request #1, Response #225a, Page AENV-254.

Ivanhoe states, "*Carcinogenic PAH profiles are provided in Appendix L of Volume 3.*" Appendix L2 does not include a toxicity profile for a Carcinogenic PAH group.

a. Provide the TEFs used to assess the carcinogenic PAH group and the calculations used to estimate concentrations for this group.

Carcinogenic PAHs profiles were provided in Volume 3, Appendix L and the Total B(a)P Equivalency was calculated as follows:

where:

Total B(a)PE= total benzo(a)pyrene equivalency
$[PAH_i]$ = concentration of carcinogenic PAH*i*
TEF_i = benzo(a)pyrene toxic equivalency factor for carcinogenic PAH_i

Specifically, the concentration of each carcinogenic PAH within the various environmental media (e.g., soil, water) were multiplied by their corresponding benzo(a)pyrene toxicity equivalent factor (TEF) to derive a B(a)P toxic equivalency. The TEF values are shown in Table SIR2 93-1. These equivalencies were then summed to determine the Total B(a)P toxic equivalency for that specific environmental media. These Total B(a)P toxic equivalencies were then evaluated against the Total B(a)P equivalency toxicological reference value (TRV). The benzo(a)pyrene TEFs and the Total B(a)P TRV were sourced from Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV 2009).

Table SIR2 93-1: Carcinogenic PAHs Toxic Equivalent Factors

Carcinogenic PAHs Compound	TEF
Benzo(a)anthracene	0.1
Benzo(b+j)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Benzo(ghi)perylene	0.01
Benzo(a)pyrene	1.0
Chrysene	0.01
Dibenzo(ah)anthracene	1.0
Indeno(123-cd)pyrene	0.1

Literature Cited:

Alberta Environment (AENV). 2009, *Alberta Tier 1. Soil and Groundwater Remediation Guidelines*. Environmental Policy Branch, Environmental Assurance Division, February 2009.

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94. Volume 4: Supplemental Information Request #1, Response #230a, Page AENV-259.
Ivanhoe states, "*Those COPCs not discussed in the appendix are provided below.*" A profile for particulate matter was not provided. Other toxicity profiles are not complete.

a. Provide a toxicity profile for particulate matter.

<u>Particulate Matter</u>

PM is a complex mixture with components having diverse chemical and physical characteristics, generally classified by their aerodynamic properties.

The epidemiological evidence on PM is substantial, comprising hundreds of reports. The range of adverse health effects linked to exposure to ambient particulate pollution has broadened, and now includes not only increased short- and long-term mortality but risk for both adverse respiratory and cardiovascular outcomes.

These effects mainly involve production of an inflammatory response, exacerbation of existing airway disease (e.g., hyper-reactivity) or impairment of pulmonary defence mechanisms. Inhaled PM may increase the production of antigen-specific immunoglobulins, alter airway reactivity to antigens or affect the ability of the lungs to handle bacteria, suggesting that exposure may result in enhanced susceptibility to microbial infection. Inflammation is considered central to producing many of the health effects attributed to PM. Inflammation can be produced by oxidative stress via redoxsensitive transcription factors, and numerous studies have demonstrated the ability of PM and surrogates to cause oxidative stress (WHO 2005a).

The respiratory tract is the portal of entry for inhaled particles and, consequently, clinical or subclinical effects in the respiratory tract may be reflected in subsequent events in other systems, or particles may be translocated outside of the respiratory tract without producing any observable pulmonary response. One potential pathway for extrapulmonary effects of PM is via systemic transport of cytokines produced in the lungs during an inflammatory response. Another potential pathway is through effects on coagulation properties that lead to increased risk of stroke or myocardial infarction. PM may also result in endothelial and general vascular dysfunction and chronic exposure may increase the progression of atherosclerosis (WHO 2005a).

An ambient air criteria of 25 $\mu g/m^3$ for 24-hr period has been adopted by WHO (2005b) for $PM_{2.5}$ exposures based on evidence from epidemiological studies. This value was used to re-assess the acute exposures for $PM_{2.5}$ concentrations. For chronic exposure to $PM_{2.5}$, the WHO annual exposure value of 10 $\mu g/m^3$ was used to assess chronic risks. This chronic value represents the lower end of the range over which significant effects on survival were observed in the American Cancer Society's (ACS) study.

Because the WHO values are the lowest guidelines available, they were used in the current assessment for $PM_{2.5}$ exposures (see SIR2 95b).

b. Complete the toxicity profile for the aliphatic and aromatic hydrocarbon to include the inhalation TRVs. Include calculations and references.

See Table SIR2 94-1. Route extrapolation calculations from oral to inhalation are not provided because actual chronic inhalation values have been provided.

Table SIR2 94-1: Toxicological Reference Values for TPH Fractions

Chemical	Agency	Tolerable Daily Intake mg/kg-day		Tolerable Concentration mg/m^3		Relative Absorption Factor		
		Oral	Dermal	Acute Inhalation	Chronic Inhalation	Ingestion	Dermal	Inhalation
F2 Aliphatic C_{10}-C_{12}	CCME (2008)	0.1	NA	NA	1.0	1	NA	1
	TRV for Assessment	0.1	NA	NA	1.0	1	NA	1
F2 Aliphatic C_{12}-C_{16}	CCME (2008)	0.1	NA	NA	1.0	1	NA	1
	TRV for Assessment	0.1	NA	NA	1.0	1	NA	1
F2 Aromatic	CCME (2008)	0.04	NA	NA	0.2	1	NA	1
	TRV for Assessment	0.04	NA	NA	0.2	1	NA	1

Note:
NA – not available.

Literature Cited:

Canadian Council of Ministers of the Environment (CCME). 2008. *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil*.

World Health Organization (WHO). 2005a. *Air Quality Guidelines: Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide*. Global Update 2005.

World Health Organization (WHO). 2005b. *Air Quality Guidelines: Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide*. Global Update 2005. Summary of Risk Assessment.

95. Volume 4: Supplemental Information Request #1, Response #233a, Page AENV-262.
Ivanhoe states, "*Risks associated with $PM_{2.5}$ were not re-assessed since the Canada Wide Standards (CWS) TRV used in the application was developed in part on considerations to potential impacts to public health*." The CWS for $PM_{2.5}$ was developed as a target for reduction of air pollutants in areas of concern. The CSW also describes the implementation of "*continuous improvement, pollution prevention, and keeping-clean areas-clean programs in areas with ambient concentrations below the CWS levels*" The CSW states that for areas with air quality below the CSW "*it would be wrong to convey the impression that no action is required in these areas or that it would be acceptable to allow pollutant levels to rise to the CWS levels.*" This indicates that the CWS may not be the best choice for the assessment of potential human health effects for a new development. More conservative, health based guidelines are available from US EPA (2005), WHO (2005), CARB and NAAQO.

a. Explain why the less conservative CWS was selected for the HHRA instead the more conservative objectives selected by three other jurisdictions for the protection of human health.

The Canada-Wide Standard (CWS) was selected because it is applicable in Alberta, whereas objectives from other jurisdictions are not. The CWS is developed for the Canadian environment taking into account background PM data. Alberta's AAAQO are consistent with CWS. Using these standards has been consistently applied in previous and current health assessments submitted to and approved by the Alberta Government.

b. Provide an assessment of potential human health effects using a TRV more appropriate to the region and justify the TRV chosen.

Table SIR2 95-1 provides a $PM_{2.5}$ assessment based on WHO (2005), the most conservative of the referenced guidelines, in comparison to the AAAQO results from the EIA.

Table SIR2 95-1: Revised $PM_{2.5}$ Hazard Quotient Using the Daily 24-hour WHO and AAAQO Guidelines

Receptor	Baseline		Application		PDC	
	AAAQO	WHO	AAAQO	WHO	AAAQO	WHO
FMT1	0.2	0.3	0.2	0.3	0.3	0.3
MC	1.1	1.4	1.1	1.4	1.3	1.6
DC	0.9	1.0	0.9	1.1	1.0	1.2
FMK	1.1	1.4	1.2	1.4	1.3	1.6
FMT2	1.0	1.2	1.0	1.2	1.2	1.4
BL	1.0	1.2	1.0	1.2	1.1	1.3
AR	1.0	1.1	1.0	1.1	1.0	1.2
BC	1.2	1.5	1.2	1.5	1.4	1.6
DSC	0.8	1.0	0.8	1.0	0.9	1.0
FC	0.9	1.1	0.9	1.1	1.0	1.2
WC	0.9	1.1	0.9	1.1	1.0	1.2
FMM	0.8	0.9	0.8	1.0	1.3	1.6
AC	0.5	0.6	0.5	0.6	0.6	0.7
GWC	0.9	1.1	0.9	1.1	1.1	1.3
GEC	0.9	1.1	1.0	1.1	1.0	1.2
TC	1.1	1.3	1.1	1.3	1.1	1.4
KL	1.0	1.2	1.0	1.2	1.0	1.2
FMT	0.4	0.5	0.5	0.5	0.6	0.7
LWC	0.9	1.0	0.9	1.0	0.9	1.1
LEC	0.7	0.9	0.7	0.9	0.8	0.9
MPOI	5.5	6.6	5.5	6.6	10.4	12.4

Results of the $PM_{2.5}$ assessment for numerous locations are marginally higher than the threshold value of 1.0. This is a reflection of using a more conservative TRV, combined with conservative assumptions in the air quality modelling. Despite the higher result for the maximum point of impingement (MPOI), the Project itself does not increase the risk to human health since the application results are not greater than the baseline result.

Table SIR2 95-2 provides a $PM_{2.5}$ assessment for chronic exposure, based on WHO (2005). Note, AAAQO does not provide an annual (chronic) $PM_{2.5}$ hazard quotient and, therefore, comparison to WHO guidelines is not possible.

Table SIR2 95-2: $PM_{2.5}$ Hazard Quotient Using Annual (Chronic) WHO Guidelines

Receptor	Baseline	Application	PDC
FMT1	0.05	0.1	0.1
MC	0.4	0.4	0.4
DC	0.3	0.3	0.4
FMK	0.5	0.5	0.6
FMT2	0.5	0.5	0.6
BL	0.4	0.4	0.5
AR	0.5	0.5	0.5
BC	0.6	0.6	0.7
DSC	0.3	0.3	0.4
FC	0.4	0.4	0.4
WC	0.5	0.5	0.5
FMM	0.4	0.4	0.6
AC	0.2	0.2	0.2
GWC	0.4	0.4	0.6
GEC	0.4	0.4	0.5
TC	0.5	0.5	0.5
KL	0.5	0.5	0.5
FMT	0.1	0.1	0.2
LWC	0.4	0.4	0.5
LEC	0.3	0.3	0.3
MPOI	3.7	3.7	7.1

Results of the chronic $PM_{2.5}$ assessment for all locations other than MPOI, are lower than the threshold value of 1.0, despite using a more conservative TRV, combined with conservative assumptions in the air quality modelling. The Project itself does not increase the risk to human health since the application results are not greater than the baseline result.

Literature Cited:

World Health Organization (WHO). 2005. *Air Quality Guidelines: Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide*. Global Update 2005. Summary of Risk Assessment.

96. Volume 4: Supplemental Information Request #1, Response #239a, Page AENV-268.

Ivanhoe states that the MPOI was not assessed for $PM_{2.5}$ because it is not "*a static location but would change daily depending on emissions and meteorological conditions*." This is true for the predicted air concentrations of all contaminants estimated for the MPOI.

a. Calculate and discuss the potential risk of exposure to $PM_{2.5}$ at the MPOI.

See response to SIR2 95b.

97. Volume 4: Supplemental Information Request #1, Response #242, Page AENV-271. Ivanhoe did not address the $PM_{2.5}$ results which indicated that the highest concentrations were not at the MPOI. Instead they have removed the MPOI location for $PM_{2.5}$ from the HHRA. Thus, information has not been provided for the original SIR.
The MPOI is a hypothetical location designed to represent a highly conservative estimate of potential exposure for each chemical, so as to represent the highest potential risk.

a. Provide results for all receptor locations including the MPOI.

See response to SIR2 95b.

b. Explain and resolve the discrepancy where results of the SUM15 assessment at some receptor locations are greater than the MOPI.

There is an error in the result table for the SUM15 $PM_{2.5}$ risks. The MPOI values were not evaluated for the SUM15 and a revised table is provided (Table 18.5-2 (Rev)).

Table 18.5-2 (Rev): Changes in Mortality and Hospital Admissions Risks Due to Exposures to $PM_{2.5}$ Above Canada Wide Standards (per 1 000 000)

Receptor Location	SUM15 ($PM_{2.5}$)								
	Mortality			RHA			CHA		
	Baseline	Application	Planned Development	Baseline	Application	Planned Development	Baseline	Application	Planned Development
AC	0.00000	0.00000	2.78972	0.00000	0.00000	1.28223	0.00000	0.00000	1.09163
AR	1.73066	1.88565	3.02220	0.79546	0.86669	1.38909	0.67722	0.73786	1.18260
TC1	4.54622	4.64954	2.09229	2.08956	2.13705	0.96167	1.77895	1.81938	0.81872
BL	1.91148	1.98897	0.56828	0.87857	0.91418	0.26120	0.74797	0.77829	0.22237
TC2	0.07749	0.12915	0.28414	0.03562	0.05936	0.13060	0.03032	0.05054	0.11118
TC3	0.18082	0.18082	0.61994	0.08311	0.08311	0.28494	0.07075	0.07075	0.24258
TC4	0.64577	0.69743	0.90408	0.29681	0.32056	0.41554	0.25269	0.27291	0.35377
FMK	3.92628	4.10709	0.36163	1.80462	1.88773	0.16622	1.53637	1.60712	0.14151
FMM	0.41329	0.43912	0.10332	0.18996	0.20183	0.04749	0.16172	0.17183	0.04043
FMT	0.00000	0.00000	0.12915	0.00000	0.00000	0.05936	0.00000	0.00000	0.05054
FMT1	0.00000	0.00000	1.39486	0.00000	0.00000	0.64112	0.00000	0.00000	0.54582
FMT2	2.89305	3.12552	2.37643	1.32972	1.43658	1.09227	1.13206	1.22303	0.92991
TC5	0.41329	0.46495	18.52066	0.18996	0.21371	8.51260	0.16172	0.18194	7.24722
TC6	0.36163	0.38746	0.54245	0.16622	0.17809	0.24932	0.14151	0.15162	0.21226
KL	0.67160	0.67160	1.47235	0.30869	0.30869	0.67673	0.26280	0.26280	0.57614
TC7	0.36163	0.38746	0.00000	0.16622	0.17809	0.00000	0.14151	0.15162	0.00000
TC8	0.64577	0.67160	0.00000	0.29681	0.30869	0.00000	0.25269	0.26280	0.00000
TC9	2.50558	2.63474	0.59411	1.15164	1.21100	0.27307	0.98045	1.03098	0.23248
TC10	1.03323	1.03323	0.12915	0.47490	0.47490	0.05936	0.40431	0.40431	0.05054
TC11	1.70483	1.85982	0.20665	0.78359	0.85482	0.09498	0.66711	0.72775	0.08086

Notes:

FMT1 - Fort McKay First Nation, FMK - Fort McKay, FMT2 - Fort McKay First Nation, BL - Beaver Lake, AR - Athabasca River, FMM - Fort McMurray, AC - Athabasca Chipewyan, KL - Kearl Lake, FMT - Fort McMurray First Nation, TC1 to TC11 - Trappers' Cabins.

RHA – Respiratory Hospital Admissions.

CHA – Cardiac Hospital Admissions.

98. Volume 4: Supplemental Information Request #1, Response #246, Page AENV-285. In Table SIR 246-2, carcinogens were ranked with non-carcinogens and the reference sources for the toxicity data were not provided. Some chemicals included in Appendix L1 were not included in the tables provide with the SIR 246 (e.g., 7,12 dimethylbenz[a]anthracence).

a. Screen carcinogens and non-carcinogens separately for chronic inhalation.

For the application and the SIR responses, carcinogenic and noncarcinogenic chemicals were screened separately. However, some chemicals (i.e., benzene, B(a)P, and arsenic) exhibit both carcinogenic and non-carcinogenic effects and, therefore, are present on both screening lists. Table SIR2 98-1 summarizes the results of the non-carcinogenic chemicals screening. Screening of carcinogenic chemicals by chronic inhalation, including naphthalene, is provided in Table SIR2 98-2.

Table SIR2 98-1: Non-Carcinogenic Chemicals Inhalation Exposure Screening

Chemicals	Total Emission	RfC (mg/m^3)	Toxicity Potency	Weighting	Cumulated Toxicity Potency
NO_x	**2.47E+02**	**6.00E-02**	**4116.66667**	**7.60E-01**	**0.76**
SO_2	**2.92E+01**	**3.00E-02**	**973.33333**	**1.80E-01**	**0.94**
Manganese	**9.00E-03**	**4.00E-05**	**225.00000**	**4.16E-02**	**0.98**
Arsenic	**4.40E-04**	**1.50E-05**	**29.33333**	**5.42E-03**	**0.99**
CO	8.91E+01	6.00E+00	14.85000	2.74E-03	0.99
Aluminum	7.40E-02	5.00E-03	14.80000	2.73E-03	0.99
Formaldehyde	3.83E-02	3.00E-03	12.76667	2.36E-03	0.99
Mercury	2.20E-04	3.00E-05	7.33333	1.35E-03	1.00
Aromatic	2.38E-01	2.00E-01	1.19000	2.20E-04	1.00
Aliphatic C_5-C_8	8.63E-01	2.00E-01	4.31500	7.97E-04	1.00
Aliphatic C_9-C_{18}	5.09E-01	2.00E-01	2.54500	4.70E-04	1.00
Benzene	4.35E-02	2.00E-02	2.17500	4.02E-04	0.00
H_2S	4.30E-03	2.00E-03	2.15000	3.97E-04	1.00
Lead	2.60E-03	1.50E-03	1.73333	3.20E-04	1.00
n-hexane	9.20E-01	6.70E-01	1.37313	2.54E-04	1.00
n-pentane	1.33E+00	1.00E+00	1.33000	2.46E-04	1.00
Benzo (a) pyrene	6.13E-07	5.00E-07	1.22600	2.26E-04	1.00
COS	6.07E-04	5.00E-04	1.21400	2.24E-04	1.00
Xylenes	4.77E-02	1.00E-01	0.47700	8.81E-05	1.00
Toluene	1.23E-01	3.00E-01	0.41000	7.57E-05	1.00
Naphthalene	3.12E-04	3.00E-03	0.10400	1.92E-05	1.00
Phenanthrene	8.69E-06	1.00E-04	0.08690	1.60E-05	1.00
Dichlorobenzene	6.13E-04	8.00E-03	0.07663	1.42E-05	1.00
Ethyl Benzene	2.01E-02	1.00E+00	0.02010	3.71E-06	1.00
2-Methyl Naphthalene	1.23E-05	6.00E-03	0.00205	3.79E-07	1.00
CS2	5.56E-04	7.00E-01	0.00079	1.47E-07	1.00
Benzo (g,h,i) perylene	6.13E-07	1.20E-02	0.00005	9.43E-09	1.00
Acenaphthylene	9.19E-07	3.50E-02	0.00003	4.85E-09	1.00
Pyrene	2.56E-06	1.00E-01	0.00003	4.73E-09	1.00
Fluoranthene	1.53E-06	1.40E-01	0.00001	2.02E-09	1.00
Fluorene	1.43E-06	1.40E-01	0.00001	1.89E-09	1.00
Acenaphthene	9.19E-07	2.10E-01	0.00000	8.08E-10	1.00
Anthracene	1.23E-06	1.00E+00	0.00000	2.27E-10	1.00

Note: Chemicals representing 99% of the total toxic potency have bolded text and shaded boxes

Table SIR2 98-2: Carcinogenic Chemicals Inhalation Exposure Screening

Chemicals	Total Emission	Unit Risk	Risk Specific Dose	Toxicity Potency	Weighting	Cumulated Toxicity Potency
Arsenic	**4.40E-04**	**28**	**3.6E-07**	**1232.00000**	**0.73890586**	**0.73890586**
Benzene	**4.35E-02**	**0.1**	**1.0E-04**	**435.00000**	**0.26089614**	**0.99980200**
Benzo (a) pyrene	6.13E-07	3.08	3.2E-06	0.18880	0.00011324	0.99991524
Dibenzo(a,h) anthracene	6.13E-07	1.2	8.3E-06	0.07356	0.00004412	0.99995936
Benzo (k) fluoranthene	9.19E-07	0.39	2.6E-05	0.03584	0.00002150	0.99998086
Benzo (a) anthracene	9.19E-07	0.11	9.1E-05	0.01011	0.00000606	0.99998692
Benzo (b) fluoranthene	9.19E-07	0.11	9.1E-05	0.01011	0.00000606	0.99999298
Indeno(1,2,3-cd)pyrene	9.19E-07	0.11	9.1E-05	0.01011	0.00000606	0.99999904
Chrysene	9.19E-07	0.011	0.000909	0.00101	0.00000061	0.99999965
7,12-Dimethylbenz(a)anthracene	8.18E-06	7.10E-04	1.4E-02	0.00058	0.00000035	1.00000000
Naphthalene	3.12E-04	3.40E-08	294.1176	0.00000	0.00000000	1.00000000
3-Methylcholanthrene	9.19E-07	6.30E-06	1.6E+00	0.00000	0.00000000	1.00000000

Note: Chemicals representing 99% of the total toxic potency have bolded text and shaded boxes

b. Provide reference for all toxicity data used.

Arsenic

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c. Included all chemicals present in the facility emissions in the screening tables.

See response to SIR2 98a.

99. Volume 4: Supplemental Information Request #1, Response #251a, Page AENV-294. Ivanhoe states, "*COS does not have any potential for binding to soils, remaining in water, or bioaccumulating in vegetation or animals.*" Yet, the chemical screening for persistence and bioaccumulation ranks COS as one of the most potentially bioaccumulative and the most persistent chemical of the emissions list.

a. Explain how COS ranks as more persistent and potentially bioaccumulating than other chemicals known to demonstrate these properties.

This is the result of the simply of applying the literature K_{ow} value for COS in the screening procedure. Ivanhoe agrees that COS should not bioaccumulate in any ecological or human receptor. COS was removed from the bioaccumulation screening table and the revised screening did not result in the addition of any new chemical of potential concern (COPC) (Table L1-3 (Rev)).

Table L1-3 (Rev): Screening of Emitted Noncarcinogens Based on Bioaccumulation

Chemicals	Total Emissions	Log K_{ow}	RfD (mg/kg-day)	Toxic Potency	Weighting	Cumulated Toxic Potency
Benzene	**4.35E-02**	**2.43**	**5.00E-04**	**211.410000**	**0.6048674**	**0.6048674**
n-hexane	**9.20E-01**	**3.90**	**6.00E-02**	**59.800000**	**0.1710944**	**0.7759618**
Aliphatic C_9-C_{18}	**5.09E-01**	**5.58**	**1.00E-01**	**28.420204**	**0.0813133**	**0.8572752**
Aromatic	**2.38E-01**	**3.94**	**4.00E-02**	**23.454595**	**0.0671062**	**0.9243814**
Toluene	**1.23E-01**	**2.70**	**2.00E-02**	**16.605000**	**0.0475087**	**0.9718901**
n-pentane	**1.33E+00**	**3.39**	**7.00E-01**	**6.441000**	**0.0184284**	**0.9903185**
Aliphatic C_5-C_8	8.63E-01	4.45	5.00E+00	0.767555	0.0021961	0.9925146
Xylenes	4.77E-02	3.10	2.00E-01	0.739350	0.0021154	0.9946300
Ethyl Benzene	2.01E-02	3.10	1.00E-01	0.623100	0.0017828	0.9964127
H2S	4.30E-03	0.23	3.00E-03	0.329667	0.0009432	0.9973559
Thiophenes	2.49E-03	1.81	1.50E-02	0.300460	0.0008596	0.9982156
Formaldehyde	3.83E-02	0.35	9.50E-02	0.141105	0.0004037	0.9986193
Arsenic	4.40E-04	0.68	3.00E-03	0.099733	0.0002853	0.9989046
Dichlorobenzene	6.13E-04	3.60	3.00E-02	0.073560	0.0002105	0.9991151
Aliphatic C_{19}-C_{34}	1.25E-02	11.01	2.00E+00	0.068835	0.0001969	0.9993120
Lead	2.60E-03	0.73	3.60E-02	0.052722	0.0001508	0.9994629
Naphthalene	3.12E-04	3.30	2.00E-02	0.051480	0.0001473	0.9996102
Mercury	2.20E-04	0.62	3.00E-03	0.045467	0.0001301	0.9997403
Aluminum	7.40E-02	0.33	1.00E+00	0.024420	0.0000699	0.9998101
Manganese	9.00E-03	0.23	1.00E-01	0.020700	0.0000592	0.9998694
Mercaptans	1.23E-05	0.65	5.70E-04	0.014026	0.0000401	0.9999095
CS2	5.56E-04	2.20	1.00E-01	0.012232	0.0000350	0.9999445
2-Methyl Naphthalene	1.23E-05	3.90	4.00E-03	0.011993	0.0000343	0.9999788
Phenanthrene	8.69E-06	4.50	7.10E-03	0.005508	0.0000158	0.9999946
Benzo (g,h,i) perylene	6.13E-07	6.22	7.10E-03	0.000537	0.0000015	0.9999961
Acenaphthylene	9.19E-07	4.08	7.10E-03	0.000528	0.0000015	0.9999976
Pyrene	2.56E-06	4.90	3.00E-02	0.000418	0.0000012	0.9999988
Fluoranthene	1.53E-06	5.00	4.00E-02	0.000191	0.0000005	0.9999993
Fluorene	1.43E-06	4.20	4.00E-02	0.000150	0.0000004	0.9999998
Acenaphthene	9.19E-07	3.90	6.00E-02	0.000060	0.0000002	0.9999999
Anthracene	1.23E-06	4.50	3.00E-01	0.000018	0.0000001	1.0000000

Note: Chemicals representing 99% of the total toxic potency have bolded text and shaded boxes.

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100. Volume 4: Supplemental Information Request #1, Response #252b, Page AENV-295.
This response does not address the original SIR. The original SIR states, "*the screening methods described in Appendix L1 to identify persistent and bioaccumulative COPC do not identify chemicals known to bioaccumulate and persist (e.g., carcinogenic PAHs, metals) but instead identifies chemicals not usually included due to their volatility (e.g., benzene, carbonyl sulphide).*" The formulas Ivanhoe use to calculate the *Bioaccumulation Potency* and *Persistence Potency* in Appendix L-1, Section 1.2 and 1.3 are unfamiliar. Their accuracy is unsubstantiated and requires scientific proof to support their application.

a. Provide scientific evidence supporting the use and validity of these formulas.

Based on discussions with AHW, the screening methods for bioaccumulation and persistence have been recalculated based solely on K_{ow} and chemical-specific half life. Emissions rates were not considered in the screening process. As a result, five new chemicals were added to the original COPC list:

- 3-methylcholanthrene;
- carbon disulfide;
- dichlorobenzene;
- mercaptans; and
- pyrene.

Modelling of multi-media exposure to 3-methylcholanthrene, carbon disulfide, dichlorobenzene, mercaptans and pyrene by human receptors demonstrated that the Project itself does not increase the risk of adverse health effect to the aforementioned receptor (Appendix SIR2 K). In some instances where some risks are shown in the PDC scenario, these risks are already present at baseline level and the project itself does not contribute to any significant extent to the cumulative risk.

b. Provide references and supporting documentation for the use of these formulas.

See response to SIR2 100a.

Literature Cited:

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101. Volume 4: Supplemental Information Request #1, Response #253a, Page AENV-297.

a. Identify whether any of the carcinogenic COPCs have the same carcinogenic endpoints or target organ (e.g., lung, kidney, liver) and calculate the total ILCR for those groups.

As specified in Volume 4, SIR 253a, none of the carcinogenic COPCs have the same target organ and, therefore, the incremental lifetime cancer risk cannot be summed.

102. Volume 4: Supplemental Information Request #1, Response #256a, Page AENV-300.

The OEHHA describe a carcinogenic exposure limit for naphthalene for chronic inhalation based on an NTP (2000) study. Neither the US EPA nor HC have included an evaluation of the 2000 NTP study results in the establishment of their chronic inhalation guidelines. Naphthalene is currently under re-assessment by the US EPA which has establish a draft carcinogenic TRV. The International Agency for Research on Cancer (IARC 2002) has concluded that naphthalene is *possibly carcinogenic to humans (Group 2B).* Ivanhoe treats other *Group B* chemicals as carcinogens (e.g., acetaldehyde, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene) in the HHRA.

a. Include an assessment of the potential carcinogenicity of naphthalene following chronic inhalation.

See response to SIR2 98a. When using the unit risk in the screening process, naphthalene is screened out of the COPC list.

103. Volume 4: Supplemental Information Request #1, Response #258a, Page AENV-304.

a. Provide reference sources for data in Table SIR 258-1.

See response to SIR2 98b.

104. Volume 4: Supplemental Information Request #1, Response #262a, Pages AENV-308 to AENV-315.

A spot check of the literature sources provided still does not include the correct date of publication of the TRV. For example the RAIS link describes the IRIS TRV for benzene; this data was revised in 2000, not 2010 as indicated. Similarly the RAIS link for B[a]P also used the IRIS TRV which was last revised in 1994, not 2010. Other discrepancies were the OEHHA for benzene and the MDEP reference for carbonyl sulfide. There may be others.

a. Provide accurate reference for all literature/data sources; include publication dates of the TRVs.

See response to SIR2 98b.

105. Volume 4: Supplemental Information Request #1, Response #270a, Page AENV-323.
Ivanhoe states, "*The inhalation TRV in mg/m3 was adjusted as a dose (mg/kg-d) for the modelling effort.*"

a. Provide the calculations used to adjust from an air concentration (mg/m3) to a dose (mg/kg-d).

Based on the toddler inhalation rate and body weight provided by Health Canada (9.3 m^3/d and 16.5 kg, respectively), a hypothetical inhalation TRV of 1 mg/m^3 would become an inhalation dose of:

$$1 \text{ mg/m}^3 \times 9.3 \text{ m}^3\text{/d} \div 16.5 \text{ kg} = 0.564 \text{ mg/kg-d}$$

106. Volume 4: Supplemental Information Request #1, Response #271 a, d, Page AENV-334.

In response SIR 271a, Ivanhoe states, "*the predicted 9th highest 1 hour SO_2 concentration arising from the HTLTM flare … is 433.5µg/m3. This represents the worst flare upset case and all other upset scenarios are within this range. This predicted concentration resulting from the upset scenario remained below AENV Ambient Air Quality Objective* [AAAQO] *of 450µg/m3 for SO_2."* However, in the response to SIR 72b, Table SIR 72-1 provided predicted 1 hour maximum SO_2 concentrations due to upset flaring to be higher than 433.5µg/m3 and the AAAQO.

a. Explain this discrepancy.

The maximum value of 433.5 µg/m^3 reported in response Volume 4, SIR 271a refers to the Project-alone scenario. The maximum predicted concentration of 475 µg/m^3 presented in Volume 4, Table SIR 72-1 includes the contribution of baseline sources (i.e., Application Case).

b. Provide the potential human health risk associated with all upset conditions.

Risk estimates for the Application Case under "Upset Conditions" for SO_2 results in a Hazard Quotient of 1.06. This specific scenario (Upset Conditions) is defined as a worst case-scenario and does not reflect the conditions prevailing under normal operation. These "Upset Conditions" are short in duration and infrequent. Even though the Hazard Quotient exceeds the criterion of 1, the exceedance is minimal and, therefore, the associated potential human health risk is low.

In response to SIR 271d, Ivanhoe states: *See Response to SIR 61a.* However, an assessment of the potential public health/safety impact associated with project related traffic is not addressed under SIR 61, nor is a Traffic Impact Assessment provided as requested by SIR 61a.

c. Provide an assessment of the potential public health/safety impact of increased traffic in the region due to the project.

Information from the Project was provided to Ledcor to include in the CMAR TIA. This assessment includes the potential traffic impacts of the Project, as well as other projects that may impact the region. Key traffic safety components included in the TIA are:

- at the 2012 (construction) horizon, all intersections operate with acceptable Levels of Service and Volume to Capacity ratios when unsignalized, with the exception of eastbound traffic at the intersection of Highway 63/Highway 69. Although this movement exceeds typically acceptable limits, it alone does not warrant intersection upgrades due to the relatively low traffic volumes on that leg of the intersection. It should also be noted that the Traffic Signal Warrant Analysis shows that signalization is warranted at the 2012 horizon. However, the warrant is barely met and as such, it is recommended that traffic volumes be monitored prior to installing traffic signals at that intersection;

- at the 2026 (peak operations) horizon, the following intersection upgrades are required (in addition to those required at the 2012 horizon):
  - Highway 63/Highway 69 – signalization and dual southbound left lanes;
  - Highway 69/Airport Road – signalization and dual eastbound left lanes;
  - Highway 69/CMAR – none;
  - Highway 69/Spruce Valley Drive – none;
- at the 2031 (20-year) horizon, the following upgrades (in addition to those required at the 2026 horizon) are required:
  - Highway 63/Highway 69 – none;
  - Highway 69/Airport Road – dual southbound right lanes;
  - Highway 69/CMAR – none;
  - Highway 69/Spruce Valley Drive – none;
- sight distances are acceptable for all four analyzed intersections based on the variety of vehicle types expected to utilize the CMAR;
- full intersection illumination is required for signalized intersections. The intersections of Highway 69/CMAR and Highway 69/Spruce Valley Drive do not warrant illumination at any design horizon;
- discussions with Alberta Transportation have indicated that two sets of potential upgrades for the intersection of Highway 63/Highway 69 are planned and are as follows:
  - construction of a roundabout at the current intersection location – this upgrade will negate the need for traffic signals, as discussed above, to be installed and construction may start as early as 2012; and
  - relocation of the intersection and construction of an interchange – this long-term upgrade would negate the need for intersection signalization and the construction of dual southbound left turn lanes. If the intersection relocation and interchange construction is not completed by the time the CMAR reaches peak operation (expected by 2026), the roundabout discussed above should be monitored to ensure efficient operations.

APPROVALS

The responses to questions in this Approvals section will not be considered as part of the EIA completeness decision made by Alberta Environment.

ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT

107. Volume 4: Supplemental Information Request #1, Response #108, Page AENV-85. Ivanhoe provides a table outlining the wetland disturbance areas. The *Water Act* may require that an approval be obtained before undertaking construction activity in a wetland.

a. Clarify if any wetlands are being impacted by the proposed infrastructure and clarify when Ivanhoe will submit a *Water Act* Application if required for this activity. It is expected that a review of historical aerial photos is completed to ensure that open water bodies are identified in the wet years.

Impacts to wetlands are described in SIR2 50a. Ivanhoe anticipates the need for *Water Act* authorizations for collection, testing and release or disposal of precipitation falling on CPF and well pad areas, and for diversion of natural surface water around Project facilities, including those constructed in a wetland. Applications will be submitted after approval of the Project to meet construction timelines.

108. Volume 4: Supplemental Information Request #1, Response #113, Page AENV-91. Ivanhoe states, "*The watercourses identified on the Constraints Map are generally nonflowing or ephemeral drainage. Encroachments on non fish-bearing watercourse buffers create minimal environmental impact as long as sedimentation is prevented and drainage is maintained.*"

a. Clarify how sedimentation is prevented and drainage is maintained. Specify the type and level of best management practices used to ensure the conveyance of the water and prevention of water quality degradation.

Erosion and sedimentation will be mitigated using the best management practices in Alberta Transportation's Erosion and Sediment Control Manual (AT 2011). The selection and implementation of appropriate erosion and sediment control measures will be based on results of site evaluations (AT 2011).

Fens and undefined drainage courses will be maintained using berms around well pads, culverts at all low points along road crossings, and culverts at regular intervals through fens. Ivanhoe plans to maintain a 100 m buffer from all watercourses with a defined channel (Table SIR2 PU-1).

109. Volume 4: Supplemental Information Request #1, Response #114, Page AENV-92. Ivanhoe states, "*Ivanhoe will make application under all applicable legislation for the channel diversions, including applications under the Alberta Water Act and Federal Fisheries Act.*"

a. Clarify when Ivanhoe will submit a *Water Act* application for the channel diversions.

Further to SIR2 52a, stream diversions are no longer required for the Project, therefore, *Water Act* applications for channel diversions are not required.

b. Clarify if any other open bodies of water are being impacted for the construction of Ivanhoe's proposed infrastructure for the Tamarack Integrated Oil Sands Project. It is expected that a review of historical aerial photos is completed to ensure that open water bodies are identified in the wet years. Disturbance of open bodies of water may trigger a *Water Act* approval.

Refer to response SIR2 107a.

c. Clarify if Ivanhoe will be seeking a temporary or permanent diversion water licence under the *Water Act* for the potential use of runoff water, if accumulated surface water within runoff ponds or SAGD pads do not meet regulatory requirements for release.

Ivanhoe does not intend to use surface runoff water in the process. If treatment to the EPEA approval release requirements is not possible then Ivanhoe will truck the excess water off-site and dispose of such water at a licensed disposal facility. If this occurs, then Ivanhoe will apply for a temporary diversion license under the *Water Act* from AENV.

110. Volume 4: Supplemental Information Request #1, Response #277, Page AENV-330. Ivanhoe states, "The FGD is a dry lime scrubbing technology, which does not produce nor is it designed to capture NOx emissions. Please refer to the NOx emissions data on Table SIR 70-1." Table SIR 70-1, page 27, summarizes the construction phase emissions. The original question was asked in relation to the major air emission sources at the Central Processing Facility, particularly the FGD/HTL units, listed in Table ATT6-3.

a. Application, Volume 1, Attachment 6- Page 6, Table ATT6-3 shows NOx emissions of 6.04 t/d from each of the two proposed FGD units under Tamarack Phase 1 HTL and Phase 2 HTL, respectively. Based on that, provide the following information:

i. What is the source of these NOx emissions?

The NO_x emissions from the FGD stacks represent the sum of the emissions from the steam generators and the HTL™ reheater. HTL™ reheater emissions arise primarily from the combustion of coke.

ii. How were the NOx emissions calculated or estimated?

The emissions from the steam generators are conservatively estimated from the limits prescribed by the Canadian Council of Ministers of the Environment guidelines and AENV (2007). Emissions from the HTL™ reheater are estimated based on the design basis of 500 ppm NO_x by volume in the flue gas.

iii. If indeed the two FGD unit stacks are the major sources of NOx emissions, discuss what options Ivanhoe is considering or implementing to minimize NOx emissions from these units.

For fired heaters, where existing controls are proven and regularly utilized, Ivanhoe has specified ultra-low NO_x burners that conform to the industry standard BACT for NO_x emissions. NO_x control from the FGD stacks has not been included in the Project due to capital cost and operability constraints of Selective Catalytic or Non-Catalytic Reduction technology.

b. Based on Ivanhoe's response to (a), provide a revised Table ATT6-3 if needed.

Not applicable.

Literature Cited:

Alberta Environment (AENV). 2007. *Alberta Ambient Air Quality Objectives – Fine Particulate Matter ($PM_{2.5}$).* February 2007.

111. Volume 4: Supplemental Information Request #1, Response #279, Page AENV-332.

a. Using the Rational Method as described in A Guide to Content of Industrial Applications, Alberta Environment, September 1999, provide the size/volume (m3) and dimensions (L x W x D) of the proposed runoff pond on the Central Processing Facility.

To calculate pond sizing requirements, Ivanhoe used the 24-hr rainfall amounts as follows:

24-hr rainfall:

- 1:100 yr Max 96.9 mm;
- 1:25 yr Max 77.9 mm; and
- 1:10 yr Max 65.5 mm.

For the CPF, the following assumptions were used:

- 1:100 year rainfall over 24 hours;
- 640 000 m^2 site area (800 m x 800 m); and
- runoff coefficient of 0.8.

Required pond runoff storage volume is calculated as:

- 96.9 mm/1 000 x 640 000 m^2 x 0.8 = 49 613 m^3

This matches the results presented in Volume 4, Table SIR 279-10.

Actual pond size shown on Volume 1, Figure 2.3-2 is:

- Outer Pond Area (at high water level) = 15 539 m^2;
- Inner Pond Area (area at max. depth) = 5 625 m^2;
- Pond Maximum Depth = 7.0 m; and
- Active Volume Fraction = 75% (i.e., assume max 25% full).

Volume = (15 539 – 5 625) m^2 x 7 m/2 + 5 625 m^2 x 7 m
= 74 074 m^3

Active Volume = 74 074 m^3 x 75% = 55 556 m^3

Storage time = 55 556 m^3/(49 613 m^3/24 hrs) = 26.9 hours

FEDERAL

The responses to questions in this Federal section will not be considered as part of the EIA completeness decision made by Alberta Environment and Water.

112. Volume 4: Supplemental Information Request #1, Response #282, Page AENV-346. Federal legislation (*Species at Risk Act*, Section 79(2)) requires that, for projects under federal review, adverse project effects be identified for listed wildlife species. Also, if a project is carried out, measures must be taken to avoid or lessen those effects on listed species and to monitor them. These measures must be taken regardless of the significance of the impact on listed species. This requirement reflects the status of listed species (i.e., declining or low populations) and thus the potential greater risk to populations posed by industrial development. Because of their status, considerable effort and attention should be placed on identifying and mitigating impacts on listed species.
To monitor the effects of the project on listed species, it is necessary to understand the distribution and relative abundance of wildlife prior to project disturbance. This data is crucial for monitoring changes in species distribution and abundance following project development, and validating Environmental Assessment predictions. Currently, the yellow rail surveys completed by Ivanhoe are not adequate to determine the potential presence of yellow rail in the TLSA. Environment Canada (EC) recommends 3 surveys within a season to maximize detection probability of rails (Bazin and Baldwin 2007). There is also some suggestion that detection is greatest during new moon periods when conditions are darkest (Prescott et al. 2002). EC notes that when repeated surveys were conducted in the Imperial Kearl Lake lease, a high number of rails were detected, with the highest numbers detected in late June and mid-July, and the lowest in mid-June (Golder 2008). EC notes that these densities are amongst the highest reported in Canada, illustrating the importance of the oil sands region for this species. Detection probability of yellow rails in the Tamarack lease was likely low, given the timing of the survey (relatively early in the breeding season) and limited survey effort (one survey only).

Literature Cited:
Golder Associates. 2008. Kearl Oil Sands Project Yellow Rail Surveys. Prepared for Imperial Oil Resources Ventures Limited.

a. Describe how Ivanhoe plans to monitor the effects of the project on listed species;

Ivanhoe will develop a wildlife monitoring plan in accordance with the terms and conditions of the Project approval and in consideration of the *Species at Risk Act* (SARA) listed species identified in the EIA. The final monitoring plans will be approved by AENV and ASRD. The wildlife monitoring plan is anticipated to include:

- a long-term plan to monitor the responses of wildlife to above ground pipelines, features associated with these pipelines and analyze the effectiveness of mitigation;

- a plan to identify existing wildlife habitat connectivity including:
  - an assessment of the function of any potential or existing habitat connectivity corridors identified, and barriers to use;
  - a discussion about potential mitigation options;
  - investigate the opportunity to participate in regional initiatives;
- a description of methods and frequency for monitoring wildlife species of concern; and
- a discussion of corrective measures that could be implemented to protect affected species of concern, in the event that impacts are in excess of those predicted for the Project.

b. Describe whether existing data is suitable to characterize baseline distribution and abundance of listed species in the TLSA, including yellow rail (see comments above);

Existing data is suitable to characterize baseline distribution and abundance of listed species in the TLSA. Wildlife surveys conducted in the TLSA included the following:

- *reconnaissance survey*: September 2008;
- *owl call-playback survey*: April 2009;
- *ungulate pellet group counts*: May 2009;
- *amphibian survey*: May 2009;
- *yellow rail survey*: June 2009;
- *songbird point counts*: June 2009;
- *raptor call-playback survey*: June 2009;
- *bat mist netting and acoustic survey*: July 2009; and
- *winter track counts*: February 2010.

Incidental observations of wildlife were also recorded during all surveys, including incidental observation recorded during surveys by other disciplines. These surveys characterize baseline conditions for the listed wildlife species in the TLSA, and that the EIA was completed in compliance with the final Terms of Reference provided by AENV.

c. Describe whether existing baseline data is suitable for rigorous effects monitoring; and,

The baseline data presented within the application was not intended to be used as the basis for effects monitoring programs. As described in SIR2 112a, it is expected that the wildlife monitoring plan will include the collection of baseline data as a basis for effects monitoring.

d. Given the above information, describe whether additional baseline surveys, including yellow rail surveys, will be conducted to adequately document baseline conditions for monitoring purposes.

See responses to SIR2 112a, b and c.

113. Volume 4: Supplemental Information Request #1, Response #283, Page AENV-347. Environment Canada (EC) does not accept the use of surrogate or umbrella species to assess project effects on listed species. No two species have identical habitat requirements. Thus, using one species (or guild) to represent the habitat requirements of a listed species may over- or under-estimate the impact of a project on a listed species. It is important to identify impacts as accurately as possible to ensure application of effective mitigation, namely measures to avoid or lessen project effects. As the primary impact of the Tamarack project is habitat loss, it is important to identify measures to avoid species at risk habitat, or to lessen impacts to species at risk habitat. To do so requires understanding the distribution and amount (area) of habitat for listed species in the TLSA, and the extent of direct and indirect habitat loss. This analysis has not been completed.

a. Complete an analysis of project effects on individual listed species that may interact with the project, including quantification of direct and indirect habitat loss for appropriate species.

The following provides a discussion of potential direct and indirect habitat loss impacts as a result of the Project for each SARA listed species that have the potential to occur in the TLSA. Final impact ratings take into consideration the many mitigation measures for wildlife and wildlife habitat that Ivanhoe has committed to adhere to for the Project.

Yellow Rail

The yellow rail (*Coturnicops noveboracensis*) is designated as a species of Special Concern by COSEWIC (2012) and is listed on Schedule 1 of SARA (2012). Within Alberta, its status remains undetermined because of a lack of species information (ASRD 2010). No yellow rails were detected in the TLSA during field surveys.

The yellow rail is a very secretive species whose life history is one of the least understood of North American birds (COSEWIC 2009). It is believed to be a semi-colonial nesting species and is more often found in groups of birds nesting together than in single pairs. The yellow rail typically occupies sedge-dominated wetlands with a dense build-up of vegetation litter for nesting (COSEWIC 2009; RIC 1998). Ephemeral water bodies that are usually dry by mid-July are often preferred, and encroachment of shrubs and cattails will decrease habitat quality (WDNR 2008). This preferred habitat for the yellow rail is limited in the boreal forest region, and annual variations in presence and/or abundance of yellow rails is closely tied to annual variation in water levels (COSEWIC 2009). In northern Alberta, yellow rails typically occupy graminoid wetland habitats (k3 ecosite).

The TLSA does not contain this preferred habitat type for the yellow rail, and therefore no direct effects as a result of habitat loss are anticipated. The impacts that indirect effects and annual variation in water levels may have on yellow rails in the region is unknown. The main direct threat to yellow rails in the boreal forests of northern Alberta is habitat loss and degradation. Indirect threats include changes to hydrological regimes by oil sands extraction and disturbance by all-terrain vehicles disrupting wetland habitat (COSEWIC 2009).

Impacts to yellow rails as a result of the Project are expected to be negative in direction, local, low in magnitude, and long-term in duration (Table SIR2 113-1). The likelihood of occurrence is low due to the lack of suitable habitat, and the effects are reversible following reclamation. Scientific confidence is low due to a lack of yellow rail population or habitat use data in the boreal forest region. The final impact rating is anticipated to be low.

Table SIR2 113-1: Project Impact Rating for the Yellow Rail

Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversibility	Confidence	Final Impact Rating
Negative	Local	Low	Long-term	Low	Reversible	Low	Low

Common Nighthawk

The common nighthawk (*Chordeiles minor*) is designated as Threatened by COSEWIC (2012), is on Schedule 1 of SARA (2012), and is listed as Sensitive in Alberta (ASRD 2010). This species was detected in the TLSA.

Common nighthawks are most active at sundown and occur in a variety of habitats throughout the boreal forest. Breeding sites include open habitats where the ground is devoid of vegetation, such as burns, forest clearings, logged areas, rocky outcrops, quarries, and gravel roads and rooftops (COSEWIC 2007a). Common nighthawks are also present in mixedwood, coniferous, and jack pine forests. As such, common nighthawks may use a wide variety of both natural and disturbed habitats throughout the TLSA and the amount of potential habitat loss for this species is difficult to predict; however, should all of these habitat types be included in the assessment of potential suitable habitat loss (ecosites: a1, b4, c1, d3, e3, f3, g1, h1, i1, j1, k1, and regen), Project development will remove approximately 90 ha (6.6%) of available common nighthawk habitat.

A number of reasons have been suggested for this species' decline, including declines in insect populations due to large-scale insecticide use, fire suppression, changes in harvesting practices that reduce the number of open areas in forested habitats, cultivation and cattle grazing, terrestrial predators, collisions with motor vehicles, and a reduction in flat gravel roofs in urban areas (COSEWIC 2007a).

Common nighthawks are an adaptable species, and clearing and reclamation activities throughout the region may potentially lead to some increases in suitable habitat in the boreal forest; therefore, Project impacts may be both negative and positive in direction (Table SIR2 113-2). Effects are anticipated to be local and long-term. The likelihood of occurrence is high and effects are reversible following reclamation. Scientific confidence is high due to an understanding of this species' biology and habitat use in the boreal forest. Removal of 6.6% of suitable common nighthawk habitat results in a moderate magnitude, however, due in part to the adaptability and wide variety habitat use of common nighthawks, the final impact rating is low.

Table SIR2 113-2: Project Impact Rating for the Common Nighthawk

Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversibility	Confidence	Final Impact Rating
Negative/ Positive	Local	Moderate	Long-term	High	Reversible	High	Low

Canada Warbler

The Canada warbler (*Wilsonia canadensis*) is designated as Threatened by COSEWIC (2012), is on Schedule 1 of SARA (2012), and is listed as Sensitive in Alberta (ASRD 2010). One Canada warbler was detected in the TLSA and this location has been avoided by the Project footprint.

Canada warblers will breed in a wide variety of deciduous, coniferous, mixedwood, and old growth forest habitats, though a key requirement is for these habitats to contain a well-developed shrub layer and a structurally complex forest floor (COSEWIC 2008). They may also occur in riparian shrubland habitats and regenerating stands. All of these habitat types were included in the assessment of potential habitat loss for the Canada warbler, which resulted in the removal of approximately 170 ha (17.5%) of available Canada warbler habitat. However, these habitats represent varying quality and suitability for the Canada warbler and this assessment is overly conservative because not all of these habitats are likely to support large amounts of the complex, shrubby understory preferred by Canada warblers. As such, habitat loss is overestimated for this species.

Factors responsible for Canada warbler declines are not fully understood, though it is believed that the decline is primarily the result of habitat clearing in their winter range, where up to 95% of the species' primary mountain forest habitat has been converted to agriculture (COSEWIC 2008). In Canada, Canada warbler declines may be linked to habitat loss from forestry and oil and gas activities, road development, grazing by forest ungulates, and a decline in insect outbreaks (COSEWIC 2008).

The impact to Canada warblers as a result of the Project is expected to be negative, local, high in magnitude, and long-term in duration (Table SIR 113-3). The likelihood of occurrence is high and the effects are reversible following reclamation. Confidence is low due to the wide range of habitat types that were included in the assessment and subsequent likelihood of an overestimation of habitat loss. Though habitat loss is potentially high in magnitude, mitigation measures such as clearing timing restraints and the avoidance of the location where the Canada warbler was detected results in a final impact rating of moderate.

Table SIR2 113-3: Project Impact Rating for the Canada Warbler

Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversibility	Confidence	Final Impact Rating
Negative	Local	High	Long-term	High	Reversible	Low	Moderate

Rusty Blackbird

The rusty blackbird (*Euphagus carolinus*) is listed as Sensitive in Alberta (ASRD 2010), as Special Concern by COSEWIC (2012), and is on Schedule 1 of SARA (2012). The North American population of rusty blackbirds is estimated at 2 million, though there has been a 90% reduction in the population over the last 30 years (Greenberg and Droege 1999). No rusty blackbirds were detected in the TLSA.

Rusty blackbird breeding primarily occurs within the boreal forest and approximately 70% of the global breeding range for the species is located in the boreal forests of Canada (COSEWIC 2006). Rusty blackbirds are typically associated with open water and/or riparian habitats and prefer riparian shrublands and forest wetlands, rarely using the forest interior (Greenberg and Matsuoka 2010; COSEWIC 2006). The Project will potentially remove approximately 38 ha (8.6%) of this preferred rusty blackbird habitat. This includes graminoid and shrubby wetlands, shrubland, treed bogs, and undifferentiated wetlands; however, these habitats are expected to be of variable quality for the rusty blackbird.

Rusty blackbirds are one of the few bird species that require wooded wetlands throughout the entire year and are, therefore, vulnerable to negative factors affecting wetlands (Greenberg and Matsuoka 2010). Suitable wetland habitat may be indirectly affected by water use, drainage and pumping activities associated with oil and gas. Rusty blackbird declines may also be the result of bird control programs for nuisance species in the United States, wetland contamination, and competition by invasive dominant blackbird species (COSEWIC 2006).

The impact to rusty blackbirds are expected to be negative in direction, local, moderate in magnitude, and long-term in duration (Table SIR2 113-4). The likelihood of occurrence is high and effects are reversible following reclamation. Scientific confidence is low due to a lack of rusty blackbird population or habitat use data in the boreal forest region. The final impact rating is anticipated to be moderate.

Table SIR2 113-4: Project Impact Rating for the Rusty Blackbird

Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversibility	Confidence	Final Impact Rating
Negative	Local	Moderate	Long-term	High	Reversible	Low	Moderate

Olive-sided Flycatcher

The olive-sided flycatcher (*Contopus cooperi*) is listed as May be At Risk in Alberta (ASRD 2010), designated as Threatened by COSEWIC (2012), and is on Schedule 1 of SARA (2012). Two olive-sided flycatchers were detected in riparian habitat in the TLSA during field studies.

Habitat for the olive-sided flycatcher occurs near open areas containing tall trees or snags for perching and foraging. Breeding in the boreal forest most likely occurs in semi-open coniferous and mixedwood forests along edges and openings, often near open water or wetlands (COSEWIC 2007b). The amount of potential habitat loss for this species is difficult to predict.

The olive-sided flycatcher population is experiencing significant declines throughout their range (COSEWIC 2007b). The causes of the declines are unclear, though it has been suggested that habitat alteration on their wintering grounds may be a significant factor. Other factors may include increased nest predation in logged habitats, forest management practices, and a general reduction in insect prey (COSEWIC 2007b).

The impact to olive-sided flycatchers as a result of the Project is expected to be negative in direction, local, and moderate in magnitude (Table SIR2 113-5). Effects will be long-term in duration, the likelihood of occurrence is high, and the effects are reversible following reclamation. Due to uncertainties surrounding the predicted habitat loss and a lack of understanding of the reasons for species decline, confidence in the assessment is low. The location where the two olive-sided flycatchers were detected will not be impacted by the Project footprint and clearing timing restraints will ensure active nest sites are not destroyed. However, due to the uncertainty in the assessment, the final impact rating is conservatively predicted to be moderate.

Table SIR2 113-5: Project Impact Rating for the Olive-sided Flycatcher

Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversibility	Confidence	Final Impact Rating
Negative	Local	Moderate	Long-term	High	Reversible	Low	Moderate

Wolverine

The wolverine (*Gulo gulo*) is listed as May be At Risk in Alberta (ASRD 2010), is designated as Special Concern by COSEWIC (2012), and is listed on Schedule 3 of SARA (2012). No wolverines were detected in the TLSA during field surveys.

Wolverines are found in low densities and over large home ranges in a variety of habitats (Ruggiero *et al.* 2007; Petersen 1997). Home range size typically varies from 6 500 ha to 100 000 ha, though larger ranges up to 150 000 ha have been recorded (Petersen 1997). Wooded areas are important habitats for wolverines since they provide abundant cover and food resources, though specific habitat preferences are difficult to ascribe to wolverines, and wolverine presence and density is influenced more by prey availability (primarily ungulates) and proximity to humans than by specific habitat or landscape attributes (Petersen 1997).

In Alberta, wolverine populations have been declining as a result of habitat fragmentation, declining caribou populations, and human-caused mortality (Ruggiero *et al.* 2007; Slough 2007). As a conservative approach, all available habitat types within the TLSA were identified as preferred habitat for this species. Therefore, the Project will remove approximately 349 ha (14.7%) of available habitat.

Impacts to the wolverine are expected to be negative in direction, local, and considering all habitat types, high in magnitude (Table SIR2 113-6). Effects will be long-term in duration, the likelihood of occurrence is high, and the effects are reversible following reclamation. Due to uncertainties surrounding the predicted habitat loss, confidence in the assessment is moderate.

However, the wolverine is a very wide ranging species, habitat loss included all habitat types, no wolverines were detected in the TLSA, and mitigation will include surveys designed to identify and avoid active den sites; therefore, the final impact rating is low.

Table SIR2 113-6: Project Impact Rating for the Wolverine

Direction	Geographic Extent	Magnitude	Duration	Likelihood	Reversibility	Confidence	Final Impact Rating
Negative	Local	High	Long-term	High	Reversible	Moderate	Low

Literature Cited:

Alberta Sustainable Resource Development (ASRD). 2010. *General Status of Alberta Wild Species 2010*. Available at: http://srd.alberta.ca/BiodiversityStewardship/SpeciesAtRisk/GeneralStatus/GeneralStatusofAlbertaWildSpecies2010/Default.aspx.

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Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2007a. *COSEWIC Status Report on the Common Nighthawk Chordeiles minor in Canada*. Prepared for the Committee on the Status of Endangered Wildlife in Canada. Prepared by Carl Savignac, Chelsea, Quebec. vi +25 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2007b. *COSEWIC Assessment and Status Report on the Olive-sided Flycatcher Contopus cooperi in Canada*. Prepared for the Committee on the Status of Endangered Wildlife in Canada. Prepared by Jennie Pearce and David Anthony Kirk, Ottawa, Ontario. vii + 25 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2008. *COSEWIC Assessment and Status Report on the Canada Warbler Wilsonia canadensis in Canada*. Prepared for the Committee on the Status of Endangered Wildlife in Canada. Prepared by Carl Savignac, Ottawa, Ontario. vi +35 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2009. *COSEWIC Assessment and Status Report on the Yellow Rail Coturnicops noveboracensis in Canada*. Prepared for the Committee on the Status of Endangered Wildlife in Canada. Prepared by Andrew Horn, Ottawa, Ontario. vii + 32 pp.

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Resources Inventory Committee (RIC). 1998. *Inventory Methods for Marsh Birds: Bitterns and Rails*. Standards for Components of British Columbia's Biodiversity No. 7. Prepared by Ministry of Environment, Lands and Parks Resources Inventory Branch for the Terrestrial Ecosystems Task Force Resources Inventory Committee.

Ruggiero, L.F., K.S. McKelvey, K.B. Aubry, J.P. Copeland, D.H. Pletscher, and M.G. Hornocker. 2007. *Wolverine Conservation and Management*. Journal of Wildlife Management 71(7): 2145-2146.

SARA (*Species at Risk Act*). 2012. Available at: http://www.sararegistry.gc.ca/default_e.cfm.

Slough, B.G. 2007. *Status of the wolverine Gulo gulo in Canada*. Wildlife Biology 13: Supplemental 2.

Wisconsin Department of Natural Resources (WDNR). 2008. *Yellow Rail Fact Sheet*. Available at: http://dnr.wi.gov. Website Accessed: January 2008.

114. Volume 4: Supplemental Information Request #1, Response #285, Page AENV-353. The primary mitigation measure proposed by Ivanhoe for loss of habitat is reclamation. Although considerable effort and research is being directed towards reclamation, it is important to recognize the current uncertainties and limitations with reclamation. Specifically, successful re-colonization of reclaimed habitat by listed species in the oil sands region has not been demonstrated, thus the long-term success of reclamation is unknown. Whether the diversity and density of listed (and other) species in reclaimed habitats will be similar to pre-disturbance conditions is unknown. Also, some habitats such as bogs and fens may not be reclaimed and may be lost permanently (e.g., by conversion to shallow water) or for a long period of time (e.g., loss of old growth forest). These habitats are important for several listed species. Because of these uncertainties and limitations, other measures are warranted to mitigate the effects of habitat loss on listed species. One additional mitigation measure used in the oil sands region is habitat offsets. Offsets have been used as mitigation for oil sands mines, and were proposed by Total E&P Canada for the Joslyn III SAGD project (however, since this project was abandoned, the offsets were applied to the Joslyn North Mine project instead).

a. Based on the species-specific impact analysis requested above, describe how Ivanhoe will mitigate any permanent or long-term loss of habitat for listed species resulting from project exploration, construction and operations. Mitigation should follow a hierarchal approach based on avoidance, minimization and finally restitution of effects, as described in the *Environmental Assessment Best Practice Guide for Wildlife at Risk in Canada* (2010) and *Addressing Species at Risk Act Considerations Under the Canadian Environmental Assessment Act for Species Under the Responsibility of the Minister responsible for Environment Canada and Parks Canada* (2010).

Mitigation measures will follow a hierarchal approach based on avoidance, minimization and finally restitution of effects, as described in the *Environmental Assessment Best Practice Guide for Wildlife at Risk in Canada* (2010) and *Addressing Species at Risk Act Considerations Under the Canadian Environmental Assessment Act for Species Under the Responsibility of the Minister responsible for Environment Canada and Parks Canada* (2010).

Specifically, Ivanhoe has undertaken the following mitigations in development of the Project to reduce permanent or long-term, loss of habitat for SARA listed species:

- *Avoidance*:
    - ❑ planning and development activities are integrated within the surrounding terrain, for which constraints mapping is the primary tool (Volume 1, Section 3.4);
- *Minimization*:
    - ❑ integrated land management is used to reduce footprint and minimize habitat fragmentation (Volume 1, Section 3.3.6.7);

- progressive reclamation to advance reclamation in parallel with the progression of site development (Volume 1, Section 3.3);
- low impact construction techniques (Volume 1, Section 3.4); and
- use of low impact seismic during resource delineation programs (Volume 1, Section 3.4).

- *Restitution*:
  - reclamation of disturbed areas as outlined in the C&R Plan (Volume 1, Section 3.0); and
  - participation in regional initiatives to investigate appropriate strategies and methods for reclaimed fen and bogs disturbed by oil and gas development (Volume 1, Section 3.3.5.5).

Ivanhoe is not proposing habitat offsets as a mitigation strategy because by following the mitigation measures outlined in the Project application and as described in the two guidance documents referenced above, impacts from the Project will be appropriately managed and mitigated.

ERRATA

115. Volume 4, Project update. Figure PU-1.

a. Year round access appears to be missing from Figure PU-1. Other figures in Volume 4 show the location unchanged for the original submission so it was assumed no change was made. Is this correct?

Year-round access is included on the figure. It is adjacent to the pipeline ROW in between the well pads and the CPF.

Appendix SIR2 A

Supplemental ERCB Questions

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1) Provide Ivanhoe's interpreted seismic sections one through six, annotated with all formation tops (we have not yet seen lines 1 - 3, or the east portion of line 5).

The requested interpreted seismic sections are presented in Appendix SIR2 F, Figures SIR2 F-8 through SIR2 F-13.

2) Provide mapping illustrating the locations of interpreted faults within the following stratigraphic intervals:

a) cap rock

The requested map is provided in Appendix SIR2 F, Figure SIR2 F17.

b) reservoir

Horizons showing the location of faults at reservoir level could not be reliably mapped based on the available seismic and well data; therefore, they have not been provided.

c) pre-Cretaceous

The requested map is provided in Appendix SIR2 F, Figure SIR2 F-14.

3) Provide a detailed discussion on the geological processes that caused faulting the project area including timing of the onset and duration of faulting with respect to emplacement of cap rock, reservoir, and pre-Cretaceous strata.

Detailed discussion of the geological processes that caused faulting in the Project Area is presented in SIR2 6. Most faults in the Project Area terminate within the McMurray Formation. The few faults which extend into the Wabiskaw B shale have small offsets with limited conductivity and are therefore not expected to have a material impact on cap rock integrity (Appendix SIR2 F, Figure SIR2 F-17).

4) Provide a discussion on what impact identification of faults will have on project plans, including, but not limited to:

a) whether Ivanhoe plans to modify proposed drainage patterns to avoid fault affected areas. If applicable, provide a project update including a supporting discussion on the rationale for determining an appropriate stand-off distance both parallel and perpendicular to interpreted fault strike, and

At the Wabiskaw B shale, faulting is not expected to require modification of the proposed drainage patterns. However, because of performance uncertainty, Ivanhoe plans to hold development of the Pattern G until the end of Phase 1 and to modify the well lengths of well pairs in Pattern A as discussed in SIR2 6 and the SIR2 Project Update. The approval for development of Pattern G is expected once information from the data monitoring in the area is available and reviewed with the Energy Resources Conservation Board (ERCB).

In the vicinity of the local high in Pattern G, pressure changes will be monitored since they will affect the effective stress and shear strength of the faults. The stability of the faults to stress/strain effects transferred beyond the zone of pressure and temperature changes has been modeled in the current Geosim analysis through investigation of residual shear strength in the cap rock zones. It is commonly accepted that the residual shear strength of materials provides a reasonable estimate of fault shear strength. The Geosim modeling evaluates the shear strength based on any orientation of shear failure surface. The fault dip is reasonably close to vertical. This means the fault is closely aligned with one of the principal stress directions and minimizes the initial shear stress on that specific plane. Therefore, the risk for shear failure and slip in the vertical direction (normal faulting) is much less than analyzed in the model.

b) whether additional monitoring is appropriate near fault affected areas. If necessary provide an update to the monitoring program.

The Reservoir Monitoring Plan described in Appendix SIR2 D will be adequate to monitor potential impacts in the faulted areas. Tiltmeters will be used to identify any subsurface movement in conjunction with InSAR along with direct pressure/temperature measurements obtained from observations wells located within Pattern G.

5) Provide a discussion on what effect steam injection may have on faults including:

a) whether faults may be opened or reactivated by steam injection,

Injection pressures have been designed to remain below the minimum total stress. The normal total stress will be somewhat greater than this stress as the fault planes are not aligned perpendicular to the interpreted minimum horizontal stress direction. Therefore, it is not expected that the faults will be opened in tension. The shear strength of the faults is not expected to be exceeded (fault reactivation) as the operation has been designed for the residual strength of the caprock materials. Monitoring in the vicinity of the faults and specific implementation plans for Pattern G will be provided to the ERCB prior to implementation of Pattern G.

b) what pressure is necessary to open or reactivate faults, and

The pressure required to reactivate faults depends on the local stress state, fault orientation, well pair offset, and pressure and temperature history in the region surrounding the fault. The Project is designed such that pressures will not result in reactivation of a fault of any orientation, having the residual shear strength of the cap rock and subject to the current interpreted initial stress state of the development area. Adjustments to the current plan at the time of Pattern G development will be discussed with the ERCB prior to Pattern G development.

c) whether a brecciated or increased permeability zone exists along the fault or within the fault zone.

An increase/decrease in permeability (for the faulted zone through mudstone materials) could be present, but the likely increase of permeability is less than 10 times the intact material permeability based on experience and public lab testing results (Yale *et al.* 2010). The faulted zone in the sand intervals is expected to cause a decrease in permeability.

Literature Cited:

Yale, D., T. Mayer and J. Wang. 2010. *Geomechanics of Oil Sands Under Injection.* Paper ARMA 10-257, presented at the 44th US Rock Mechanics Symposium and 5th U.S.-Canada Rock Mechanics Symposium, held in Salt Lake City, UT June 27–30, 2010.

Ivanhoe Energy

Appendix SIR2 B

Updated Well Cross Sections for Phase 1 Well Patterns

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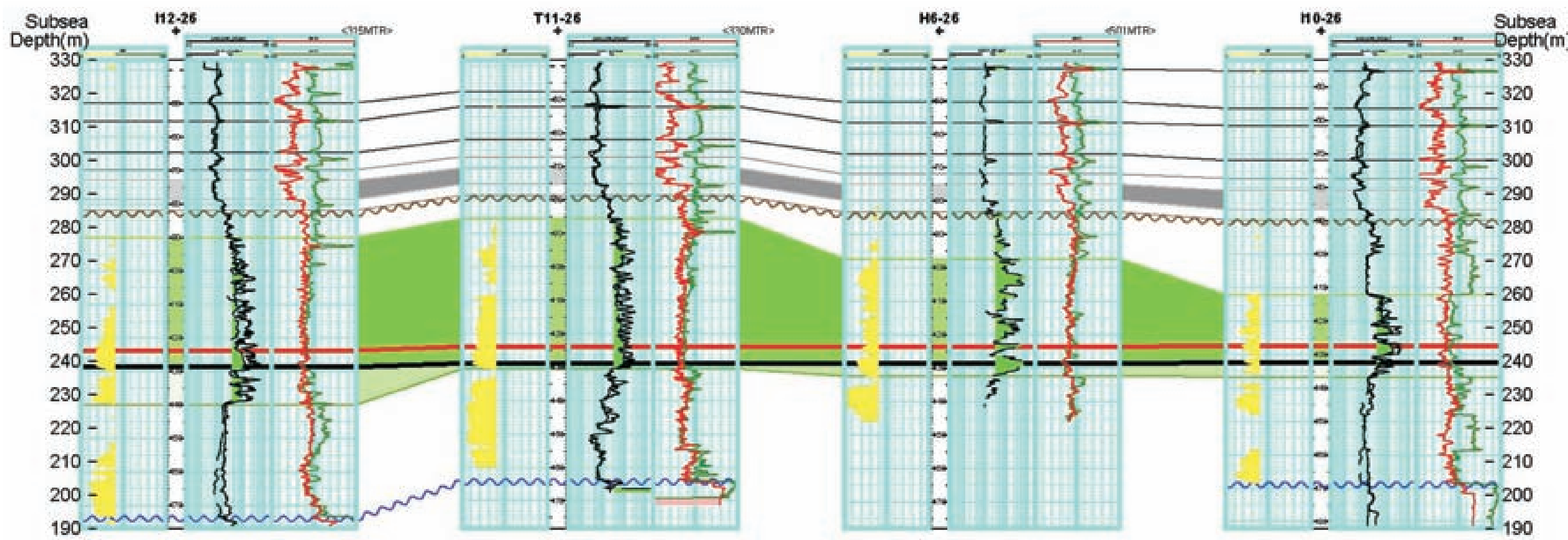

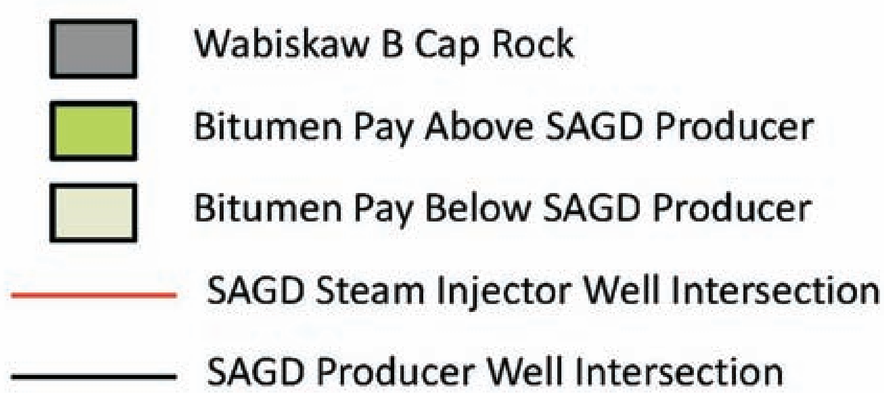

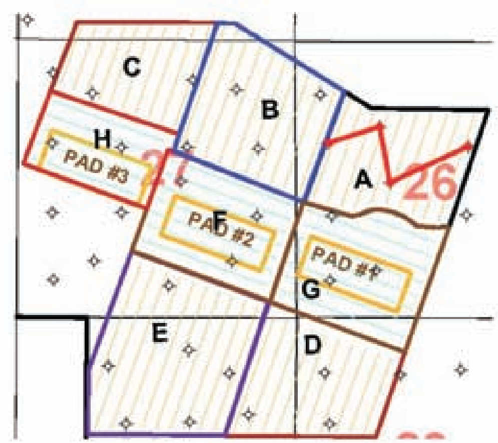

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Tamarack Project

SAGD Well Cross Section for Pattern A in Phase 1 Development Area

DATE: June 2012		SIR2-Fig02.01-46 (Rev) 12-06-29	**Figure SIR2 2.1-46 (Rev)**
PROJECT: CE0374601		DRAWN BY: AMEC	
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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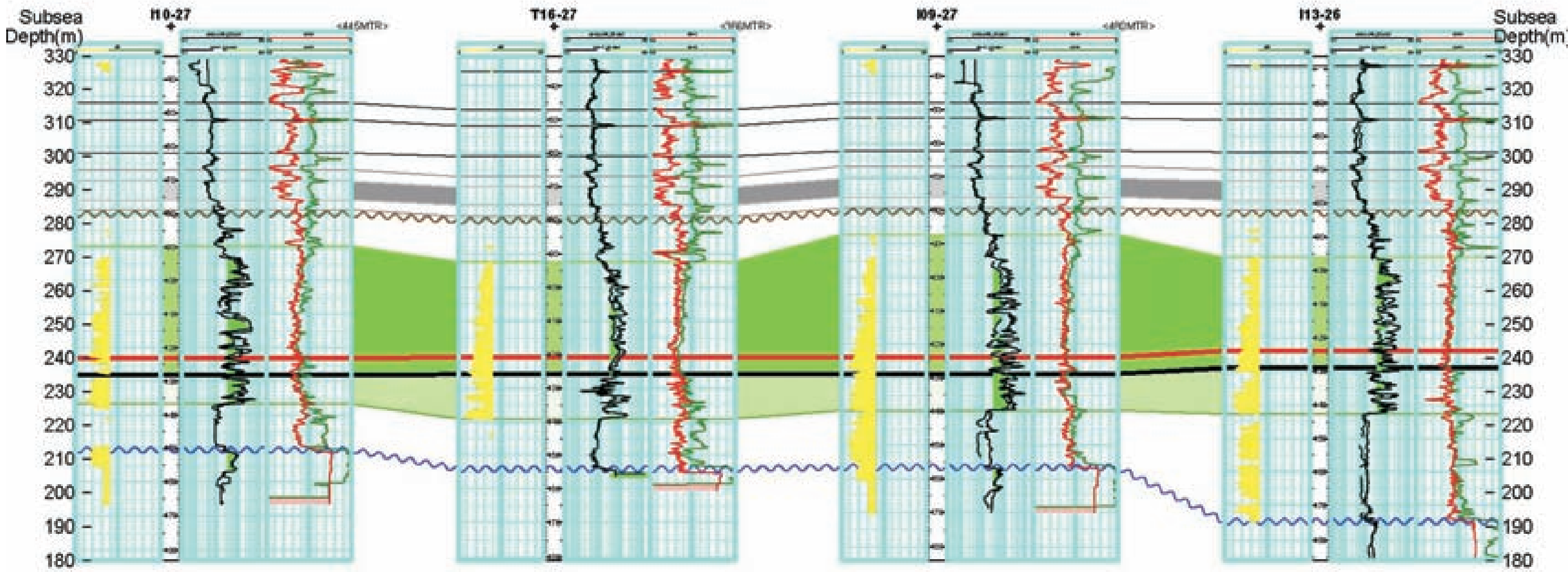


Wabiskaw B Cap Rock

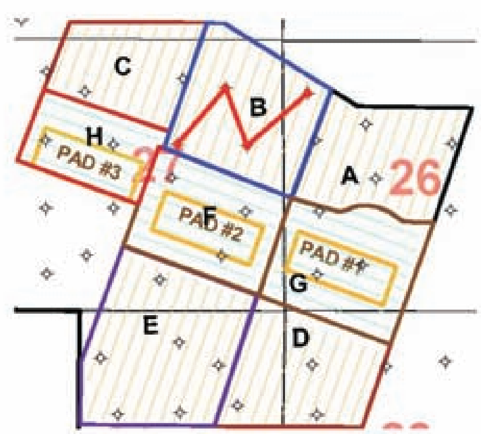
Bitumen Pay Above SAGD Producer

Bitumen Pay Below SAGD Producer

SAGD Steam Injector Well Intersection

SAGD Producer Well Intersection

Cross Section Index Map



Source: Ivanhoe.

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Tamarack Project

SAGD Well Cross Section for Pattern B in Phase 1 Development Area

DATE: June 2012		SIR2-Fig02.01-47 (Rev) 12-06-29	Figure SIR2 2.1-47 (Rev)
PROJECT: CE0374601		DRAWN BY: AMEC	
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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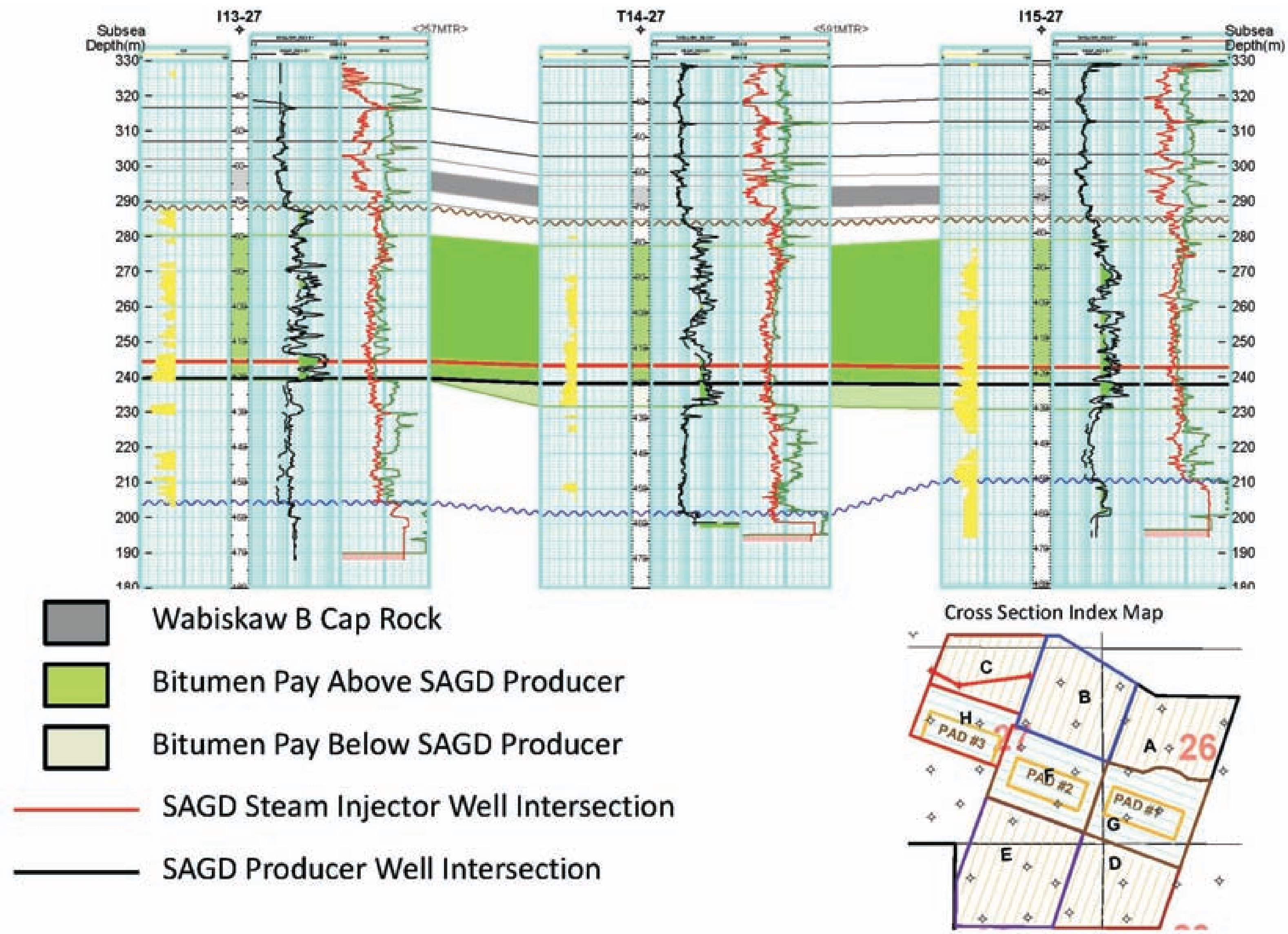

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Ivanhoe Energy Tamarack Project	SAGD Well Cross Section for Pattern C in Phase 1 Development Area	DATE: June 2012 PROJECT: CE0374601 ANALYST: TM QA/QC: TJR MAJ EH	SIR2-Fig02.01-48 (Rev) 12-06-29 DRAWN BY: AMEC PREPARED BY: Ivanhoe

Figure SIR2 2.1-48 (Rev)

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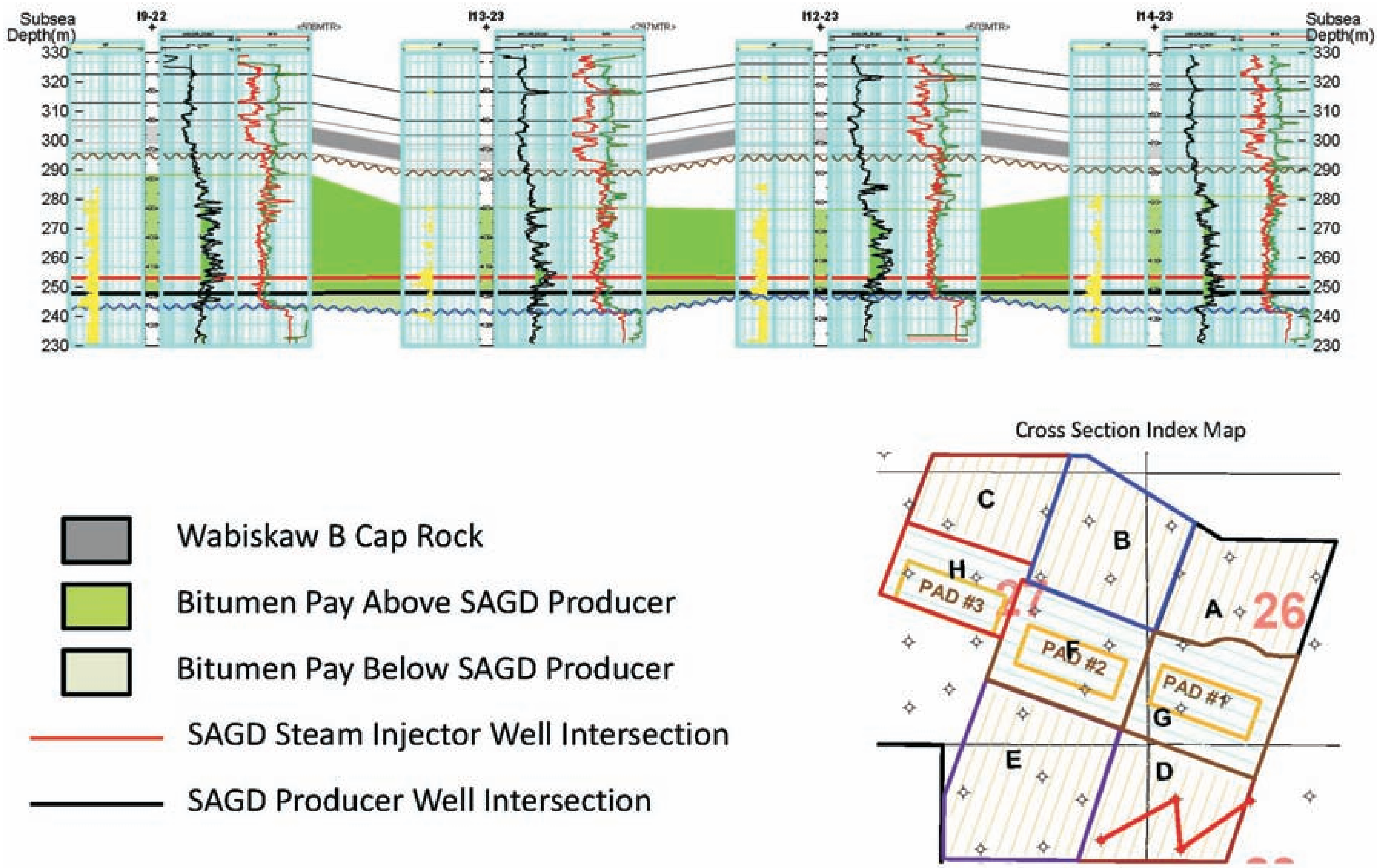

Source: Ivanhoe.

Ivanhoe Energy **Tamarack Project**	SAGD Well Cross Section for Pattern D in Phase 1 Development Area	DATE: June 2012	SIR2-Fig02.01-49 12-06-29	**Figure SIR2 2.1-49 (Rev)**
		PROJECT: CE0374601	DRAWN BY: AMEC	
		ANALYST: TM / QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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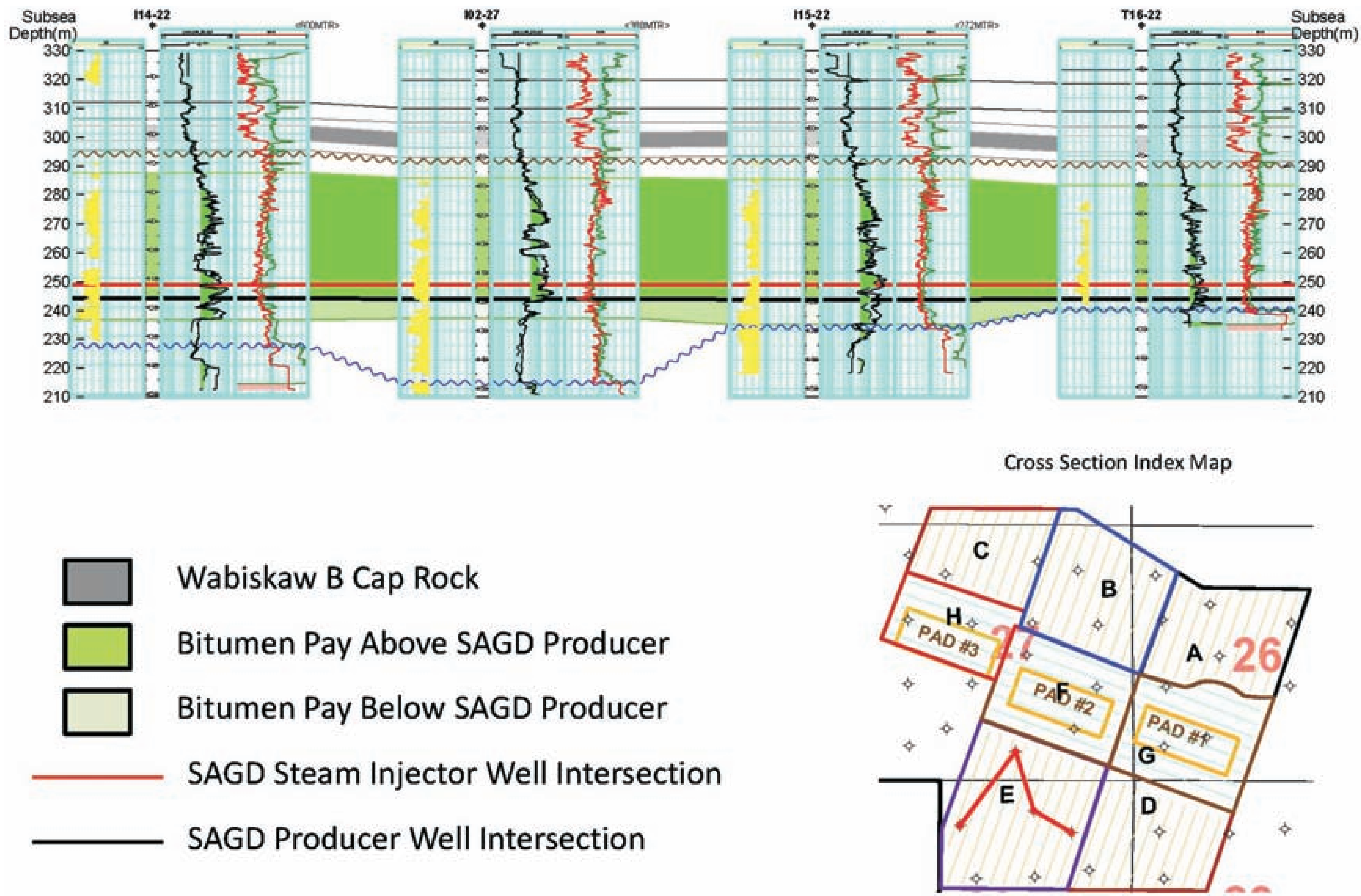

Source: Ivanhoe.

Ivanhoe Energy
Tamarack Project

SAGD Well Cross Section for Pattern E in Phase 1 Development Area

DATE: June 2012		SIR2-FigB-01 12-06-29	**Figure SIR2 B-1**
PROJECT: CE0374601		DRAWN BY: AMEC	
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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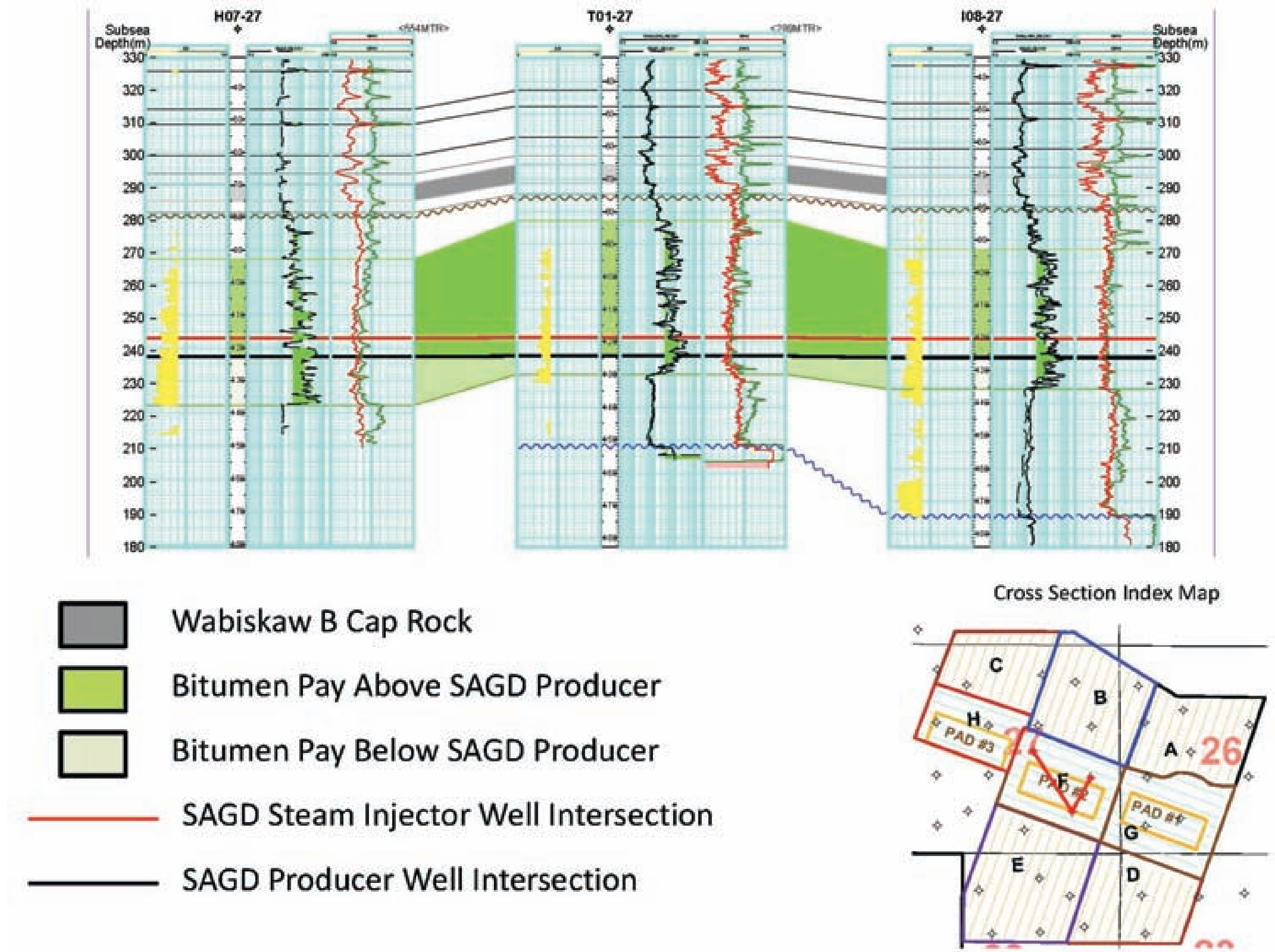

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SAGD Well Cross Section for Pattern F in Phase 1 Development Area

DATE: June 2012		SIR2-Fig02.01-52 12-06-29
PROJECT: CE0374601		DRAWN BY: AMEC
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe

Figure SIR2 2.1-52 (Rev)

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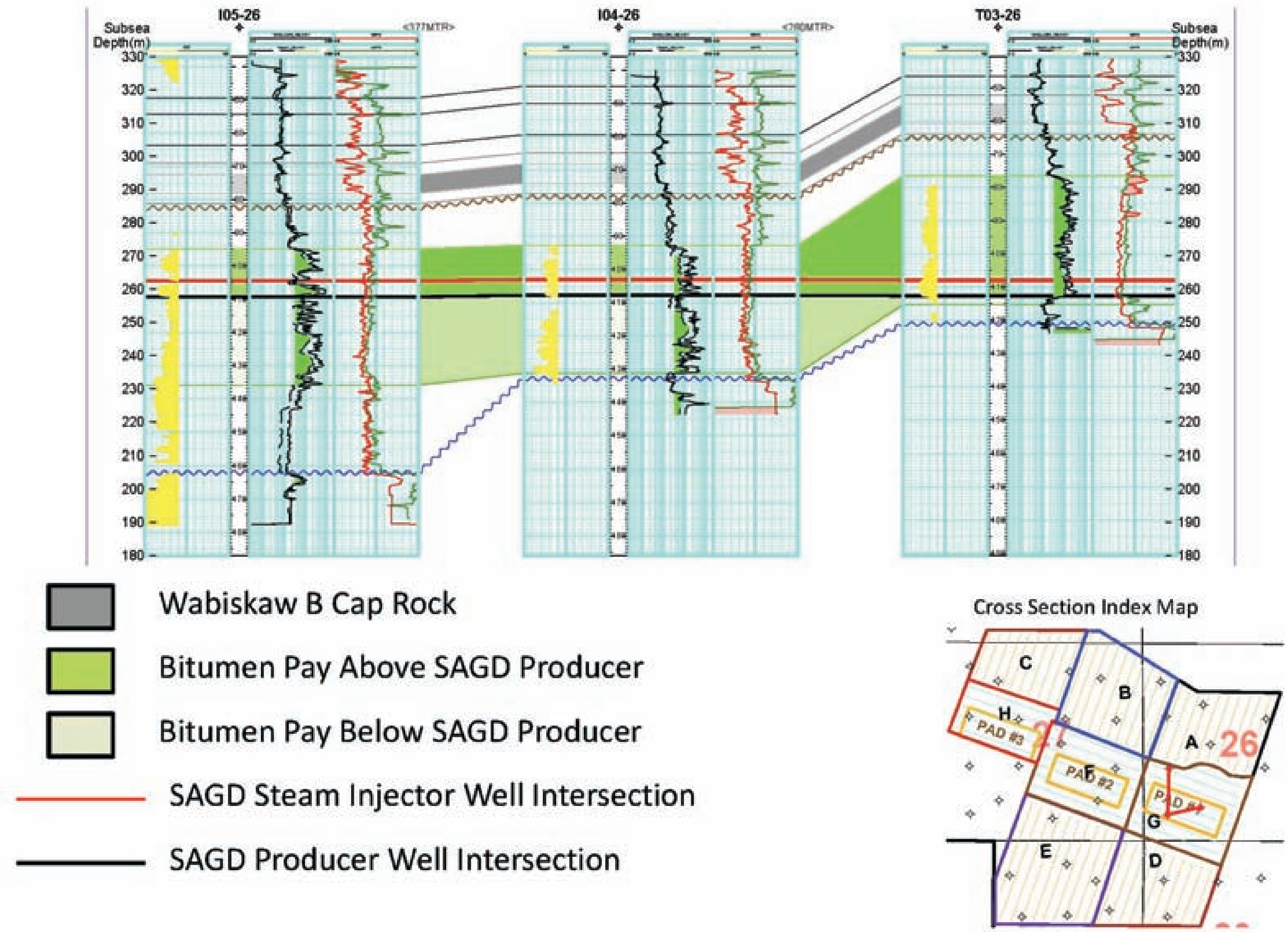

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Ivanhoe Energy Tamarack Project	SAGD Well Cross Section for Pattern G in Phase 1 Development Area	DATE: June 2012 PROJECT: CE0374601 ANALYST: TM QA/QC: TJR MAJ EH	SIR2-Fig02.01-53 (Rev) 12-06-29 DRAWN BY: AMEC PREPARED BY: Ivanhoe

Figure SIR2 2.1-53 (Rev)

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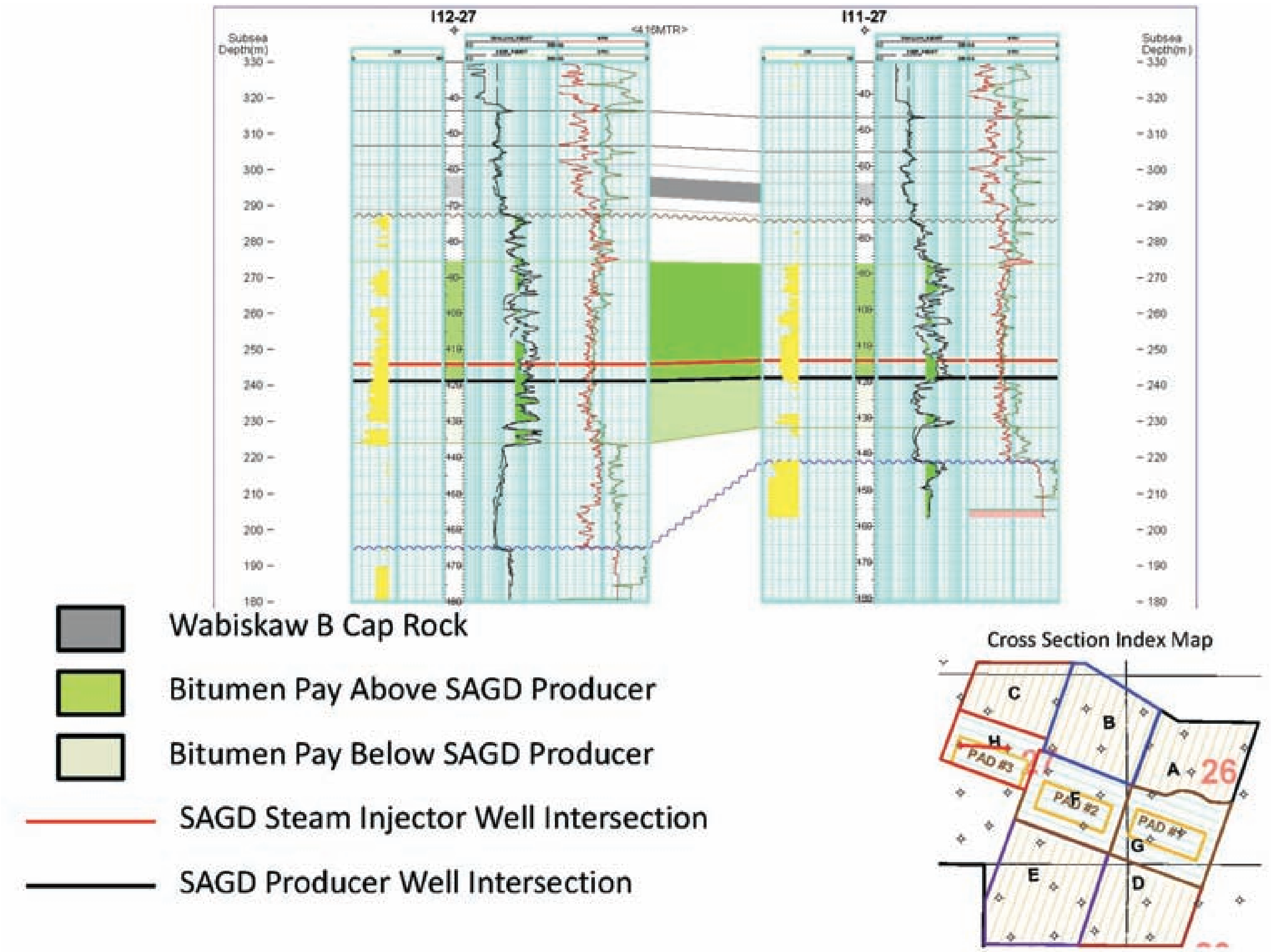

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Ivanhoe Energy Tamarack Project	SAGD Well Cross Section for Pattern H in Phase 1 Development Area	DATE: June 2012	SIR2-FigB-02 12-06-29	Figure SIR2 B-2
		PROJECT: CE0374601	DRAWN BY: AMEC	
		ANALYST: TM; QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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Appendix SIR2 C

Cap Rock Isopach Maps

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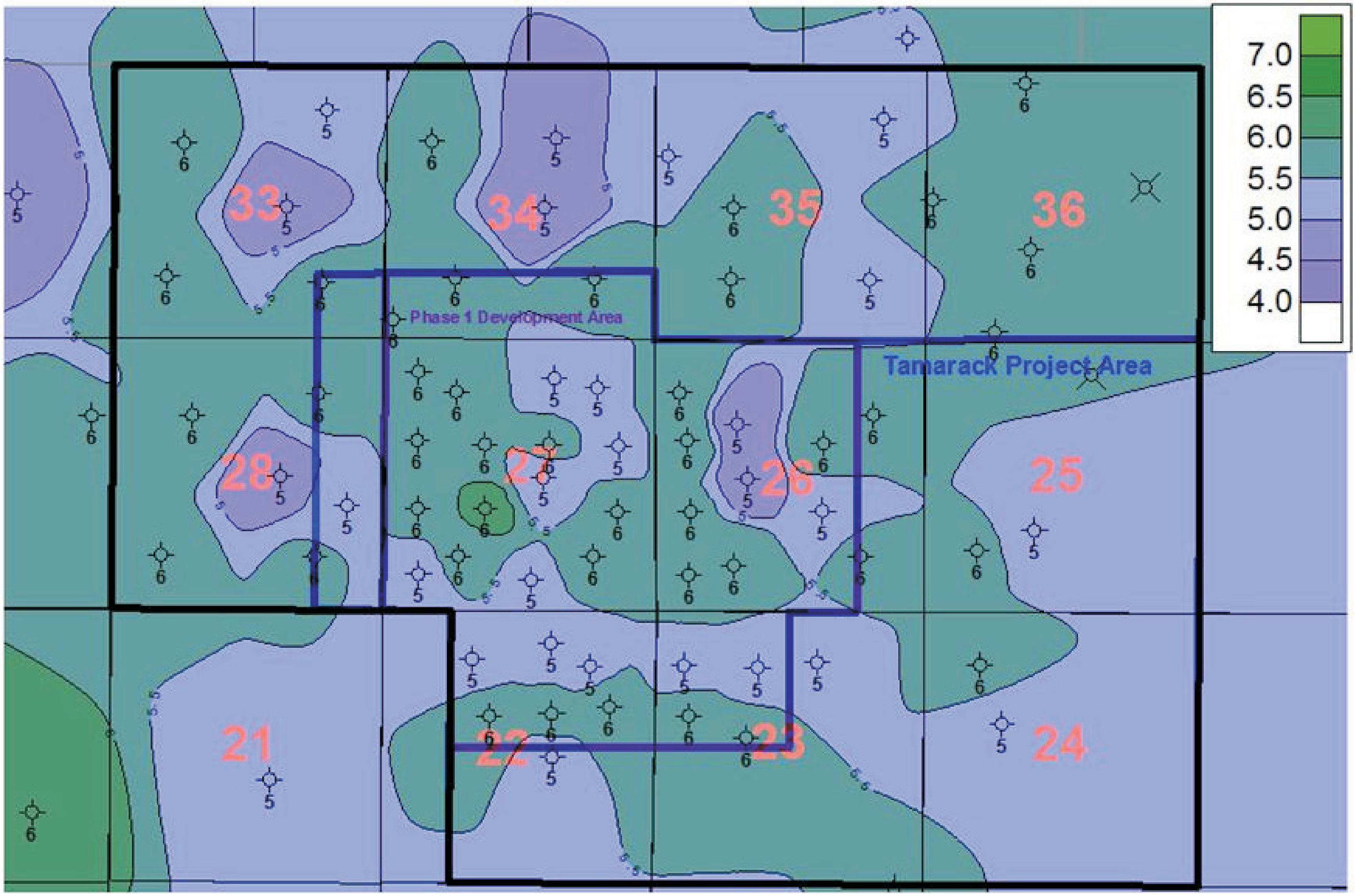

Source: Ivanhoe.

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Wabiskaw B Shale Isopach Map (m)

DATE: June 2012	SIR2-FigC-01 12-06-29		Figure SIR2 C-1
PROJECT: CE0374601	DRAWN BY: AMEC		
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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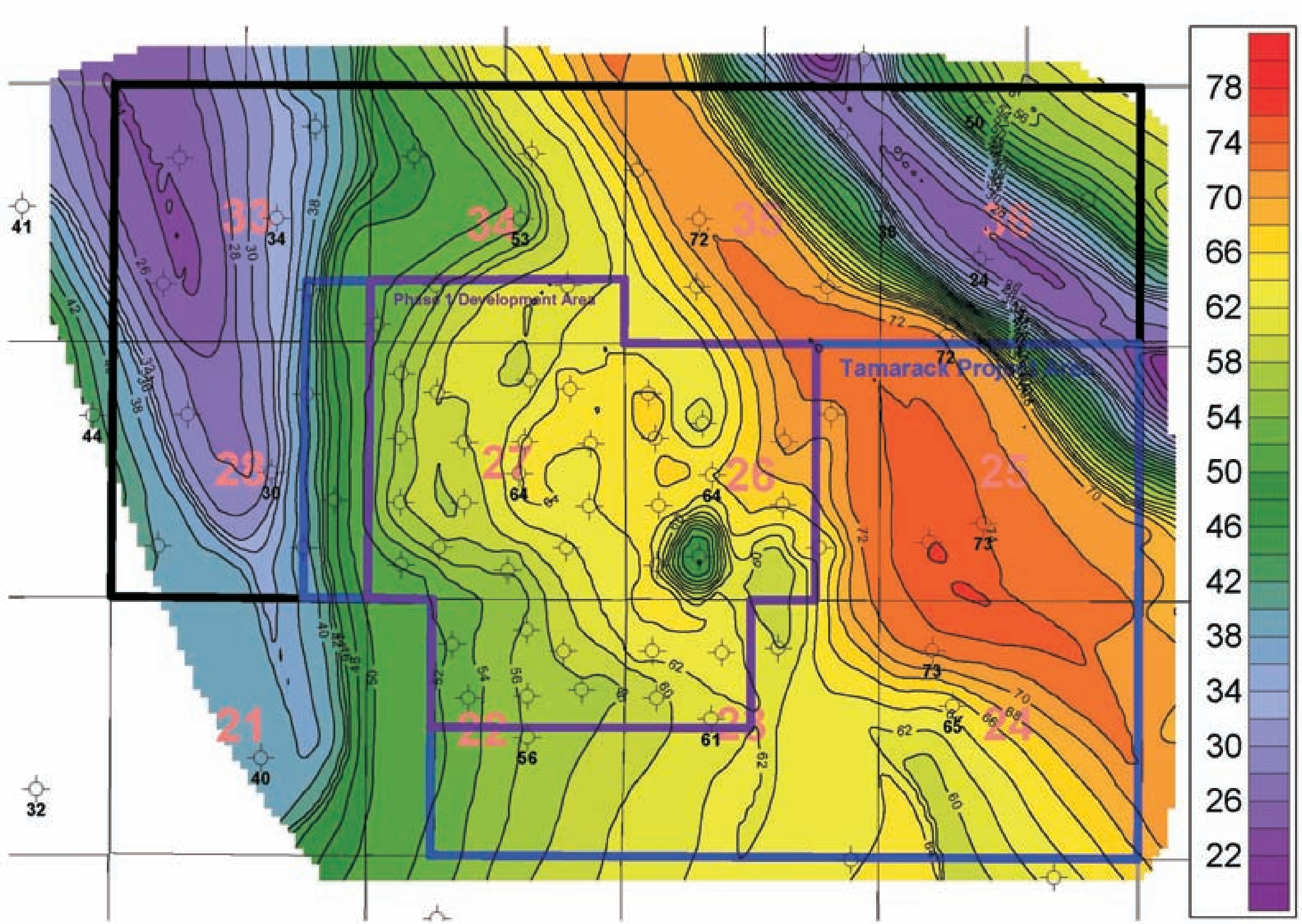

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Tamarack Project

Top Clearwater Shale to Top Wabiskaw C Isopach Map (CI = 2m)

DATE: June 2012		SIR2-FigC-02 12-06-29	Figure SIR2 C-2
PROJECT: CE0374601		DRAWN BY: AMEC	
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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Appendix SIR2 D

Reservoir Monitoring Plan

Introduction

Ivanhoe has developed an overall reservoir monitoring approach for Phase 1 of the Tamarack project. It is envisioned that the Reservoir Monitoring Plan (the Plan) will encompass monitoring of both the surface area and subsurface monitoring (observation wells, producing wells, and injection wells) to provide a real time monitoring of the Tamarack SAGD project. The Plan will also monitor for effects of the Tamarack SAGD operations in the Suncor MSL. The following document presents a conceptual plan, which will be further refined based on future subsurface investigation and once final design engineering for the project is completed.

The multi-level Plan is designed around a holistic approach which will combine measurements and data from a number of different sources in order to provide an accurate understanding of the SAGD processes within the reservoir, to monitor for unexpected subsurface events and to adaptively manage these events should they occur. This Plan will provide extensive near real time information to allow for modifications to the SAGD operations to improve performance and maximize the time to react to subsurface events.

The accurate measurement of surface elevation changes above a SAGD project is required by the ERCB in the annual progress reports. Depending on the depth of the reservoir and distance from operating SAGD developments, the surface movement can vary from a few centimetres up to 30 or more centimetres and may cause a change in the surface water drainage pattern and impact surface equipment.

The Plan will consist of the following technologies:

- Observation Wells;
- Tiltmeter Array with GPS Stations;
- InSAR Corner Point Reflector Array; and
- Production and Injection Well Downhole Monitoring.

A number of surface monitoring schemes are currently being used by industry to monitor SAGD operations. They include survey heave monuments, InSAR satellite surveys using corner point reflectors, permanently installed GPS monuments, and tiltmeters arrays. The frequency of data collection varies greatly between the different methods. Survey heave monuments are the lowest frequency of data collection in the order of 2 to 4 times per year. The InSAR satellite surveys are typically conducted once or twice per month and the GPS monuments and tiltmeter arrays can provide continuous real time data acquisition.

Observation Wells

Ivanhoe will be using observation wells to monitor the SAGD conformance at the reservoir level and also monitor the area outside of the project to ensure that the project does not have any negative effects on the surrounding area. These wells will be added as required throughout the life of the project as development progresses. The Project will have 37 observation wells located within the steam-flood area based on a density of approximately 1 observation well for every 2 SAGD well pairs. Additionally, there will be a further 8 observation wells external to the project to monitor the area adjacent to the Phase 1 SAGD Development area with 4 of the external wells located in the Suncor MSL between the Phase 1 Development area and the Suncor tailings pond. Additional observation wells may be added if warranted based on operational field experience.

Each observation well will be equipped to continuously monitor and collect electronically both temperature (distributed temperature sensor (DTS)) and pressure (vibrating wire Piezometers) at certain intervals within the bitumen reservoir, localized top gas areas, and in the overlaying cap rock formations on a daily basis. The formations to be monitored for both temperature and pressure include the Lower McMurray, Middle McMurray, Upper McMurray, and the Wabiskaw C sands. Additionally, the temperature of the Clearwater and Wabiskaw Shales will be monitored. The data collected daily from the observation wells will complement the information gained from the surface monitoring arrays and will enable effective monitoring of the cap rock and SAGD performance. The observation wells for Phase 1 Development are shown in Figure 1.

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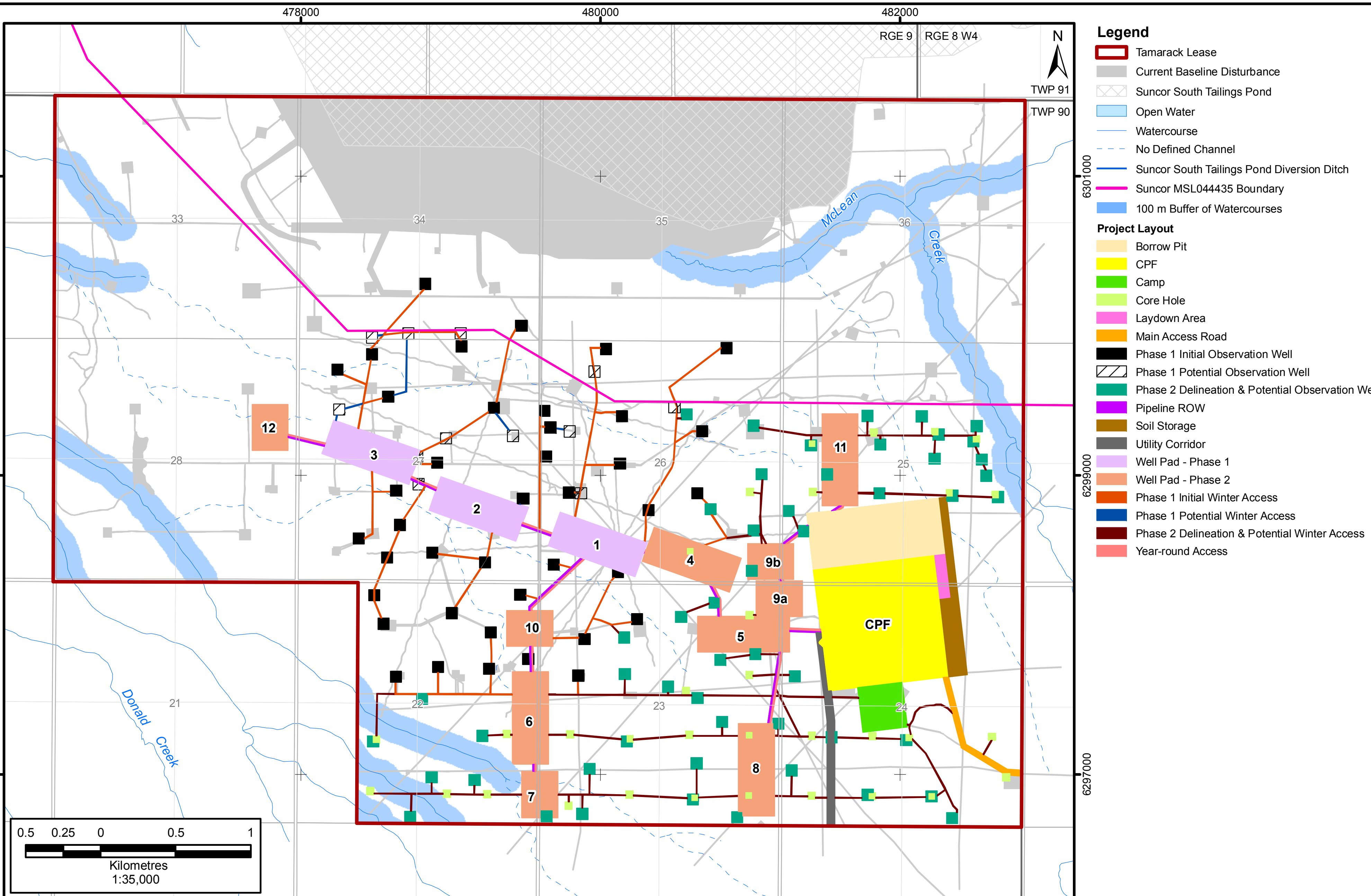

Sources: Ivanhoe, Spatial Data Warehouse Ltd.

Path: S:\Gis\Projects\CE\IvanhoeEnergy\CE0374601_Tamarack_SIRs2\ArcGIS\Appendix SIR2 D - Reservoir Monitoring Plan\SIR2-FigD-01 Project Layout.mxd

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Tamarack Project

Project Layout

DATE: May 2012		SIR2-FigD-01 Project Layout 12-06-29	
PROJECT: CE0374601		PROJECTION/DATUM: UTM Zone 12 NAD83	
ANALYST: TM	QA/QC: TJR MAJ EH	DRAWN BY: AMEC	PREPARED BY: AMEC

Figure SIR2 D-1

Tiltmeter Array with GPS Stations

The real time measurement of the surface deformation is the recommended frequency of data collection at the Tamarack Project due to its depth and proximity to other industrial developments. A combination of a limited array of GPS monitoring points in combination with a high density tiltmeter array is considered to be the best-in-class technology currently available in industry.

The tiltmeter array was designed to provide significant information at the reservoir level in order to understand the growth of the individual SAGD steam chests and, when combined with the subsurface well data will be a very effective means of understanding reservoir and cap rock changes, as a function of time. It is expected that this data will provide information that will be helpful in guiding SAGD well operations to improve performance. The tiltmeters will provide:

- Real-time monitoring of the individual well pairs;
- Mapping of steam conformance within the monitored area;
- Detection and characterization of long-term reservoir processes on adjacent properties; and
- Precise mapping of surface deformation above the project wells.

The information gained from this level of monitoring will provide the ability to detect, locate and characterize shallow fluid/steam migrations should they occur and allow timely intervention to avoid a potential surface breach. The data will increase the reservoir level knowledge and allow for optimization of the project to maximize production and overall bitumen recovery.

For the Tamarack Phase 1 area, the tiltmeter array shown in Figure 2 will consist of approximately 700 tiltmeters and 14 GPS stations which will be well distributed throughout and adjoining the Phase 1 area. The current array is conceptual in nature and the final installation of the array will be adjusted to take advantage of existing surface disturbances and clearings. New disturbances will be minimized as much, as possible, by:

- Minimizing equipment at each location (i.e. small, shallow (approximately 12 m deep), cased well, co-locating equipment (tiltmeters and InSAR), etc.;
- Access will be temporary and disturbance will be allowed to revegetate naturally;
- Clearing will be minimized, using handcutting and low impact clearing, to allow access for a small drilling unit;
- Completing work in the winter; and
- Accessing site infrequently, after installation (for service only), by foot or by quad/snowmobile.

The array will be installed over the initial patterns with build-out occurring as Phase 1 is developed.

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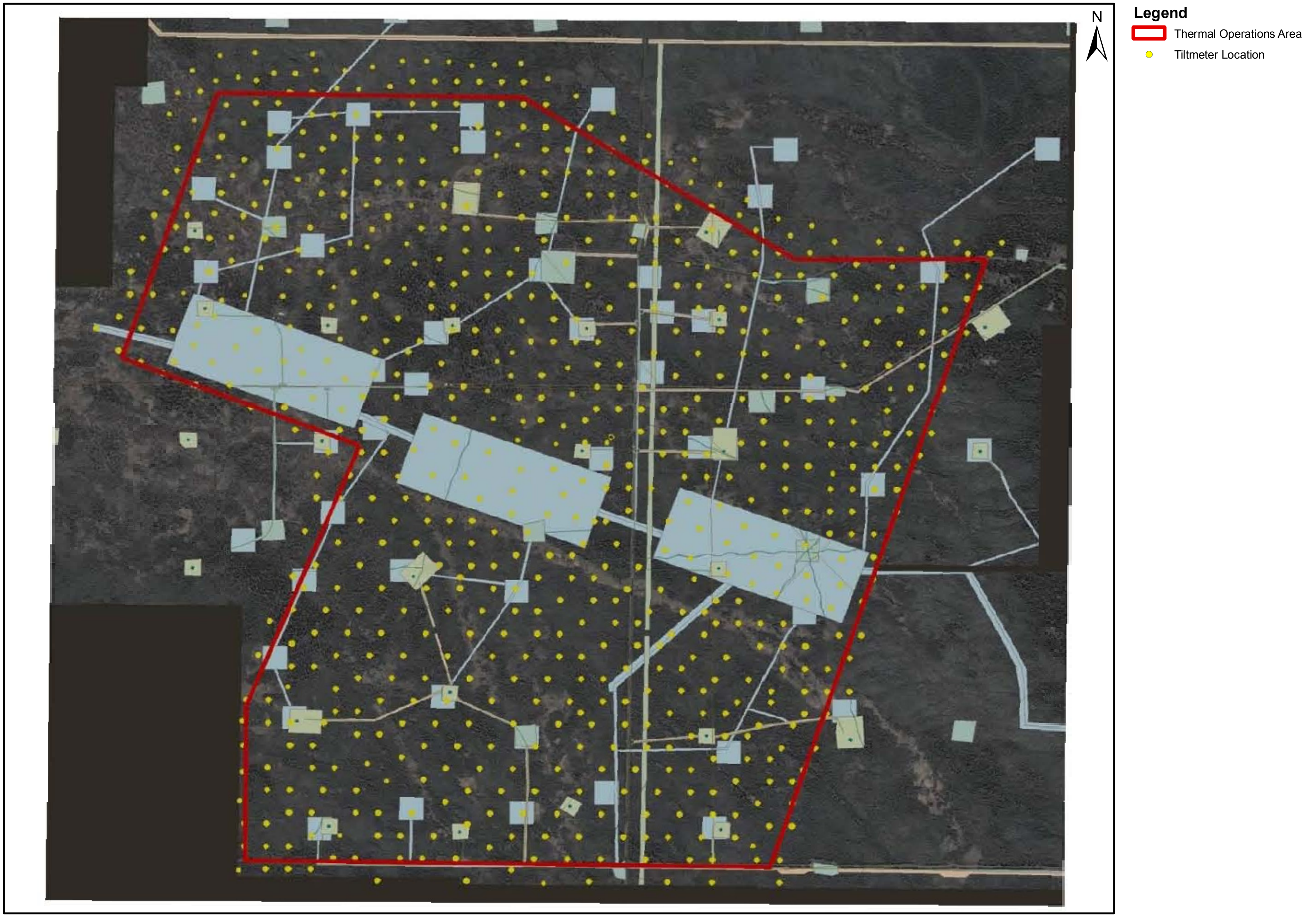

Sources: Ivanhoe

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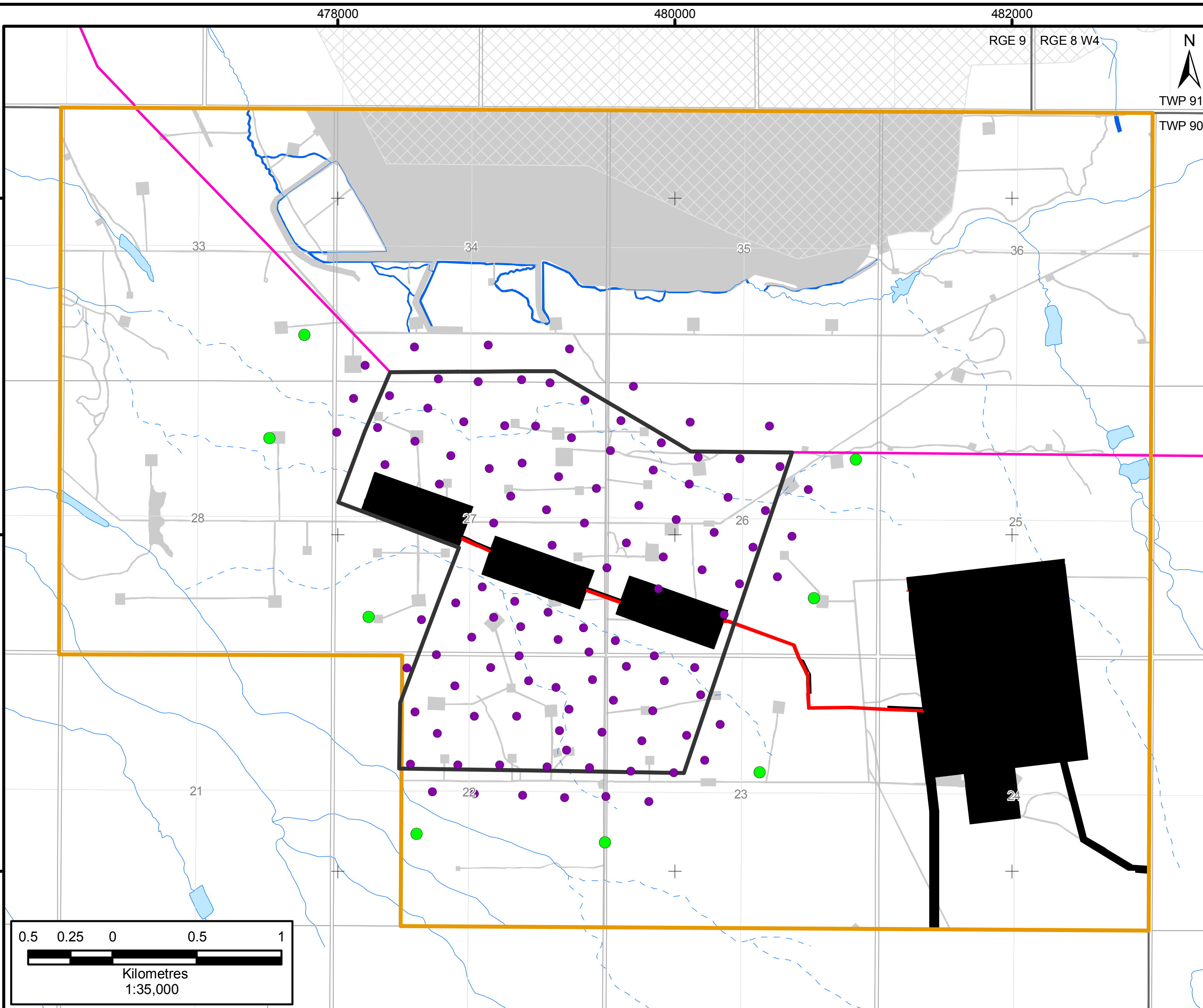
Ivanhoe Energy
Tamarack Project

Phase 1 Tiltmeter Array

DATE: June 2012	SIR2-FigD-02 Tiltmeter Array 12-06-29		Figure SIR2 D-2
PROJECT: CE0374601	PROJECTION/DATUM: UTM Zone 12 NAD83		
ANALYST: TM; QA/QC: TJR MAJ EH	DRAWN BY: AMEC	PREPARED BY: AMEC	

InSAR Corner Point Reflector Array

The Interferometric Synthetic Aperture Radar (InSAR) satellite monitoring is an effective means of tracking surface elevation changes over a large area with little surface disruption. The frequency of the data surveys are related to the orbit of the monitoring satellite and are typically on the order of 8 or more days between measurements. Since this frequency may not be sufficient in monitoring this project Ivanhoe elected to use the previously discussed tiltmeter array as the primary source of surface movement data acquisition. The InSAR data will be used as an independent method to supplement the tiltmeter data. The InSAR surveys will be conducted regularly (3 images a month) and a report will be generated on a quarterly basis. The array shown in Figure 3 will be composed of approximately 120 corner point and natural/manmade reflectors. As with the tilt meters, the current InSAR array is conceptual only. The corner point reflectors will be co-located with the tiltmeters and/or observation wells and on areas of current disturbance, as much as possible.



Legend

- Terrestrial LSA
- Tamarack Project Above Ground Pipeline
- Tamarack Project Footprint
- Baseline Disturbance
- Suncor South Tailings Pond
- Open Water
- Watercourse
- No Defined Channel
- Suncor South Tailings Pond Diversion Ditch
- Suncor MSL044435 Boundary
- Thermal Operations Area
- Proposed Corner Point Reflector
- Reference Corner Point Reflector

Sources: Ivanhoe, Spatial Data Warehouse Ltd.

Path: S:\Gis\Projects\CE\IvanhoeEnergy\CE0374601_Tamarack_SIRs2\ArcGIS\Appendix SIR2 D - Reservoir Monitoring Plan\SIR2-FigD-03 InSAR Array.mxd

Ivanhoe Energy

Tamarack Project

Phase 1 InSAR Array

DATE: June 2012		SIR2-FigD-03 InSAR Array 12-06-29		**Figure SIR2 D-3**
PROJECT: CE0374601		PROJECTION/DATUM: UTM Zone 12 NAD83		
ANALYST: TM	QA/QC: TJR MAJ EH	DRAWN BY: AMEC	PREPARED BY: AMEC	

Production and Injection Wells

The continuous monitoring of the downhole temperature and pressures of both the injection and production wells will be used in combination with other data sources to evaluate and optimize the SAGD well performance. The temperature distribution along the injection wells will allow for the identification of areas along the wellbore that are not accepting sufficient steam. This data will aid in the design of well operations to improve steam distribution. Similarly, the temperature monitoring of the producing well will allow for identification of underperforming intervals and areas of direct steam communication. The temperature and pressure differential between the injection and producing wells will also aid in defining the sub-cool zone so as to avoid steam breakthrough into the producing well.

The producing wells temperature will be monitored using a DTS string run to the toe of the horizontal section inside a coiled tubing string. To monitor the producing well bottomhole pressure a pressure gauge will be run to the toe of the producing well using the same coiled tubing string. The DTS and pressure sensor will be tied into a surface control panel and the information will be relayed on a real-time basis to the field operators and the Calgary office.

In a similar fashion the injection wells temperature will be monitored using a DTS string run to the toe of the horizontal section inside a coiled tubing string. The coiled tubing will be run inside the long injection string. The monitoring of the injection well bottomhole pressure will utilize a pressure gauge run to the toe of the injection well using the same coiled tubing string. The DTS and pressure sensor will be tied into a surface control panel and the information will be relayed on a real-time basis to the field operators and the Calgary office.

Adaptive Management

Based on the information obtained from the Reservoir Monitoring Plan, Ivanhoe will be able to detect subtle changes in cap rock and the reservoir and be able to optimize steam injection and production to safely maximize the recovery of bitumen in the Project Area. Ivanhoe will have the means to identify abnormalities to the cap rock integrity well in advance of a potential surface breach and respond by implementing the necessary corrective actions to prevent such an event. The monitoring of the tiltmeter array is continuous and near real time. The array is monitored 24 hours per day. A potential abnormality in the reservoir will be detected quickly and an almost immediate response is accomplished through three steps:

- Detection (Field array is sampled hourly)
  - Field acquisition system, storage, and transmission
- Analysis and Reporting (Data is analyzed hourly upon receipt)
  - Pre-processing
  - Automated search for reportable event
  - Engineering review of identified event
  - Notification to operator indicating the severity of the event and identification offending wells (within a few hours of data receipt)
- Operator response (upon notification)
  - Depending on severity, the event will be reviewed and field operators notified to:
    - adjust offsetting steam injection;
    - continuation or increase in production from well patterns to reduce formation pressure;
    - implementation of Ivanhoe's ERP; and
    - other actions as necessary.

Appendix SIR2 E

Record of Consultation with Aboriginal Communities

Ivanhoe – Tamarack Project
Aboriginal Contact Summary by Stakeholder (October 2011 – May 2012)

Athabasca Chipewyan First Nation (ACFN)						
ROC#	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
1995	E-mail	10/13/2011	Program Manager (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) TUS: Ivanhoe approved the TUS scope of work provided by ACFN, in principle. 2) Sharing Agreement: Ivanhoe is looking forward to comments from ACFN on the Sharing Agreement provided for review (see also ROC1942).	2) FOLLOW-UP CLOSED: Discussed further on 11/10/25 (see ROC2090). See follow-up in ROC2046.
2013	E-mail	10/24/2011	Director (ACFN IRC) Project Lead (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for August-September 2011. Requested that any comments be provided to AENV (cc: Ivanhoe); they will be included in the next bi-monthly report.	
2089	Phone Call	10/25/2011	TK Coordinator (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Called to discuss the TEK Sharing Agreement. Learned that ACFN Program Manager was no longer working directly for IRC but still in a consulting role. Spoke with TK Coordinator and he provided me with contact number for the ex-Program Manager to follow up with status.	FOLLOW-UP COMPLETE: Call completed on 11/11/02 (see ROC2046).
2090	Phone Call	10/25/2011	Program Manager (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Called to discuss the TEK Sharing Agreement. ACFN Project Lead is now responsible for the TK Sharing Agreement (see also ROCs 1351, 1942, 1995).	1) FOLLOW-UP COMPLETE: Contacted on 11/11/02 (see ROC2046).
2039	E-mail	11/02/2011	Consultant (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) ACFN requested that Ivanhoe fill in the provided fact sheet template regarding Ivanhoe's projects by 11/11/17 (to be used to brief Chief & Council, and inform Elders and Members).	1) FOLLOW-UP COMPLETE: Fact sheet provided on 11/11/16 (see ROC2059).
2046	E-mail	11/02/2011	Project Lead (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) ACFN provided a copy of the IRC agreement signed by Chief & Council (see also ROCs 1942, 1995, 2089, 2090). Ivanhoe to review.	1) FOLLOW-UP CLOSED. See follow-up in ROC2155.
2058	E-mail	11/15/2011	Consultant (ACFN IRC)		1) ACFN followed up to see if Ivanhoe will be able to fill out the Fact Sheets (see ROC02039) by 11/11/17.	1) FOLLOW-UP COMPLETE: Fact sheet provided on 11/11/16 (see ROC2059).
2059	E-mail	11/16/2011	Consultant (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the requested Fact Sheets (see ROCs 2039, 2058).	

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2155	E-mail	12/02/2011	Project Lead (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) ACFN requested an update on Ivanhoe's review of the IRC agreement. Ivanhoe is still reviewing and will get back to ACFN with comments within the week (see also ROCs 0716, 0994, 1149, 1173, 1199, 2090, 2046).	1) FOLLOW-UP COMPLETE: Comments provided on 11/12/06 (see ROC2174).
2161	E-mail	12/05/2011	Director (ACFN IRC) Project Lead (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe has filed responses to AENV's and ERCB's supplemental information requests. Asked that ACFN let them know how many hard and electronic copies they would like.	1) FOLLOW-UP COMPLETE: No response received. One CD and hard copy provided on 12/12/09 (see ROC2245).
2174	E-mail	12/06/2011	Project Lead (ACFN IRC)	Director, HS&E Regulatory (Ivanhoe)	1) IRC Agreement: Ivanhoe would like to meet with ACFN to discuss the agreement provided on 11/12/02 (see ROC2155). 2) TK Sharing Agreement: Ivanhoe would like to meet with ACFN to discuss the TUS information collection outlined in the TUS scope of work.	1) FOLLOW-UP COMPLETE: Meeting to discuss set for 12/04/03 (see ROC2611). See follow-up in ROC2611.
2245	Letter	12/09/2011	Director (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2197	E-mail	12/13/2011	Director (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Confirmation from FedEx of delivery of SIR package (see ROC2245) to ACFN (tracking #795493522315).	
2278	E-mail	12/15/2011	Director (ACFN IRC) Project Lead (ACFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for October-November 2011. Requested that any comments be provided to AENV with a copy to Ivanhoe; they will be included in the next bi-monthly report.	1) FOLLOW-UP CLOSED: No comments received.
2491	E-mail	02/03/2012	Director (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a short meeting with ACFN on 12/02/09 to introduce the new Consultation Coordinator and discuss the project. The IRC Director requested that Ivanhoe contact the Project Lead to set up the meeting.	1) FOLLOW-UP COMPLETE: Requested a meeting through the Project Lead on 12/02/03 (see ROC2696).
2696	E-mail	02/03/2012	Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a meeting with ACFN on 12/02/09. ACFN to confirm if they are available (see ROC2491).	1) FOLLOW-UP CLOSED: ACFN did not respond. Sent another meeting request on 12/02/28 (see ROC2567). See follow-up in ROC2567.

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2597	Phone Call	02/13/2012	Program Manager (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) ACFN requested a project update and shape files for the project. Ivanhoe is reviewing Round 2 SIRs and answering Statements of Concern. Will send shape files by e-mail.	1) FOLLOW-UP COMPLETE: Shape files provided on 12/02/16 (see ROC2549).
2641	E-mail	02/14/2012	Project Lead (ACFN IRC)	Director, HS&E Regulatory (Ivanhoe)	1) ACFN submitted a scope of work (on behalf of themselves and MCFN) for a third-party review of the Supplemental Information Requests.	1) FOLLOW-UP CLOSED: Ivanhoe will not fund an SIR review as the SIRs are for information only (see ROC2535, 12/02/15).
2535	E-mail	02/15/2012	Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe responded to ACFN's request for funding for a third-party review of the Supplemental Information Requests (see ROC2641). As the SIRs were provided to ACFN for information only and are directed to the regulators, no funding will be provided for third-party reviews.	
2549	E-mail	02/16/2012	Program Manager (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the requested shape files (see ROC2597).	
2547	E-mail	02/21/2012	Director (ACFN IRC) Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the December 2011 - January 2012 bi-monthly consultation log for review, and requested that any comments be provided by e-mail to AEW and cc'd to Ivanhoe.	1) FOLLOW-UP CLOSED: No comments received.
2567	E-mail	02/28/2012	Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a meeting with ACFN on 12/03/15 to set up a consultation plan for the remainder of the year, and also to discuss the TEK/TLU proposal and agreement and the ACFN IRC agreement (see also ROCs 2491, 2696). 2) ACFN asked for comments/response on their SOC back before that meeting, but Ivanhoe is not sure if the Statement of Concern responses will be ready prior to that date.	1) FOLLOW-UP CLOSED: Third request for meeting sent on 12/03/06 (see ROC2588). See follow-up in ROC2588.
2588	E-mail	03/06/2012	Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Further to Ivanhoe's initial request on 12/02/28 (see ROC2567), Ivanhoe asked if ACFN is available to meet on 12/03/15 (see also ROCs 2491, 2696).	1) FOLLOW-UP COMPLETE: ACFN is not available that date (see ROC2609, 12/03/12). See follow-up in ROC2609.

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ROC#	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2609	E-mail	03/12/2012	Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested confirmation if ACFN is available to meet on 12/03/15; they are not. ACFN suggested 12/03/30, 12/04/02 or 12/04/03 as potential dates. Ivanhoe to confirm if any of these dates work (see ROC2588).	1) FOLLOW-UP COMPLETE: Ivanhoe confirmed that 12/04/03 works for them (see ROC2611, 12/03/13).
2611	E-mail	03/13/2012	Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe is available to meet on 12/04/03 and requested confirmation of time from ACFN.	1) FOLLOW-UP COMPLETE: Meeting confirmed for 10:00 am (see ROC2660, 12/03/27).
2674	Phone Call	03/20/2012	Land Use Coordinator (ACFN)	Consultation Coordinator (Ivanhoe)	1) ACFN has an invoice for Ivanhoe relating to their traditional use study. Ivanhoe had agreed they would commit to funding a TUS once a TK agreement is reached. However, as no agreement had been signed to date, Ivanhoe will not pay the invoice at this time. Agreed to discuss the study and agreement at the scheduled 12/04/03 meeting.	1) FOLLOW-UP COMPLETE: Items discussed on 12/04/03.
2660	E-mail	03/27/2012	Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Meeting with ACFN confirmed for 12/04/03 at the IRC office. ACFN will send possible agenda items to Ivanhoe.	1) FOLLOW-UP COMPLETE: Meeting held on 12/04/03.

Athabasca Chipewyan First Nation (ACFN)						
ROC#	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2852	Meeting	04/03/2012	Program Manager (ACFN IRC), Project Lead (ACFN IRC)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) IRC Agreement/Funding: Ivanhoe and ACFN will discuss Ivanhoe becoming a full member of the IRC after the Western Management Study has been completed. 2) TK/TLU Study: Ivanhoe needs a TK Sharing Agreement in place before funds can be released to ACFN for a TK/TLU study. ACFN noted the agreement should cover: (a) allow Ivanhoe to file the information with regulators; (b) protect knowledge of ACFN knowledge holders; and (c) ensure the information is for specific to the project for one-time use. Ivanhoe would need to have the right to comment on the study and would file it with regulators. Ivanhoe suggested that ACFN contact MCFN for a template of their agreement. 3) Statement of Concern (SOC): Ivanhoe expects to have a response to ACFN's SOC by the end of April, after which they would like to have a technical meeting to discuss the SOCs. 4) Federal Triggers: ACFN asked if the project has any federal triggers; Ivanhoe confirmed it does not. 5) 2012 Consultation Plan: Ivanhoe would like to have a consultation plan in place with ACFN as they are nearing the regulatory phase of the Tamarack Project. ACFN suggested it would be best to wait until after the Western Management Study before discussing the consultation plan.	1) FOLLOW-UP OUTSTANDING: Determine membership level after study is complete. 2) FOLLOW-UP OUTSTANDING: ACFN and Ivanhoe to discuss a TK Sharing Agreement. 3) FOLLOW-UP OUTSTANDING: Hold meeting to discuss SOC once response is provided from Ivanhoe. Update: Ongoing. 5) FOLLOW-UP OUTSTANDING: ACFN and Ivanhoe to prepare a consultation plan for 2012. Update: Ongoing.
2742	E-mail	04/18/2012	Director (ACFN IRC), Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the bimonthly contact report for February-March 2012. Any comments from ACFN will be included in the next bimonthly report.	
2819	E-mail	05/14/2012	Chief (ACFN)	Regulatory Affairs Consultant (Ivanhoe)	1) Regulatory Affairs Consultant requested a meeting with ACFN to discuss resolution of their SOC as well as project issues.	1) FOLLOW-UP OUTSTANDING: ACFN to let Regulatory Affairs Consultant know of their availability for a meeting to discuss project issues. Update: Ongoing.

Athabasca Chipewyan First Nation (ACFN)						
ROC#	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2851	E-mail	05/15/2012	Project Lead (ACFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided draft notes for the 12/04/03 meeting (see ROC2852). Requested that any changes/comments be provided by 12/05/31.	1) FOLLOW-UP CLOSED: No comments received. Item closed.

Chipewyan Prairie Dene First Nation (CPDFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
1994	E-mail	10/13/2011	Executive Director (CPDFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe touched base with CPDFN to see if there was anything they wished to discuss regarding the Tamarack Project. CPDFN will contact someone other than the Manager, Regulatory & Consultation at Ivanhoe if they wish to discuss the project.	
2034	Phone Call	10/14/2011	Executive Director (CPDFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe left a message to discuss the Executive Director's concerns in dealing with Ivanhoe's Manager, Regulatory & Consultation.	1) FOLLOW-UP NOT COMPLETED: No return phone call received from CPDFN. Item closed.
2243	Letter	12/09/2011	Executive Director (CPDFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2190	E-mail	12/12/2011	Executive Director (CPDFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Confirmation from FedEx of delivery of SIR package (see ROC2243) to CPDFN (receipt #797823999071).	
2283	E-mail	12/15/2011	Executive Director (CPDFN IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for October-November 2011. Requested that any comments be provided to AENV with a copy to Ivanhoe; they will be included in the next bi-monthly report.	1) FOLLOW-UP CLOSED: No comments received.
2543	E-mail	02/21/2012	Executive Director (CPDFN IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the December 2011 - January 2012 bi-monthly consultation log for review, and requested that any comments be provided by e-mail to AEW and cc'd to Ivanhoe.	1) FOLLOW-UP CLOSED: No comments received.
2700	Invoice	04/02/2012	Administrative Coordinator (CPDFN)	Director, HS&E Regulatory (Ivanhoe)	1) CPDFN invoiced Ivanhoe for IRC fees for Q2 (April - June 2012).	

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
1979	E-mail	10/03/2011	Councillor (FMFN #468) Interim Director (FMFN #468) Chief (FMFN #468) Councillor (FMFN #468) Consultant (Fourth Meridian Consulting)	Manager, Regulatory & Consultation (Ivanhoe)	1) Further to Ivanhoe's letter to the Chief dated 11/09/08 (see ROC1974) regarding the governance workshop, Ivanhoe requested the following information prior to finalizing payment: detailed budget, list of deliverables and review of deliverables. Once this information is received by Ivanhoe, payment for the workshop will be provided.	1) FOLLOW-UP COMPLETE: Information provided on 11/10/03 (see ROC1980).
1980	E-mail	10/03/2011	Interim Director (FMFN #468) Consultant (Fourth Meridian Consulting)	Manager, Regulatory & Consultation (Ivanhoe)	1) In response to Ivanhoe's requests (see ROCs 1974 and 1979), budget information was provided for the governance workshop. Deliverables will be developed through participation at the workshop and therefore will not be available in advance. Payment must be received before the workshop in order to attend. Requested that Ivanhoe confirm their attendance at the workshop.	FOLLOW-UP COMPLETE: Attendance confirmed and payment provided on 11/10/06 (see ROC1985).
1982	E-mail	10/06/2011	Consultant (Fourth Meridian Consulting)	Manager, Regulatory & Consultation (Ivanhoe)	1) Fourth Meridian thanked those who accepted the invitation to attend the governance workshop. A member of the facilitation team will contact attendees in advance of the workshop. An overview of the workshop was also provided.	
1985	E-mail	10/06/2011	Consultant (Fourth Meridian Consulting)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided payment for attendance at the FMFN #468 governance workshop (see ROC1980).	
1986	E-mail	10/06/2011	Interim Director (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the 11/08/24 meeting notes (see ROC1892) to the Interim Director and asked that he have the Chief review them by 11/10/20. 2) Ivanhoe requested a meeting with the Interim Director on 11/10/16.	1) FOLLOW-UP CLOSED: No comments received; item closed (per JH, 11/12/07). 2) FOLLOW-UP COMPLETE: Meeting for 11/10/12 confirmed on 11/10/07 (see ROC1988).
1988	E-mail	10/07/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Breakfast meeting confirmed for 11/10/12.	FOLLOW-UP COMPLETE: Meeting held on 11/10/12 (see ROC2020).
1992	E-mail	10/11/2011	Interim Director (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 confirmed meeting for 9:00 am on 11/10/12.	

Fort McMurray #468 First Nation (FMFN #468)						
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2020	Meeting	10/12/2011	Interim Director (FMFN #468 IRC) Representative (FMFN #468 IRC)	VP, Engineering, Marketing & Infrastructure (Ivanhoe) Manager, Regulatory & Consultation (Ivanhoe)	1) Overview: New FMFN #468 Interim Director was introduced to Ivanhoe. Ivanhoe provided a summary of the project to date for FMFN #468. 2) Clearwater Multi-user Access Road: Ivanhoe was originally a proponent but is now just a user of the road. The Interim Director would like to get more in-depth information on this at a later date. 3) Relationship: Ivanhoe has had regular meetings with the IRC and Chief & Council. Ivanhoe is funding a feasibility study for a bridge across the Christina River to the reserve. Ivanhoe and FMFN #468 are finalizing an annual social investment workplan. 4) Open House: The last IRC Director had requested another open house for the project as attendance at the last one was limited. This will be discussed going forward. 5) Invoice: Ivanhoe has not been invoiced for full IRC membership for 2011. The Interim Director will send an invoice for this ASAP. 6) Governance Workshop: High level of support for the workshop; 15 community members plus industry will attend.	1) FOLLOW-UP CLOSED: Ivanhoe to send a summary of the relationship between FMFN #468 and Ivanhoe to the Interim Director by 11/11/15. See follow-up in ROC2064. 5) FOLLOW-UP COMPLETE: Invoice provided on 11/11/16 (see ROC2120).
2067	Phone Call	10/13/2011	Cross-Cultural Trainer (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) Cross-cultural training proposed by FMFN #468 cancelled as not enough companies could attend. FMFN #468 to let Ivanhoe know when the training is rescheduled.	1) FOLLOW-UP OUTSTANDING: FMFN #468 to provide new date to Ivanhoe when available.
2067	Phone Call	10/13/2011	Cross-Cultural Trainer (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) Cross-cultural training proposed by FMFN #468 cancelled as not enough companies could attend. FMFN #468 to let Ivanhoe know when the training is rescheduled.	1) FOLLOW-UP OUTSTANDING: FMFN #468 to provide new date to Ivanhoe when available.
2067	Phone Call	10/13/2011	Cross-Cultural Trainer (FMFN #468)	Director, HS&E Regulatory (Ivanhoe)	1) Cross-cultural training proposed by FMFN #468 cancelled as not enough companies could attend. FMFN #468 to let Ivanhoe know when the training is rescheduled.	1) FOLLOW-UP CLOSED: No date has been provided to date. Item closed and will be re-opened if a new date is provided.

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2011	E-mail	10/24/2011	Consultant (Fourth Meridian Consulting)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 provided the agenda for the governance workshop. Confirmed that accommodations have been booked for Ivanhoe.	
2012	E-mail	10/24/2011	Interim Director (FMFN #468) Representative (FMFN #468 SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for August-September 2011. Requested that any comments be provided to AENV (cc: Ivanhoe); they will be included in the next bi-monthly report.	
2100	E-mail	10/28/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided contact information for the FMKFN IRC for FMFN #468 to discuss their organizational change.	
2110	Workshop	10/28/2011	Chief, Councillors, Community Members, IRC staff (FMFN #468) Facilitators Various Industry representatives	Manager, Regulatory & Consultation (Ivanhoe)	1) Workshop: Facilitated workshop with First Nation leadership, community members and industry to discuss consultation protocol and community development. 2) IRC Funding: Confirmed amount for 2011 IRC funding. FMFN #468 to invoice Ivanhoe for 2011.	2) FOLLOW-UP CLOSED: FMFN #468 to send Ivanhoe an invoice. Requested again at 11/11/16 meeting (see ROC2112). See follow-up in ROC2112.
2024	E-mail	10/31/2011	Interim Director (FMFN #468 IRC) Representative (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided notes for the 11/10/12 meeting (see ROC2020). Requested that any changes be provided by 11/11/25.	FOLLOW-UP CLOSED: No changes received; notes considered final (per JH, 11/12/07).
2052	E-mail	11/09/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested a meeting with the Interim Director when he is in Calgary the week of 11/11/14.	1) FOLLOW-UP COMPLETE: Meeting set for 11/11/15 (see ROC2053, 11/11/10).
2053	E-mail	11/10/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Meeting set with Interim Director in Calgary on 11/11/15 at 9:00 am.	1) FOLLOW-UP COMPLETE: Meeting held on 11/11/16 (see ROC2112).

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2063	Letter	11/10/2011	Chief (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) Governance Workshop: FMFN #468 thanked those who sponsored and attended. They are committed to working together to retain the progress developed from the workshop. 2) Consultation records: FMFN #468 has asked all industry in the RMWB that has worked with FMFN #468 to provide pertinent information on past and present interaction and engagement with FMFN #468. This will assist them in understanding past relationships and to develop their framework for future consultation.	
2064	Letter	11/10/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 requested information on FMFN #468 programs supported, business contracts, TLU agreements, TEK studies, consultation records, agreements, company projects and past/current SOCs. Asked that this information be forwarded by 11/11/18.	1) FOLLOW-UP COMPLETE: Information provided on 11/11/23 (see ROC2081).
2055	E-mail	11/14/2011	TUS Consultant (Traditional Knowledge Facilitator)	Manager, Regulatory & Consultation (Ivanhoe)	1) TK Facilitator has not yet received sign-off for the February TK report/meeting.	
2056	E-mail	11/15/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 provided two letters (see ROCs 2063 and 2064) (from the Chief and Interim Director) asking for consultation and business information on contacts with FMFN #468. Requested this information by 11/11/18.	
2118	E-mail	11/15/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe will prepare the requested consultation and funding records (see ROC2056) by the end of the week.	FOLLOW-UP COMPLETE: Records sent on 11/11/23 (see ROC2081).
2060	E-mail	11/16/2011	Advisor (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 provided information on its new Advisor.	
2070	E-mail	11/16/2011	Advisor (FMFN #468) Consultant 2 (Fourth Meridian Consulting)	Manager, Regulatory & Consultation (Ivanhoe)	1) Fourth Meridian noted that the follow-up work for the workshop was done within the original budget. Requested that their past employee, now working for FMFN #468, clarify his position to Industry.	

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2112	Meeting	11/16/2011	Interim Director (FMFN #468 IRC) Representative (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) IRC Funding: FMFN #468 to send an invoice for 2011 funding ASAP; Ivanhoe will expedite when received. 2) Consultation Plan: FMFN #468 and Ivanhoe to develop a consultation plan for 2012 to identify the process for addressing issues (see also ROCs 0945, 1384, 1406, 1656, 1727). Per the request of the previous IRC Director, Ivanhoe will work with FMFN #468 to plan a community event as part of the 2012 plan (see also ROC2020). 3) SOCs: Ivanhoe will respond to SOCs from FMFN #468 after the first round of SIRs are submitted. 4) Consultation Records: Ivanhoe provided copies of all past consultation summaries sent to AENV. Still to provide a summary of funding (consultation, social investment and other) provided and consultation undertaken. 5) Contact Person: The Interim Director is the sole point of contact for Ivanhoe going forward. 6) TEK/TLU Report: Final report from February TEK/TLU study still needs to be approved by Chief & Council. Ivanhoe would like to provide it to regulators ASAP so it is included in the decision-making process (see also ROCs 1496, 1599, 1836, 1840). 7) LTBA: Discussed setting up a long-term benefits agreement (LTBA) for the project. FMFN #468 to determine how they would like to move forward with this (see also ROCs. 8) Bridge/Reserve Access: Ivanhoe would like to know if a bridge to the reserve (study funded by Ivanhoe) is still a priority as part of a potential LTBA; FMFN #468 to confirm.	1) FOLLOW-UP COMPLETE: Invoice provided on 11/11/16 (see ROC2120). 2) FOLLOW-UP OUTSTANDING: Meet to discuss 2012 consultation plan. FOLLOW-UP OUTSTANDING: Organize a community event by 12/01/31. 3) FOLLOW-UP OUTSTANDING: Ivanhoe to provide a copy of the SIRs to FMFN #468. 4) FOLLOW-UP COMPLETE: Summary provided on 11/11/23 (see ROC2081). 6) FOLLOW-UP OUTSTANDING: FMFN #468 to get the report signed off by Chief & Council by 12/01/31. 7) FOLLOW-UP OUTSTANDING: FMFN #468 to identify a process for negotiating a LTBA by 12/12/31. 8) FOLLOW-UP OUTSTANDING: FMFN #468 to confirm the bridge is still a priority by 12/01/31. 9) FOLLOW-UP OUTSTANDING: FMFN #468 to provide a list of funding opportunities by 12/01/15. FOLLOW-UP OUTSTANDING: Ivanhoe to provide a budget for social investment by 12/01/15.

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
					9) Social Investment: Ivanhoe and FMFN #468 to develop a social investment work plan for 2012 that outlines all funding Ivanhoe can provide and the programs it will go to (see also ROCs 0945, 1384, 1406, 1656, 1727). FMFN #468 to provide Ivanhoe with a list of Chief & Council sanctioned funding opportunities, and Ivanhoe to determine a budget. 10) 2011-12 Winter Drilling Program: Ivanhoe has cut back its winter drilling program and will only be doing seismic work. Will contact FMFN #468 business for any available opportunities.	FOLLOW-UP OUTSTANDING: Ivanhoe and FMFN #468 to finalize a social investment work plan for 2012 by 12/01/31. 10) FOLLOW-UP ONGOING: Ivanhoe to provide bid opportunities for the 2012 seismic program as they become available.
2112	Meeting	11/16/2011	Interim Director (FMFN #468 IRC) Representative (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	2) Consultation Plan: FMFN #468 and Ivanhoe to develop a consultation plan for 2012 to identify the process for addressing issues (see also ROCs 0945, 1384, 1406, 1656, 1727). Per the request of the previous IRC Director, Ivanhoe will work with FMFN #468 to plan a community event as part of the 2012 plan (see also ROC2020). 3) SOCs: Ivanhoe will respond to SOCs from FMFN #468 after the first round of SIRs are submitted. 6) TEK/TLU Report: Final report from February TEK/TLU study still needs to be approved by Chief & Council. Ivanhoe would like to provide it to regulators ASAP so it is included in the decision-making process (see also ROCs 1496, 1599, 1836, 1840). 7) LTBA: Discussed setting up a long-term benefits agreement (LTBA) for the project. FMFN #468 to determine how they would like to move forward with this (see also ROCs. 8) Bridge/Reserve Access: Ivanhoe would like to know if a bridge to the reserve (study funded by Ivanhoe) is still a priority as part of a potential LTBA; FMFN #468 to confirm.	2) FOLLOW-UP OUTSTANDING: Meet to discuss 2012 consultation plan. FOLLOW-UP OUTSTANDING: Organize a community event by 12/01/31. 3) FOLLOW-UP COMPLETE: SIRs sent on 11/12/09 (see ROC2239). 6) FOLLOW-UP COMPLETE: Report received by Ivanhoe on 12/02/08. 7) FOLLOW-UP OUTSTANDING: FMFN #468 to identify a process for negotiating a LTBA by 12/12/31. 8) FOLLOW-UP OUTSTANDING: FMFN #468 to confirm the bridge is still a priority by 12/01/31. 9) FOLLOW-UP OUTSTANDING: FMFN #468 to provide a list of funding opportunities by 12/01/15.

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
					9) Social Investment: Ivanhoe and FMFN #468 to develop a social investment work plan for 2012 that outlines all funding Ivanhoe can provide and the programs it will go to (see also ROCs 0945, 1384, 1406, 1656, 1727). FMFN #468 to provide Ivanhoe with a list of Chief & Council sanctioned funding opportunities, and Ivanhoe to determine a budget. 10) 2011-12 Winter Drilling Program: Ivanhoe has cut back its winter drilling program and will only be doing seismic work. Will contact FMFN #468 business for any available opportunities.	FOLLOW-UP COMPLETE : Budget amount provided by Ivanhoe on 11/23/10 (see ROC2310) (missed closing this item on a previous report). FOLLOW-UP OUTSTANDING: Ivanhoe and FMFN #468 to finalize a social investment work plan for 2012 by 12/01/31. 10) FOLLOW-UP CLOSED: Winter program complete. NOTE: Many of these items are ongoing.
2119	E-mail	11/16/2011	Advisor (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe congratulated FMFN #468's Advisor in his new role.	
2120	E-mail	11/16/2011	Executive Assistant 2 (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 provided their Q4 2011 invoice (dated 11/11/01) for payment.	
2169	E-mail	11/16/2011	Executive Assistant (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 provided their invoice for IRC dues for Q1-Q4 2011.	
2071	E-mail	11/17/2011	Advisor (FMFN #468) Consultant 2 (Fourth Meridian Consulting)	Manager, Regulatory & Consultation (Ivanhoe)	1) Further to ROCs 2060 and 2070, FMFN #468's new Advisor confirmed for Industry that he is no longer with Fourth Meridian Consulting, and that he is not acting in a legal capacity for FMFN #468 at this time. Also provided contact information for FMFN #468.	
2081	E-mail	11/23/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the information on consultation and activity with FMFN #468, as requested (see ROC2064).	
2096	E-mail	11/24/2011	Advisor (FMFN #468) Interim Director (FMFN #468 IRC) Representative (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) As FMFN #468's consultant had not received the copy of social investment and consultation funding provided by Ivanhoe on 11/11/23 (see ROC2081), Ivanhoe provided another copy of it.	

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2102	E-mail	11/28/2011	Advisor (FMFN #468) Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 confirmed their courier address for the package Ivanhoe has to send them.	
2106	E-mail	11/29/2011	Interim Director (FMFN #468 IRC) Representative (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided a draft of the notes for the 11/11/16 meeting (see ROC2112). Requested that FMFN #468 provide any changes by 11/12/15. 2) Ivanhoe reminded FMFN #468 to finalize the TEK/TLU study from February 2011.	1) FOLLOW-UP CLOSED: No changed received (per Jeremy, 12/02/13).
2461	E-mail	12/05/2011	Advisor (FMFN #468) Interim Director (FMFN #468 IRC) Representative (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. Ivanhoe asked how many copies of the updated CD/hard copies they would like.	1) FOLLOW-UP COMPLETE: No response received, but one hard and one CD copy provided on 11/12/09 (see ROC2239).
2167	E-mail	12/06/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested a casual meeting on 11/12/07.	1) FOLLOW-UP COMPLETE: Meeting confirmed (see ROC2175).
2175	E-mail	12/07/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Casual meeting confirmed for 11/12/07.	1) FOLLOW-UP COMPLETE: Meeting held on 11/12/07 (see ROC2203).
2203	Meeting	12/07/2011	Interim Director (FMFN 468 IRC)	Manager, Regulatory & Consultation (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Introduced the IRC Director to Ivanhoe's new Consultation Coordinator. Identified that the Director of Regulatory HS&E would still attend most meetings. 2) Discussed FMFN #468's potential involvement in CEMA/SEWG and the Stony Mountain Footprint Management Plan (SMFMP).	
2179	E-mail	12/08/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 provided information on their availability over the next month.	
2180	E-mail	12/08/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe suggested that FMFN #468 might wish to be involved in the CEMA initiative (SEWG Stony Mountain Footprint management Plan Pilot Project), and provided further information on the project.	

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2183	Email	12/09/2011	Interim Director (FMFN 468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Discussed the SMFMP and suggested talking further in January 2012.	1) FOLLOW-UP COMPLETE: Discussed again on 11/12/14 (see ROC2272).
2186	E-mail	12/09/2011	Advisor (FMFN #468) Consultant 1 (Fourth Meridian Consulting) Consultant 2 (Fourth Meridian Consulting) Consultant 3 (Moving Forward Ltd.)		1) A copy of the final notes for the 11/10/27-28 workshop were provided.	
2239	Letter	12/09/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2272	E-mail	12/14/2011	Interim Director (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe)	1) Will discuss the SEWG Stony Mountain Footprint Management Plan Pilot Project in January.	1) FOLLOW-UP COMPLETE: Ivanhoe provided FMFN #468 with the CEMA contact on 12/02/28 (see ROC2565).
2280	E-mail	12/15/2011	Interim Director (FMFN #468 IRC) Representative (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for October-November 2011. Requested that any comments be provided to AENV with a copy to Ivanhoe; they will be included in the next bi-monthly report.	1) FOLLOW-UP CLOSED: No comments received.
2310	E-mail	12/19/2011	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe let FMFN #468 know how much funding they have available to put towards FMFN #468 community investment. Requested that FMFN #468 send a list of funding priorities so a budget can be finalized.	1) FOLLOW-UP OUTSTANDING: FMFN #468 to provide funding priorities.
2321	E-mail	12/20/2011	Advisor (FMFN #468)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMFN #468 thanked everyone for hard work and contributions in 2011, and looks forward to 2012.	
2400	Email	01/19/2012	TUS Consultant	Manager, Regulatory & Consultation (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMFN /468 TEK Consultant will be meeting with FMFN /468 IRC Director to discuss the February 2011 report. 2) Informed her that Ivanhoe has a new Consultation Coordinator.	1) FOLLOW-UP COMPLETE: Report provided on 12/02/08.

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2426	E-mail	01/25/2012	Interim Director (FMFN #468 IRC)	Manager, Regulatory & Consultation (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a casual meeting to catch up while in Fort McMurray on 12/01/26. FMFN #468's Interim Director is not available that day.	
2501	E-mail	02/06/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe agreed to assist FMFN #468 with sponsorship for the Aboriginal Achievement Awards.	
2502	E-mail	02/06/2012	TUS Consultant (TK Facilitator) Interim Director (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe)	1) FMFN #468 has approved release of the spring 2011 wildlife field report. Asked that conditions requested by the Elders be discussed with Ivanhoe. Ivanhoe will contact FMFN #468 to discuss once they have reviewed the report.	1) FOLLOW-UP COMPLETE: Report received on 12/02/09 (see ROC2522). See follow-up in ROC2522.
2595	Meeting	02/08/2012	Interim Director (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMFN #468 Update: Provided information on staff changes and new roles. 2) Wildlife Report: FMFN #468 will get a copy of the report sent to Ivanhoe as soon as possible. 3) Consultation Plan: Ivanhoe would like to discuss the 2012 consultation plan. FMFN #468 would like to wait until they have finished reorganization before meeting.	2) FOLLOW-UP COMPLETE: Copy of report received by Ivanhoe on 12/02/09 (see ROC2522).
2522	E-mail	02/09/2012	TUS Consultant (TK Facilitator) Interim Director (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe)	1) FMFN #468's TK Facilitator provided the final version of the wildlife field report for FMFN #468 (figures attached separately).	
2525	E-mail	02/10/2012	TUS Consultant (TK Facilitator) Interim Director (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe)	1) Ivanhoe thanked FMFN #468 for the wildlife field report (see ROC2525). Ivanhoe will be providing the report to AENV.	
2530	E-mail	02/14/2012	Advisor (FMFN #468)	Director, HS&E Regulatory (Ivanhoe)	1) FMFN #468 Chief & Council requested separate meetings with various industry companies in Calgary the week of 12/03/12-16. Ivanhoe to let them know what day works best.	1) FOLLOW-UP COMPLETE: Meeting set for 12/03/13 (see ROC2533, 12/02/15).
2533	E-mail	02/15/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Dinner meeting set for 12/03/13 with FMFN #468 in Calgary. FMFN #468 to confirm numbers.	1) FOLLOW-UP COMPLETE: Numbers confirmed on 12/02/16 (see ROC2536).

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2536	E-mail	02/16/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Meeting with FMFN #468 on 12/03/13 confirmed by FMFN #468, along with numbers for dinner.	
2540	E-mail	02/21/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a short meeting on 12/02/23-24 to discuss the upcoming meeting in Calgary with Chief & Council on 12/03/13.	1) FOLLOW-UP COMPLETE: FMFN #468 Advisor is not available to meet in advance of the 12/03/13 meeting (see ROC2555, 12/02/22). However, there was a call before the meeting on 12/03/13 (see ROC2646).
2541	E-mail	02/21/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the December 2011 - January 2012 bi-monthly consultation log for review, and requested that any comments be provided by e-mail to AEW and cc'd to Ivanhoe.	1) FOLLOW-UP CLOSED: No comments received.
2555	E-mail	02/22/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 is unavailable to meet to discuss the 12/03/13 meeting. However, they will send an agenda and there will be conversation before the meeting.	1) FOLLOW-UP COMPLETE: Agenda provided on 12/03/07 (see ROC2589).
2558	E-mail	02/24/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 requested a location and names for those from Ivanhoe who will be attending the 12/03/13 meeting.	1) FOLLOW-UP COMPLETE: Names and location provided on 12/02/26 (see ROC2561).
2561	E-mail	02/26/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the location for dinner as well as names of those from Ivanhoe who will be attending the 12/03/13 meeting (see ROC2558). Requested that FMFN #468 provide names of who they will have attending.	1) FOLLOW-UP COMPLETE: Attendees provided on 11/03/07 (see ROC2589).
2563	E-mail	02/28/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a list of people to attend the meeting on 12/03/13, as well as a quick call to discuss some ideas prior to the meeting. FMFN #468 will send an agenda and list of people in the next week and will also give Ivanhoe a call.	
2564	E-mail	02/28/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) As the restaurant has asked Ivanhoe to pre-order for the 12/03/13 meeting, Ivanhoe requested that FMFN #468 send names of those attending as well as their menu choices in advance of the meeting.	1) FOLLOW-UP COMPLETE: Menu items discussed on 12/03/06 (see ROC2642).

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2565	E-mail	02/28/2012	Advisor (FMFN #468) Interim Director (FMFN #468 IRC) Band Manager (FMFN #468)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMFN #468 requested, and Ivanhoe provided, the contact information for CEMA for FMFN #468 to discuss the Stony Mountain Pilot Project (see ROC2272).	
2582	E-mail	03/05/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a time to speak regarding the upcoming 12/03/13 meeting.	1) FOLLOW-UP COMPLETE: Chat held on 12/03/13 (see ROC2646).
2642	Phone Call	03/06/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 sees the 12/03/13 dinner meeting as a chance for the new Chief & Council to get to know Ivanhoe's senior management team; it will be a relationship-building exercise. 2) Discussed protocols for the meeting (gifts, blessing). 3) No equipment will be required as there will not be a formal presentation.	
2589	E-mail	03/07/2012	Advisor (FMFN #468)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMFN #468 provided three documents for consideration before the meeting, as well as the agenda and names of those who will be attending the 12/03/13 meeting (see ROCs 2555, 2564).	
2592	E-mail	03/08/2012	TUS Consultant (TK Facilitator) Interim Director (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Ivanhoe thanked FMFN #468's TK Facilitator for the Elders Wildlife Field Report, and would like to set a time with her and FMFN #468 to discuss the report and next steps. There are a couple of items that require clarification. Ivanhoe requested potential dates to meet.	1) FOLLOW-UP CLOSED: Ivanhoe contacted FMFN #468 on 12/03/14 to set up meeting (see ROC2616). See follow-up in ROC2616.
2593	E-mail	03/09/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) In preparation for the 12/03/13 meeting, Ivanhoe provided a letter to Chief Kreutzer (see ROC2672) as well as bios of the Ivanhoe team who will attend the meeting.	
2594	Letter	03/09/2012	Chief (FMFN #468)	President (Ivanhoe)	1) The COO of Ivanhoe introduced himself and provided some background information on Ivanhoe. He looks forward to meeting the Chief and FMFN #468 members on 12/03/13.	

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2600	E-mail	03/09/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided a copy of the letter to Chief Kreutzer (see ROC2594) and requested that it be passed on to the chief. Also enclosed bios of the Ivanhoe team that would be attending the meeting.	
2605	E-mail	03/12/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested confirmation that: (a) the e-mail sent Friday was received (see ROC2593); (b) there will be no formal presentation for the dinner meeting; and (c) it is ok to exchange gifts for the Chief & Council before the meal begins.	1) FOLLOW-UP COMPLETE: Confirmed on 12/03/13 by phone (see ROC2646).
2646	Phone Call	03/13/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 confirmed that the info package received by Ivanhoe would be reviewed at a high level during the dinner (no formal presentation) and then FMFN #468 would answer any questions. Discussed protocols for the evening. FMFN #468 requested a short private meeting with Ivanhoe senior management after the dinner (see ROC2605).	
2673	Meeting	03/13/2012	FMFN #468: - Chief - Interim Director - Councillors 1 & 2 - Advisor - Band Manager - Christina River Enterprises - Centerfire Group - Socio-Ec Consultant	Ivanhoe: - President - Executive VP Upstream - VP Engineering - Manager, Corporate Communications - Director, HS&E Regulatory - Consultation Coordinator	1) FMFN #468 introduced the new C&C and members of their senior administration to Ivanhoe's executives. 2) Discussed the importance of understanding each others' cultures and working together. Ivanhoe's president would like to visit their community. 3) FMFN #468 provided a review of their community plan document. 4) FMFN #468 contractors provided information on their companies. 5) FMFN #468 provided the revised budget and an update.	2) FOLLOW-UP CLOSED: Discussed further in letter dated 12/03/21 (see ROC2625). See follow-up in ROC2625. 5) FOLLOW-UP CLOSED: See further discussion in ROC2619.

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2616	E-mail	03/14/2012	Interim Director (FMFN #468 IRC) Band Manager (FMFN #468)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Ivanhoe thanked FMFN #468 for the meeting the previous evening (see ROC2673). 2) Ivanhoe asked for a date to discuss Ivanhoe's comments on the Elders' wildlife report so that it can be submitted to AEW (see also ROCs 2502 and 2592).	2) FOLLOW-UP OUTSTANDING: FMFN #468 to let Ivanhoe know what date works best for them to discuss the Wildlife Report. Update: Ongoing.
2618	E-mail	03/16/2012	Band Manager (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Per FMFN #468's request, Ivanhoe provided copies of consultation records to date, FMFN #468's SOC, the technical review and the memo/minutes from the February 2011 meeting with the TK Facilitator.	
2619	E-mail	03/19/2012	Interim Director (FMFN #468 IRC) Executive Assistant (FMFN #468) Band Manager (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Ivanhoe received an invoice from FMFN #468 for IRC fees, and requested that FMFN #468 contact them to discuss the amount (see also ROC2620).	1) FOLLOW-UP CLOSED: FMFN #468 is available to discuss on 12/03/23; Ivanhoe to confirm time (see ROC2629, 12/02/23). See follow-up in ROC2629.
2620	E-mail	03/19/2012	Interim Director (FMFN #468 IRC) Band Manager (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested clarification on some of the items noted in the IRC budget.	1) FOLLOW-UP CLOSED: FMFN #468 is available to discuss on 12/03/23; Ivanhoe to confirm time (see ROC2629, 12/02/23). See follow-up in ROC2629.
2625	Letter	03/21/2012	Chief (FMFN #468)	President (Ivanhoe)	1) Ivanhoe thanked FMFN #468 for the meeting on 12/03/13 (see ROC2673), and appreciated the information provided that gives Ivanhoe a better understanding of FMFN #468's vision for the future. 2) Ivanhoe's COO would like to visit the community and have a meeting in May; their Consultation Coordinator will contact the Chief's advisor to set up this meeting.	2) FOLLOW-UP COMPLETE: Discussed at the 12/05/01 meeting (see ROC2795).
2626	E-mail	03/21/2012	Advisor (FMFN #468) Chief (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided a copy of the COO's letter to Chief Kreutzer (see ROC2625).	
2629	E-mail	03/21/2012	Band Manager (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 is available on 12/03/23 to discuss the Q1 IRC funding; Ivanhoe to confirm a time.	1) FOLLOW-UP COMPLETE: Ivanhoe confirmed that 12/03/23 works; meeting set for 1:00 pm (see ROC2632, 12/03/22).

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2647	E-mail	03/21/2012	Advisor (FMFN #468)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMFN #468's Advisor to the Chief provided contact information for the person covering for the Interim Director while he is on holidays.	
2632	E-mail	03/22/2012	Band Manager (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) Meeting to discuss Q1 IRC funding set for 12/03/23 at Ivanhoe's office (see ROC2629).	1) FOLLOW-UP CLOSED: Unable to meet; will do a phone call instead (see ROC2633, 12/03/23). See follow-up in ROC2633.
2633	E-mail	03/23/2012	Band Manager (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 is unable to meet in person so the meeting will be a phone call instead (see ROC2632).	1) FOLLOW-UP COMPLETE: Phone call held on 12/03/23.
2672	Phone Call	03/23/2012	Band Manager (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	Ivanhoe and FMFN #468 discussed questions Ivanhoe had about the budget. FMFN #468 will send a revised budget in the near future.	1) FOLLOW-UP COMPLETE: Budget provided on 12/03/28 (see ROC2663).
2662	Letter	03/28/2012	Advisor (FMFN #468) Chief (FMFN #468)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMFN #468 thanked Ivanhoe for the meeting (see ROC2673) and noted the themes that emerged from the discussions. Outlined the information to be provided by both FMFN #468 and Ivanhoe, as follows. FMFN #468: Comprehensive Community Plan Briefing Document, first iteration of the New Process, Part 2 of the Governance Workshop, and a brochure on the new Group of Companies. Ivanhoe: corporate culture documents, examples of Aboriginal success stories, business procurement needs, regulatory snapshot, new contact to be copied on all correspondence, and IRC Funding Agreement.	1) FOLLOW-UP OUTSTANDING: Ivanhoe and FMFN #468 to send requested information. Update: Ongoing. 1) FOLLOW-UP: OUTSTANDING: Prepare a Comprehensive Community Plan Briefing Document. Update: Second phase of governance workshop occurred on 12/06/07; briefing documents were not available at the meeting.
2663	E-mail	03/28/2012	Advisor (FMFN #468)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMFN #468 provided the revised 2012 IRC operational budget for consideration.	
2710	E-mail	04/05/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a meeting with FMFN #468 on 12/04/18 (see also ROC2714).	1) FOLLOW-UP COMPLETE: Not available on 12/04/18; meeting set for 12/04/23 instead (see ROC2727).

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2714	Phone Call	04/05/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe left a voicemail, requesting a meeting to discuss the FMFN #468 IRC budget on 12/04/18.	1) FOLLOW-UP COMPLETE: Not available on 12/04/18; meeting set for 12/04/23 instead (see ROC2727).
2727	Phone Call	04/16/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 is not available to meet on 12/04/18 (see ROC2710). Meeting set for 12/04/23 instead. Ivanhoe to send an e-mail re: time and place.	1) FOLLOW-UP COMPLETE: Details provided on 12/04/17 (see ROC2730).
2730	E-mail	04/17/2012	Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Meeting on 12/04/23 set for 8:15 am.	1) FOLLOW-UP COMPLETE: Meeting held on 12/04/23 (see ROC2930).
2738	E-mail	04/18/2012	Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the bimonthly contact report for February-March 2012. Any comments from FMFN #468 will be included in the next bimonthly report.	
2930	Meeting	04/23/2012	Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Governance Workshop: Will take place 12/06/05-07; industry is invited on 12/06/07. Ivanhoe will have a representative at the meeting. 2) Chief-to-Chief Meeting: FMFN #468 will provide some potential dates for the meeting. Potential agenda items include: tour of the community; traditional dinner; sweet grass offering/smudging ceremony; visit to Gregoire Lake; visit to a trap line or trappers cabin. 3) IRC Budget: FMFN #468 provided further detail to Ivanhoe on some of the line items. Ivanhoe approved the budget increase and asked that an invoice for the remaining Q1 fees be sent to Ivanhoe.	
2757	E-mail	04/24/2012	Band Manager (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a meeting with FMFN #468 on 12/05/04 to discuss the TEK report. FMFN #468 to confirm availability.	1) FOLLOW-UP CLOSED: Meeting not held.

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2769	E-mail	04/26/2012	Student Employment and Training Coordinator (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe)	1) Ivanhoe requested a casual meeting on 12/05/01 to catch up.	1) FOLLOW-UP COMPLETE: Meeting confirmed on 12/04/27 (see ROC2773).
2773	E-mail	04/27/2012	Student Employment and Training Coordinator (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe)	1) FMFN #468 confirmed availability for casual meeting on 12/05/01.	1) FOLLOW-UP COMPLETE: Meeting held on 12/05/01 (see ROC2932).
2795	E-mail	05/01/2012	Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) FMFN #468 requested a date for the Chief-to-Chief meeting. Ivanhoe expects to have a possible date in the next couple days.	1) FOLLOW-UP COMPLETE: Dates provided on 12/05/07 (see ROC2801).
2932	Meeting	05/01/2012	Student Employment and Training Coordinator (FMFN #468 IRC)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) FMFN #468 provided Ivanhoe with information on the Summer Student Employment Program. Ivanhoe will review.	
2801	E-mail	05/07/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe suggested a Chief-to-Chief meeting on either 12/06/13 or 14 (see ROC2795).	1) FOLLOW-UP COMPLETE: FMFN #468 is available 12/06/14 (see ROC2803, 12/05/08).
2921	Phone Call	05/07/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) Left voicemail suggesting either 12/06/13 or 14 for the Chief-to-Chief meeting.	1) FOLLOW-UP COMPLETE: Date provided on 12/05/08 (see ROC2803).
2803	E-mail	05/08/2012	Advisor (FMFN #468), Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 is available for a Chief-to-Chief meeting on 12/05/14. Requested that Ivanhoe provide details on time, place and agenda. .	1) FOLLOW-UP COMPLETE: Ivanhoe requested that the meeting be changed to 12/06/13 (see ROC2834, 12/05/16).
2810	E-mail	05/09/2012	Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a rough agenda for the Chief-to-Chief meeting on 12/06/14 (see also ROC2803); FMFN #468 will provide later in the day.	1) FOLLOW-UP COMPLETE: Rough itinerary provided on 12/05/09 (see ROC2811).
2811	E-mail	05/09/2012	Advisor (FMFN #468), Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) FMFN #468 provided a rough itinerary for the Chief-to-Chief meeting on 12/06/14 (see also ROC2810).	

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2922	Phone Call	05/09/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 confirmed availability for a Chief-to-Chief meeting on 12/06/14 (see ROC2803).	1) FOLLOW-UP COMPLETE: Ivanhoe requested that the meeting be changed to 12/06/13 (see ROC2834, 12/05/15).
2927	Phone Call	05/09/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) Discussed agenda for the Chief-to-Chief meeting on 12/06/14. FMFN #468 to e-mail an agenda to Ivanhoe. 2) Ivanhoe asked if a new IRC Director had been hired. Decision is close; will let industry know when it is final.	1) FOLLOW-UP COMPLETE: Agenda provided on 12/05/09 (see ROC2811).
2928	Phone Call	05/10/2012	Councillor (FMFN #468)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) FMFN #468 requested funding towards a new head dress for the Chief; Ivanhoe to discuss and get back to FMFN #468.	1) FOLLOW-UP CLOSED: No formal request provided.
2833	E-mail	05/15/2012	Advisor (FMFN #468)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) FMFN #468 provided information on their new IRC Director.	
2834	E-mail	05/15/2012	Advisor (FMFN #468), Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) As the Ivanhoe CEO is not available on 12/06/14, Ivanhoe asked if the Chief-to-Chief meeting could be changed to 12/06/13. If this date does not work for FMFN #468, Ivanhoe requests that FMFN #468 provide other alternative dates.	1) FOLLOW-UP COMPLETE: Ivanhoe requested that the meeting be changed to 12/06/13 (see ROC2834, 12/05/16).
2850	E-mail	05/16/2012	Advisor (FMFN #468), Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 confirmed 12/06/15 for the Chief-to-Chief meeting.	1) FOLLOW-UP COMPLETE: Request for date change on 12/05/24 - back to 12/06/14 (see ROC2870).
2869	E-mail	05/24/2012	Advisor (FMFN #468), Consultant (Moving Forward Ltd.)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) FMFN #468 invited Industry to their community governance workshop on 12/06/07. Ivanhoe will attend.	Attended by Ivanhoe on 12/06/07.
2870	E-mail	05/24/2012	Advisor (FMFN #468), Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe is now available on 12/06/14 for the Chief-to-Chief meeting and asked if it could be moved back to that date.	1) FOLLOW-UP COMPLETE: Date confirmed on 12/05/30 (see ROC2939).

Fort McMurray #468 First Nation (FMFN #468)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2902	E-mail	05/29/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested confirmation that the agenda provided is set. FMFN #468 to confirm.	1) FOLLOW-UP COMPLETE: Agenda provided on 12/05/30 (see ROC2939).
2910	E-mail	05/30/2012	Advisor (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 noted that Treaty Day has been moved to 12/08/20.	
2911	E-mail	05/30/2012	Interim Director (FMFN #468 IRC), Band Manager (FMFN #468)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided notes from the 12/04/23 meeting and requested any changes/comments by 12/06/06.	1) FOLLOW-UP CLOSED: No comments received. Notes considered final.
2939	E-mail	05/30/2012	Interim Director (FMFN #468 IRC)	Consultation Coordinator (Ivanhoe)	1) FMFN #468 confirmed the agenda for the 12/06/14 meeting (see ROC2902). Also asked if Ivanhoe would be renting a large van for the meeting.	1) FOLLOW-UP OUTSTANDING: Ivanhoe to let FMFN #468 know if they will be renting a van.

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
1993	E-mail	10/04/2011	Director (FMKFN Sustainability Dept.)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMKFN provided information on a cross-cultural workshop for Ivanhoe and requested that Ivanhoe contact the training directly if interested in the program. Date of workshop is 11/10/18-20.	
1991	E-mail	10/07/2011	Program Manager (FMKFN Sustainability Dept.)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested a meeting with FMKFN's Project Manager in Fort McMurray on 11/10/12 if he is available.	1) FOLLOW-UP COMPLETE: Not available that day. Meeting set for 11/11/02 (see ROC2026, 11/10/31).
2015	E-mail	10/24/2011	Program Manager (FMKFN Sustainability Dept.) Director (FMKFN Sustainability Dept.)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for August-September 2011. Requested that any comments be provided to AENV (cc: Ivanhoe); they will be included in the next bi-monthly report.	
2018	E-mail	10/25/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested a meeting with FMKFN the week of 11/10/31-11/11/04.	1) FOLLOW-UP COMPLETE: Meeting set for 11/11/02, 1:00-4:00 pm (see ROC2022, 11/10/28).
2091	Phone Call	10/25/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested a meeting with FMKFN the week of 11/10/31 (see also ROC2018).	1) FOLLOW-UP COMPLETE: Meeting set and held on 11/11/02 (see ROC2111).
2021	E-mail	10/27/2011	Program Manager (FMKFN SD) Director (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMKFN requested that their Senior Environmental Advisor be the main contact for the consultation logs until a new Regulatory Coordinator is in place. Logs do not need to be sent to the SD Director.	
2022	E-mail	10/28/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Meeting set for 11/11/02, 1:00-4:00 pm.	1) FOLLOW-UP COMPLETE: Meeting held on 11/11/02 (see ROC2111).
2023	E-mail	10/28/2011	Program Manager (FMKFN SD) Director (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe asked if the Project Manager should be copied on the consultation logs being sent to the FMKFN Senior Environmental Advisor.	1) FOLLOW-UP CLOSED: No answer received. Item closed (per JH, 11/12/07).

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2026	E-mail	10/31/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Date and time of 11/11/02 meeting confirmed by FMKFN (see ROC2022).	1) FOLLOW-UP COMPLETE: Meeting held on 11/11/02 (see ROC2111).
2027	E-mail	10/31/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) New Team Members: FMKFN SD introduced its new Senior Environmental Advisor and air consultant. 2) Newsletter: Provided information on their bi-monthly newsletter.	
2111	Meeting	11/02/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) SD Update: FMKFN provided an update on the SD. Looking towards using long-term benefits agreements (LTBAs) to capitalize on development. Have a new process for consultation using focus groups instead of community open houses. SD is covering the shortfall in their 2011 budget out of funds that would have returned to the community. Additional funding will be required for 2012. 2) LTBA: Ivanhoe is interested in signing a LTBA, but feels the Tamarack Project will have a lower level of impact than other projects and has less cash flow; agreement would have to reflect this. 3) Project Consultation: Ivanhoe and FMKFN to discuss a consultation plan for 2012, as well as potentially using Advisory Committees. 4) Project Update: Supplemental Information Requests (SIRs) will be sent out by the end of the month. 5) SOCs: Ivanhoe would like to meet with FMKFN to discuss their air SOCs in January. 6) Terrestrial Thresholds Project: Scope has been finalized. FMKFN to invoice Ivanhoe for the study (see also ROC1633). 7) Access Management Issues: Decided that this item (see ROC1633) be closed.	3) FOLLOW-UP CLOSED: Consultation meeting set for 12/02/23. 4) FOLLOW-UP COMPLETE: SIRs sent on 11/12/05 (see ROC2160). 5) FOLLOW-UP COMPLETE: Meeting to discuss SOCs set for 12/02/01 (see ROC2109). 6) FOLLOW-UP COMPLETE: Invoice provided on 11/11/16 (see ROC2120).

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
					8) 2011-12 Winter Drilling Program: Program cut back and no drilling will occur this winter. Ivanhoe to discuss with FMKFN again next year if there will be a 2012-13 drilling program. 9) TEK/TLU: FMKFN is looking to digitize its TEK/TLU and make it current and requires funding to do so. Ivanhoe suggested that this be discussed at the funders' meeting on 11/11/21.	
2075	E-mail	11/17/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Confirmation of meeting on 11/11/21, 12:00 pm at the Elders centre.	1) FOLLOW-UP COMPLETE: Meeting held on 11/11/21 (see ROC2113).
2113	Meeting	11/21/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD) Director (FMKFN SD) Consultant 2(Integral Ecology) Trappers Coordinator (FMKFN SD) Various Industry representatives	Manager, Regulatory & Consultation (Ivanhoe)	1) SD Update: FMKFN introduced new staff, mandate, operational principles, and summary of consultation for projects around Moose Lake. 2) Events Protocol: FMKFN presented their Planned & Unplanned Events Protocol for industry to follow if there is an event. 3) Consultation Guidelines: FMKFN will be changing their consultation guidelines for projects going forward. Would like to see jobs advertised in the communities. Moving away from Elders Groups to Advisory Groups. Honorariums have increased, as has the age for Elders. Will continue with separate focus groups for air, water and reclamation. Trappers will be approaching industry to renegotiate the 2009 trappers compensation matrix. 4) TLU: Looking at a territory-wide TLU study; currently planned to fund through the IRC. 5) Community Information System (CIS): FMKFN presented this system that will be developed in association with the TLU study. Will load industry shape files into a database to be compared against existing information. Will be used for consultation.	4) FOLLOW-UP COMPLETE: Discussed through Husky on 12/02/09. 7) FOLLOW-UP COMPLETE: Discussed through Husky on 12/02/09.

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
					6) 2010 IRC Report: Discussed the 2010 financial statement. Deficit covered from revenues, but FMKFN does not feel the Band should have to cover consultation costs because of industry impacts. 7) 2012 IRC Budget: Budget provided; contains a large increase. Ivanhoe concerned about the size of the increase. FMKFN will provide a breakdown by company using the funding formula.	
2113	Meeting	11/21/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD) Director (FMKFN SD) Consultant 2(Integral Ecology) Trappers Coordinator (FMKFN SD) Various Industry representatives	Manager, Regulatory & Consultation (Ivanhoe)	4) TLU: Looking at a territory-wide TLU study; currently planned to fund through the IRC. 7) 2012 IRC Budget: Budget provided; contains a large increase. Ivanhoe concerned about the size of the increase. FMKFN will provide a breakdown by company using the funding formula.	4) FOLLOW-UP COMPLETE: Discussed through Husky on 12/02/09. 7) FOLLOW-UP COMPLETE: Discussed through Husky on 12/02/09.

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2276	Letter	11/21/2011	Director (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) 2011-12 Winter Program: FMKFN SD expressed their concerns on behalf of the First Nation and Métis regarding the winter program. Concerns related to effects of the project and cumulative effects from all projects on their traditional territory, reserves and communities, and in particular effects on wildlife. Requested that Ivanhoe provide a summary of potential program impacts, list of past and anticipated projects in their territory and maps of disturbances (for the trappers). Also requested consultation with ASRD re: cumulative impacts. Requested that Ivanhoe contact their Trapper Coordinator to determine which trappers might be affected, and provided information on meeting with trappers. Once the noted information is provided and consultation with trappers is concluded, they will provide a letter (upon request) confirming that Ivanhoe's consultation is considered complete for this program.	1) FOLLOW-UP CLOSED: Ivanhoe called to discuss on 11/11/25 (see further follow-up in ROC2315).
2082	E-mail	11/23/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested an update on the portion of the 11/11/21 meeting (see ROC2113) that he missed. Requested a copy of the expected 2012 membership fees for Ivanhoe based on the formula. Will discuss once this information has been reviewed by Ivanhoe.	1) FOLLOW-UP CLOSED: See follow-up in ROC2142.
2142	E-mail	11/23/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMKFN confirmed that it would provide fee information and would be having one-on-one meetings with companies that have concerns or need explanations (see ROC2082).	1) FOLLOW-UP COMPLETE: Discussed through Husky on 12/02/09.
2141	E-mail	11/24/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	FMKFN provided an update on the terrestrial thresholds project.	

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2315	Phone Call	11/25/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) 2011-12 Winter Program: Ivanhoe called to discuss the letter of objection sent to Ivanhoe dated 11/11/21 [see ROC2276] and copied to ASRD with regard to the OSE Exploration program for 2011-12. Asked that the Senior Environmental Advisor call back to discuss.	1) FOLLOW-UP CLOSED: Contact made but not discussed on 12/12/15 (see follow-up in ROC2277).
2103	E-mail	11/28/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided notes for the 11/11/02 meeting (see ROC2111). Requested that FMKFN provide any comments by 11/12/15.	1) FOLLOW-UP CLOSED: No comments provided.
2104	E-mail	11/28/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD) Director (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested FMKFN's courier address for a package Ivanhoe wishes to send.	1) FOLLOW-UP COMPLETE: Address provided.
2108	E-mail	11/28/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe proposed five dates for the technical air meeting and requested that FMKFN determine the one that works best. Suggested the meeting should be in Calgary.	1) FOLLOW-UP COMPLETE: Meeting set for 12/02/01 (see ROC2109).
2109	E-mail	11/29/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Air meeting confirmed for 12/02/01 in Calgary. FMKFN to provide a scope and budget for attending.	1) FOLLOW-UP CLOSED: Meeting date changed to 12/02/03. FOLLOW-UP COMPLETE: Scope and budget provided on 12/01/11 (see ROC2367).
2148	E-mail	12/01/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD) Canadian Natural Resources Limited	Manager, Regulatory & Consultation (Ivanhoe)	1) FMKFN asked if the 12/02/01 meeting could be changed to 12/01/31.	1) FOLLOW-UP COMPLETE: Requested that the meeting be changed to 12/02/03 (see ROC2153).
2153	E-mail	12/01/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMKFN requested that the meeting scheduled for 12/02/01 be moved to 12/02/03 (see also ROC2148). Ivanhoe to confirm availability for that day.	1) FOLLOW-UP COMPLETE: Confirmed for 12/02/03 (see ROC2376, 12/01/12).

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2160	E-mail	12/05/2011	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe has filed responses to AENV's and ERCB's supplemental information requests. Asked that FMKFN let them know how many hard and electronic copies they would like.	1) FOLLOW-UP COMPLETE: Copies provided on 11/12/09 (see ROC2214).
2166	E-mail	12/05/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe approved FMKFN's proposal and specified Ivanhoe's contribution towards the Terrestrial Threshold Study.	
2176	E-mail	12/07/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Budget: FMKFN is working on the IRC budget based on comments received. Information on company contributions will be available by 11/12/09. Meeting set for 11/12/15 in Calgary for anyone who wishes to discuss. 2) Territory-wide TLUS: FMKFN will send copies of the 11/11/21 presentations and a template schedule on 11/12/09.	1) FOLLOW-UP COMPLETE: Company contribution info sent on 11/12/12 (see ROC2188). 2) FOLLOW-UP COMPLETE: Presentations sent on 11/12/13 (see ROC2267).
2177	E-mail	12/07/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Further to Ivanhoe's request in ROC2160, FMKFN would like one electronic and one hard copy of the SIRs for the office. They will also send a list of others who should receive a copy.	1) FOLLOW-UP COMPLETE: List provided by FMKFN on 11/12/07 (see ROC2181). SIR copies sent by Ivanhoe on 11/12/09 (see ROC2256).
2181	E-mail	12/07/2011	Consultant 1 (FMKFN SD)(	Manager, Regulatory & Consultation (Ivanhoe)	1) Further to Ivanhoe's request (see ROC2177), FMKFN's consultant provided technical team contact information for SIR distribution.	1) FOLLOW-UP COMPLETE: SIRs sent on 12/01/16 (see ROC2442).
2182	E-mail	12/08/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMKFN provided the breakdown for Ivanhoe of their portion of the IRC budget. Ivanhoe to review and get back to FMKFN with comments. 2) Ivanhoe will attend the IRC budget meeting on 11/12/15.	1) FOLLOW-UP COMPLETE: Comments provided on 11/12/14 (see ROC2273). 2) FOLLOW-UP COMPLETE: No longer in person meeting; will be a conference call (see follow-up in ROC2188).
2246	Letter	12/09/2011	Consultant 1 (FMKFN SD)(	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2256	Letter	12/09/2011	Director (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2188	E-mail	12/12/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) 11/11/21 Meeting Documents: FMKFN provided the documents from the meeting. Meeting in Calgary on 11/12/15 changed to conference call. 2) Budget: FMKFN provided the draft 2012 budget breakdown per company.	1) FOLLOW-UP COMPLETE: Attended call on 11/12/15 (see ROC2319).
2192	E-mail	12/12/2011	Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe reviewed the FMKFN comments on the 11/11/02 meeting notes (see ROC2111) and made minor edits. Final notes attached. FMKFN to let Ivanhoe know if any further changes are required.	FOLLOW-UP CLOSED: No further comments received.
2267	E-mail	12/13/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe received the draft budget and will attend the conference call to discuss.	1) FOLLOW-UP COMPLETE: Attended call on 11/12/15 (see ROC2319).
2268	E-mail	12/13/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMKFN provided information relating to the 11/11/21 meeting (see ROC2113).	
2273	E-mail	12/14/2011	Program Manager (FMKFN SD) Director (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Provided questions Ivanhoe has regarding the 2012 draft proposed budget, to be discussed at the 11/12/15 meeting.	
2277	E-mail	12/15/2011	Sr Environmental Advisor (FMKFN SD)	Director, HS&E Regulatory (Ivanhoe)	1) 2011-12 Winter Program: FMKFN provided a copy of their letter of concern regarding the winter program by e-mail (see ROC2276 for letter). Ivanhoe requested that FMKFN call him regarding the letter as he believed that issues had been closed off and ASRD deemed consultation complete on 11/10/04 (see ROC2315).	1) FOLLOW-UP COMPLETE: Discussed on 11/11/25 (see ROC2315). (missed on last report)
2281	E-mail	12/15/2011	Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for October-November 2011. Requested that any comments be provided to AENV with a copy to Ivanhoe; they will be included in the next bi-monthly report.	1) FOLLOW-UP CLOSED: No comments received.

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2284	E-mail	12/15/2011	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) FMKFN provided a new conference call number for the 11/12/15 call (see ROC2267).	
2319	Meeting	12/15/2011	Program Manager (FMKFN SD) Accountant (FMKFN) Director (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Meeting with industry to discuss the IRC budget and funding formula.	1) FOLLOW-UP OUTSTANDING: Hold another meeting to discuss the funding formula.
2366	E-mail	01/11/2012	Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMKFN requested from Ivanhoe (and industry) dates for meetings with FMKFN in Q1. Ivanhoe suggested 12/02/23, 12/04/12 and 12/06/12. FMKFN to confirm dates.	1) FOLLOW-UP COMPLETE: Meeting set for 12/02/23 (see ROC of 12/02/09).
2367	E-mail	01/11/2012	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) FMKFN provided a scope and budget for the air meeting to be held in Calgary on 12/02/01; it was approved by Ivanhoe. FMKFN to confirm the meeting will be in the afternoon, and if they wish a downtown or southeast meeting.	1) FOLLOW-UP COMPLETE: Meeting date changed to 12/02/03 (see ROC2375).
2375	E-mail	01/12/2012	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Cancelled the 12/02/01 meeting request; meeting set for 12/02/03 to discuss air issues (see ROC2367).	
2376	E-mail	01/12/2012	Program Manager (FMKFN SD)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe confirmed that the meeting with FMKFN to discuss air issues would be held on 12/02/03 and not 12/02/01.	1) FOLLOW-UP COMPLETE: Meeting held on 12/02/03.
2430	E-mail	01/23/2012	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe asked if FMKFN would like to have lunch prior to or include it with the meeting on 12/02/03.	1) FOLLOW-UP COMPLETE: FMKFN confirmed no lunch included (see ROC2433, 12/01/30).
2433	E-mail	01/30/2012	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN confirmed the meeting will not include lunch (see ROC2430).	
2490	E-mail	02/03/2012	Human Services Manager (FMKFN)	Consultation Coordinator (Ivanhoe)	1) FMKFN provided the dates for their upcoming Treaty Days.	

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ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2637	Meeting	02/03/2012	Consultant 1 Program Manager (FMKFN SD) Consultant 2 Sr Environmental Advisor (FMKFN SD) Consultant 3 (Unknown)	AMEC: - Project Manager - Air Specialists (3) Ivanhoe: - VP Engineering - Director, HS&E Regulatory - Consultation Coordinator	1) Discussed FMKFN's air quality concerns from their SOC. Specific parts of the SOCs included: SOCs 1, 2-8, 9, 10, 11, 12-15, 16, 17 and 18. 2) Issues raised: (a) Request for a pre-development baseline in the EIA. (b) Reheater energy impacts. (c) NOx emissions from boilers greater than 15.8 g/GJ. (d) NOx emissions from reheater greater than Policy 1b guidelines. (e) SOx emissions greater than Horizon project emissions. (f) Applicability of Directive 2011-03 to the Tamarack Project. (g) Community involvement in monitoring. (h) Odors and odor management. (i) Community-based monitoring. (j) Regional monitoring groups.	1) FOLLOW-UP COMPLETE: Responses provided on 12/05/14 (see ROC2828). 2) FOLLOW-UP OUTSTANDING: Ivanhoe to provide FMKFN with energy inputs for the reheater.
2506	E-mail	02/06/2012	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe thanked FMKFN for the meeting on 12/02/03 (see ROC2637). Ivanhoe will provide draft notes by 12/02/10 for FMKFN to review. 2) Ivanhoe requested that the Senior Environmental Advisor confirm that he is still available to meet on 12/02/23.	1) FOLLOW-UP CLOSED: Notes will be provided by 12/03/14 (see ROC2585, 12/03/06). See follow-up in ROC2585. 2) FOLLOW-UP COMPLETE: Meeting confirmed for 1:30 pm on 12/02/23 (see ROC2546, 12/02/21).
2528	E-mail	02/13/2012	Consultant 1	Director, HS&E Regulatory (Ivanhoe)	1) FMKFN requested that Ivanhoe provide them with shape files by 12/02/17 for the project, access road and lease boundary for their internal community consultation sessions.	1) FOLLOW-UP COMPLETE: Shape files provided on 11/02/14 (see ROC2531).
2545	E-mail	02/21/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the December 2011 - January 2012 bi-monthly consultation log for review, and requested that any comments be provided by e-mail to AEW and cc'd to Ivanhoe.	1) FOLLOW-UP CLOSED: No comments provided.
2546	E-mail	02/21/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Meeting confirmed for 1:30 pm on 12/02/23 in Fort McKay.	1) FOLLOW-UP COMPLETE: Meeting held on 12/02/23 (see ROC2651).

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ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2651	Meeting	02/23/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe Update: Recently received the second round of SIRs from AEW and are expecting more from the ERCB in the coming weeks. Working on responses to the Statement of Concern; expect to be completed in early spring. Expecting project approval later this year. Very little work this winter (some seismic, gravel exploration and reclamation), which will be finished soon. 2) FMKFN Update: They have hired three new executives; reporting structure is still being worked on. 3) Air Quality Meeting: FMKFN felt the meeting was productive. Ivanhoe will provide meeting notes in the next couple weeks. 4) SD Budget: Ivanhoe will need to follow up with the SD Director for an update on the budget. 5) New Community Consultation Process: FMKFN will be using community focus groups to discuss projects, run by SD staff and consultants. Ivanhoe would still like to see some way that industry can interact with community members if open houses are no longer used. Cost is still to be determined. FMKFN is aiming to have a report with site-specific information completed by mid-May. 6) SOC: Ivanhoe is working on responses. Once complete, they would like to meet with FMKFN to discuss. Discussed having a meeting similar to the air quality one. Discussed the potential of negotiating a bilateral agreement if the SOCs can't be addressed through this process. 7) Access Management: Discussed FMKFN's concerns about access management. They relate to all existing and proposed projects, not just the Tamarack Project. Specific issues would be discussed at the focus group sessions.	1) FOLLOW-UP COMPLETE: Update provided at the 12/05/01 meeting (see ROC2940). 4) FOLLOW-UP CLOSED: Budget discussed further on 12/03/13 (see ROC2613). See follow-up in ROC2613. 9) FOLLOW-UP CLOSED: Meeting not held. See follow-up in ROC2974.

Fort McKay First Nation (FMKFN)						
ROC #	Event Type	Event Date	Stakeholder List	Team List	Comments	Follow-up and Outstanding Actions
					8) Potential Chief-to-Chief Meeting: Ivanhoe inquired into the process of setting up a chief-to-chief meeting; FMKFN to provide this information. 9) Next Meeting: Date changed from 12/04/12 to 12/05/01.	
2576	E-mail	02/28/2012	Accountant (FMKFN)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe questioned the invoice received from FMKFN IRC as they believed their contract was only for one year (2011). Ivanhoe to follow up with the Manager, Environmental Affairs when he is back from holidays.	1) FOLLOW-UP COMPLETE: Invoice should be disregarded (see ROC2584, 12/03/06).
2568	E-mail	02/29/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN provided an invoice for their subconsultant's participation at the 12/02/03 meeting.	
2570	E-mail	03/01/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe thanked FMKFN for the invoice (sent for processing). Will distribute the notes from the 12/02/03 (see ROC2637) and 12/02/23 (see ROC2651) in the next few days.	
2584	E-mail	03/06/2012	Accountant (FMKFN)	Consultation Coordinator (Ivanhoe)	1) FMKFN confirmed that the invoice for the Terrestrial Thresholds Project should be disregarded (see ROC2576).	
2585	E-mail	03/06/2012	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided an update of the status of the 12/02/03 meeting notes (see ROC2637) - they are being reviewed by the technical staff at AMEC and should be available mid next week (see also ROC2506).	
2598	E-mail	03/08/2012	Human Services Manager (FMKFN)	Consultation Coordinator (Ivanhoe)	1) Provided the 12/03/05 letter from the Director by e-mail [see ROC2678].	
2644	Phone Call	03/08/2012	Human Services Manager (FMKFN)	Consultation Coordinator (Ivanhoe)	1) FMKFN provided clarification on the new consultation process outlined in the 12/03/08 letter (see ROC2678). Ivanhoe has no issues with the new process, but would like to know what other methods FMKFN SD will have for Ivanhoe to engage directly with community members.	
2599	E-mail	03/09/2012	Human Services Manager (FMKFN)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe's Consultation Coordinator provided his contact information for FMKFN.	

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ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2640	E-mail	03/15/2012	Program Manager (FMKFN SD) Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided notes for the 12/02/03 meeting (see ROC2637). Requested that FMKFN provide any comments at their earliest opportunity.	1) FOLLOW-UP OUTSTANDING: FMKFN to provide comments on the 12/02/03 meeting notes.
2652	E-mail	03/27/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided notes from the 12/02/23 meeting (see ROC2651) and asked for comments/clarification if needed.	1) FOLLOW-UP COMPLETE: Comments provided on 12/03/29 (see ROC2664).
2659	E-mail	03/27/2012	Program Manager (FMKFN SD) Industry & Stakeholder Relations Advisor (Husky Energy)	Director, HS&E Regulatory (Ivanhoe)	1) Based on discussions with Industry and FMKFN SD, Husky's understanding going forward is that: (a) future 2012 invoices will be adjusted for updates to the funding formula inputs and the funding for 2012 Environmental Community Programs will be handled separately and is not included in the funding formula at this time.	
2664	E-mail	03/29/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN provided comments on the 12/02/23 meeting notes (see ROC2651). Ivanhoe responded to those comments, and FMKFN to Ivanhoe's comments.	
2675	E-mail	03/29/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided further comments on the 12/02/23 meeting notes (see ROC2664). FMKFN responded to the comments.	1) FOLLOW-UP CLOSED: Waiting for comments from FMKFN's consultant. See follow-up in ROC2940 (12/05/01).
2731	E-mail	04/17/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested confirmation of the 12/05/01 meeting. 2) Ivanhoe requested a meeting that same day with the SD Dept. Director and the Oil Sands Initiatives Director to discuss a potential bilateral agreement.	1) FOLLOW-UP CLOSED: Requested confirmation again on 12/04/25. See follow-up in ROC2756. 2) FOLLOW-UP COMPLETE: Will try to meet 12/04/23 instead (see ROC2745).
2737	E-mail	04/18/2012	Program Manager (FMKFN SD), Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the bimonthly contact report for February-March 2012. Any comments from FMKFN will be included in the next bimonthly report. 2) FMKFN requested a Word version of the report.	2) FOLLOW-UP COMPLETE: Word version provided on 12/04/19 (see ROC2746).

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ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2741	E-mail	04/18/2012	Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a meeting with FMKFN on 12/04/23 to discuss a bilateral agreement. FMKFN to confirm if they are available (see also ROCs 2731 and 2744).	1) FOLLOW-UP COMPLETE: FMKFN will contact Ivanhoe if available (12/04/20, ROC2752).
2744	Phone Call	04/18/2012	Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe left a voicemail requesting a short meeting with FMKFN on 12/04/23 to discuss the bilateral agreement (see also ROCs 2731 and 2741).	1) FOLLOW-UP: COMPLETE: FMKFN will contact Ivanhoe if available (12/04/20, ROC2752).
2745	Casual Meeting	04/18/2012	Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN is in meeting for most of 11/04/23, but will contact Ivanhoe if done early and can meet with Ivanhoe that day.	1) FOLLOW-UP CLOSED: Ivanhoe not available (12/04/23, see ROC2753).
2746	E-mail	04/19/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the bimonthly contact report in Word format. 2) FMKFN noted one addition to the report for an action item that was completed: for ROC2651, added that FMKFN provided contact information for the Chief’s Administrative Assistant as well as protocols for setting up a meeting between Ivanhoe’s CEO and the FMKFN Chief.	
2747	Invoice	04/19/2012	Accounts Receivable (FMKFN)	Consultation Coordinator (Ivanhoe)	1) FMKFN provided an invoice for community consultation.	
2749	E-mail	04/20/2012	Accounts Receivable (FMKFN)	Consultation Coordinator (Ivanhoe)	1) FMKFN invoice for Q1 fees approved for processing.	
2752	E-mail	04/20/2012	Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe followed up to conversation on 12/04/18 to confirm that the SD Director will contact Ivanhoe on Monday if he has time available to meet (see ROC2745).	
2753	E-mail	04/23/2012	Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe is not available to meet on 12/04/23. Requested a meeting on 12/05/01 instead.	1) FOLLOW-UP COMPLETE: FMKFN is available on 12/05/01 (12/04/25, ROC2765).
2756	E-mail	04/24/2012	Program Manager (FMKFN SD), Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested confirmation if FMKFN is available to meet on 12/05/01 (see also ROC2731).	1) FOLLOW-UP COMPLETE: Meeting confirmed on 12/04/25 (see ROC2765).

Fort McKay First Nation (FMKFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2765	E-mail	04/25/2012	Program Manager (FMKFN SD), Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Meeting with FMKFN for 12/05/01 confirmed.	1) FOLLOW-UP COMPLETE: Meeting held on 12/05/01 (see ROC2794).
2776	E-mail	04/27/2012	Program Manager (FMKFN SD), Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided agenda items for the 12/05/01 meeting.	
2794	E-mail	05/01/2012	Program Manager (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe had to leave the 12/05/01 meeting early; asked if a teleconference could be set for later in the week.	1) FOLLOW-UP CLOSED: Second request for call on 12/05/07. See ROC2792 for follow-up.
2940	Meeting	05/01/2012	Program Manager (FMKFN SD), Sr Environmental Advisor (FMKFN SD)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Draft minutes complete, FMKFN to review and finalize.	
2919	Phone Call	05/04/2012	Program Manager (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe called to discuss the SD budget. FMKFN was unavailable to talk at the time and will call back either later in the day or next week.	1) FOLLOW-UP COMPLETE: Call held on 12/05/07 (see ROC2920).
2792	E-mail	05/07/2012	Program Manager (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a short call (see ROC2794).	1) FOLLOW-UP CLOSED: Discussed further on 12/05/04 (see ROC2919).
2800	E-mail	05/07/2012	Program Manager (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN Update: Provided an update on new staff that have joined the SD. 2) Treaty Days: Provided information on Treaty Days 12/06/21-24. 3) Budget Meeting: Requested industry attendance at a budget meeting on 12/05/11 for partners who have not paid their 2012 fees in full. 4) Community Information System: Will be rolled out soon. 5) ACs/Tours: AC meetings and tours will be set up in the next week.	

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2920	Phone Call	05/07/2012	Program Manager (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe agreed to fund the SD budget in its current form and will not need to attend the 12/05/11 budget meeting (see also ROC2919). Concern was expressed regarding the amount of the increase as well as including community-based monitoring programs as they are not specific to consultation on the Tamarack Project. Ivanhoe hopes that SD funding and community-based initiatives can be included as part of a negotiated agreement.	
2805	E-mail	05/08/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Community Advisory Group (CAG) meeting set for 12/06/12 for Ivanhoe. FMKFN provided a list of group members. Tasks for the meeting include: (a) agenda - Ivanhoe; (b) contact CAG members, catering, honorarium, tobacco and venue - FMKFN.	1) FOLLOW-UP CLOSED: Meeting postponed to Fall (see ROC2839, 12/05/15).
2807	E-mail	05/09/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Regular Meeting: Ivanhoe requested that FMKFN propose alternative dates for this meeting. 2) CAG: Ivanhoe had some questions about the group: (a) Function of the group, in light of the project being recently reviewed in the community consultation sections. Requested information on potential discussion items and other clarifications on the CAG format.	2) FOLLOW-UP COMPLETE: Answers provided on 12/05/14 (see ROC2825).
2814	E-mail	05/09/2012	Program Manager (FMKFN SD)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) FMKFN provided an update on the Terrestrial Thresholds Study.	
2929	Phone Call	05/11/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN will provide a response to Ivanhoe's queries about the CAG meeting (see ROC2807) in the next couple of days.	
2818	E-mail	05/14/2012	Oil Sands Initiatives (FMKFN SD)	Regulatory Affairs Consultant (Ivanhoe)	1) Regulatory Affairs Consultant asked if FMKFN had identified a time to meet with Ivanhoe to discuss resolution of FMKFN's SOC.	1) FOLLOW-UP OUTSTANDING: FMKFN to provide availability. Update: Ongoing.

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ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2825	E-mail	05/14/2012	Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN provided answers to Ivanhoe's questions. Also provided potential discussion items and clarifications requested.	
2828	Letter	05/14/2012	Director (FMKFN SD)	Director, HS&E Regulatory (Ivanhoe)	1) Ivanhoe provided its formal response to FMKFN's SOC from March 2011 (see ROC1409). Requested a technical meeting to discuss the response, as well as potential mitigation and benefits through negotiated agreements.	1) FOLLOW-UP CLOSED: Discussed by phone on 12/06/11.
2829	E-mail	05/15/2012	Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided electronic copies of the letter from Ivanhoe regarding FMKFN's SOC (see ROC2828) and their responses to the SOC. Noted that the documents will be submitted to AEW and ERCB as part of the public submission for the project.	
2835	Letter	05/15/2012	Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided a copy of the notes and traditional land use data map referenced in the FMKFN SOC 102. It has been sent under separate cover from the SOC response (see ROC2828) to protect the names and identities of the meeting attendees.	
2836	E-mail	05/15/2012	Sr Environmental Advisor (FMKFN SD), Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided electronic copies of the FMKFN SOC 102 cover letter (see ROC2835), as well as the referenced meeting notes and shape files for the TLU area.	
2839	E-mail	05/15/2012	Program Manager (FMKFN SD), Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe is ok with the format of the CAG meeting Requested that the meeting be postponed until fall 2012, once Ivanhoe has submitted responses to the second round of SIRs and answered FMKFN's SOC.	1) FOLLOW-UP COMPLETE: Confirmed that postponing the meeting to fall is ok (see ROC2904, 12/05/29).
2844	E-mail	05/16/2012	Program Manager (FMKFN SD), Sr Environmental Advisor (FMKFN SD), Director (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN acknowledged receipt of Ivanhoe's response to their SOCs (see ROC2829). They will contact FMKFN in the next week to set up a technical meeting to discuss the response.	1) FOLLOW-UP CLOSED: See follow-up in ROC2904.

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2846	E-mail	05/16/2012	Consultant 4 (IFMKFN SD	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Integral Ecology requested, and Ivanhoe provided, Ivanhoe's contact for FMKFN's community information system.	
2904	E-mail	05/29/2012	Program Manager (FMKFN SD), Sr Environmental Advisor (FMKFN SD)	Consultation Coordinator (Ivanhoe)	1) FMKFN is ok with postponing the first CAG meeting with Ivanhoe until fall, but noted that two meetings would need to be planned in the fall to meet the requirements of 3/year. 2) Ivanhoe requested an update on FMKFN's review of the SOC response. FMKFN consultants should have the review done by mid-June; looking at July to set up a meeting to discuss.	1) FOLLOW-UP OUTSTANDING: Plan CAG meeting for fall. 2) FOLLOW-UP OUTSTANDING: Set up meeting to discuss SOC response.

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2014	E-mail	10/24/2011	Regulatory Affairs Coordinator (MCFN GIR) Director (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for August-September 2011. Requested that any comments be provided to AENV (cc: Ivanhoe); they will be included in the next bi-monthly report.	
2158	E-mail	12/05/2011	Land Use Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) MCFN provided the revised IK Study SOW and requested that Ivanhoe review and provide comments by 11/12/16.	1) FOLLOW-UP COMPLETE: Approval provided on 11/12/16 (see ROC2305).
2162	E-mail	12/05/2011	Regulatory Affairs Coordinator (MCFN GIR) Director (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe has filed responses to AENV's and ERCB's supplemental information requests. Asked that MCFN let them know how many hard and electronic copies they would like.	1) FOLLOW-UP COMPLETE: MCFN requested 2 copies on 11/12/06 (see ROC2173).
2173	E-mail	12/06/2011	Regulatory Affairs Coordinator (MCFN GIR) Director (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) SIRs: MCFN requested one copy of the SIRs be sent to them and one to MSES. 2) SOC Response: MCFN asked when Ivanhoe would be sending out a response to their SOC. Ivanhoe anticipates having this completed by the end of Q1 2012.	1) FOLLOW-UP COMPLETE: SIRs sent on 12/01/16 (see ROC2442).
2248	Letter	12/09/2011	Director (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2198	E-mail	12/13/2011	Director (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Confirmation from FedEx of delivery of SIR package (see ROC2173) to MCFN (tracking #795493529364).	
2282	E-mail	12/15/2011	Regulatory Affairs Coordinator (MCFN GIR) Director (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided the bi-monthly contact report for October-November 2011. Requested that any comments be provided to AENV with a copy to Ivanhoe; they will be included in the next bi-monthly report.	1) FOLLOW-UP CLOSED: No comments received.
2305	E-mail	12/16/2011	Director (MCFN GIR) Land Use Coordinator (MCFN GIR) TEK Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided approval of MCFN's revised IK Study Workplan (see ROC2158). Requested a draft TK Sharing Agreement for review and comment as soon as possible.	1) FOLLOW-UP COMPLETE: Provided for review on 12/01/04 (see ROC2352).

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2352	E-mail	01/04/2012	Land Use Coordinator (MCFN GIR) TEK Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) MCFN provided a draft of the TK Sharing Agreement for Ivanhoe to review.	1) FOLLOW-UP COMPLETE: Provided on 12/01/04 (see ROC2352).
2365	E-mail	01/12/2012	Land Use Coordinator (MCFN GIR) TEK Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe received the TK Sharing Agreement draft and will review as soon as possible (see also ROC2352).	1) FOLLOW-UP CLOSED: See further discussion in ROC2401.
2380	E-mail	01/16/2012	Land Use Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) MCFN proposed three dates for a conference call with industry to discuss their proposed IK study. Ivanhoe to let them know what day works best.	1) FOLLOW-UP COMPLETE: Ivanhoe prefers 12/01/19 (see ROC2384).
2381	E-mail	01/16/2012	Regulatory Affairs Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) MCFN received the copy of SIR responses, but MSES did not. Requested that Ivanhoe send a copy to MSES.	1) FOLLOW-UP COMPLETE: Sent on 12/01/16 (see ROC2442).
2384	E-mail	01/17/2012	Land Use Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe prefers 12/01/19 for the conference call (see ROC2380).	
2394	E-mail	01/17/2012	Land Use Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe)	1) Conference call to discuss the IK study set for 12/01/19.	1) FOLLOW-UP COMPLETE: Ivanhoe attended call on 12/01/19 (see ROC2460).
2399	E-mail	01/19/2012	Land Use Coordinator (MCFN GIR)	Manager, Regulatory & Consultation (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) MCFN provided an agenda for the call to discuss the IK study. Requested that each industry partner provide written confirmation that they agree with the SOW in principle.	1) FOLLOW-UP COMPLETE: Sent by e-mail on 12/01/19 (see ROC2401).
2401	E-mail	01/19/2012	Land Use Coordinator (MCFN GIR) TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) IK Study: Ivanhoe believes that conceptually the study seems feasible and is looking forward to working out the scope of work. 2) TK Sharing Agreement: Ivanhoe has comments on the agreement provided by MCFN on 12/01/04 (see ROC2352). MCFN to let Ivanhoe know if they would like the comments or if they would prefer to wait until their legal counsel drafts a new agreement.	2) FOLLOW-UP CLOSED: MCFN to send the following week (see ROC2428 for follow-up).

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2460	Phone Call	01/19/2012	Land Use Coordinator (MCFN GIR) TEK Coordinator (MCFN GIR) Industry Representatives (Nexen, Cenovus, Southern Pacific, TECK, Husky Energy, Firelight Group, Ledcor)	Manager, Regulatory & Consultation (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Meeting with Ivanhoe and other industry with projects potentially affecting MCFN lands to discuss the joint TEK/TLU study. Discussed scope of work and cost. Concerns were raised by industry regarding content and timeline, and how relevant it would be to all companies.	1) FOLLOW-UP CLOSED: Requested again on 11/01/19 (see follow-up in ROC2401).
2428	E-mail	01/26/2012	Land Use Coordinator (MCFN GIR) TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested an update on the TK Sharing Agreement provided on 12/01/04 (see ROC2352). MCFN will have it finalized in the next week or so.	1) FOLLOW-UP COMPLETE: Agreement received on 12/02/07.
2488	E-mail	02/03/2012	Director (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe)	1) MCFN GIR requested that they be allowed to bill Ivanhoe for the full normal industry contribution for GIR funding for 2012.	1) FOLLOW-UP CLOSED: Ivanhoe wishes to discuss further on 12/02/08-09 (see ROC2507, 12/02/06). See follow-up in ROC2507.
2507	E-mail	02/06/2012	Director (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe has reviewed MCFN GIR's request to increase funding to the normal industry contribution level. Ivanhoe is not willing to consider that large of an increase as they are not yet at the production phase, and would like to discuss on 12/02/08 or 09 when they are in Fort McMurray (see ROC2488).	1) FOLLOW-UP COMPLETE: Meeting set for 12/03/15 to discuss GIR fees (see ROC2529).
2512	E-mail	02/06/2012	Office Manager (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe)	1) MCFN provided an invoice for Q1 GIR fees.	
2514	E-mail	02/07/2012	Land Use Coordinator (MCFN GIR) TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN provided the MCFN TLU/TEK Sharing Agreement. Ivanhoe will review and get back to MCFN with comments.	1) FOLLOW-UP COMPLETE: Comments provided on 12/02/28 (see ROC2562).
2529	E-mail	02/13/2012	Director (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Meeting with MCFN to discuss GIR fees set for 12/03/15. MCFN reminded Ivanhoe that moving forward on the consultation process of the application does include additional GIR fees.	1) FOLLOW-UP COMPLETE: Meeting held on 12/03/15 (see ROC2686).

Ivanhoe Energy

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2548	E-mail	02/21/2012	Regulatory Affairs Coordinator (MCFN GIR) Director (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the December 2011 - January 2012 bi-monthly consultation log for review, and requested that any comments be provided by e-mail to AEW and cc'd to Ivanhoe.	1) FOLLOW-UP CLOSED: No comments received.
2562	E-mail	02/28/2012	Land Use Coordinator (MCFN GIR) TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) TEK/TLU Sharing Agreement: Ivanhoe has revised the agreement for MCFN review and comment. 2) GIR Fees: Ivanhoe requested an updated on the GIR fees, further to the 12/01/19 conference call (see ROC2460).	1) FOLLOW-UP CLOSED: Agreement not received; resent on 12/03/07 (see ROC2591). See follow-up in ROC2591. 2) FOLLOW-UP OUTSTANDING: MCFN to provide information on GIR fees.
2577	E-mail	03/05/2012	Consultant 1	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Meeting to discuss finalizing the MCFN agreement set with the Firelight Group for 12/03/07.	1) FOLLOW-UP COMPLETE: Call held on 12/03/07 (see ROC2643).
2587	E-mail	03/06/2012	Director (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided an agenda for the 12/03/15 meeting; MCFN added a couple items. Meeting date confirmed (see also ROC2529).	
2591	E-mail	03/07/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided an updated draft version of the TEK/TLU Agreement for MCFN to review, and requested confirmation of receipt (see ROC2643).	1) FOLLOW-UP COMPLETE: Agreement received and is being reviewed (see ROC2645, 12/03/08).

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2643	Phone Call	03/07/2012	TEK Coordinator (MCFN GIR) Consultant 2	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) IK Study: Ivanhoe agreed to be part of the IK study as long as: (a) a TK Agreement between MCFN and Ivanhoe is in place; (b) Ivanhoe is provided with a schedule outlining timeframes for deliverables and payments; and (c) the budget is reasonable. Firelight Group anticipates that a draft of the report will be provided to MCFN by mid-June. 2) TK Agreement: MCFN was unable to find a copy of the agreement provided by Ivanhoe on 12/02/28 (see ROC2562). Ivanhoe will resend after the phone call. MCFN believes there will be no issues working through the proposed changes as long as the spirit and intent of the original agreement are lived up to and that Ivanhoe understand MCFN wishes to control its traditional knowledge.	2) FOLLOW-UP COMPLETE: Agreement provided by e-mail on 12/03/07 (see ROC2591).
2645	Phone Call	03/08/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN will be reviewing the agreement with their legal counsel; agreed to do so before the 12/03/15 meeting so that any questions/comments can be discussed at that time. Ivanhoe believes the spirit and intent of the original agreement is still in place, and confirmed that they do not plan to use the information collected outside of the Tamarack Project regulatory process.	1) FOLLOW-UP CLOSED: Ivanhoe requested again if MCFN had reviewed the agreement (see ROC2624, 12/03/20). See follow-up in ROC2624.
2610	E-mail	03/12/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe asked if MCFN had had a chance to review the TEK/TLU agreement provided on 12/03/07 (see ROC2591).	

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2686	Meeting	03/15/2012	Regulatory Affairs Coordinator (MCFN GIR) Director (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Ivanhoe Update: Ivanhoe provided an update on the project and regulatory process. Introduced their new Consultation Coordinator. Confirmed the project has not triggered a DFO review, and the number of barrels/day that will be produced. 2) MCFN Update: MCFN provided results of their recent election, and described their new approach to dealing with oil sands developers. They will support agreements built around economic opportunities, environmental issues, socio-economic investment and ongoing consultation. 3) Statement of Concern: Ivanhoe expects to have responses to MCFN by the end of April, and will follow up to discuss them at that time. 4) TK Agreement: Ivanhoe will have to follow up after the meeting as MCFN's contact for the agreement was not available for the meeting. 5) Advisory Group: Ivanhoe would like to establish an Advisory Committee for the project and asked about the process for doing this. Ivanhoe will work with MCFN to coordinate a meeting to discuss in April or early May. 6) Chief-to-Chief Meeting: MCFN requested a chief-to-chief meeting with Ivanhoe senior management in Fort Chipewyan. Ivanhoe will look into the logistics. 7) Project Update: MCFN requested a copy of the application executive summary that they could post on their website. Ivanhoe to provide.	3) FOLLOW-UP OUTSTANDING: Ivanhoe to set up a meeting to discuss the SOC responses. 4) FOLLOW-UP CLOSED: Update requested update via e-mail on 12/03/20 (see ROC2624). See follow-up in ROC2624. 5) FOLLOW-UP COMPLETE: MCFN requested that Ivanhoe coordinate this with the TEK Coordinator. See follow-up in ROC2713. 6) FOLLOW-UP OUTSTANDING: Set up a chief-to-chief meeting. Update: Ivanhoe to work with MCFN to determine path forward. 7) FOLLOW-UP COMPLETE: Provided on 12/04/30 (see ROC2788).
2624	E-mail	03/20/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe asked if MCFN has had a chance to review the TK agreement yet (see also ROCs 2645 and 2610).	1) FOLLOW-UP CLOSED: Update requested by Ivanhoe again on 12/03/26 (see ROC2654). Follow-up in ROC2654.

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2649	Phone Call	03/20/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN and their legal counsel are still reviewing the TK Agreement. There are some things they would like to change, but don't believe they are major items. MCFN will try to have the agreement to Ivanhoe by the end of the week.	FOLLOW-UP OUTSTANDING: MCFN to send reviewed agreement to Ivanhoe.
2654	E-mail	03/26/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested an update on the status of the TK Agreement, in follow-up to earlier e-mail and call (see ROCs 2624, 2629).	1) FOLLOW-UP COMPLETE: Agreement updated and provided by MCFN on 12/04/02.
2668	E-mail	03/28/2012	Regulatory Affairs Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe)	1) MCFN provided a scope of work to have MSES review the Tamarack SIRs on their behalf.	1) FOLLOW-UP CLOSED: SIRs are for information only; no budget to review (see ROC2826, 12/05/14).
2699	Phone Call	04/02/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe received the draft agreement provided by MCFN (see ROC2702). Meeting set for 12/04/03 to discuss final points.	1) FOLLOW-UP COMPLETE: Meeting held on 12/04/03 (see ROC2923).
2702	E-mail	04/02/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN provided the reviewed draft TK Agreement. Ivanhoe will review and provide comments.	1) FOLLOW-UP COMPLETE: Ivanhoe requested a meeting to discuss on 12/04/03 (see ROC2699).
2706	E-mail	04/03/2012	Land Use Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe)	1) MCFN provided the final revised SOW for the MCFN-coordinated IK study. Requested comments by 12/04/13.	1) FOLLOW-UP COMPLETE: Comments provided on 12/04/05 (see ROC2709).
2875	E-mail	04/03/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN directed Ivanhoe to the appropriate point person for the IK Study.	
2923	Meeting	04/03/2012	TEK Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Discussions held on Ivanhoe's comments on the IK Sharing Agreement. MCFN to discuss some details internally and with legal counsel and will get back to Ivanhoe.	
2709	E-mail	04/05/2012	Land Use Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided comments on the SOW, as well as comments on the TK Agreement (see ROC2706). 2) Ivanhoe is also working on a document that captures Ivanhoe's proposed process for incorporating IK information into the project, and will forward by 12/04/10 for review.	2) FOLLOW-UP COMPLETE: Comments provided on 12/04/25 (see ROC2761).

Mikisew Cree First Nation (MCFN)						
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2712	E-mail	04/05/2012	Regulatory Affairs Coordinator (MCFN GIR), Director (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided draft notes for the 12/03/15 meeting (see ROC2686). Requested that comments be provided at their earliest opportunity.	1) FOLLOW-UP CLOSED: Comments requested again on 12/04/30. See ROC2788 for follow-up.
2713	E-mail	04/05/2012	Regulatory Affairs Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe)	1) MCFN's TEK Coordinator will work with Ivanhoe to set up an Advisory Committee meeting in the near future (see also ROC2686).	1) FOLLOW-UP COMPLETE: Ivanhoe asked for potential dates on 12/04/17 (see ROC2728).
2715	E-mail	04/10/2012	Land Use Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) MCFN requested clarification on the timeline for the IK study; Ivanhoe provided this. MCFN will have a revised copy to Ivanhoe by 12/04/13.	1) FOLLOW-UP COMPLETE: Comments provided on 12/04/13 (see ROC2722).
2722	E-mail	04/13/2012	Land Use Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) MCFN provided the revised IK Study SOW. Requested approval by 12/04/27.	1) FOLLOW-UP CLOSED: Ivanhoe provided edits (not approval) on 12/04/18. See follow-up in ROC2733.
2728	E-mail	04/17/2012	Regulatory Affairs Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested potential meeting dates for an Advisory Committee meeting. 2) Ivanhoe asked if MCFN has reviewed the 12/03/15 meeting notes (see ROCs 2686 and 2713).	1) FOLLOW-UP COMPLETE: Potential dates provided on 12/04/30 (see ROC2779). 2) FOLLOW-UP COMPLETE: Requested comments again on 12/04/30. See follow-up in ROC2788.
2732	Invoice	04/17/2012	Office Manager (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe)	1) MCFN GIR provided an invoice for Q2 fees.	
2733	E-mail	04/18/2012	Land Use Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided comments on the IK Study SOW (see ROC2722).	
2739	E-mail	04/18/2012	Regulatory Affairs Coordinator (MCFN GIR), Director (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the bimonthly contact report for February-March 2012. Any comments from MCFN will be included in the next bimonthly report.	

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2754	E-mail	04/24/2012	Land Use Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) IK Study SOW: Ivanhoe requested an update on the IK Study SOW. MCFN is working on the changes Ivanhoe provided and will send a revised SOW soon. Ivanhoe has a letter prepared outlining the process for incorporating IK information into the Project, and will forward it once the SOW is signed off. 2) IK Sharing Agreement: Ivanhoe requested an update on the agreement. MCFN noted that the contact for the agreement is the TEK Coordinator. Ivanhoe will contact him directly for an update.	2) FOLLOW-UP CLOSED: Requested again on 12/04/26. See follow-up in ROC2767.
2755	E-mail	04/24/2012	Director (MCFN GIR), Land Use Coordinator (MCFN GIR), TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe had a number of issues with the latest draft and provided comments for consideration. MCFN forwarded Ivanhoe's comments on the IK Sharing Agreement to their legal team and will get back to Ivanhoe the following week with comments. 2) Ivanhoe requested confirmation that the IK Study SOW approval would be pushed back because the IK Sharing Agreement would not be approved by the 12/04/27 deadline; MCFN confirmed that the deadline for the SOW would not change. Noted that MCFN will provide Ivanhoe with the uncoordinated SOW if support can't be confirmed by 12/04/27.	1) FOLLOW-UP COMPLETE: MCFN provided comments on 12/04/25 (see ROC2760). 2) FOLLOW-UP COMPLETE: Ivanhoe will not support the IK Study SOW before signing the IK Sharing Agreement (see ROC2759, 12/04/25).
2782	E-mail	04/24/2012	TEK Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested an update on the IK Sharing Agreement and if the 12/04/05 draft had been reviewed (see ROC2733).	1) FOLLOW-UP COMPLETE: Status provided by Melody on 12/04/25 (see ROC2760).
2784	Phone Call	04/24/2012	Consultant 2 (Firelight Group)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe left a voicemail requesting an update on the status of the IK Study Scope of Work and asked for a return call.	1) FOLLOW-UP COMPLETE: Ivanhoe requested an update on 12/04/27. See follow-up in ROC2770.
2785	Phone Call	04/24/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Discussed the status of the IK Sharing Agreement (see also ROC2782). MCFN will circulate the most recent draft internally and to their legal counsel for review.	

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2884	Phone Call	04/24/2012	Director (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) IK Sharing Agreement: Ivanhoe is willing to sign the agreement (assuming the requested changes are made); MCFN to confirm the agreement is ok with Chief & Council. 2) Negotiation of SOCs: MCFN requested a letter from Ivanhoe regarding Ivanhoe's interest in further managing SOCs.	1) FOLLOW-UP COMPLETE: C&C comments provided on 12/04/27 (see ROC2771). 2) FOLLOW-UP COMPLETE: Request provided by Ivanhoe on 12/04/25 (see ROC2759).
2759	E-mail	04/25/2012	Director (MCFN GIR), Land Use Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe)	1) IK Study: Ivanhoe committed funding for the study, with two conditions: the IK Agreement is finalized, Phase 1 assessment results are included in the study. 2) IK Sharing Agreement: Ivanhoe recapped the 12/04/03 meeting at which Ivanhoe's comments on the draft IK Sharing Agreement were discussed. Ivanhoe has not yet seen comments from MCFN's legal department on that draft, and would like to get comments back ASAP so the agreement can be finalized before MCFN's 12/04/27 deadline for the IK Study. Ivanhoe provided backup for the suggested changes to the agreement. 3) Phase 1 Assessment Results: Ivanhoe requested that results from the Phase 1 assessment be included in the final report provided to Ivanhoe. Ivanhoe will work details out with Firelight. MCFN noted that the Phase 1 assessment area is already included in the IK study area and nothing needs to be added to the SOW for it. 4) Meeting request: Ivanhoe requests a process and schedule to address MCFN's SOCs.	2) FOLLOW-UP OUTSTANDING: MCFN to set schedule for negotiations.

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2760	E-mail	04/25/2012	Director (MCFN GIR), Land Use Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe)	1) IK Sharing Agreement: MCFN agreed to accept changes provided by Ivanhoe. Ivanhoe provided clarification of why they accept the responsibility of consultation but not accommodation (per 10/07/06 approval letter from AEW). 2) Negotiation of SOCs: MCFN looks forward to initiating negotiations on SOCs and sustainability for the project.	
2761	E-mail	04/25/2012	Land Use Coordinator (MCFN GIR), TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe proposed a payment schedule for the IK Study, as well as a Post-Study Plan. MCFN to confirm agreement with these.	1) FOLLOW-UP CLOSED: See follow-up on 12/04/27 (ROC2771).
2766	E-mail	04/25/2012	Consultant 1 (Firelight Group)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the IK Study SOW with comments and noted a deliverable to be added.	1) FOLLOW-UP CLOSED: Ivanhoe requested an update on 12/04/27. See follow-up in ROC2770.
2882	Phone Call	04/25/2012	Consultant 1 (Firelight Group)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe stressed the importance of finalizing the SOW before the 12/04/27 deadline from MCFN. Ivanhoe provided the changes they would like to see in the SOW and will e-mail those changes to Firelight Group. It was confirmed that the payment schedule would be included in the SOW.	1) FOLLOW-UP COMPLETE: Sent on 12/04/25 (see ROC2766).
2767	E-mail	04/26/2012	Land Use Coordinator (MCFN GIR), TEK Coordinator (MCFN GIR), Consultant 2 (Firelight Group), Consultant 1 (Firelight Group)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested the consultation areas for Appendix A of the IK Sharing Agreement so it can be included in the document.	1) FOLLOW-UP CLOSED: Requested again on 12/04/30. See follow-up in ROC2780.
2770	E-mail	04/26/2012	Consultant 1 (Firelight Group)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested an update on Firelight's review of Ivanhoe's comments on the IK Study SOW (see also ROC2766).	1) FOLLOW-UP COMPLETE: Firelight noted that MCFN has SOW to review (see ROC2885, 12/04/27).

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2771	E-mail	04/27/2012	Director (MCFN GIR), Land Use Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) MCFN provided comments on Ivanhoe's changes to the IK Study Agreement (see ROC2760). Asked if the work plan (how info is used, methodology, etc) needs to be in the agreement (an appendix) before the agreement is signed. Noted that they could put clauses about this in the main body since the work plan would not be complete that day. Ivanhoe noted that the SOW had been included as the work plan, but the final version will need to be resolved. As well, the consultation area map must be included in Appendix A of the agreement or at a minimum coordinates describing the area need to be included. Ivanhoe will not release funds until the IK Sharing Agreement is in place. Firelight is finalizing the SOW and expects to have it completed by the end of the day.	1) FOLLOW-UP CLOSED: Update requested by Ivanhoe on 12/04/30. See follow-up in ROC2781.
2772	E-mail	04/27/2012	Director (MCFN GIR), Land Use Coordinator (MCFN GIR), TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested an update on the status of the IK Sharing Agreement and the IK Study Work Plan.	1) FOLLOW-UP COMPLETE: Changes/update provided on 12/04/27 (see ROC2771).
2885	Phone Call	04/27/2012	Consultant 1 (Firelight Group)	Consultation Coordinator (Ivanhoe)	1) Firelight group has incorporated changes and signed off on the IK Study SOW. It has been forwarded to MCFN for approval.	1) FOLLOW-UP COMPLETE: Ivanhoe requested an update from MCFN on 12/04/27 (see ROC2772).

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2779	E-mail	04/30/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN noted that the second week of June would be good for an Advisory Committee meeting; Ivanhoe proposed 12/06/08. 2) Ivanhoe requested clarification on a number of items relating to the AC meeting. (a) Number of attendees: Ivanhoe prefers to keep it to 5-6 people (MCFN suggested 10-12). (b) Ivanhoe requested that membership remain consistent if possible. (c) Ivanhoe assumes that attendees will be based in Fort McMurray and will not be flown in from Fort Chipewyan. (d) Ivanhoe requested that attendees have some knowledge of the project area. (e) Ivanhoe requested amounts for honoraria, if required. (f) Ivanhoe suggested that the meeting run from 10 am - 1 pm.	1) FOLLOW-UP COMPLETE: Date confirmed on 12/05/24 (see ROC2897). 2) FOLLOW-UP COMPLETE: Questions answered on 12/05/03 (see ROC2797).
2780	E-mail	04/30/2012	Land Use Coordinator (MCFN GIR), Consultant 2 (Firelight Group), Consultant 1 (Firelight Group)	Consultation Coordinator (Ivanhoe)	1) MCFN requested that Firelight Group provide Ivanhoe with the consultation area section for Appendix A of the IK Sharing Agreement (see also ROC2767). 2) Ivanhoe noted that the agreement draft sent by MCFN today (see ROC2876) is an earlier version and did not include MCFN changes in two sections. Ivanhoe provided the most recent draft again and asked that MCFN review and advise ASAP (see also ROC2771). Agreement can be executed once approved by MCFN and the Appendix A information is received.	1) FOLLOW-UP CLOSED: Ivanhoe requested Appendix A again from MCFN on 12/05/04. See follow-up in ROC2798. 2) FOLLOW-UP COMPLETE: Review provided on 12/04/30 (see ROC2876).
2781	E-mail	04/30/2012	Land Use Coordinator (MCFN GIR), TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested updates on the status of the IK Sharing Agreement and the IK Study SOW (see also ROC2771).	1) FOLLOW-UP COMPLETE: Comments for both documents provided on 12/04/30 (see ROC2876).

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2788	E-mail	04/30/2012	Regulatory Affairs Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Project Info for Website: Ivanhoe provided MCFN with an Executive Summary memo about the project that can be linked to the MCFN GIR website. 2) 12/03/15 Meeting Notes: Ivanhoe requested comments on the notes sent 12/04/05 (see ROC2712). 3) AC Meeting: Ivanhoe requested a date for an AC meeting (see also ROC2728).	2) FOLLOW-UP CLOSED: No comments received. 3) FOLLOW-UP COMPLETE: Potential dates provided on 12/04/30 (see ROC2779).
2790	E-mail	04/30/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe asked if MCFN has a standard terms of reference used for advisory committees.	1) FOLLOW-UP CLOSED: Requested again on 12/05/04. See follow-up in ROC2799.
2876	E-mail	04/30/2012	Land Use Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN provided the revised IK Study Scope of Work.	1) FOLLOW-UP COMPLETE: SOW comments approved. Waiting for Appendix A (see ROC2793, 12/05/01).
2887	Phone Call	04/30/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe will book a conference room for the AC meeting, and will also get back to MCFN with further questions.	
2793	E-mail	05/01/2012	Land Use Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe is ok with the 12/04/30 version of the IK Study Scope of Work. Noted that once Appendix A is complete and the IK Sharing Agreement is finalized, they are good to go ahead with the study.	

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2797	E-mail	05/03/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN provided answers to Ivanhoe's questions (see ROC2779). 2) Number of attendees: Standard practice for MCFN to have 10-15 people on the AC. 3) Membership: MCFN tries to keep members consistent; currently restructuring their ACs and will let Ivanhoe know when this is complete. 4) Location of Attendees: Most will be from Fort McMurray, but some may be from other locations. 5) Knowledge of Project Area: Members are lay persons and may or may not have knowledge of the project area as limited information on the project is currently available. 6) Honoraria: Amount of honoraria was provided. 7) Length of Session: MCFN does not believe that 3 hours is adequate.	
2798	E-mail	05/04/2012	Land Use Coordinator (MCFN GIR), Consultant 2 (Firelight Group), Consultant 1 (Firelight Group), Consultant 3 (Firelight Group)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested an update on the status of the IK Sharing Agreement. Noted that the fully executed agreement (including Appendix A) is required before funds for the IK Study can be released. Attached the current draft of the agreement and requested that MCFN insert Appendix A and return for execution (see also ROCs 2767, 2780).	1) FOLLOW-UP COMPLETE: Appendix A attached by Ivanhoe on 12/05/08 (see ROC2802).

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2799	E-mail	05/04/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe responded to MCFN's comments on the AC (see ROC2797). 2) Number of Attendees: Ivanhoe is comfortable with 10 attendees. 3) Membership: Asked to be kept apprised of reorganization plans, and that reasonable efforts be taken to keep membership consistent. 4) Location of Attendees: Ivanhoe will not cover costs for those outside Fort McMurray to attend the meetings. 5) Knowledge of Project Area: Ivanhoe understands that attendees may not have specific knowledge of the project, but ask that they have some knowledge of the general project area. 6) Length of Session: Ivanhoe is open to discussing the length of the session. 7) Ivanhoe requested a standard Terms of Reference for ACs (see also ROC2790).	7) FOLLOW-UP OUTSTANDING: MCFN to send standard TOR for ACs.
2802	E-mail	05/08/2012	Director (MCFN GIR), Land Use Coordinator (MCFN GIR), TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the signed IK Sharing Agreement (with Appendix A) and requested that MCFN sign and return one copy.	1) FOLLOW-UP CLOSED: Ivanhoe requested an update on the signing of the agreement on 12/05/09. See follow-up in ROC2808.
2808	E-mail	05/09/2012	Land Use Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) IK Study: MCFN requested, and Ivanhoe provided, the project shape files. 2) IK Sharing Agreement: Ivanhoe requested an update on the IK Sharing Agreement, sent to MCFN on 12/05/08 for signing (see also ROC2802).	
2820	E-mail	05/14/2012	Director (MCFN GIR), Legal Counsel (MCFN)	Regulatory Affairs Consultant (Ivanhoe)	1) Regulatory Affairs Consultant requested a meeting with MCFN's lawyer to discuss resolution of their SOC.	1) FOLLOW-UP OUTSTANDING: MCFN to let Regulatory Affairs Consultant know of their availability for a meeting.

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2826	E-mail	05/14/2012	Regulatory Affairs Coordinator (MCFN GIR), Director (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) MCFN followed up on the SOW they submitted to review the Supplemental Information Requests (SIRs) (see ROC2668). 2) Ivanhoe noted that they were provided for MCFN's information only and were directed at the regulators; therefore, Ivanhoe will not be providing funding for any third-party reviews (funding has not been provided to any groups). Ivanhoe is working on answers to MCFN's SOC and will set up a technical meeting to review those when complete. 3) MCFN noted that it is normal practice to review all aspects of the application, including SIRs. Requested that Ivanhoe draft a letter to the regulators requesting that they cover the cost of MCFN's review of the SIRs. 4) Ivanhoe clarified that they have not provided funding to any group to review SIRs to date, and believes their responses to MCFN's SOC will address any questions MCFN may have about the project. 5) ISSUE: MCFN believes they should receive funding to review the SIRs as they are part of Ivanhoe's application. If Ivanhoe is not willing to fund the review, Ivanhoe should write a letter to the regulators to request they fund the review. 6) Ivanhoe will not write the requested letter but agreed to note MCFN request in the bi-monthly reporting process.	
2857	E-mail	05/18/2012	Land Use Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) MCFN requested a shape file of the total project footprint as the one sent earlier (see ROC2808) doesn't seem to correspond to the local study area in the EIA.	1) FOLLOW-UP CLOSED: Provided on 12/05/22 (see ROC2860).

Mikisew Cree First Nation (MCFN)						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2860	E-mail	05/22/2012	Land Use Coordinator (MCFN GIR), TEK Coordinator (MCFN GIR)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided a copy of the shape files submitted with the original application (see ROC2857). 2) The IK Sharing Agreement has been signed by the Chief and will be forwarded to Ivanhoe shortly.	2) FOLLOW-UP CLOSED: MCFN will send on 12/05/25. See follow-up in ROC2897.
2934	Phone Call	05/22/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) IK Sharing Agreement has been signed by the Chief. MCFN will send a copy to Ivanhoe once they are able to scan it.	1) FOLLOW-UP CLOSED: MCFN will send on 12/05/25. See follow-up in ROC2897.
2897	E-mail	05/24/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN requested time and location for the AC meeting scheduled for 12/06/08. 2) MCFN will send the signed IK Sharing Agreement to Ivanhoe on 12/05/25 (see also ROC2680).	1) FOLLOW-UP CLOSED: Ivanhoe will contact MCFN on 12/05/28 to discuss (12/05/25). See follow-up in ROC2899. 2) FOLLOW-UP COMPLETE: Agreement provided on 12/05/25 (see ROC2883).
2883	E-mail	05/25/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) MCFN provided a signed copy of the IK Sharing Agreement.	
2899	E-mail	05/25/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe will contact MCFN on 12/05/28 to discuss logistics for the AC meeting (see also ROC2897).	1) FOLLOW-UP CLOSED: Ivanhoe can no longer meet on 12/06/08 and requested a different date. See follow-up in ROC2907.
2907	E-mail	05/29/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe is no longer available for an AC meeting on 12/06/08 (see ROC2899). MCFN requested that Ivanhoe propose three alternate dates for the meeting.	1) FOLLOW-UP COMPLETE: Dates suggested on 12/05/30 (see ROC2913).
2908	E-mail	05/29/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided MCFN with their copy of the fully executed IK Sharing Agreement.	
2913	E-mail	05/30/2012	TEK Coordinator (MCFN GIR)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe suggested 12/06/27 or 28 for the AC meeting (see ROC2907).	1) FOLLOW-UP COMPLETE: Meeting set for 12/06/28 (on 12/06/04).

Métis Nation of Alberta						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2247	Letter	12/09/2011	President, Region 1 (Métis Nation of Alberta)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2288	Letter	12/15/2011	Manager of Industry Relations (Métis Nation of Alberta)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	

Métis Local 63						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2164	Phone Call	12/01/2011	Manager of Sustainable Development (Métis Local 63)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested and was provided with their courier address.	
2258	Letter	12/09/2011	President (Métis Local 63)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2777	E-mail	04/26/2012	Executive Director (Métis Local 63)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a meeting on 12/05/01. FMKFN to confirm availability.	1) FOLLOW-UP COMPLETE: Confirmed on 12/04/28 (see ROC2948).
2948	E-mail	04/28/2012	Executive Director (Métis Local 63)	Consultation Coordinator (Ivanhoe)	1) Meeting confirmed for 12/05/01 (see ROC2777).	
2949	Meeting	05/01/2012	President (Métis Local 63), Executive Director (Métis Local 63)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Introduced new staff from Ivanhoe and Métis Local 63. Both organizations provided updates on recent activities. 2) Métis Local 63 provided information on Fort McKay Métis Management Corp. as well as other businesses and potential JVs. 3) Métis Local 63 provided Ivanhoe with a request for sponsorship for their upcoming Métis Days. Ivanhoe to review and get back to them.	3) FOLLOW-UP OUTSTANDING: Ivanhoe to review Métis Days sponsorship.

Conklin Métis Local 193						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2222	Letter	12/09/2011	President (Conklin Métis Local 193)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29.	

Métis Local 125						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2212	Letter	12/09/2011	President (Métis Local 125)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29.	

Chard Métis Local 214						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2252	Letter	12/09/2011	President (Chard Métis Local 214)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	

Willow Lake Métis Local 780						
ROC#	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2241	Letter	12/09/2011	President (Willow Lake Métis Local 780)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	

Métis Local 1935						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
1984	E-mail	10/05/2011	General Manager (Métis Local 1935) Office Manager (Métis Local 1935) Administrative Assistant (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) The Métis Local 1935 Administrative Assistant - Oil & Gas is leaving as of 11/10/14. Information on her replacement was provided.	
2010	E-mail	10/21/2011	Administrative Assistant - O&G (Métis Local 1935)		1) Métis Local 1935 provided Ivanhoe with the results of their elections.	
2042	E-mail	11/03/2011	Events Coordinator (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Métis Local 1935 requested, and Ivanhoe provided, Ivanhoe's mailing address.	
2043	E-mail	11/03/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Métis Local 1935 requested a meeting with Ivanhoe to discuss the TOR.	1) FOLLOW-UP COMPLETE: Ivanhoe is available to meet on 11/11/21 (see ROC2047).
2047	E-mail	11/06/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe agreed to meet with Métis Local 1935; suggested 11/11/21.	1) FOLLOW-UP COMPLETE: Meeting confirmed for 11/11/21 at 9:30 am (see ROC2049, 11/11/07).
2049	E-mail	11/07/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Meeting for 11/11/21 confirmed.	1) FOLLOW-UP COMPLETE: Meeting held on 11/11/21 (see ROC2084).
2076	E-mail	11/17/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Métis Local 1935 provided their Christmas break schedule.	
2084	Meeting	11/21/2011	General Manager (Métis Local 1935) Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	Summary of DRAFT notes: 1) MOU/GNA: Current Good Neighbour Agreement ends 12/03/31. Ivanhoe and Métis Local 1935 to review the terms before it expires. Suggested it be made “evergreen” with a clause allowing the parties to change it when required.	1) FOLLOW-UP CLOSED: Métis Local 1935 to resend the MOU to Ivanhoe to review. Item closed per discussion on 11/11/29 (see ROC2107). See follow-up in ROC2107. FOLLOW-UP CLOSED: Both to update and re-sign the Good Neighbour Agreement.

Métis Local 1935						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
					2) 11/04/27 Meeting Notes (see ROC1495): Ivanhoe signed off on the notes. Ivanhoe confirmed current funding will carry over into 2012. Ivanhoe requested that Regulatory & Environmental Planner be removed from their mailing list. 3) Activities: Métis Local 1935 provided an update of the activities that occurred in 2011. Ivanhoe provided an update of their as well. 4) Helicopter Overflight: Overflight with trapper rebooked and done in June; met with both trappers in September. 5) SIRs: Ivanhoe will send out copies of the Supplemental Information Requests when prepared (in about a week). 6) Bridge: Ivanhoe provided an overview. Ledcor is the lead for building. 7) Project Approval: Hoping for Q4 2012 approval, with construction start in Q1 2013. 8) JVs: Métis Local 1935 would like to ensure MOUs signed are still in force if Ivanhoe is involved in any joint ventures. 9) Camps: Discussed the possibility of camps and camp services during construction. 10) AC TOR: Discussed having youth on the committee, as well as liability of youth on site tours. Ivanhoe will discuss with its management the possibility of having up to two youth on the AC, with honorariums going directly to their schools for specific programs. Ivanhoe requested a letter from the school board outlining the program and expressing its support.	Item closed per discussion on 11/11/29 (see ROC2107). See follow-up in ROC2107. 2) FOLLOW-UP COMPLETE: Signed minutes provided on 11/11/21 (see ROC2095). 5) FOLLOW-UP COMPLETE: Provided on 11/12/09 (see ROC2242). 10) FOLLOW-UP COMPLETE: Youth involvement in Advisory Committee confirmed on 11/12/01. 10) FOLLOW-UP COMPLETE: Decision provided on 11/12/01 (see ROC2154).
2094	E-mail	11/17/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe requested confirmation of the 11/11/21 meeting with Métis Local 1935.	1) FOLLOW-UP COMPLETE: Meeting held on 11/11/21 (see ROC2084).

Métis Local 1935						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2095	E-mail	11/21/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Métis Local 1935 provided a signed copy of the 11/04/27 meeting notes (see ROC1495).	
2107	E-mail	11/29/2011	General Manager (Métis Local 1935) Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided comments on the 11/11/21 draft meeting notes provided by Métis Local 1935 (see ROC2084). Discussion on Good Neighbour Agreement vs. MOU. In the end, Ivanhoe suggested adding to the notes that the issue was clarified after the meeting, and that nothing needs to be re-signed but the 2012 work plan will be updated.	1) FOLLOW-UP OUTSTANDING: Meeting notes still to be finalized.
2121	E-mail	11/28/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Métis Local 1935 provided the 11/11/21 meeting notes (see ROC2084) for review by Ivanhoe.	1) FOLLOW-UP COMPLETE: Comments provided on 11/11/29 (see ROC2107).
2154	E-mail	12/01/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) TOR: Discussion on contents. Ivanhoe to review and add revisions as discussed. 2) MOU: Métis Local 1935 confirmed they are ok with not signing an MOU until Ivanhoe is further along in the project. 3) Work Plan: Métis Local 1935 provided a proposal for funding for 2012-13. Ivanhoe reviewed and asked for clarification on a couple items.	1) FOLLOW-UP COMPLETE: Provided on 11/12/19 (see ROC2309). 3) FOLLOW-UP COMPLETE: Clarification covered in the draft work plan provided on 12/02/10.
2156	E-mail	12/02/2011	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Work Plan: Ivanhoe confirmed that Métis Local 1935 should invoice the work plan as discussed (see ROC2154). 2) TOR: Ivanhoe will get back to Métis Local 1935 soon with the revisions.	1) FOLLOW-UP COMPLETE: Invoice provided.
2242	Letter	12/09/2011	General Manager (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2309	E-mail	12/19/2011	General Manager (Métis Local 1935) Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Ivanhoe provided a draft of the Advisory Committee Terms of Reference, revised based on recent discussions. Métis Local 1935 to let Ivanhoe know if they have any comments.	1) FOLLOW-UP COMPLETE: Requested a meeting to discuss (see ROC2420, 12/01/23).

Métis Local 1935						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2358	E-mail	01/10/2012	Events Coordinator (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Métis Local 1935 provided the sponsorship package for the 2012 Métis Fest.	
2420	E-mail	01/23/2012	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe)	1) Métis Local 1935 requested a meeting to discuss the Advisory Committee TOR (see ROC2309). Ivanhoe's new Consultation Coordinator will set up a meeting in the near future.	1) FOLLOW-UP COMPLETE: E-mail request sent on 12/01/24 (see ROC2423).
2423	E-mail	01/23/2012	Administrative Assistant - O&G (Métis Local 1935)	Manager, Regulatory & Consultation (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Ivanhoe asked for potential meeting dates to discuss the Advisory Committee TOR.	1) FOLLOW-UP COMPLETE: Meeting set for 12/03/06 (see ROC2424, 12/01/24).
2424	E-mail	01/24/2012	Administrative Assistant - O&G (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Meeting to discuss the Advisory Committee Terms of Reference set for 12/03/06.	1) FOLLOW-UP COMPLETE: Meeting held on 12/02/09 instead.
2487	E-mail	02/02/2012	Administrative Assistant - O&G (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Meeting to discuss the project set for 12/02/09 at the Métis Local 1935 office.	1) FOLLOW-UP COMPLETE: Meeting held on 12/02/09 (see ROC2638).
2524	E-mail	02/10/2012	Administrative Assistant - O&G (Métis Local 1935)	Director, HS&E Regulatory (Ivanhoe)	1) Métis Local 1935 confirmed the correct version of the 11/11/21 meeting notes (see ROC2084).	
2537	E-mail	02/16/2012	Administrative Assistant - O&G (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Métis Local 1935 provided a copy of the 2010 workplan (see ROC2154).	
2617	E-mail	03/16/2012	Events Coordinator (Métis Local 1935)	Director, HS&E Regulatory (Ivanhoe)	1) Métis Local 1935 requested volunteers for Métis Fest.	1) FOLLOW-UP COMPLETE: Ivanhoe can provide two helpers (see ROC2622, 12/03/20).
2621	E-mail	03/20/2012	Administrative Assistant - O&G (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the signed notes from the 12/02/09 meeting (see ROC2638). 2) Ivanhoe asked if the 12/04/22 Advisory Committee meeting is still a go, and if there is anything specific the group wishes to discuss at the meeting. Also requested a list of those expected at the meeting.	2) FOLLOW-UP CLOSED: Followed up by Métis Local 1935 on 12/04/12. See follow-up in ROC2720.
2622	E-mail	03/20/2012	Events Coordinator (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe can provide two helpers for Métis Fest (see ROC2617).	

Métis Local 1935						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2631	E-mail	03/22/2012	Events Coordinator (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe confirmed they are available to help at Métis Fest in the morning (see ROC2622).	
2638	Meeting	02/09/2012	Administrative Assistant - O&G (Métis Local 1935)	Director, HS&E Regulatory (Ivanhoe) Consultation Coordinator (Ivanhoe)	1) Advisory Committee: Ivanhoe confirmed that a one-time letter from a student's school confirming that honorariums will be directed to student activities is required. Youth need to be 18 for site tours, so AC youth should be 18 (all AC members therefore 18+). Agreement should be signed before next meeting. Tentative date for next meeting is 12/04/24. 2) Federal/Provincial Monitoring: Discussed the new policy and that Ivanhoe will meet those requirements at startup. 3) MOU: 2012 amounts agreed on. Métis Local 1935 to send updated 2012 plan to Ivanhoe. 4) Ivanhoe Update: Project is in the second round of the regulatory process; third round expected in 2-3 months. Hoping for Q4 approval and construction in 2013. 5) Site Tour: Access has prevented many site tours to date. AC would like to see the site before construction begins. Will be discussed at the next AC meeting. 6) Métis Local 1935 Update: Provided information on activities coming up in 2012.	1) FOLLOW-UP CLOSED: Ivanhoe requested confirmation of date for next meeting on 12/03/20 (see ROC2621). 1) FOLLOW-UP OUTSTANDING: Métis Local 1935 to adjust wording of TOR to reflect honorarium and age wording; to be signed before the next meeting. 3) FOLLOW-UP COMPLETE: Work plan provided on 12/02/16 (see ROC2537).
2667	E-mail	02/09/2012	Administrative Assistant - O&G (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Next Advisory Committee meeting set for 12/04/24.	1) FOLLOW-UP CLOSED: Meeting postponed until a new GM is in place (see ROC2726, 12/04/16).
2720	E-mail	04/12/2012	Admin Assistant - O&G 2 (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Métis Local 1935 requested confirmation of the Advisory Committee meeting set for 12/04/24.	1) FOLLOW-UP CLOSED: Meeting postponed until a new GM is in place (see ROC2726, 11/04/16).
2724	Invoice	04/13/2012	Bookkeeper (Métis Local 1935)	Director, HS&E Regulatory (Ivanhoe)	1) Métis Local 1935 provided an invoice for the 2012/13 work plan.	

Métis Local 1935						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2726	E-mail	04/16/2012	Admin Assistant - O&G 2 (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested that the Advisory Committee meeting be postponed until the new General Manager is available.	1) FOLLOW-UP: Hold AC meeting after new GM is in place.
2740	E-mail	04/18/2012	Admin Assistant - O&G 2 (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Ivanhoe provided the bimonthly contact report for February-March 2012. Any comments from Métis Local 1935 will be included in the next bimonthly report.	
2774	E-mail	04/27/2012	Events Coordinator (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Métis Local 1935 provided details about Métis Fest 2012.	
2914	E-mail	05/31/2012	Admin Assistant - O&G 2 (Métis Local 1935)	Consultation Coordinator (Ivanhoe)	1) Métis Local 1935 provided the signed minutes of the 12/02/09 meeting (see ROC2638).	
2931	Community Event	05/25/2012	Admin Assistant - O&G 2 (Métis Local 1935)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Ivanhoe attended Métis Local 1935's Métis Fest.	

Métis Local 2020						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2213	Letter	12/09/2011	President (Métis Local 2020)	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29.	

Other Aboriginal Groups						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2806	E-mail	05/08/2012	CEO (Athabasca Tribal Council)	Director, HS&E Regulatory (Ivanhoe)	1) ATC and CPDFN requested sponsorship for the third ATC First Nation Regional Gathering in mid-August 2012 at CPDFN (Janvier).	1) FOLLOW-UP OUTSTANDING: Ivanhoe to respond to request.
2840	E-mail	05/15/2012	CEO (Christina River Dene Nation Council)	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) CRDNC provided information on their organization, which has Métis, First Nations, Bill C-31 and Inuit members residing in Chard/Janvier South. Métis Local 214 has been dissolved and replaced by this incorporated society. They are partners with McKay Métis Management.	

Trappers						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2086	Phone Call	10/18/2011	RFMA 1582	Manager, Regulatory & Consultation (Ivanhoe)	1) 2011-12 Winter Drilling Program: Ivanhoe is cutting back on the winter program this year and will likely only be doing seismic work. Drilling is being postponed.	
2178	Drop-in Visit	12/07/2011	RFMA 1582	Manager, Regulatory & Consultation (Ivanhoe)	1) 2011-12 Winter Program: Ivanhoe will be doing seismic and a gravel exploration this summer, and will send him the locations of the disturbances.	1) FOLLOW-UP COMPLETE: Information provided at 12/02/14 meeting.
2232	Letter	12/09/2011	RFMA 1582	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2196	E-mail	12/13/2011	RFMA 1582	Director, HS&E Regulatory (Ivanhoe)	1) 2011-12 Winter Program: Provided trapper with an overview of the program. Requested information on his traplines so that the seismic team knows where they are. Total new disposition disturbance being prepared and will be sent in the New Year.	1) FOLLOW-UP COMPLETE: Discussed at the 12/02/14 meeting (see ROC2639).
2493	Phone Call	02/03/2012	RFMA 1582	Consultation Coordinator (Ivanhoe)	1) New Consultation Coordinator introduced himself. 2) Ivanhoe will be starting reclamation work on the Tamarack lease, and requested that the trapper review the map showing reclamation areas and advise Ivanhoe if he is trapping in that area. 3) Ivanhoe would also like to meet with the trapper on 12/02/08 or 09 to touch base.	2) FOLLOW-UP COMPLETE: Map mailed on 12/02/03 (see ROC2636). See ROC2636 for further follow-up. 3) FOLLOW-UP COMPLETE: Meeting held on 12/02/14 (see ROC2639).
2636	E-mail	02/03/2012	RFMA 1582	Consultation Coordinator (Ivanhoe)	1) Provided trapper with a map of the area Ivanhoe plans to reclaim so he can identify if he is trapper in that area (see ROC2493).	1) FOLLOW-UP CLOSED: Trapper not in the area (discussed at 12/02/14 meeting, ROC2639).
2527	E-mail	02/13/2012	RFMA 1582	Consultation Coordinator (Ivanhoe)	1) Ivanhoe apologized for not having time to meet with the trapper when in Fort McMurray the previous week. Suggested a meeting on 12/02/14 instead.	1) FOLLOW-UP COMPLETE: Meeting confirmed on 12/02/14 (see ROC2534).
2534	E-mail	02/14/2012	RFMA 1582	Consultation Coordinator (Ivanhoe)	1) Meeting confirmed for 12/02/14 (see ROC2527).	1) FOLLOW-UP COMPLETE: Meeting held on 12/02/14 (see ROC2639).

Trappers						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2639	Meeting	02/14/2012	RFMA 1582	Consultation Coordinator (Ivanhoe)	1) Ivanhoe's Consultation Coordinator introduced himself to the trapper. 2) Discussed success of the trapper's lines this year; some were damaged by other company(s) (not Ivanhoe) so the season was not as successful as it should have been.	
2704	Phone Call	04/02/2012	RFMA 1582	Consultation Coordinator (Ivanhoe)	1) Ivanhoe requested a breakfast meeting on 12/04/03; trapper is unavailable. Will set a meeting for a different date.	
2087	Phone Call	10/18/2011	RFMA 2422	Manager, Regulatory & Consultation (Ivanhoe)	1) 2011-12 Winter Drilling Program: Left message to inform him that Ivanhoe is cutting back on the winter program this year and will likely only be doing seismic work. Drilling is being postponed.	
2259	Letter	12/09/2011	RFMA 2422	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2271	Phone Call	12/13/2011	RFMA 2422	Manager, Regulatory & Consultation (Ivanhoe)	1) 2011-12 Winter Program: Provided information on gravel and seismic programs for 2011-12 winter season. Ivanhoe has hired a new Consultation Coordinator who was starting right away; and he will provide a map of the areas and the access later in the week.	1) FOLLOW-UP COMPLETE: Provided at meeting held on 11/12/15 (see ROC2299).
2299	Meeting	12/15/2011	RFMA 2422	Consultation Coordinator (Ivanhoe)	1) 2011-12 Winter Program: Provided trapper with a map relating to the program; he had no concerns with the proposed work. 2) Wildlife: There has been an increase in rabbits and decrease in wolves in the area; believes this may be because of activity in the area.	
2705	Phone Call	04/02/2012	RFMA 2422	Consultation Coordinator (Ivanhoe)	1) Meeting with Richard set for 12/04/03 to touch base on the project.	1) FOLLOW-UP COMPLETE: Meeting held on 12/04/03 (see ROC2707).

Trappers						
ROC #	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-up and Outstanding Actions**
2707	Meeting	04/03/2012	RFMA 2422	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Trapper provided an update on his trapping season. Noted that increased traffic and activity in the area make it more difficult to trap furbearers. Also noted that piles of snow or gravel created access issues near Sam's cabin; may have been put there by one of Ivanhoe's contractors. Trapper to determine if they are snow or gravel; Ivanhoe will make efforts to have it corrected (if gravel).	1) FOLLOW-UP OUTSTANDING: Trapper to confirm snow/gravel piles; Ivanhoe to correct if required.
2227	Letter	12/09/2011	RFMA 273	Manager, Regulatory & Consultation (Ivanhoe)	1) Notification that responses to the first round of SIRs were filed with AENV and the ERCB on 11/11/29. CD version of the Application, including the SIRs, was provided.	
2932	Meeting	05/01/2012	RFMA 273	Director, HS&E Regulatory (Ivanhoe), Consultation Coordinator (Ivanhoe)	1) Introduced Ivanhoe's new Consultation Coordinator and provided and update on the project.	

Wood Buffalo First Nations Elder's Society						
ROC#	**Event Type**	**Event Date**	**Stakeholder List**	**Team List**	**Comments**	**Follow-Up and Outstanding Actions**
2397	Phone Call	01/18/2012	Honorary Chief (Wood Buffalo First Nations Elder's Society)	Manager, Regulatory & Consultation (Ivanhoe)	1) Wood Buffalo First nations Elder's Society received the update letter and requested a hard copy of the application.	
2422	Phone Call	01/18/2012	Honorary Chief (Wood Buffalo First Nations Elder's Society)	Consultation Coordinator (Ivanhoe)	1) Arranged meeting to discuss project and drop off application on 12/01/21.	1) FOLLOW-UP COMPLETE: Meeting held on 12/01/21 (see ROC2413).
2452	Phone Call	01/18/2012	Honorary Chief (Wood Buffalo First Nations Elder's Society)	Manager, Regulatory & Consultation (Ivanhoe)	1) Honorary Chief requested a hard copy of the Tamarack Application.	1) FOLLOW-UP COMPLETE: Hard copy provided at 12/01/21 meeting (see ROC2413).
2413	Meeting	01/21/2012	Honorary Chief (Wood Buffalo First Nations Elder's Society)	Consultation Coordinator (Ivanhoe)	1) Application: Ivanhoe provided a hard copy of the application. WBES would like funding to review the application. Ivanhoe to let them know if funding is available. 2) Open House: WBES would like an open house regarding the project; Ivanhoe to confirm if they will hold one. 3) Project Concerns: WBES has concerns about the project and will be filing an SOC; did not specify concerns. 4) Wildlife/Fish: WBES asked if caribou or fish were found in the area. Ivanhoe's studies did not encounter signs of either. Concerned that wildlife are being driven out of the area before surveys are being done.	1) FOLLOW-UP COMPLETE: Ivanhoe is not willing to fund a review, but will discuss any questions (see ROC2470, 11/01/27). 2) FOLLOW-UP COMPLETE: Ivanhoe is not willing to hold a separate open house (see ROC2470, 12/01/27).
2470	Meeting	01/27/2012	Honorary Chief (Wood Buffalo First Nations Elder's Society)	Manager, Regulatory & Consultation (Ivanhoe)	1) Wood Buffalo First Nations Elder's Society requested funding to review the Tamarack. Application. Ivanhoe is willing to discuss any issues and concerns with the project, but is not prepared to pay for funding of a technical review.	

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Appendix SIR2 F

Seismic Survey Results

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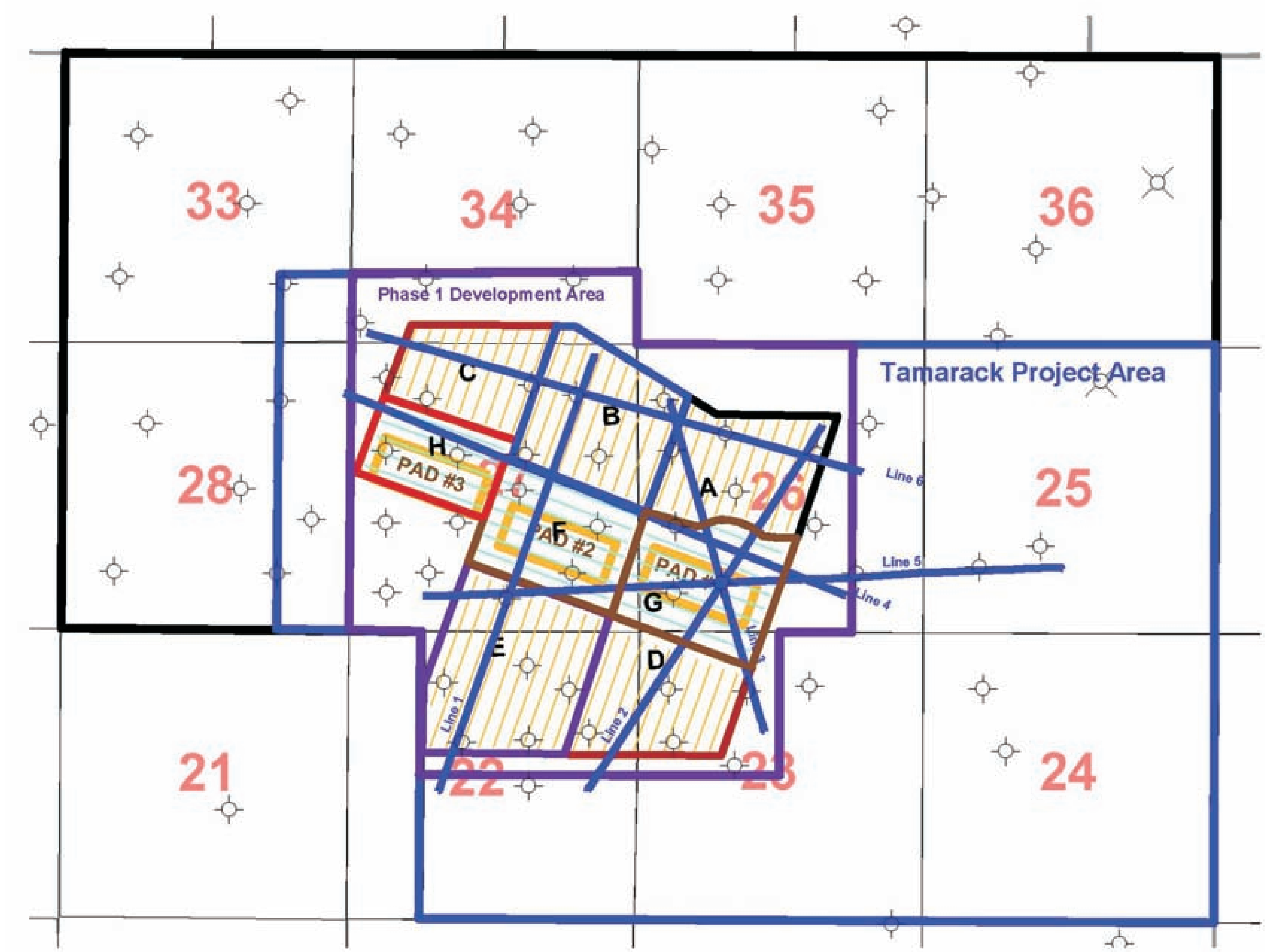

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Ivanhoe Energy

Tamarack Project

Tamarack Seismic Program Layout Map

DATE: June 2012		SIR2-FigF-01 12-06-29	Figure SIR2 F-1
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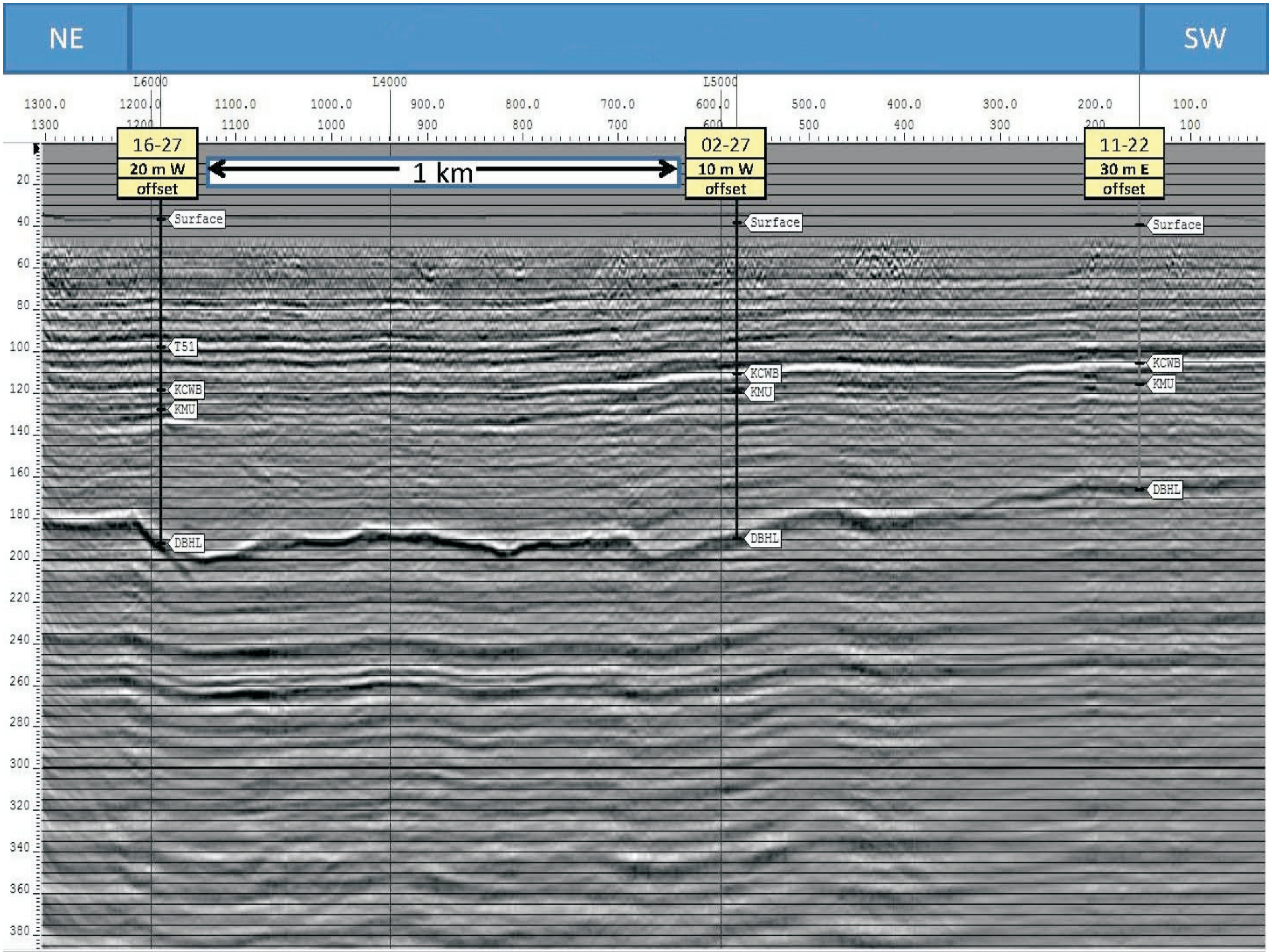
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	



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		ANALYST: TM; QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe

Figure SIR2 F-2

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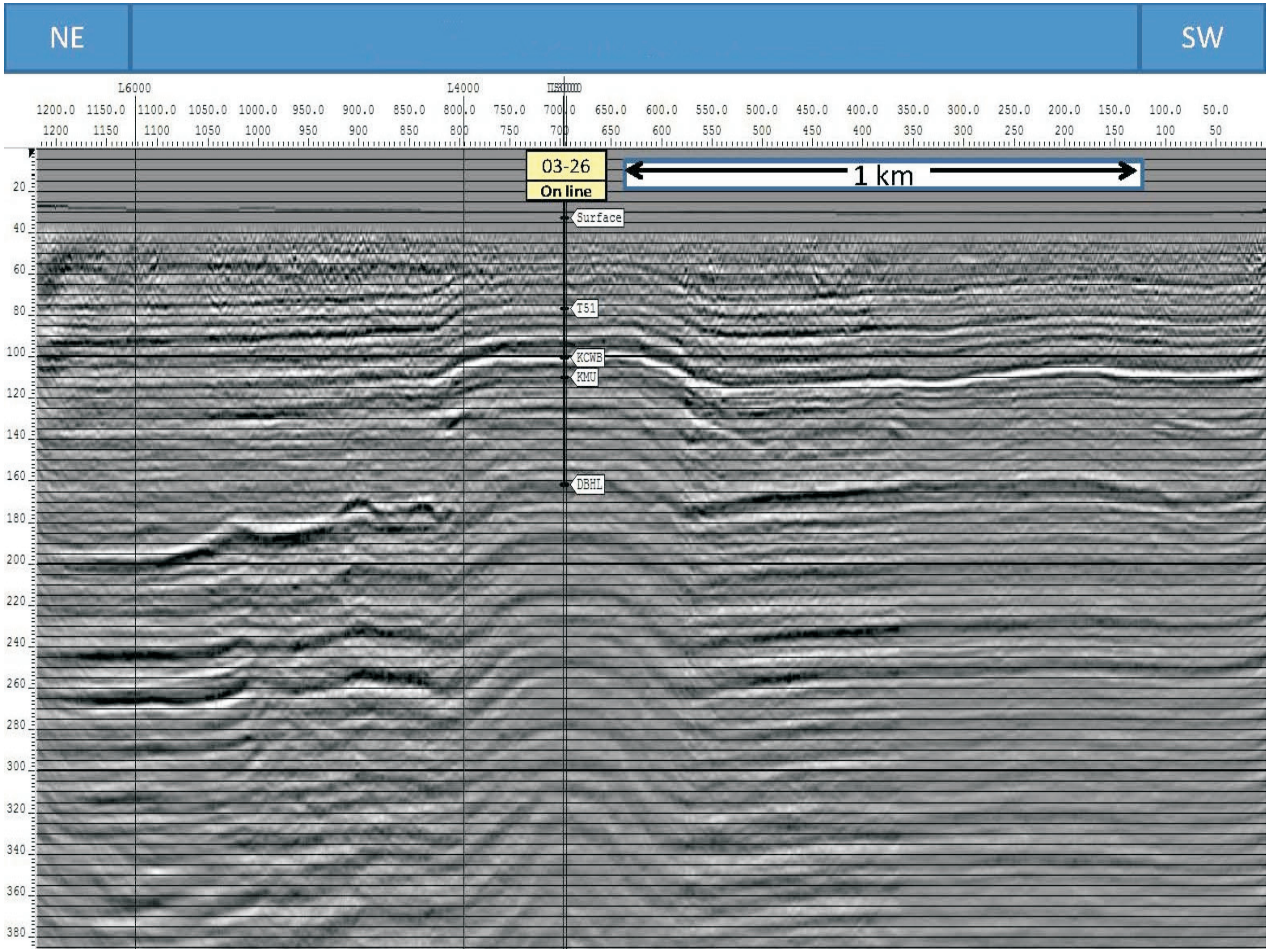

Source: Ivanhoe.

Ivanhoe Energy
Tamarack Project

Uninterpreted Seismic Line 2

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PROJECT: CE0374601	DRAWN BY: AMEC	
ANALYST: TM / QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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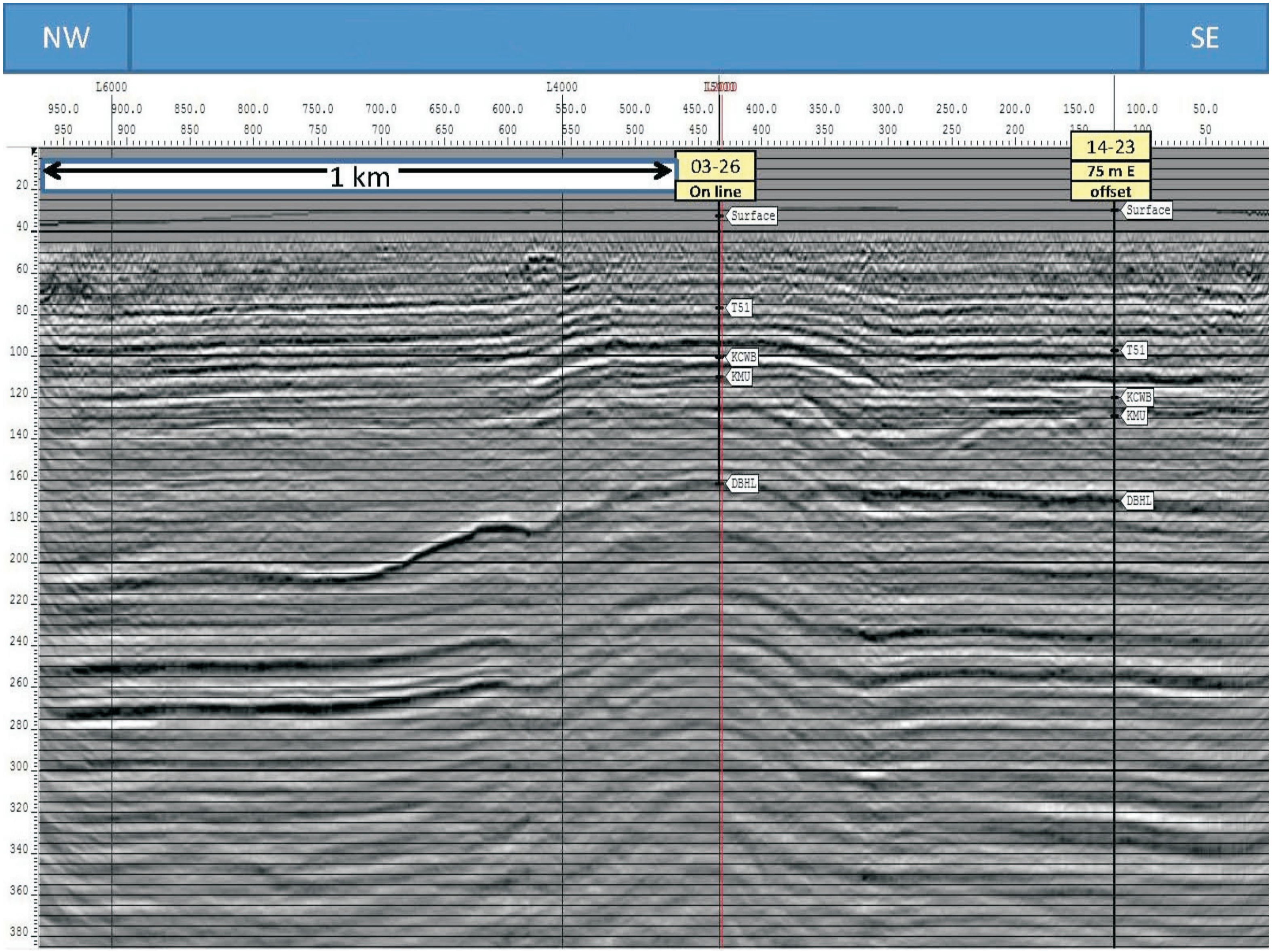

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Tamarack Project

Uninterpreted Seismic Line 3

DATE: June 2012	SIR2-FigF-04 12-06-29	
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ANALYST: TM / QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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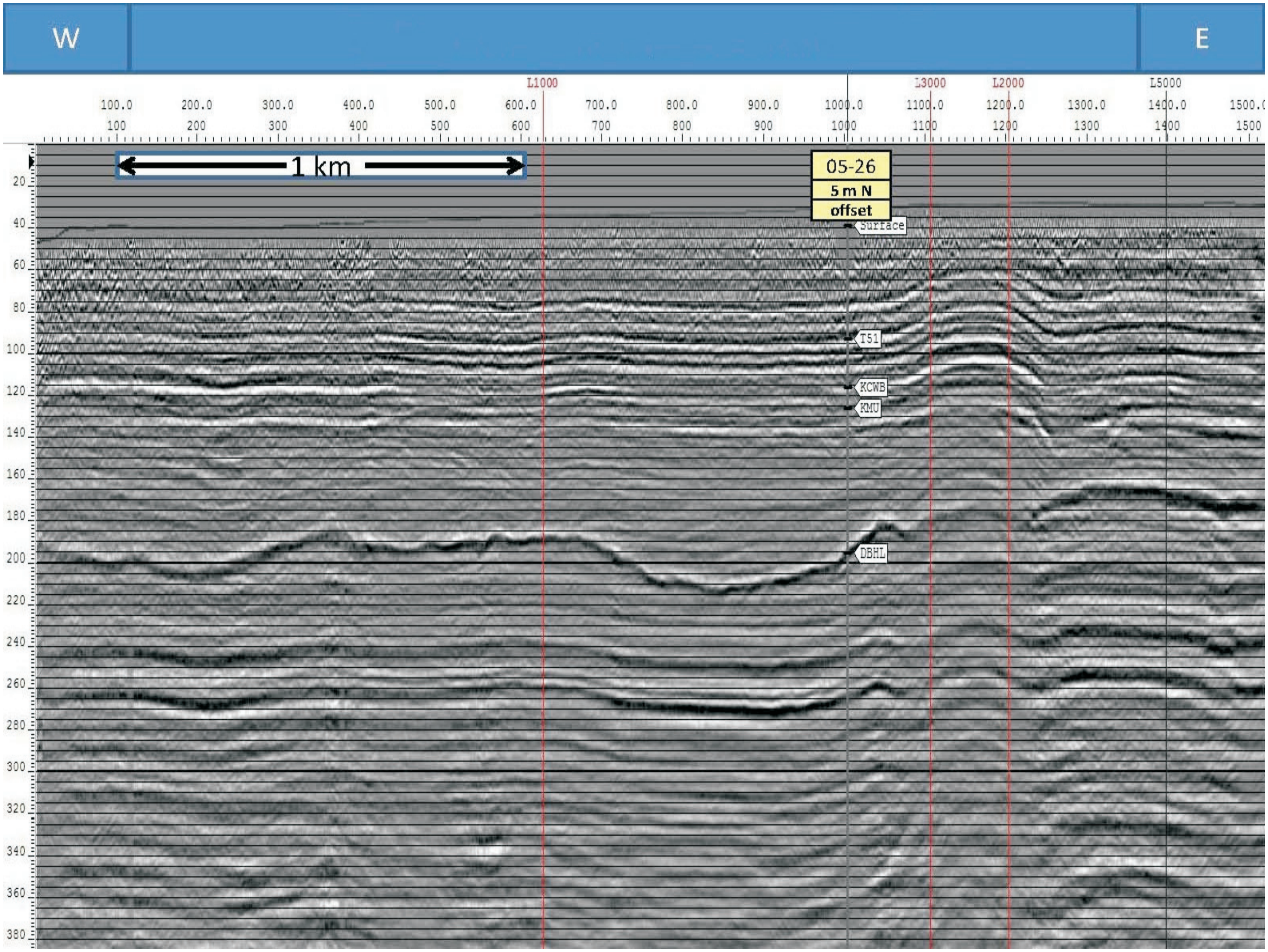

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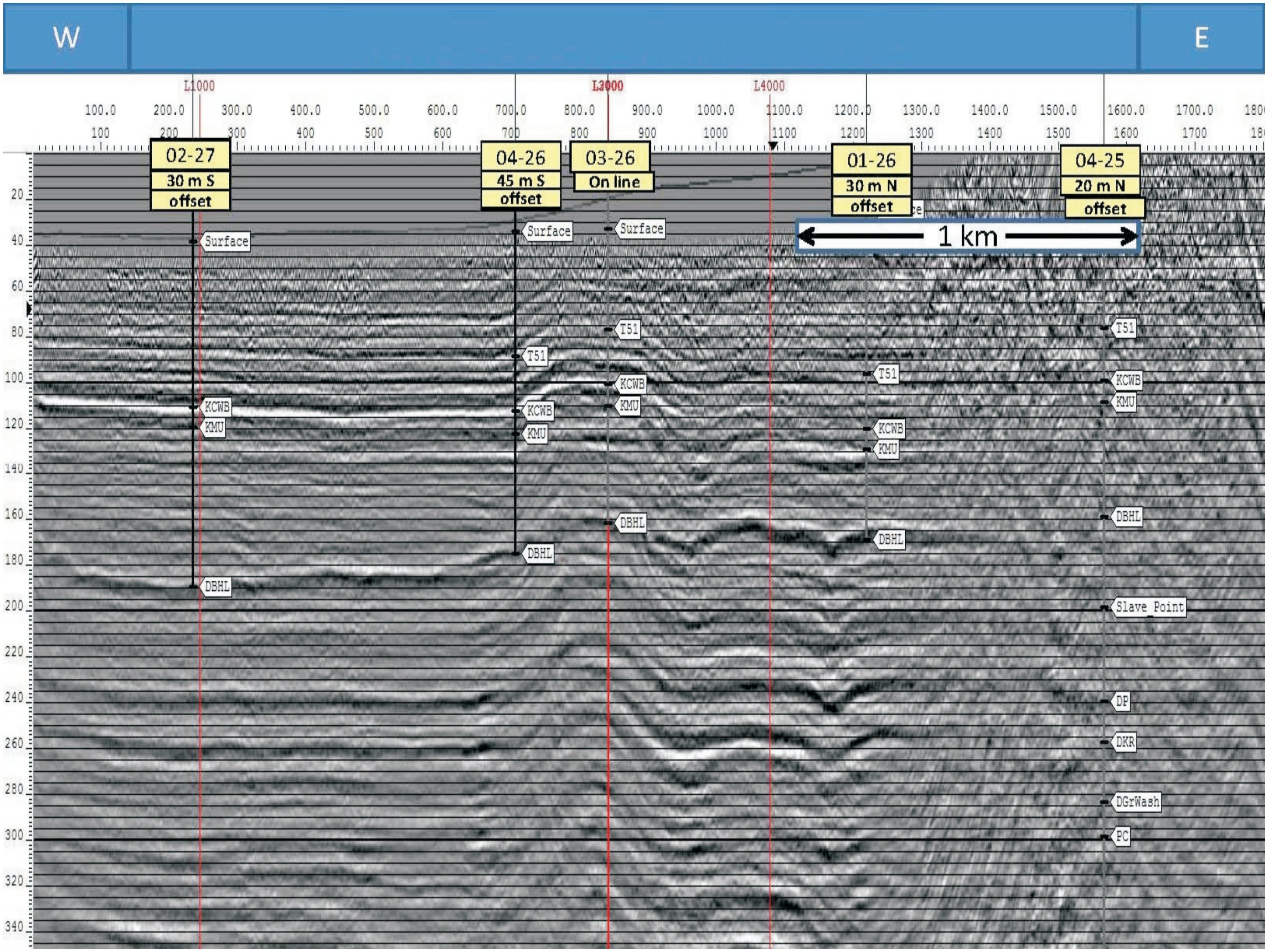

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Tamarack Project

Uninterpreted Seismic Line 5

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ANALYST: TM; QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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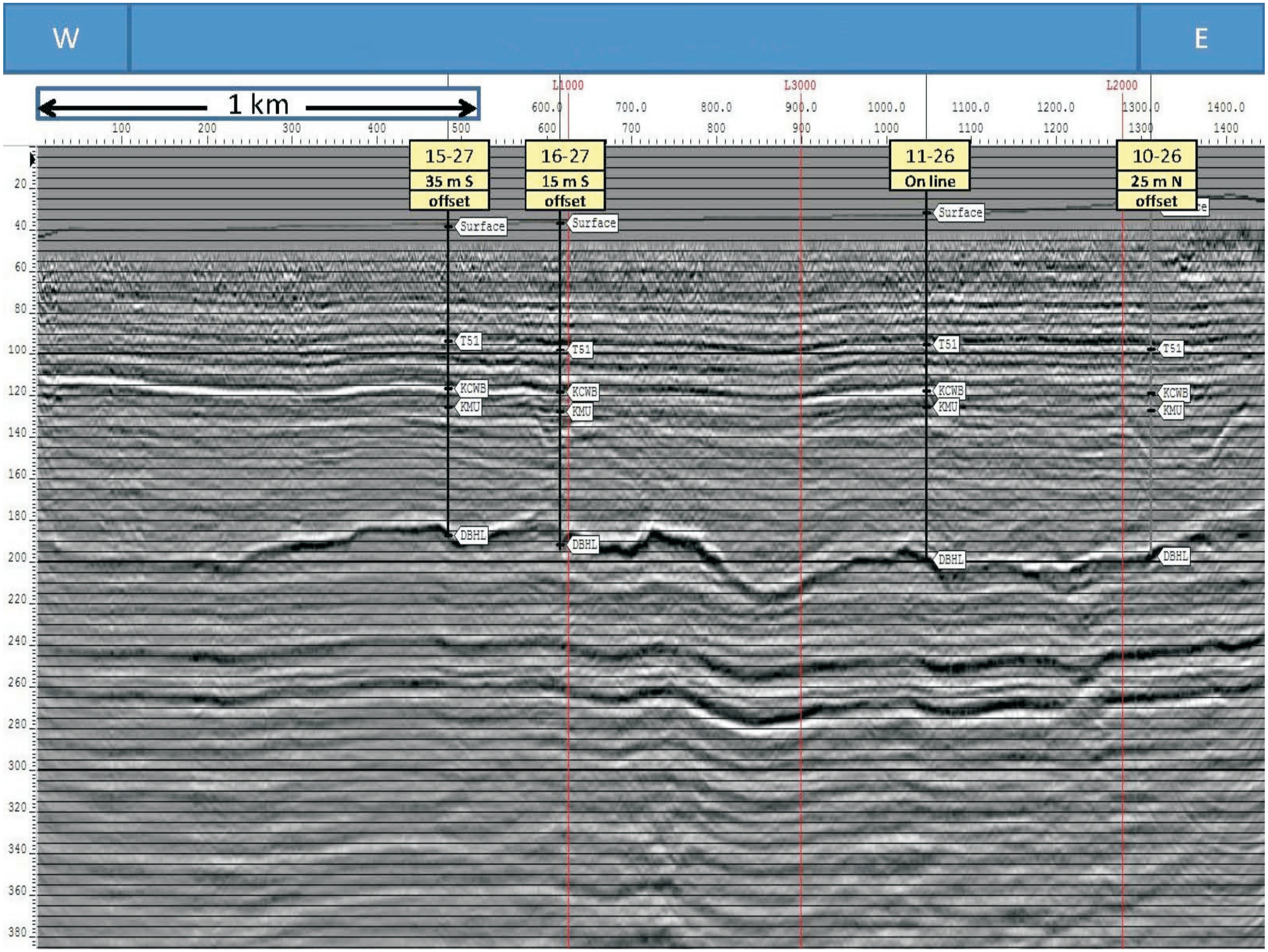

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Tamarack Project

Uninterpreted Seismic Line 6

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PROJECT: CE0374601	DRAWN BY: AMEC
ANALYST: TM / QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe

Figure SIR2 F-7

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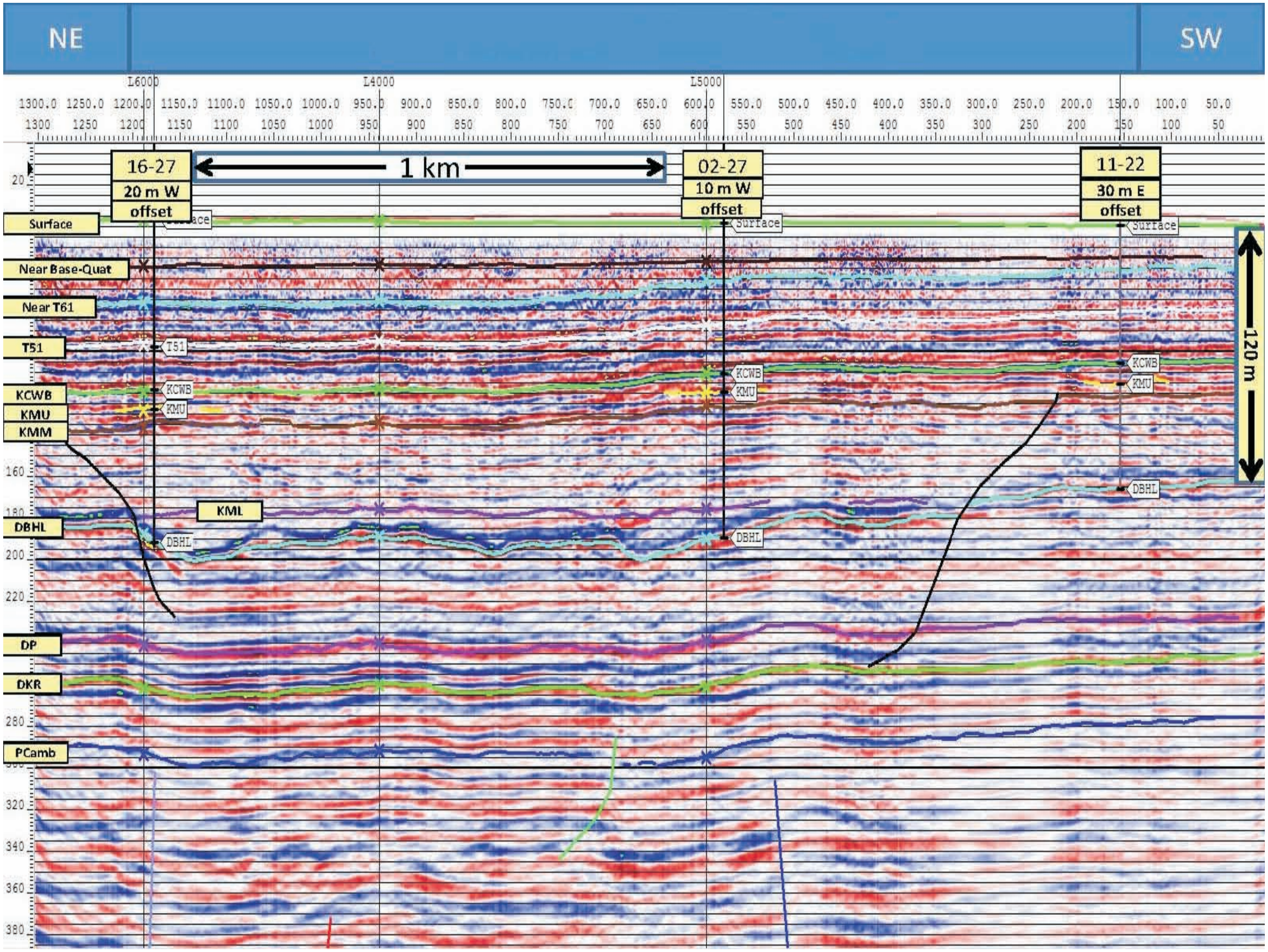

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Ivanhoe Energy Tamarack Project	Interpreted Seismic Line 1	DATE: June 2012	SIR2-FigF-08 12-06-29	Figure SIR2 F-8
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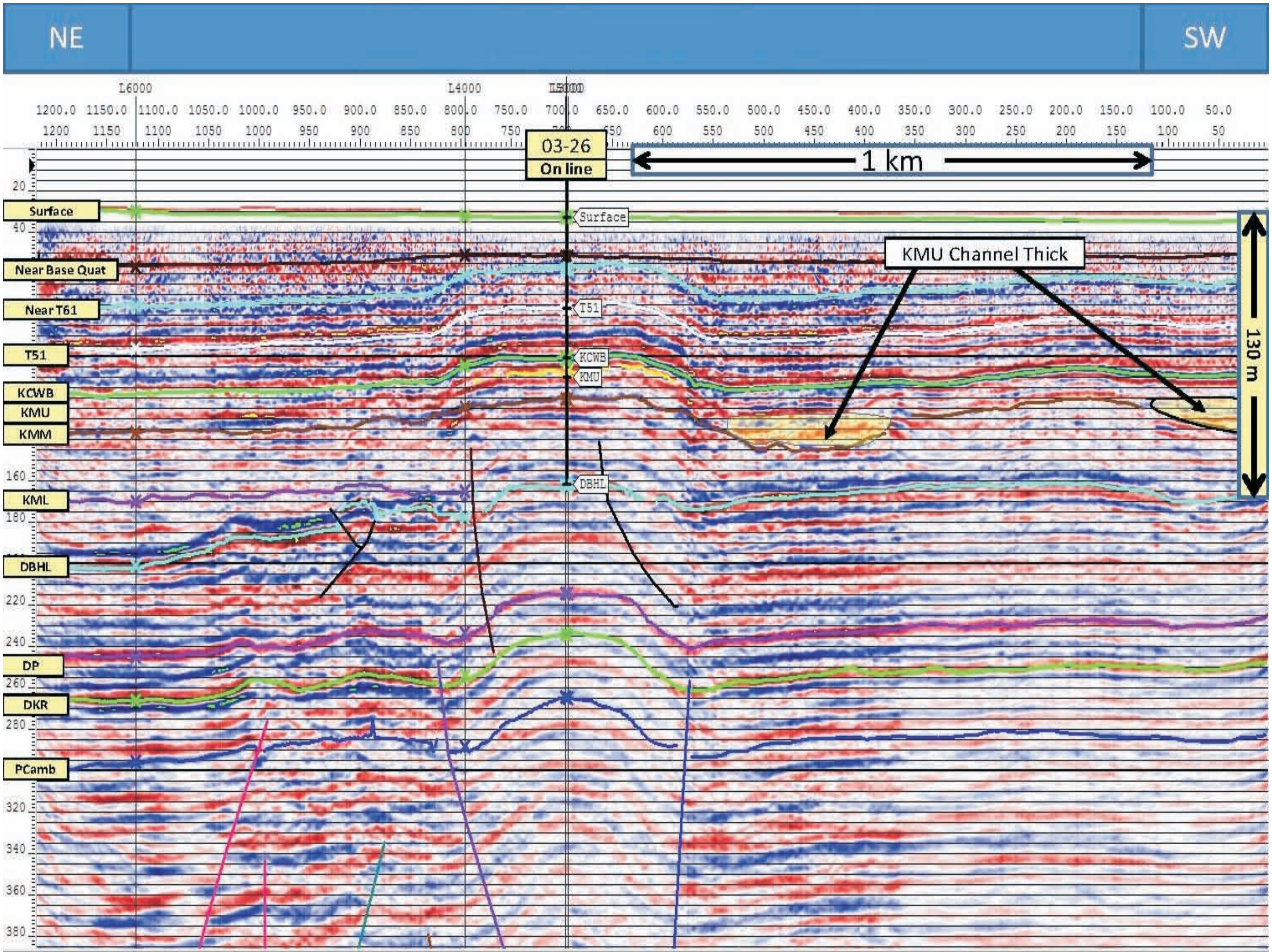

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Figure SIR2 F-9

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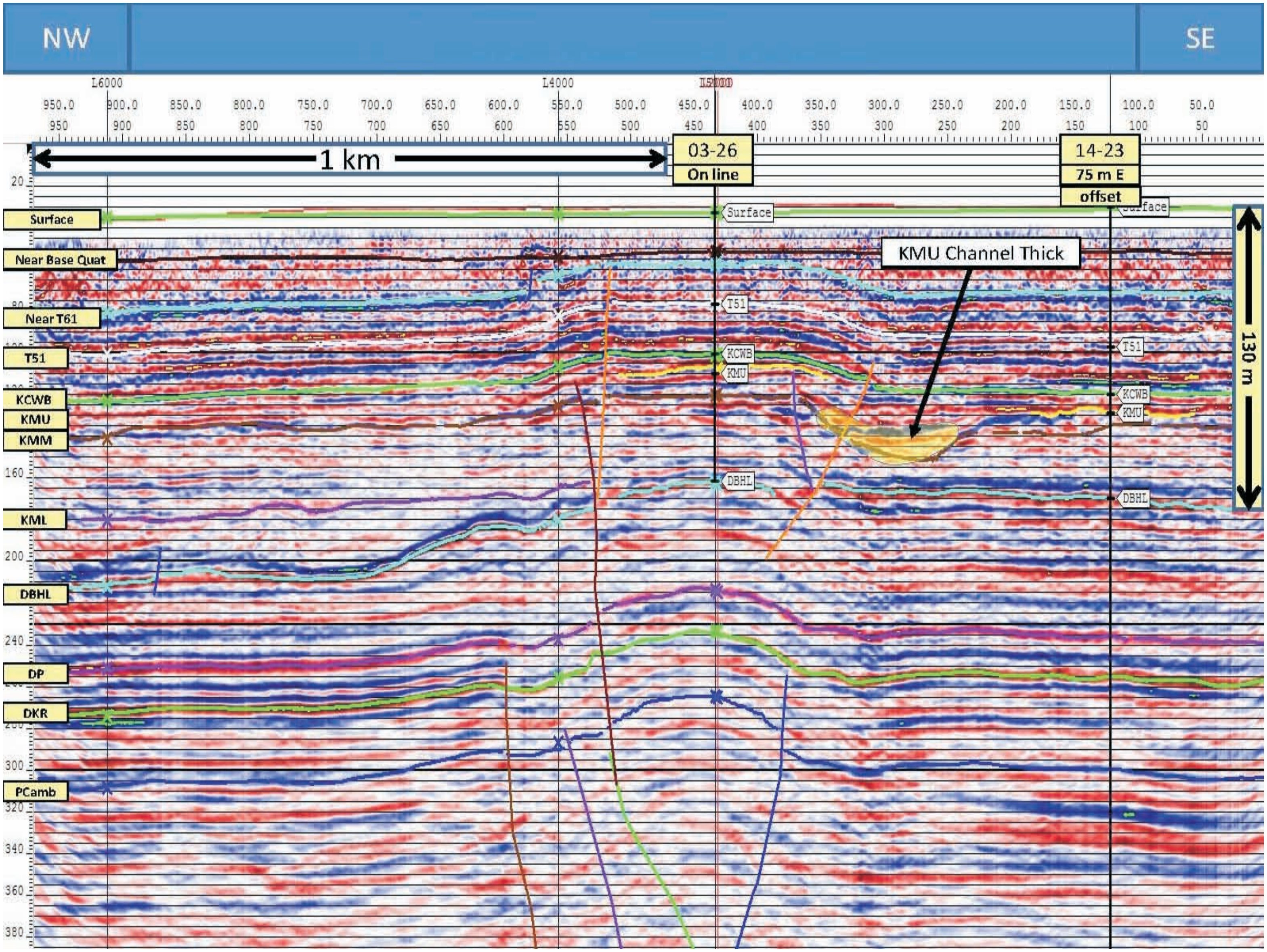

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Ivanhoe Energy
Tamarack Project

Interpreted Seismic Line 3

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ANALYST: TM; QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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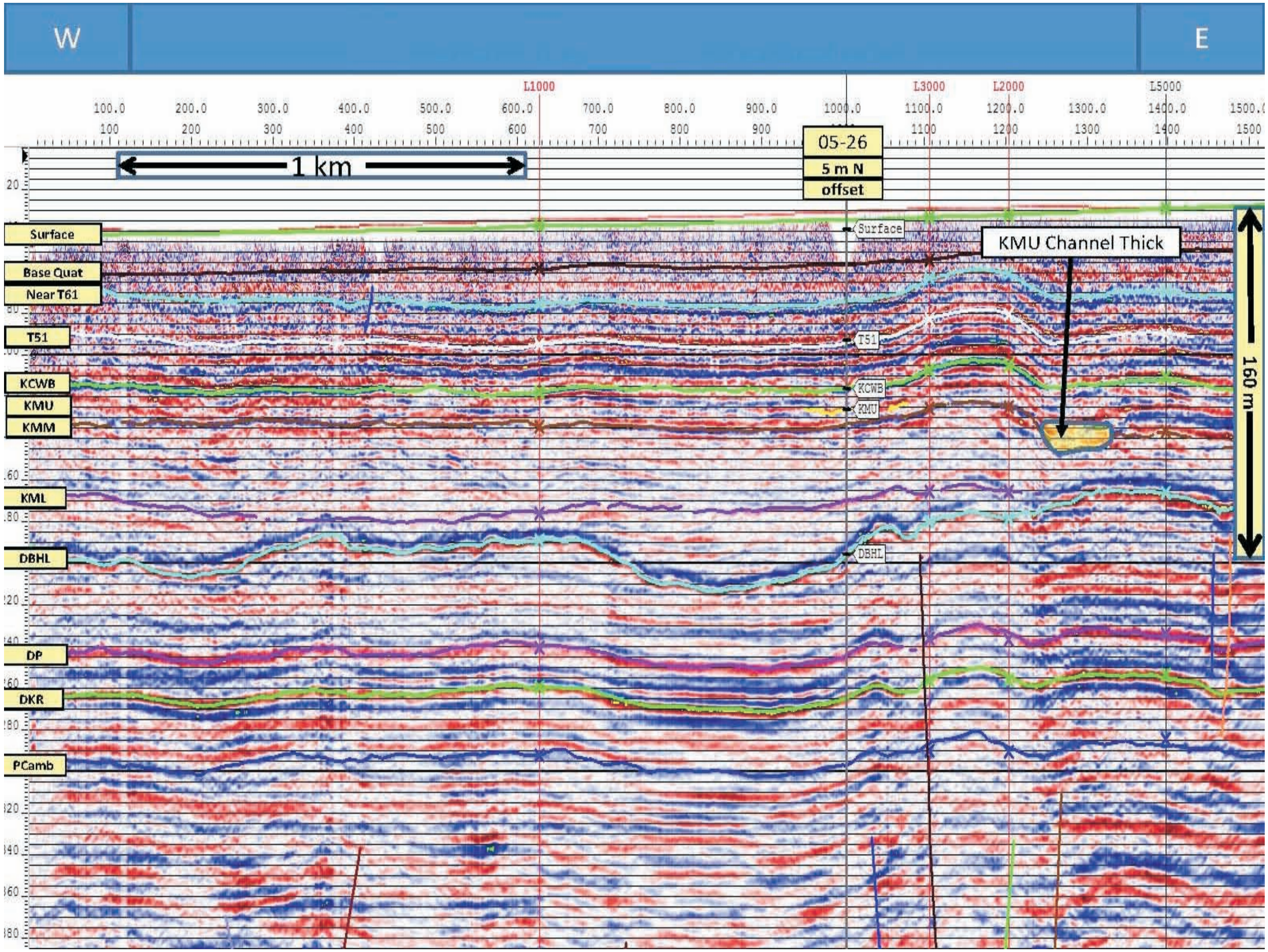

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Interpreted Seismic Line 4

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ANALYST: TM / QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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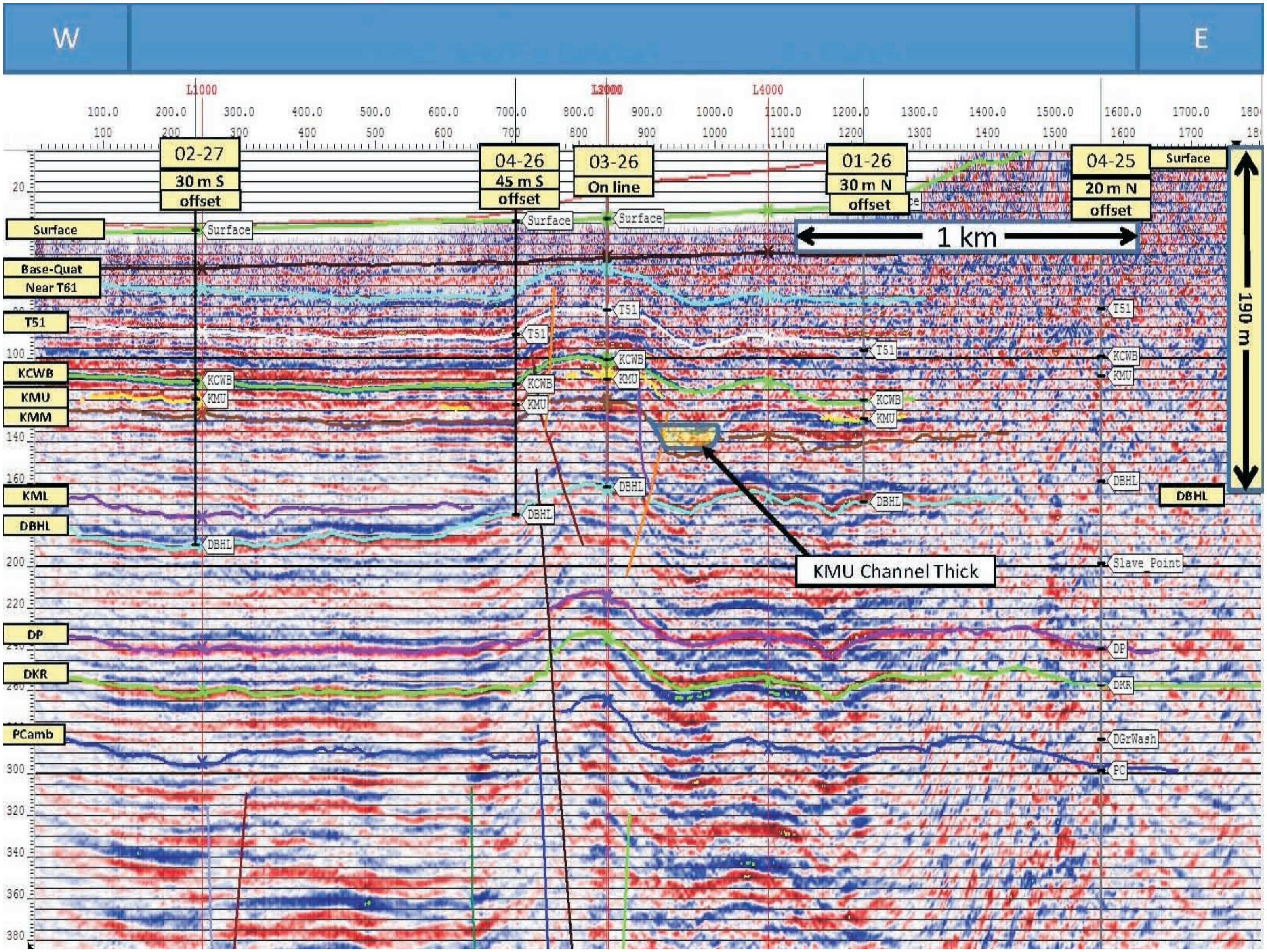

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Tamarack Project

Interpreted Seismic Line 5

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ANALYST: TM; QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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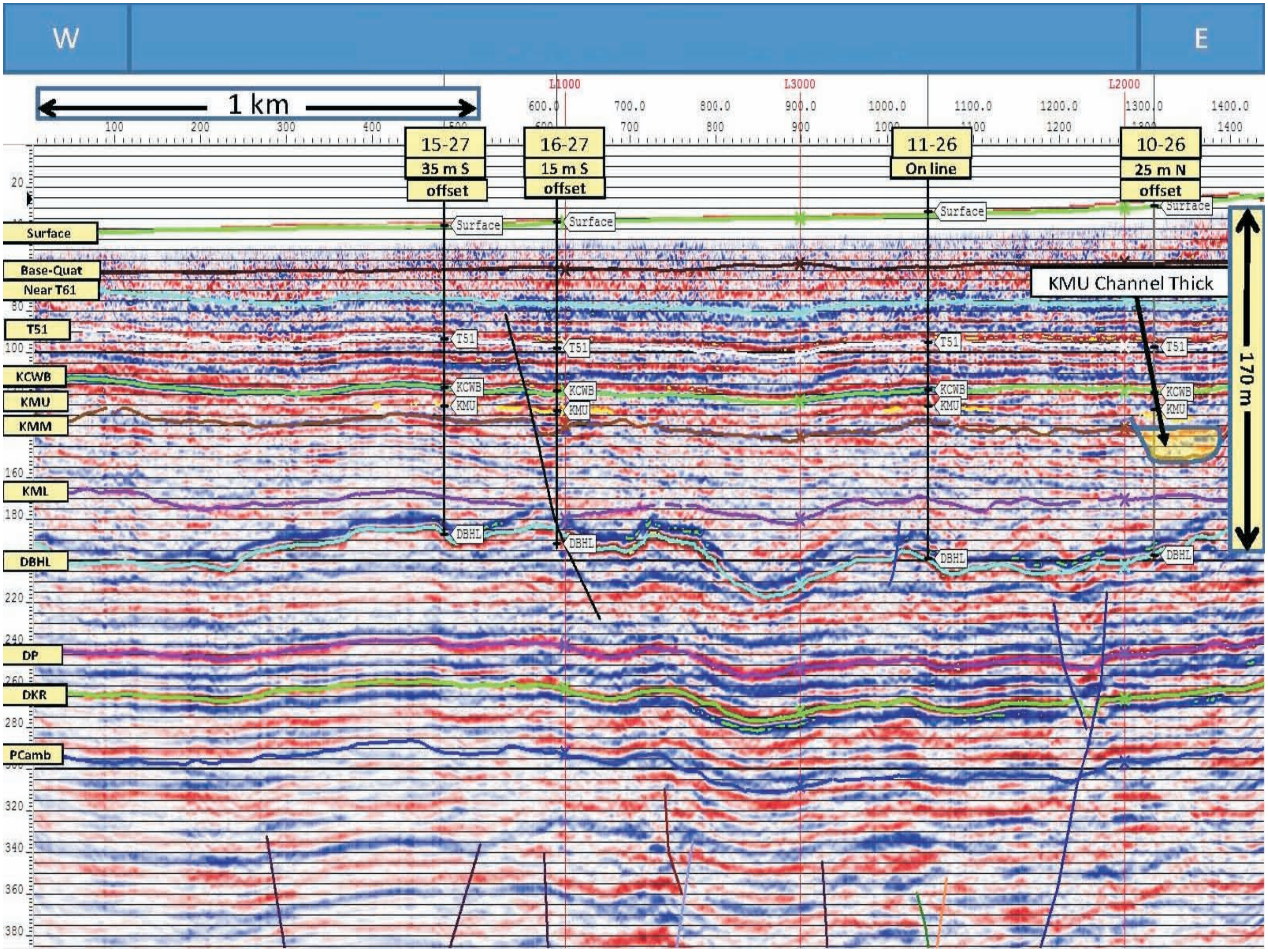

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Ivanhoe Energy
Tamarack Project

Interpreted Seismic Line 6

DATE: June 2012		SIR2-FigF-13 12-06-29	Figure SIR2 F-13
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ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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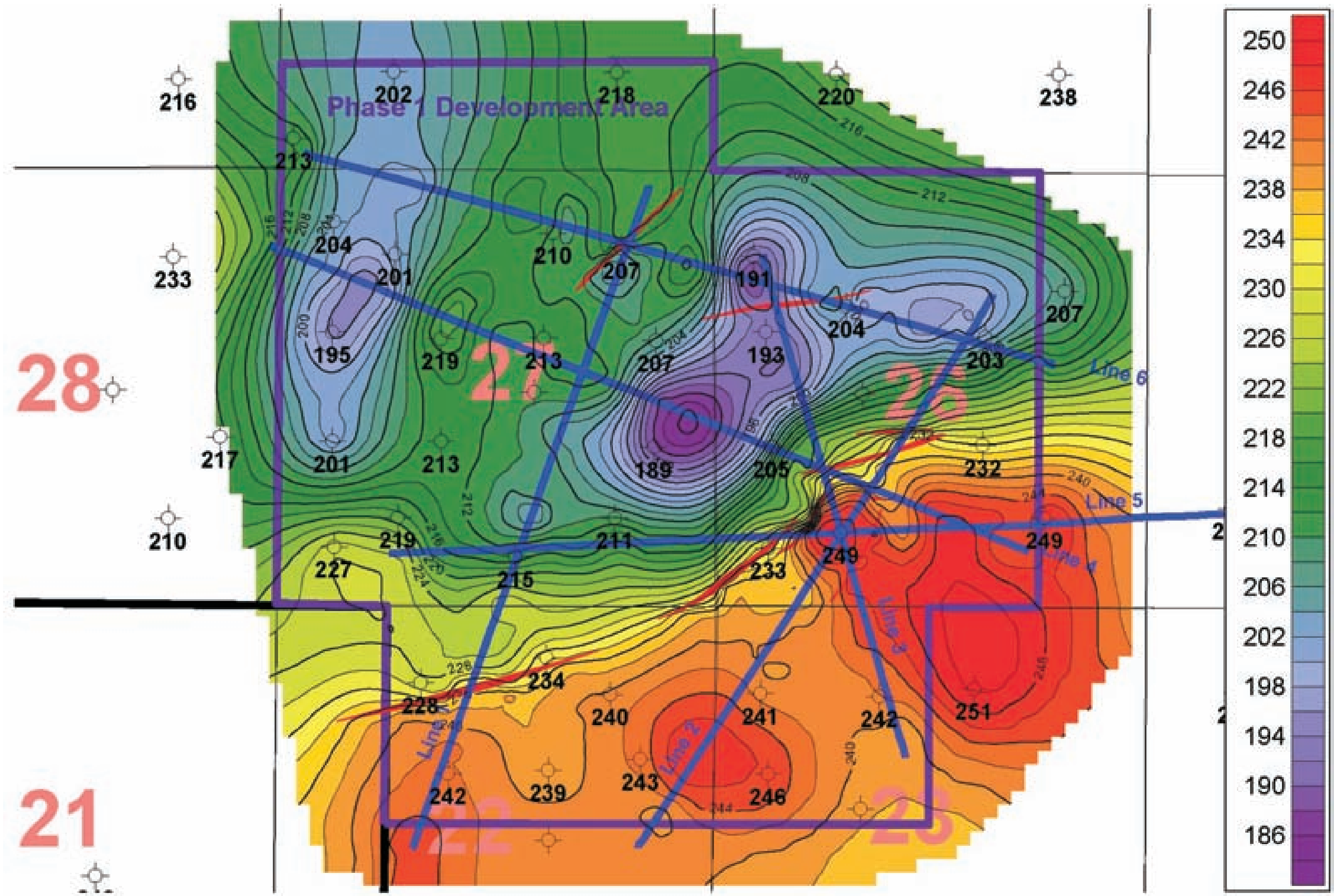

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Ivanhoe Energy
Tamarack Project

Top Devonian Depth Structure Map
MASL - CI: 2 meter

DATE: June 2012	SIR2-FigF-14 12-06-29		Figure SIR2 F-14
PROJECT: CE0374601	DRAWN BY: AMEC		
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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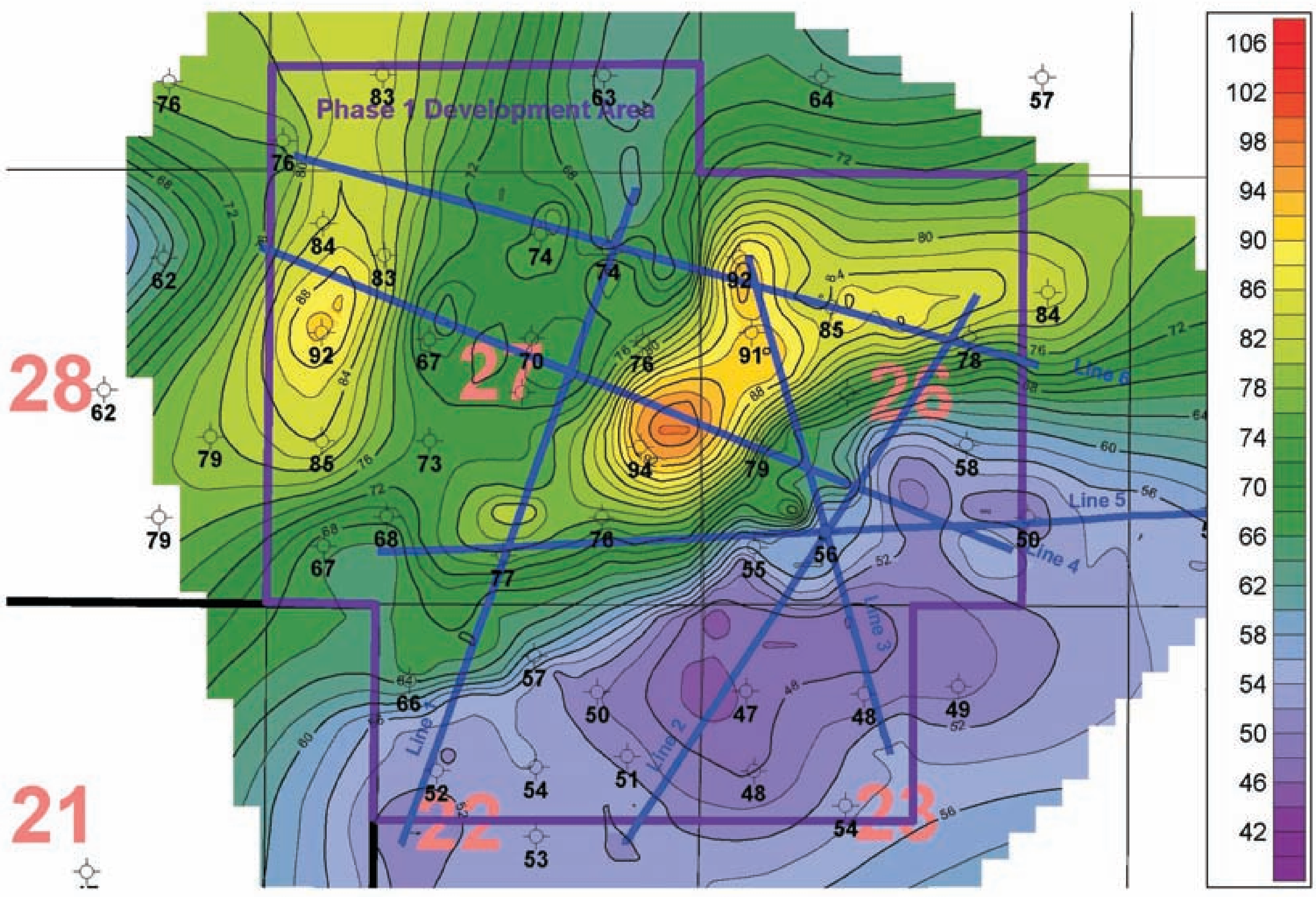

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Ivanhoe Energy Tamarack Project	Isopach Thickness Map McMurray Formation - meters - CI: 2 meter	DATE: June 2012	SIR2-FigF-15 12-06-29
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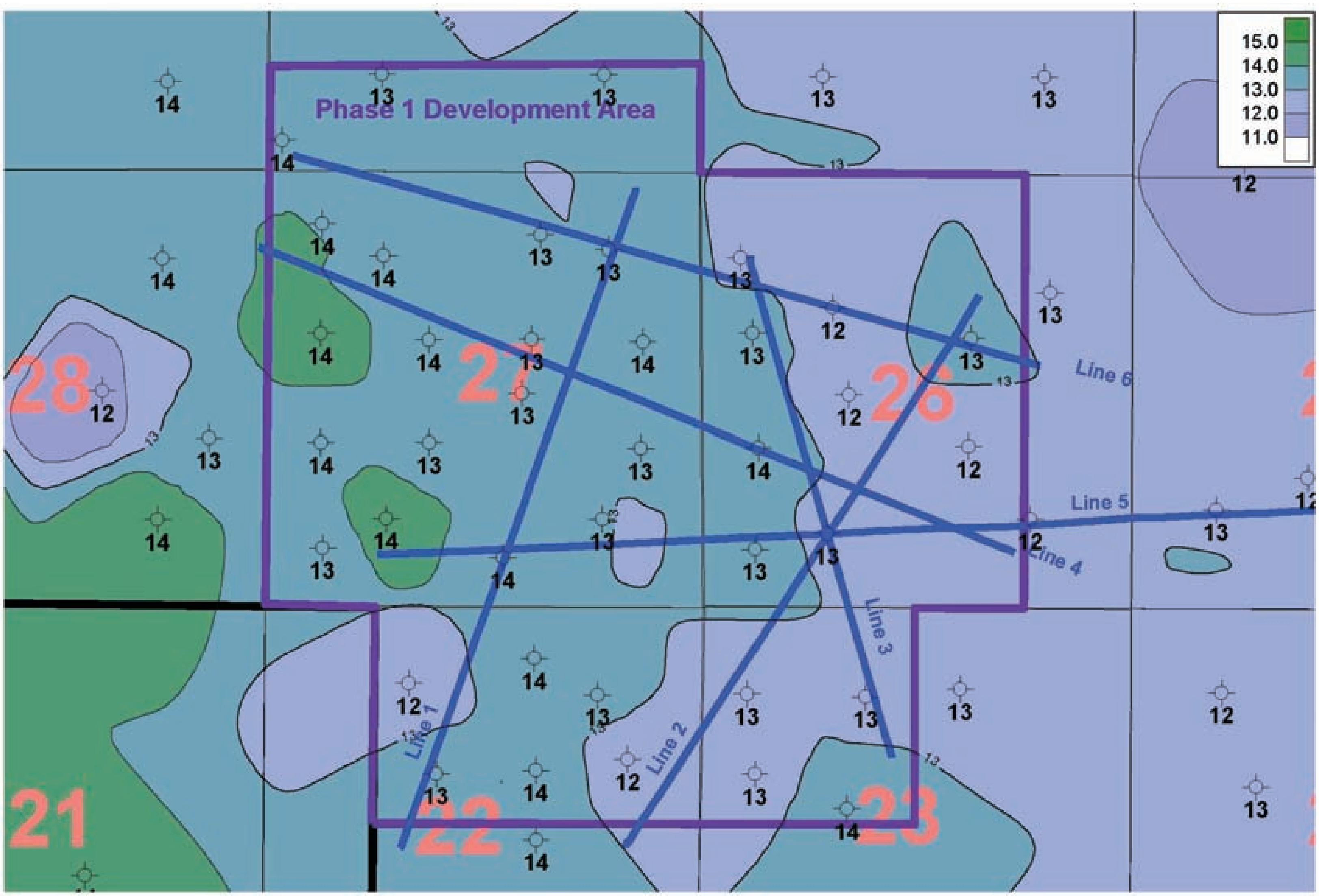
		ANALYST: TM / QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe

Figure SIR2 F-15



Source: Ivanhoe.

Ivanhoe Energy Tamarack Project	Isopach Thickness Map Wabiskaw Member - meters - CI: 1 meter	DATE: June 2012		SIR2-FigF-16 12-06-29	Figure SIR2 F-16
		PROJECT: CE0374601		DRAWN BY: AMEC	
		ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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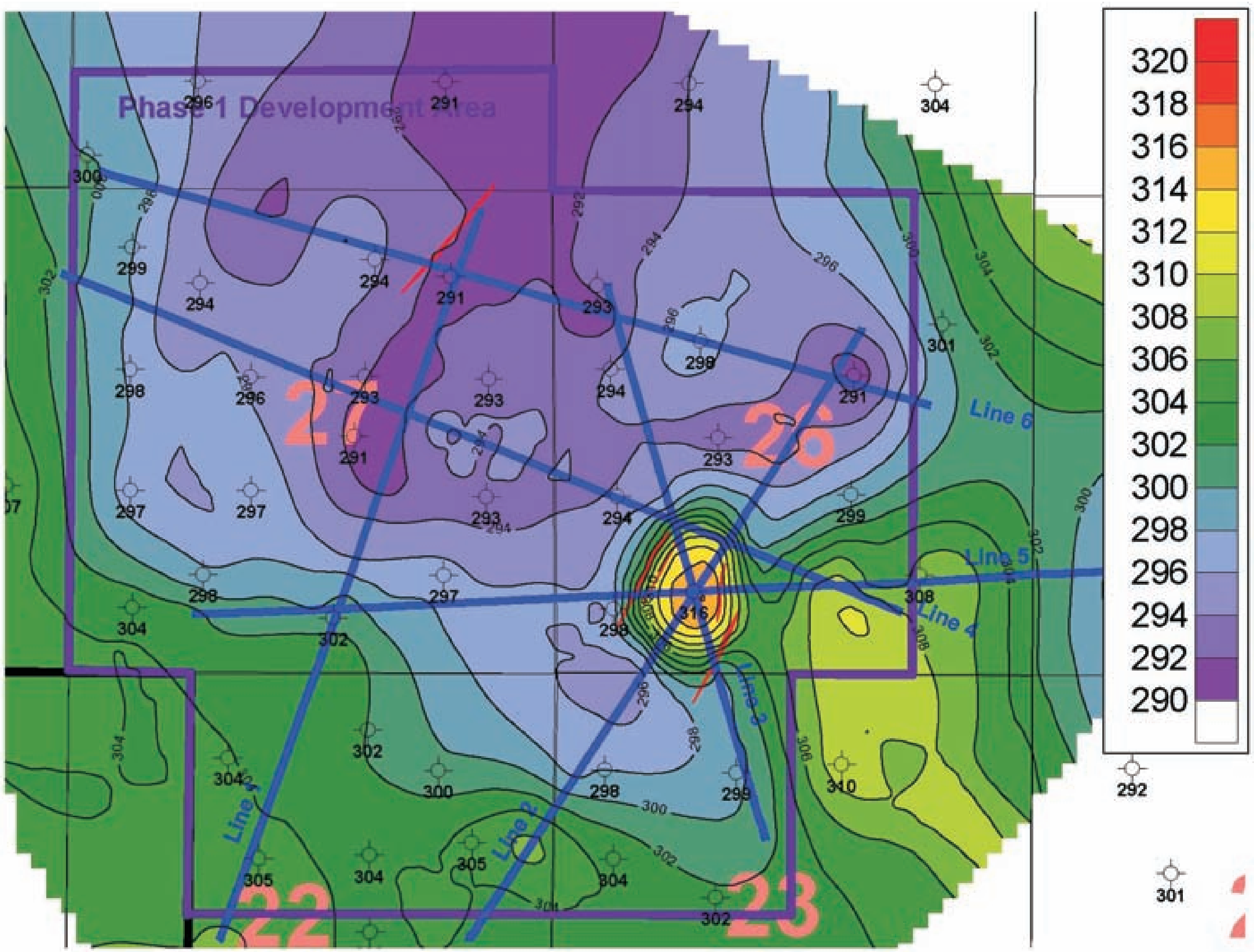

Source: Ivanhoe.

Ivanhoe Energy

Tamarack Project

Depth Structure Map
Top Wabiskaw B - MASL - CI: 2 meter

DATE: June 2012	SIR2-FigF-17 12-06-29
PROJECT: CE0374601	DRAWN BY: AMEC
ANALYST: TM; QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe

Figure SIR2 F-17

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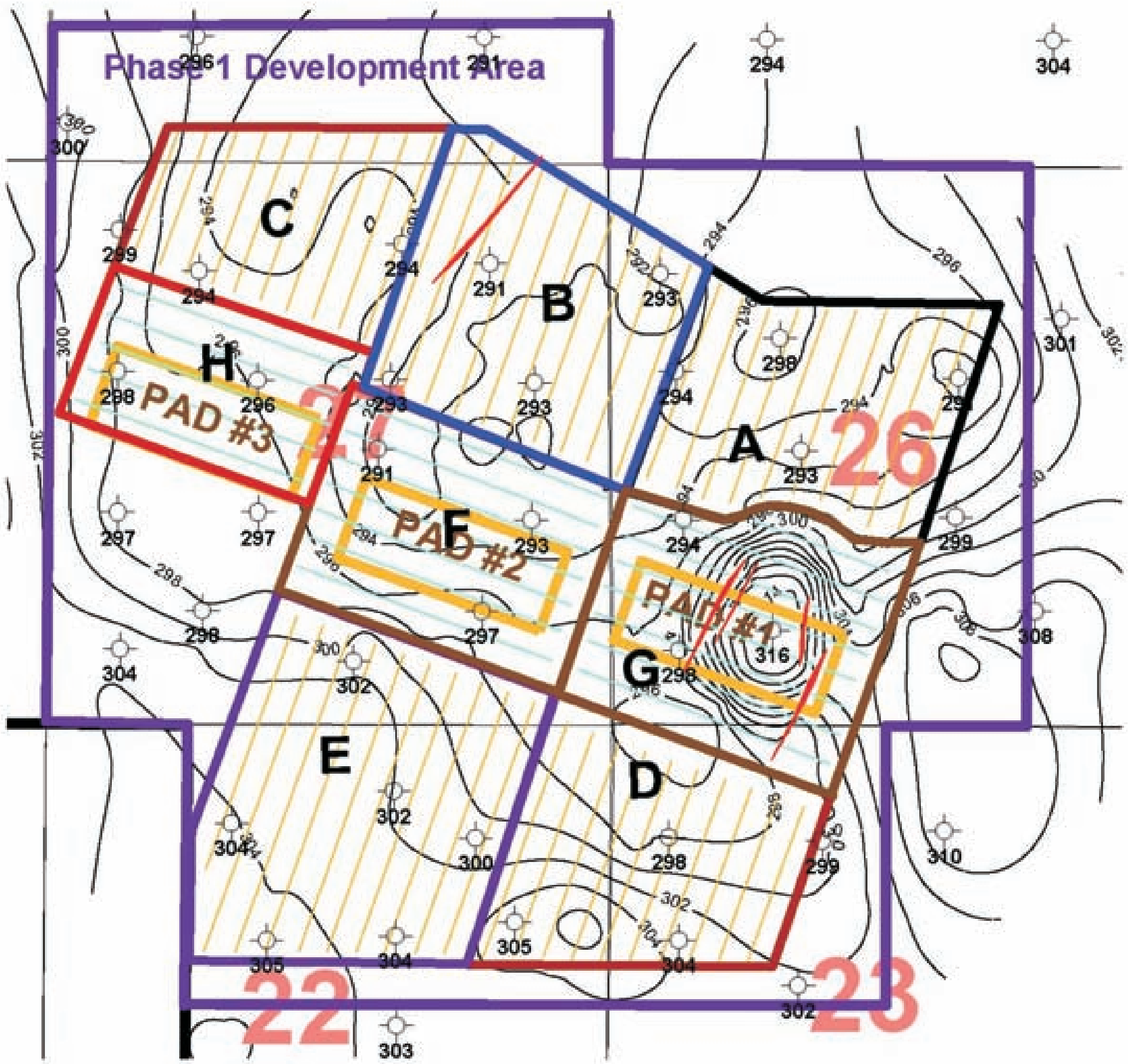

Source: Ivanhoe.

Ivanhoe Energy

Tamarack Project

Phase 1 Pattern, Pad, and SAGD Well Pair Locations, and Structure Contours at Top Wabiskaw B Cap Rock

DATE: June 2012	SIR2-FigF-18 12-06-29	Figure SIR2 F-18
PROJECT: CE0374601	DRAWN BY: AMEC	
ANALYST: TM; QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

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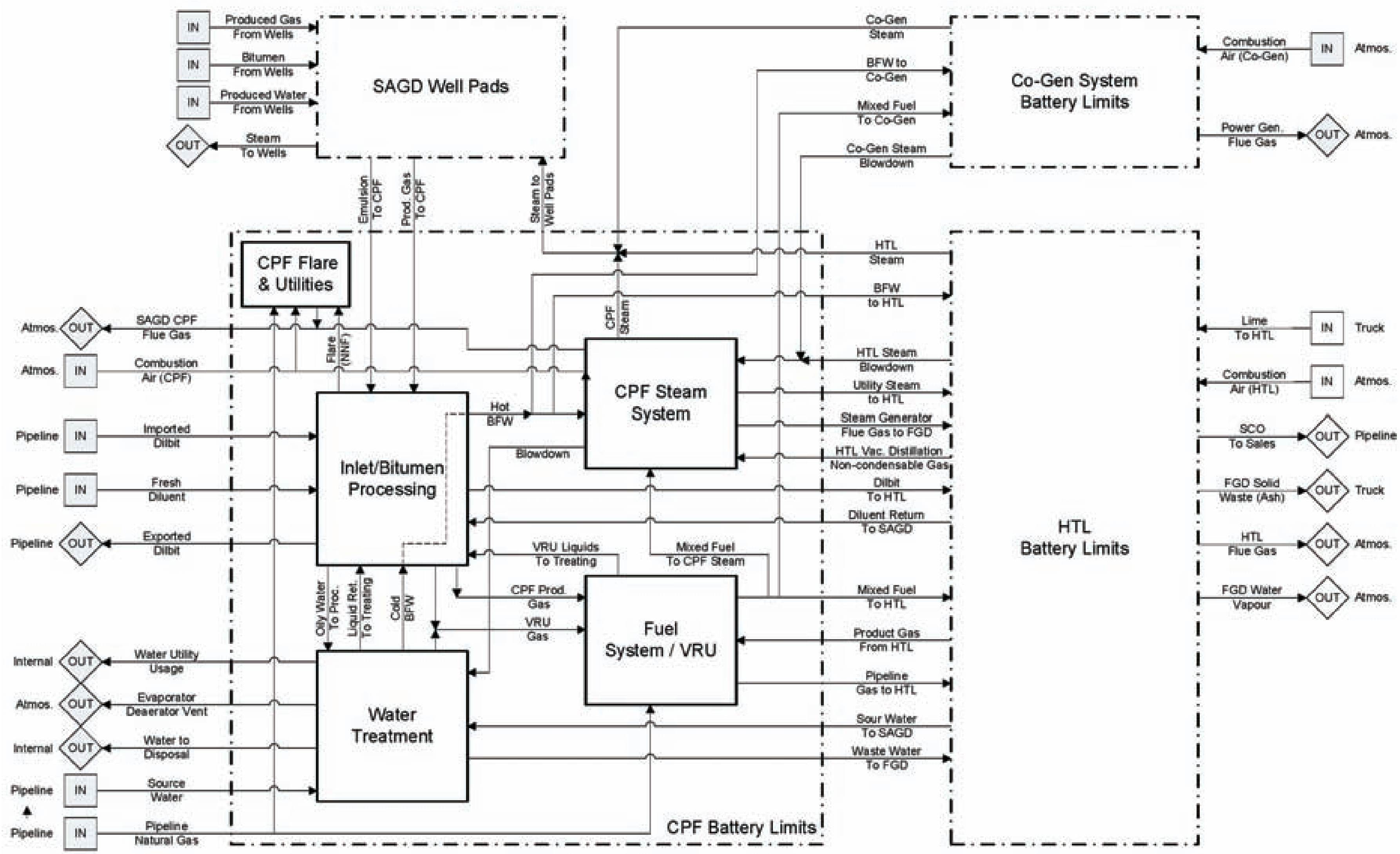
Ivanhoe Energy

Appendix SIR2 G

Block Flow Diagrams and Mass Balances



Source: Ivanhoe.

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Ivanhoe Energy

Tamarack Project

Mass Balance Diagram With HTL™

DATE: June 2012	SIR2-FigG-01 12-06-29
PROJECT: CE0374601	DRAWN BY: AMEC
ANALYST: TM / QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe

Figure SIR2 G-1

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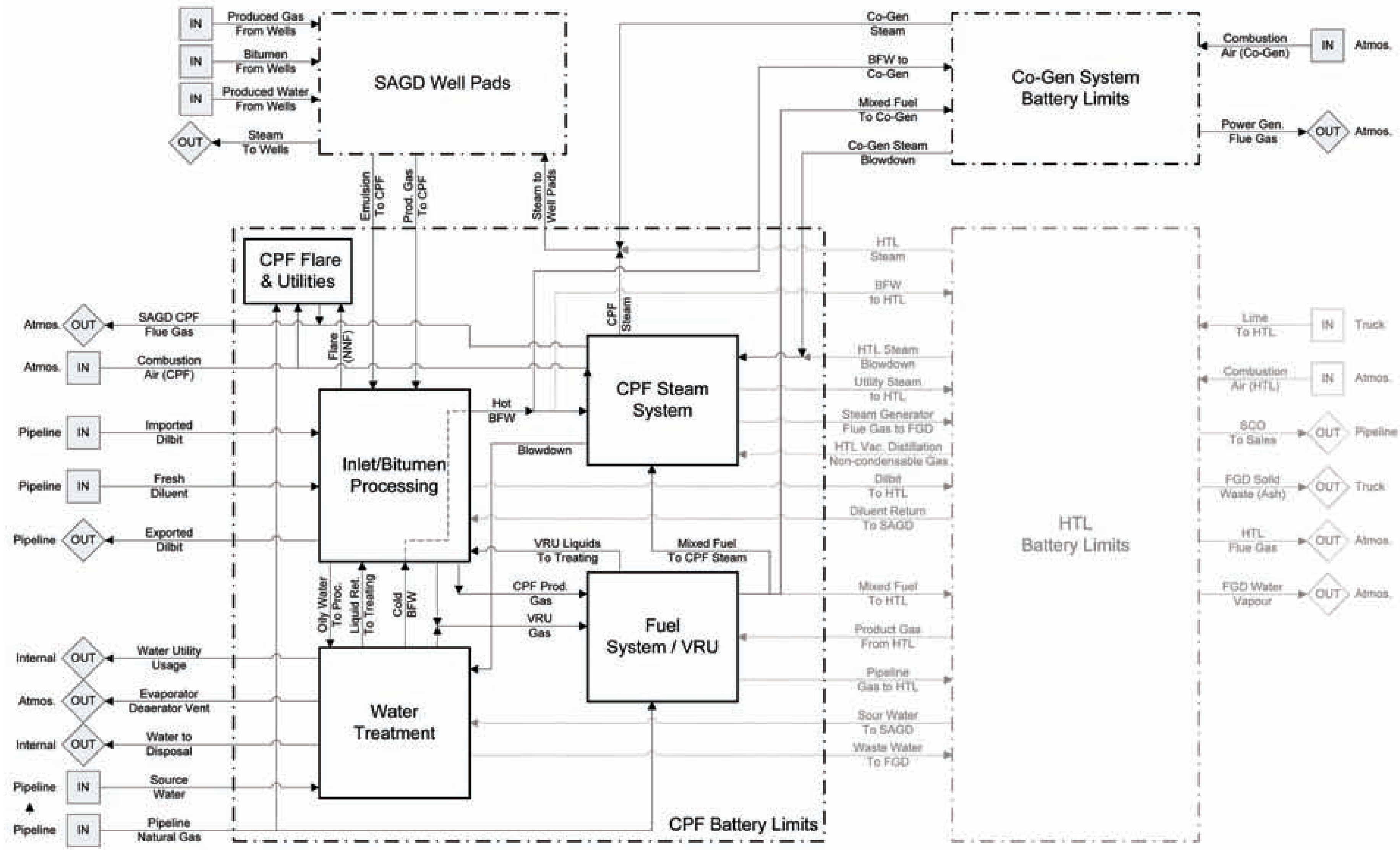

Source: Ivanhoe.

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Ivanhoe Energy
Tamarack Project

Mass Balance Diagram Without HTL™

DATE: June 2012		SIR2-FigG-02 12-06-29	Figure SIR2 G-2
PROJECT: CE0374601		DRAWN BY: AMEC	
ANALYST: TM	QA/QC: TJR MAJ EH	PREPARED BY: Ivanhoe	

Table SIR2 G-1: Tamarack Integrated Facility Water Mass Balance for SIR2 31b Phase 1 CPF Only (Years 1 to 3)

Stream	Stream Flow Mass (t/hr)	Volume (m^3/day)	Calendar Flow Mass (t/hr)	Volume (m^3/day)	Notes
Well Pads					
Produced Gas from Wells	0.0	0	0.0	0	
Bitumen from Wells	0.0	0	0.0	0	
Produced Water from Wells	343.6	8,263	326.4	7,850	Excludes dissolved solids
Steam to Wells	-361.7	-8,698	-343.6	-8,263	
Steam to Well Pads	361.7	8,698	343.6	8,263	
Emulsion to CPF	-335.8	-8,076	-319.0	-7,672	
Wet Produced Gas to CPF	-7.8	-187	-7.4	-178	
Check Balance	*-0.0*	*-0*	*0.0*	*0*	
Inlet/Bitumen Processing					
Emulsion to CPF	335.8	8,076	319.0	7,672	
Wet Produced Gas to CPF	7.8	187	7.4	178	
Imported Dilbit	0.0	0	0.0	0	
Exported Dilbit	-0.8	-19	-0.8	-18	
Fresh Diluent In	0.0	0	0.0	0	
Oily Water to Processing	-367.7	-8,842	-349.3	-8,400	
Produced Gas to Fuel System	-0.1	-4	-0.1	-3	
VRU Gas to VRU System	-0.2	-4	-0.2	-4	
Dilbit to HTL	0.0	0	0.0	0	
Diluent Return from HTL	0.0	0	0.0	0	
Cold BFW In for Heat Recovery	372.9	8,967	354.2	8,519	
Hot BFW Out	-372.9	-8,967	-354.2	-8,519	
Liquid Return from Water Treatment	25.0	600	23.7	570	
Liquid Return from VRU	0.2	5	0.2	5	
Relief and Vent to Flare	0.0	0	0.0	0	
Check Balance	*-0.0*	*-0*	*-0.0*	*-0*	
Water Treatment					
Oily Water to Processing	367.7	8,842	349.3	8,400	
Source Water In	44.0	1,057	41.8	1,004	Excludes dissolved solids
Utility Water Usage (CPF & HTL)	-9.0	-216	-8.6	-206	
Evaporator Deaerator Vent	-0.1	-2	-0.1	-2	
Water to Disposal	-15.8	-381	-15.0	-362	
VRU Gas to VRU System	-0.0	-1	-0.0	-1	
HTL Sour Water	0.0	0	0.0	0	
Waste Water to FGD	0.0	0	0.0	0	
Cold BFW Out	-372.9	-8,967	-354.2	-8,519	
Blowdown Return to Treatment	11.2	269	10.6	256	
Liquids Return to Bit. Processing	-25.0	-600	-23.7	-570	
Check Balance	*0.0*	*0*	*-0.0*	*-0*	
Fuel System/VRU					
VRU Gas from Oil/Water Proc.	0.2	5	0.2	5	
Produced Gas from Inlet/Oil Treat.	0.1	4	0.1	3	
HTL Produced Gas	0.0	0	0.0	0	
Mixed Fuel Out	-0.1	-4	-0.1	-3	
Pipeline Gas to HTL	0.0	0	0.0	0	Water in pipeline gas ignored
Pipeline Gas In	0.0	0	0.0	0	Water in pipeline gas ignored
Liquids Return to Bit Processing	-0.2	-5	-0.2	-5	
Check Balance	*0.0*	*0*	*0.0*	*0*	

Stream	Stream Flow Mass (t/hr)	Volume (m^3/day)	Calendar Flow Mass (t/hr)	Volume (m^3/day)	Notes
CPF Steam System					
Hot BFW to CPF Steam System	322.4	7,752	306.3	7,365	
Blowdown Return from Co-Gen/HTL	1.5	36	1.4	35	
Blowdown to Water Treatment	-11.2	-269	-10.6	-256	
Mixed Fuel to CPF Steam	0.1	2	0.1	2	
Vac. Distillation Non-Cond. Gas In	0.0	0	0.0	0	
Combustion Air to Steam Gens	0.0	0	0.0	0	Water vap. in comb. air ignored
Steam Gen Flue Gas to FGD	0.0	0	0.0	0	
Steam Gen Flue Gas to Atmosphere	-0.1	-2	-0.1	-2	All SG Flue Gas to FGD
Utility Steam to HTL	0.0	0	0.0	0	
CPF Steam Out to Wellpads	-312.7	-7,520	-297.1	-7,144	
Check Balance	*0.0*	*0*	*0.0*	*0*	
CPF Flare and Utilities					
Pipeline Gas to Util. and Flare Purge	0.0	0	0.0	0	Water in pipeline gas ignored
Vent and Relief Flare Flow	0.0	0	0.0	0	No flow in normal operation
Combustion Air In	0.0	0	0.0	0	Water vap. in comb. air ignored
Flue Gas to Atmosphere	0.0	0	0.0	0	
Check Balance	*0.0*	*0*	*0.0*	*0*	
Power Generation					
Mixed Fuel to Co-Gen	0.1	1	0.0	1	
Combustion Air (Power Gen.)	0.0	0	0.0	0	Water vap. in comb. air ignored
Power Gen. Flue Gas to Atmosphere	-0.1	-1	-0.0	-1	
BFW to Co-Gen	50.5	1,215	48.0	1,154	
Co-Gen Steam to Well Pads	-49.0	-1,178	-46.6	-1,119	
Co-Gen Blowdown Return	-1.5	-36	-1.4	-35	
Check Balance	*-0.0*	*-0*	*0.0*	*0*	
HTL Upgrader					
Lime to HTL	0.0	0	0.0	0	Moisture in lime ignored
Combustion & Lift Air to HTL	0.0	0	0.0	0	Water vap. in comb. air ignored
SCO to Sales	0.0	0	0.0	0	
FGD Solid Waste (Ash)	0.0	0	0.0	0	
HTL Flue Gas to Atmosphere	0.0	0	0.0	0	Combustion product water ignored
FGD Flue Water Vapour to Atmos.	0.0	0	0.0	0	
HTL Steam to Well Pads	0.0	0	0.0	0	
Utility Steam In	0.0	0	0.0	0	
BFW to HTL	0.0	0	0.0	0	
HTL Blowdown Return	0.0	0	0.0	0	
Steam Generator Flue Gas to FGD	0.0	0	0.0	0	
Vac. Distillation Non-Cond. Gas Out	0.0	0	0.0	0	
Dilbit to HTL	0.0	0	0.0	0	
Diluent Return to CPF	0.0	0	0.0	0	
Mixed Fuel to HTL	0.0	0	0.0	0	
HTL Product Gas to CPF	0.0	0	0.0	0	
Pipeline Gas to HTL	0.0	0	0.0	0	Water in pipeline gas ignored
HTL Produced Water to Treatment	0.0	0	0.0	0	
Waste Water from CPF to HTL	0.0	0	0.0	0	
Check Balance	*0.0*	*0*	*0.0*	*0*	

Note:
All water volumes are shown as liquid volume at standard conditions.

Table SIR2 G-2: Tamarack Integrated Facility Hydrocarbon Mass Balance for SIR2 31b Phase 1 CPF Only (Years 1 to 3)

Stream	Stream Flow Mass (t/hr)	Calendar Flow Mass (t/hr)	Notes
Well Pads			
Produced Gas from Wells	1.9	1.8	
Bitumen from Wells	140.7	133.7	
Produced Water from Wells	0.0	0.0	
Steam to Wells	0.0	0.0	
Steam to Well Pads	0.0	0.0	
Emulsion to CPF	-138.6	-131.7	
Wet Produced Gas to CPF	-4.0	-3.8	
Check Balance	*0.0*	*0.0*	
Inlet/Bitumen Processing			
Emulsion to CPF	138.6	131.7	
Wet Produced Gas to CPF	4.0	3.8	
Imported Dilbit	0.0	0.0	
Exported Dilbit	-157.7	-149.8	
Fresh Diluent In	17.0	16.2	
Oily Water to Processing	-0.6	-0.6	
Produced Gas to Fuel System	-1.8	-1.7	
VRU Gas to VRU System	-2.0	-1.9	
Dilbit to HTL	0.0	0.0	
Diluent Return from HTL	0.0	0.0	
Cold BFW In for Heat Recovery	0.0	0.0	
Hot BFW Out	0.0	0.0	
Liquid Return from Water Treatment	0.5	0.5	
Liquid Return from VRU	2.0	1.9	
Relief and Vent to Flare	0.0	0.0	
Check Balance	*0.0*	*0.0*	
Water Treatment			
Oily Water to Processing	0.6	0.6	
Source Water In	0.0	0.0	
Utility Water Usage (CPF & HTL)	0.0	0.0	
Evaporator Deaerator Vent	0.0	0.0	
Water to Disposal	0.0	0.0	
VRU Gas to VRU System	-0.1	-0.1	
HTL Sour Water	0.0	0.0	
Waste Water to FGD	0.0	0.0	
Cold BFW Out	0.0	0.0	
Blowdown Return to Treatment	0.0	0.0	
Liquids Return to Bit. Processing	-0.5	-0.5	
Check Balance	*0.0*	*0.0*	
Fuel System/VRU			
VRU Gas from Oil/Water Proc.	2.1	2.0	
Produced Gas from Inlet/Oil Treat.	1.8	1.7	
HTL Produced Gas	0.0	0.0	
Mixed Fuel Out	-20.0	-19.0	
Pipeline Gas to HTL	0.0	0.0	
Pipeline Gas In	18.1	17.2	
Liquids Return to Bit Processing	-2.0	-1.9	
Check Balance	*0.0*	*0.0*	

Stream	Stream Flow Mass (t/hr)	Calendar Flow Mass (t/hr)	Notes
CPF Steam System			
Hot BFW to CPF Steam System	0.0	0.0	
Blowdown Return from Co-Gen/HTL	0.0	0.0	
Blowdown to Water Treatment	0.0	0.0	
Mixed Fuel to CPF Steam	13.0	12.4	
Vac. Distillation Non-Cond. Gas In	0.0	0.0	
Combustion Air to Steam Gens	0.0	0.0	
Steam Gen Flue Gas to FGD	0.0	0.0	Combusted hydrocarbon mass
Steam Gen Flue Gas to Atmosphere	-13.0	-12.4	All SG flue gas to FGD
Utility Steam to HTL	0.0	0.0	
CPF Steam Out to Wellpads	0.0	0.0	
Check Balance	*0.0*	*0.0*	
CPF Flare and Utilities			
Pipeline Gas to Util. and Flare Purge	0.5	0.5	
Vent and Relief Flare Flow	0.0	0.0	
Combustion Air In	8.6	8.2	
Flue Gas to Atmosphere	-9.1	-8.6	Combusted hydrocarbon mass
Check Balance	*0.0*	*0.0*	
Power Generation			
Mixed Fuel to Co-Gen	7.0	6.6	
Combustion Air (Power Gen.)	0.0	0.0	
Power Gen. Flue Gas to Atmosphere	-7.0	-6.6	Combusted hydrocarbon mass
BFW to Co-Gen	0.0	0.0	
Co-Gen Steam to Well Pads	0.0	0.0	
Co-Gen Blowdown Return	0.0	0.0	
Check Balance	*0.0*	*0.0*	
HTL Upgrader			
Lime to HTL	0.0	0.0	
Combustion & Lift Air to HTL	0.0	0.0	
SCO to Sales	0.0	0.0	
FGD Solid Waste (Ash)	0.0	0.0	HC combustion products to ash (SO_x etc.)
HTL Flue Gas to Atmosphere	0.0	0.0	Includes reheater, heaters, & flare pilot combusted HC mass
FGD Flue Water Vapour to Atmos.	0.0	0.0	
HTL Steam to Well Pads	0.0	0.0	
Utility Steam In	0.0	0.0	
BFW to HTL	0.0	0.0	
HTL Blowdown Return	0.0	0.0	
Steam Generator Flue Gas to FGD	0.0	0.0	
Vac. Distillation Non-Cond. Gas Out	0.0	0.0	
Dilbit to HTL	0.0	0.0	
Diluent Return to CPF	0.0	0.0	
Mixed Fuel to HTL	0.0	0.0	
HTL Product Gas to CPF	0.0	0.0	
Pipeline Gas to HTL	0.0	0.0	
HTL Produced Water to Treatment	0.0	0.0	
Waste Water from CPF to HTL	0.0	0.0	
Check Balance	*0.0*	*0.0*	

Note:
Volume balance not shown for hydrocarbons as varying phases (vapour/liquid) and densities will produce balance.

Table SIR2 G-3: Tamarack Integrated Facility Water Mass Balance for SIR2 31b Phase 1 CPF and HTL™ (Years 4)

Stream	Stream Flow Mass (t/hr)	Volume (m^3/day)	Calendar Flow Mass (t/hr)	Volume (m^3/day)	Notes
Well Pads					
Produced Gas from Wells	0.0	0	0.0	0	
Bitumen from Wells	0.0	0	0.0	0	
Produced Water from Wells	343.6	8,263	326.4	7,850	Excludes dissolved solids
Steam to Wells	-361.7	-8,698	-343.6	-8,263	
Steam to Well Pads	361.7	8,698	343.6	8,263	
Emulsion to CPF	-335.8	-8,076	-319.0	-7,672	
Wet Produced Gas to CPF	-7.8	-187	-7.4	-178	
Check Balance	*-0.0*	*-0*	*0.0*	*0*	
Inlet/Bitumen Processing					
Emulsion to CPF	335.8	8,076	319.0	7,672	
Wet Produced Gas to CPF	7.8	187	7.4	178	
Imported Dilbit	0.0	0	0.0	0	
Exported Dilbit	0.0	0	0.0	0	
Fresh Diluent In	0.0	0	0.0	0	
Oily Water to Processing	-367.7	-8,842	-349.3	-8,400	
Produced Gas to Fuel System	-0.0	-1	-0.0	-1	
VRU Gas to VRU System	-0.1	-2	-0.1	-2	
Dilbit to HTL	-0.8	-19	-0.8	-18	
Diluent Return from HTL	0.0	0	0.0	0	
Cold BFW In for Heat Recovery	401.8	9,663	381.7	9,180	
Hot BFW Out	-401.8	-9,663	-381.7	-9,180	
Liquid Return from Water Treatment	24.9	598	23.6	568	
Liquid Return from VRU	0.1	3	0.1	3	
Relief and Vent to Flare	0.0	0	0.0	0	
Check Balance	*-0.0*	*-0*	*-0.0*	*-0*	
Water Treatment					
Oily Water to Processing	367.7	8,842	349.3	8,400	
Source Water In	53.5	1,288	50.9	1,223	Excludes dissolved solids
Utility Water Usage (CPF & HTL)	-9.0	-216	-8.6	-206	
Evaporator Deaerator Vent	-0.1	-2	-0.1	-2	
Water to Disposal	0.0	0	0.0	0	
VRU Gas to VRU System	-0.0	-0	-0.0	-0	
HTL Sour Water	23.1	556	21.9	528	
Waste Water to FGD	-20.0	-481	-19.0	-457	
Cold BFW Out	-401.8	-9,663	-381.7	-9,180	
Blowdown Return to Treatment	11.5	276	10.9	262	
Liquids Return to Bit. Processing	-24.9	-598	-23.6	-568	
Check Balance	*-0.0*	*-0*	*-0.0*	*0*	
Fuel System/VRU					
VRU Gas from Oil/Water Proc.	0.1	3	0.1	3	
Produced Gas from Inlet/Oil Treat.	0.0	1	0.0	1	
HTL Produced Gas	0.3	7	0.3	6	
Mixed Fuel Out	-0.3	-7	-0.3	-7	
Pipeline Gas to HTL	0.0	0	0.0	0	Water in pipeline gas ignored
Pipeline Gas In	0.0	0	0.0	0	Water in pipeline gas ignored
Liquids Return to Bit Processing	-0.1	-3	-0.1	-3	
Check Balance	*-0.0*	*-0*	*-0.0*	*-0*	

Stream	Stream Flow Mass (t/hr)	Volume (m^3/day)	Calendar Flow Mass (t/hr)	Volume (m^3/day)	Notes
CPF Steam System					
Hot BFW to CPF Steam System	59.7	1,436	56.7	1,364	
Blowdown Return from Co-Gen/HTL	9.7	233	9.2	221	
Blowdown to Water Treatment	-11.5	-276	-10.9	-262	
Mixed Fuel to CPF Steam	0.1	2	0.1	2	
Vac. Distillation Non-Cond. Gas In	0.0	1	0.0	1	
Combustion Air to Steam Gens	0.0	0	0.0	0	Water vap. in comb. air ignored
Steam Gen Flue Gas to FGD	-0.1	-2	-0.1	-2	
Steam Gen Flue Gas to Atmosphere	0.0	0	0.0	0	All SG flue gas to FGD
Utility Steam to HTL	-1.5	-36	-1.4	-34	
CPF Steam Out to Wellpads	-56.4	-1,357	-53.6	-1,290	
Check Balance	*0.0*	*0*	*0.0*	*0*	
CPF Flare and Utilities					
Pipeline Gas to Util. and Flare Purge	0.0	0	0.0	0	Water in pipeline gas ignored
Vent and Relief Flare Flow	0.0	0	0.0	0	No flow in normal operation
Combustion Air In	0.0	0	0.0	0	Water vap. in comb. air ignored
Flue Gas to Atmosphere	0.0	0	0.0	0	
Check Balance	*0.0*	*0*	*0.0*	*0*	
Power Generation					
Mixed Fuel to Co-Gen	0.2	4	0.2	4	
Combustion Air (Power Gen.)	0.0	0	0.0	0	Water vap. in comb. air ignored
Power Gen. Flue Gas to Atmosphere	-0.2	-4	-0.2	-4	
BFW to Co-Gen	101.0	2,430	96.0	2,308	
Co-Gen Steam to Well Pads	-98.0	-2,357	-93.1	-2,239	
Co-Gen Blowdown Return	-3.0	-73	-2.9	-69	
Check Balance	*-0.0*	*-0*	*0.0*	*0*	
HTL Upgrader					
Lime to HTL	0.0	0	0.0	0	Moisture in lime ignored
Combustion & Lift Air to HTL	0.0	0	0.0	0	Water vap. in comb. air ignored
SCO to Sales	0.0	0	0.0	0	
FGD Solid Waste (Ash)	0.0	0	0.0	0	
HTL Flue Gas to Atmosphere	0.0	0	0.0	0	Combustion product water ignored
FGD Flue Water Vapour to Atmos.	-26.2	-630	-24.9	-598	
HTL Steam to Well Pads	-207.3	-4,984	-196.9	-4,735	
Utility Steam In	1.5	36	1.4	34	
BFW to HTL	241.1	5,797	229.0	5,507	
HTL Blowdown Return	-6.7	-160	-6.3	-152	
Steam Generator Flue Gas to FGD	0.1	2	0.1	2	
Vac. Distillation Non-Cond. Gas Out	-0.0	-1	-0.0	-1	
Dilbit to HTL	0.8	19	0.8	18	
Diluent Return to CPF	0.0	0	0.0	0	
Mixed Fuel to HTL	0.1	2	0.1	2	
HTL Product Gas to CPF	-0.3	-7	-0.3	-6	
Pipeline Gas to HTL	0.0	0	0.0	0	Water in pipeline gas ignored
HTL Produced Water to Treatment	-23.1	-556	-21.9	-528	
Waste Water from CPF to HTL	20.0	481	19.0	457	
Check Balance	*-0.0*	*-0*	*0.0*	*-0*	

Note:
All water volumes are shown as liquid volume at standard conditions.

Table SIR2 G-4: Tamarack Integrated Facility Hydrocarbon Mass Balance for SIR2 31b Phase 1 CPF and HTL™ (Years 4)

Stream	Stream Flow Mass (t/hr)	Calendar Flow Mass (t/hr)	Notes
Well Pads			
Produced Gas from Wells	1.9	1.8	
Bitumen from Wells	140.7	133.7	
Produced Water from Wells	0.0	0.0	
Steam to Wells	0.0	0.0	
Steam to Well Pads	0.0	0.0	
Emulsion to CPF	-138.6	-131.7	
Wet Produced Gas to CPF	-4.0	-3.8	
Check Balance	*0.0*	*0.0*	
Inlet/Bitumen Processing			
Emulsion to CPF	138.6	131.7	
Wet Produced Gas to CPF	4.0	3.8	
Imported Dilbit	0.0	0.0	
Exported Dilbit	0.0	0.0	
Fresh Diluent In	0.3	0.3	
Oily Water to Processing	-0.6	-0.6	
Produced Gas to Fuel System	-1.9	-1.8	
VRU Gas to VRU System	-0.7	-0.7	
Dilbit to HTL	-161.2	-153.1	
Diluent Return from HTL	20.2	19.2	
Cold BFW In for Heat Recovery	0.0	0.0	
Hot BFW Out	0.0	0.0	
Liquid Return from Water Treatment	0.6	0.6	
Liquid Return from VRU	0.7	0.7	
Relief and Vent to Flare	0.0	0.0	
Check Balance	*0.0*	*-0.0*	
Water Treatment			
Oily Water to Processing	0.6	0.6	
Source Water In	0.0	0.0	
Utility Water Usage (CPF & HTL)	0.0	0.0	
Evaporator Deaerator Vent	0.0	0.0	
Water to Disposal	0.0	0.0	
VRU Gas to VRU System	-0.0	-0.0	
HTL Sour Water	0.0	0.0	
Waste Water to FGD	0.0	0.0	
Cold BFW Out	0.0	0.0	
Blowdown Return to Treatment	0.0	0.0	
Liquids Return to Bit. Processing	-0.6	-0.6	
Check Balance	*0.0*	*0.0*	
Fuel System/VRU			
VRU Gas from Oil/Water Proc.	0.7	0.7	
Produced Gas from Inlet/Oil Treat.	1.9	1.8	
HTL Produced Gas	9.7	9.2	
Mixed Fuel Out	-20.1	-19.1	
Pipeline Gas to HTL	-0.1	-0.0	
Pipeline Gas In	8.6	8.2	
Liquids Return to Bit Processing	-0.7	-0.7	
Check Balance	*0.0*	*0.0*	

Stream	Stream Flow Mass (t/hr)	Calendar Flow Mass (t/hr)	Notes
CPF Steam System			
Hot BFW to CPF Steam System	0.0	0.0	
Blowdown Return from Co-Gen/HTL	0.0	0.0	
Blowdown to Water Treatment	0.0	0.0	
Mixed Fuel to CPF Steam	2.7	2.5	
Vac. Distillation Non-Cond. Gas In	0.5	0.5	
Combustion Air to Steam Gens	0.0	0.0	
Steam Gen Flue Gas to FGD	-3.2	-3.0	Combusted hydrocarbon mass
Steam Gen Flue Gas to Atmosphere	0.0	0.0	All SG flue gas to FGD
Utility Steam to HTL	0.0	0.0	
CPF Steam Out to Wellpads	0.0	0.0	
Check Balance	*0.0*	*-0.0*	
CPF Flare and Utilities			
Pipeline Gas to Util. and Flare Purge	0.5	0.5	
Vent and Relief Flare Flow	0.0	0.0	
Combustion Air In	0.0	0.0	
Flue Gas to Atmosphere	-0.5	-0.5	Combusted hydrocarbon mass
Check Balance	*0.0*	*0.0*	
Power Generation			
Mixed Fuel to Co-Gen	14.9	14.2	
Combustion Air (Power Gen.)	0.0	0.0	
Power Gen. Flue Gas to Atmosphere	-14.9	-14.2	Combusted hydrocarbon mass
BFW to Co-Gen	0.0	0.0	
Co-Gen Steam to Well Pads	0.0	0.0	
Co-Gen Blowdown Return	0.0	0.0	
Check Balance	*0.0*	*0.0*	
HTL Upgrader			
Lime to HTL	0.0	0.0	
Combustion & Lift Air to HTL	0.0	0.0	
SCO to Sales	-117.6	-111.7	
FGD Solid Waste (Ash)	-6.9	-6.6	HC combustion products to ash (SO_x etc.)
HTL Flue Gas to Atmosphere	-12.1	-11.4	Includes reheater, heaters, & flare pilot combusted HC mass
FGD Flue Water Vapour to Atmos.	0.0	0.0	
HTL Steam to Well Pads	0.0	0.0	
Utility Steam In	0.0	0.0	
BFW to HTL	0.0	0.0	
HTL Blowdown Return	0.0	0.0	
Steam Generator Flue Gas to FGD	3.2	3.0	
Vac. Distillation Non-Cond. Gas Out	-0.5	-0.5	
Dilbit to HTL	161.2	153.1	
Diluent Return to CPF	-20.2	-19.2	
Mixed Fuel to HTL	2.5	2.4	
HTL Product Gas to CPF	-9.7	-9.2	
Pipeline Gas to HTL	0.1	0.0	
HTL Produced Water to Treatment	0.0	0.0	
Waste Water from CPF to HTL	0.0	0.0	
Check Balance	*0.0*	*0.0*	

Note:
Volume balance not shown for hydrocarbons as varying phases (vapour/liquid) and densities will produce balance.

Table SIR2 G-5: Tamarack Integrated Facility Water Mass Balance for SIR2 31b Phase 2 CPF and HTL™ (Years 5 through 19)

Stream	Stream Flow Mass (t/hr)	Volume (m^3/day)	Calendar Flow Mass (t/hr)	Volume (m^3/day)	Notes
Well Pads					
Produced Gas from Wells	0.0	0	0.0	0	
Bitumen from Wells	0.0	0	0.0	0	
Produced Water from Wells	687.2	16,527	652.9	15,700	Excludes dissolved solids
Steam to Wells	-723.4	-17,396	-687.2	-16,527	
Steam to Well Pads	723.4	17,396	687.2	16,527	
Emulsion to CPF	-671.7	-16,153	-638.1	-15,345	
Wet Produced Gas to CPF	-15.6	-374	-14.8	-355	
Check Balance	*-0.0*	*-0*	*0.0*	*0*	
Inlet/Bitumen Processing					
Emulsion to CPF	671.7	16,153	638.1	15,345	
Wet Produced Gas to CPF	15.6	374	14.8	355	
Imported Dilbit	0.0	0	0.0	0	
Exported Dilbit	0.0	0	0.0	0	
Fresh Diluent In	0.0	0	0.0	0	
Oily Water to Processing	-735.3	-17,683	-698.6	-16,799	
Produced Gas to Fuel System	-0.0	-1	-0.0	-1	
VRU Gas to VRU System	-0.2	-5	-0.2	-5	
Dilbit to HTL	-1.6	-39	-1.5	-37	
Diluent Return from HTL	0.0	0	0.0	0	
Cold BFW In for Heat Recovery	803.6	19,325	763.4	18,359	
Hot BFW Out	-803.6	-19,325	-763.4	-18,359	
Liquid Return from Water Treatment	49.7	1,196	47.3	1,137	
Liquid Return from VRU	0.2	5	0.2	5	
Relief and Vent to Flare	0.0	0	0.0	0	
Check Balance	*-0.0*	*-0*	*-0.0*	*-0*	
Water Treatment					
Oily Water to Processing	735.3	17,683	698.6	16,799	
Source Water In	107.1	2,575	101.7	2,446	Excludes dissolved solids
Utility Water Usage (CPF & HTL)	-18.0	-433	-17.1	-411	
Evaporator Deaerator Vent	-0.2	-5	-0.2	-5	
Water to Disposal	0.0	0	0.0	0	
VRU Gas to VRU System	-0.0	-1	-0.0	-1	
HTL Sour Water	46.2	1,111	43.9	1,056	
Waste Water to FGD	-40.0	-962	-38.0	-914	
Cold BFW Out	-803.6	-19,325	-763.4	-18,359	
Blowdown Return to Treatment	23.0	552	21.8	525	
Liquids Return to Bit. Processing	-49.7	-1,196	-47.3	-1,137	
Check Balance	*-0.0*	*-0*	*-0.0*	*0*	
Fuel System/VRU					
VRU Gas from Oil/Water Proc.	0.2	5	0.2	5	
Produced Gas from Inlet/Oil Treat.	0.0	1	0.0	1	
HTL Produced Gas	0.6	13	0.5	13	
Mixed Fuel Out	-0.6	-15	-0.6	-14	
Pipeline Gas to HTL	0.0	0	0.0	0	Water in pipeline gas ignored
Pipeline Gas In	0.0	0	0.0	0	Water in pipeline gas ignored
Liquids Return to Bit Processing	-0.2	-5	-0.2	-5	
Check Balance	*-0.0*	*-0*	*-0.0*	*-0*	

Stream	Stream Flow Mass (t/hr)	Volume (m^3/day)	Calendar Flow Mass (t/hr)	Volume (m^3/day)	Notes
CPF Steam System					
Hot BFW to CPF Steam System	119.4	2,872	113.5	2,729	
Blowdown Return from Co-Gen/HTL	19.4	466	18.4	443	
Blowdown to Water Treatment	-23.0	-552	-21.8	-525	
Mixed Fuel to CPF Steam	0.1	3	0.1	3	
Vac. Distillation Non-Cond. Gas In	0.0	1	0.0	1	
Combustion Air to Steam Gens	0.0	0	0.0	0	Water vap. in comb. air ignored
Steam Gen Flue Gas to FGD	-0.2	-5	-0.2	-4	
Steam Gen Flue Gas to Atmosphere	0.0	0	0.0	0	All SG flue gas to FGD
Utility Steam to HTL	-3.0	-71	-2.8	-68	
CPF Steam Out to Wellpads	-112.9	-2,715	-107.2	-2,579	
Check Balance	*0.0*	*0*	*0.0*	*0*	
CPF Flare and Utilities					
Pipeline Gas to Util. and Flare Purge	0.0	0	0.0	0	Water in pipeline gas ignored
Vent and Relief Flare Flow	0.0	0	0.0	0	No flow in normal operation
Combustion Air In	0.0	0	0.0	0	Water vap. in comb. air ignored
Flue Gas to Atmosphere	0.0	0	0.0	0	
Check Balance	*0.0*	*0*	*0.0*	*0*	
Power Generation					
Mixed Fuel to Co-Gen	0.3	8	0.3	8	
Combustion Air (Power Gen.)	0.0	0	0.0	0	Water vap. in comb. air ignored
Power Gen. Flue Gas to Atmosphere	-0.3	-8	-0.3	-8	
BFW to Co-Gen	202.1	4,859	192.0	4,616	
Co-Gen Steam to Well Pads	-196.0	-4,713	-186.2	-4,478	
Co-Gen Blowdown Return	-6.1	-146	-5.8	-138	
Check Balance	*-0.0*	*-0*	*0.0*	*0*	
HTL Upgrader					
Lime to HTL	0.0	0	0.0	0	Moisture in lime ignored
Combustion & Lift Air to HTL	0.0	0	0.0	0	Water vap. in comb. air ignored
SCO to Sales	0.0	0	0.0	0	
FGD Solid Waste (Ash)	0.0	0	0.0	0	
HTL Flue Gas to Atmosphere	0.0	0	0.0	0	Combustion product water ignored
FGD Flue Water Vapour to Atmos.	-52.4	-1,260	-49.8	-1,197	
HTL Steam to Well Pads	-414.5	-9,968	-393.8	-9,470	
Utility Steam In	3.0	71	2.8	68	
BFW to HTL	482.1	11,594	458.0	11,014	
HTL Blowdown Return	-13.3	-320	-12.7	-304	
Steam Generator Flue Gas to FGD	0.2	5	0.2	4	
Vac. Distillation Non-Cond. Gas Out	-0.0	-1	-0.0	-1	
Dilbit to HTL	1.6	39	1.5	37	
Diluent Return to CPF	0.0	0	0.0	0	
Mixed Fuel to HTL	0.1	3	0.1	3	
HTL Product Gas to CPF	-0.6	-13	-0.5	-13	
Pipeline Gas to HTL	0.0	0	0.0	0	Water in pipeline gas ignored
HTL Produced Water to Treatment	-46.2	-1,111	-43.9	-1,056	
Waste Water from CPF to HTL	40.0	962	38.0	914	
Check Balance	*-0.0*	*-0*	*0.0*	*-0*	

Note:
All water volumes are shown as liquid volume at standard conditions.

Table SIR2 G-6: Tamarack Integrated Facility Hydrocarbon Mass Balance for SIR2 31b Phase 2 CPF and HTL™ (Years 5 through 19)

Stream	Stream Flow Mass (t/hr)	Calendar Flow Mass (t/hr)	Notes
Well Pads			
Produced Gas from Wells	3.8	3.6	
Bitumen from Wells	281.4	267.4	
Produced Water from Wells	0.0	0.0	
Steam to Wells	0.0	0.0	
Steam to Well Pads	0.0	0.0	
Emulsion to CPF	-277.3	-263.4	
Wet Produced Gas to CPF	-7.9	-7.6	
Check Balance	*0.0*	*0.0*	
Inlet/Bitumen Processing			
Emulsion to CPF	277.3	263.4	
Wet Produced Gas to CPF	7.9	7.6	
Imported Dilbit	0.0	0.0	
Exported Dilbit	0.0	0.0	
Fresh Diluent In	0.6	0.6	
Oily Water to Processing	-1.3	-1.2	
Produced Gas to Fuel System	-3.8	-3.6	
VRU Gas to VRU System	-1.4	-1.3	
Dilbit to HTL	-322.4	-306.3	
Diluent Return from HTL	40.4	38.3	
Cold BFW In for Heat Recovery	0.0	0.0	
Hot BFW Out	0.0	0.0	
Liquid Return from Water Treatment	1.2	1.1	
Liquid Return from VRU	1.4	1.4	
Relief and Vent to Flare	0.0	0.0	
Check Balance	*0.0*	*-0.0*	
Water Treatment			
Oily Water to Processing	1.3	1.2	
Source Water In	0.0	0.0	
Utility Water Usage (CPF & HTL)	0.0	0.0	
Evaporator Deaerator Vent	0.0	0.0	
Water to Disposal	0.0	0.0	
VRU Gas to VRU System	-0.1	-0.1	
HTL Sour Water	0.0	0.0	
Waste Water to FGD	0.0	0.0	
Cold BFW Out	0.0	0.0	
Blowdown Return to Treatment	0.0	0.0	
Liquids Return to Bit. Processing	-1.2	-1.1	
Check Balance	*0.0*	*0.0*	
Fuel System/VRU			
VRU Gas from Oil/Water Proc.	1.5	1.4	
Produced Gas from Inlet/Oil Treat.	3.8	3.6	
HTL Produced Gas	19.4	18.5	
Mixed Fuel Out	-40.3	-38.3	
Pipeline Gas to HTL	-0.1	-0.1	
Pipeline Gas In	17.2	16.3	
Liquids Return to Bit Processing	-1.4	-1.4	
Check Balance	*0.0*	*0.0*	

Stream	Stream Flow Mass (t/hr)	Calendar Flow Mass (t/hr)	Notes
CPF Steam System			
Hot BFW to CPF Steam System	0.0	0.0	
Blowdown Return from Co-Gen/HTL	0.0	0.0	
Blowdown to Water Treatment	0.0	0.0	
Mixed Fuel to CPF Steam	5.4	5.1	
Vac. Distillation Non-Cond. Gas In	1.0	0.9	
Combustion Air to Steam Gens	0.0	0.0	
Steam Gen Flue Gas to FGD	-6.3	-6.0	Combusted hydrocarbon mass
Steam Gen Flue Gas to Atmosphere	0.0	0.0	All SG flue gas to FGD
Utility Steam to HTL	0.0	0.0	
CPF Steam Out to Wellpads	0.0	0.0	
Check Balance	*0.0*	*-0.0*	
CPF Flare and Utilities			
Pipeline Gas to Util. and Flare Purge	1.0	1.0	
Vent and Relief Flare Flow	0.0	0.0	
Combustion Air In	0.0	0.0	
Flue Gas to Atmosphere	-1.0	-1.0	Combusted hydrocarbon mass
Check Balance	*0.0*	*0.0*	
Power Generation			
Mixed Fuel to Co-Gen	29.9	28.4	
Combustion Air (Power Gen.)	0.0	0.0	
Power Gen. Flue Gas to Atmosphere	-29.9	-28.4	Combusted hydrocarbon mass
BFW to Co-Gen	0.0	0.0	
Co-Gen Steam to Well Pads	0.0	0.0	
Co-Gen Blowdown Return	0.0	0.0	
Check Balance	*0.0*	*0.0*	
HTL Upgrader			
Lime to HTL	0.0	0.0	
Combustion & Lift Air to HTL	0.0	0.0	
SCO to Sales	-235.2	-223.4	
FGD Solid Waste (Ash)	-13.8	-13.1	HC combustion products to ash (SO_x etc.)
HTL Flue Gas to Atmosphere	-24.1	-22.9	Includes reheater, heaters, & flare pilot combusted HC mass
FGD Flue Water Vapour to Atmos.	0.0	0.0	
HTL Steam to Well Pads	0.0	0.0	
Utility Steam In	0.0	0.0	
BFW to HTL	0.0	0.0	
HTL Blowdown Return	0.0	0.0	
Steam Generator Flue Gas to FGD	6.3	6.0	
Vac. Distillation Non-Cond. Gas Out	-1.0	-0.9	
Dilbit to HTL	322.4	306.3	
Diluent Return to CPF	-40.4	-38.3	
Mixed Fuel to HTL	5.1	4.8	
HTL Product Gas to CPF	-19.4	-18.5	
Pipeline Gas to HTL	0.1	0.1	
HTL Produced Water to Treatment	0.0	0.0	
Waste Water from CPF to HTL	0.0	0.0	
Check Balance	*0.0*	*0.0*	

Note:
Volume balance not shown for hydrocarbons as varying phases (vapour/liquid) and densities will produce balance.

Ivanhoe Energy

Appendix SIR2 H

Conceptual Spill Response Plan

TABLE OF CONTENTS

Ivanhoe Energy

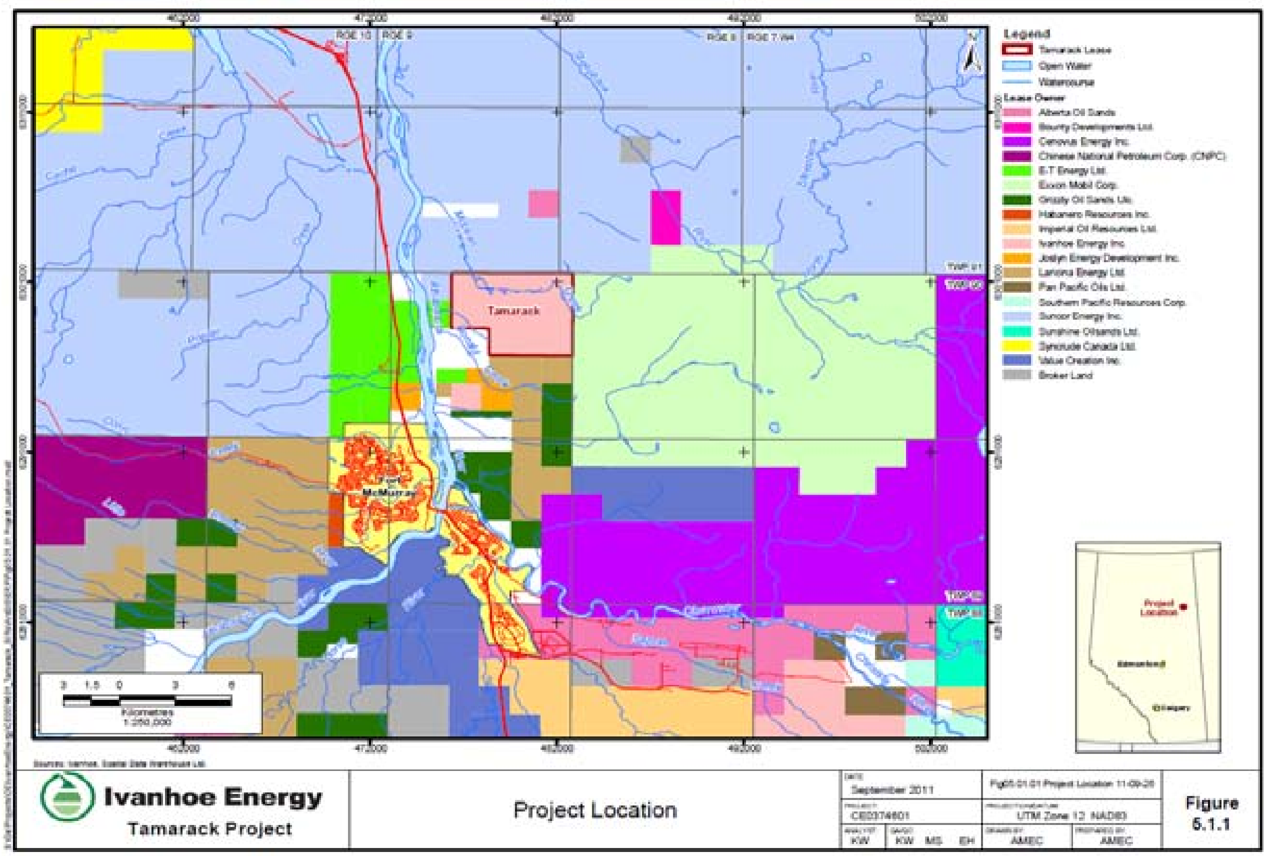
SECTION 1.0 - INTRODUCTION

Ivanhoe, as owner and operator of the Tamarack Project, is responsible for the formulation and implementation of a Spill Response Plan, as per ERCB Directive 071, prior to mobilization and subsequent construction activities. This Conceptual Spill Response Plan provides a general discussion of the requirements of a future plan. A final Spill Response Plan will be developed after detailed engineering identifies the location and layout of all facilities, ancillary equipment, potential contaminant types and sources, hazards and potential impacts. This Spill Response Plan will be fully integrated with Ivanhoe's Canadian Corporate Emergency Response Plan (CCERP) and Site Specific Emergency Response Plans.

Ivanhoe has also stated its expectation to join the Western Canadian Spill Services Ltd. (WCSS), Area "Y" Oil Spill Cooperative (Cooperative) and will maintain emergency materials at the Project site for deployment in case of an oil spill within the region, as well as be able to access equipment from the Cooperative, in case of a major event. The Spill Response Plan will incorporate and adapt the WCSS documents, *Oil Spill Contingency Manual* (October 2011) (WCSS, 2011) and *Liquid Hydrocarbon Spills – Risk Assessment Guide* (WCSS, not dated).

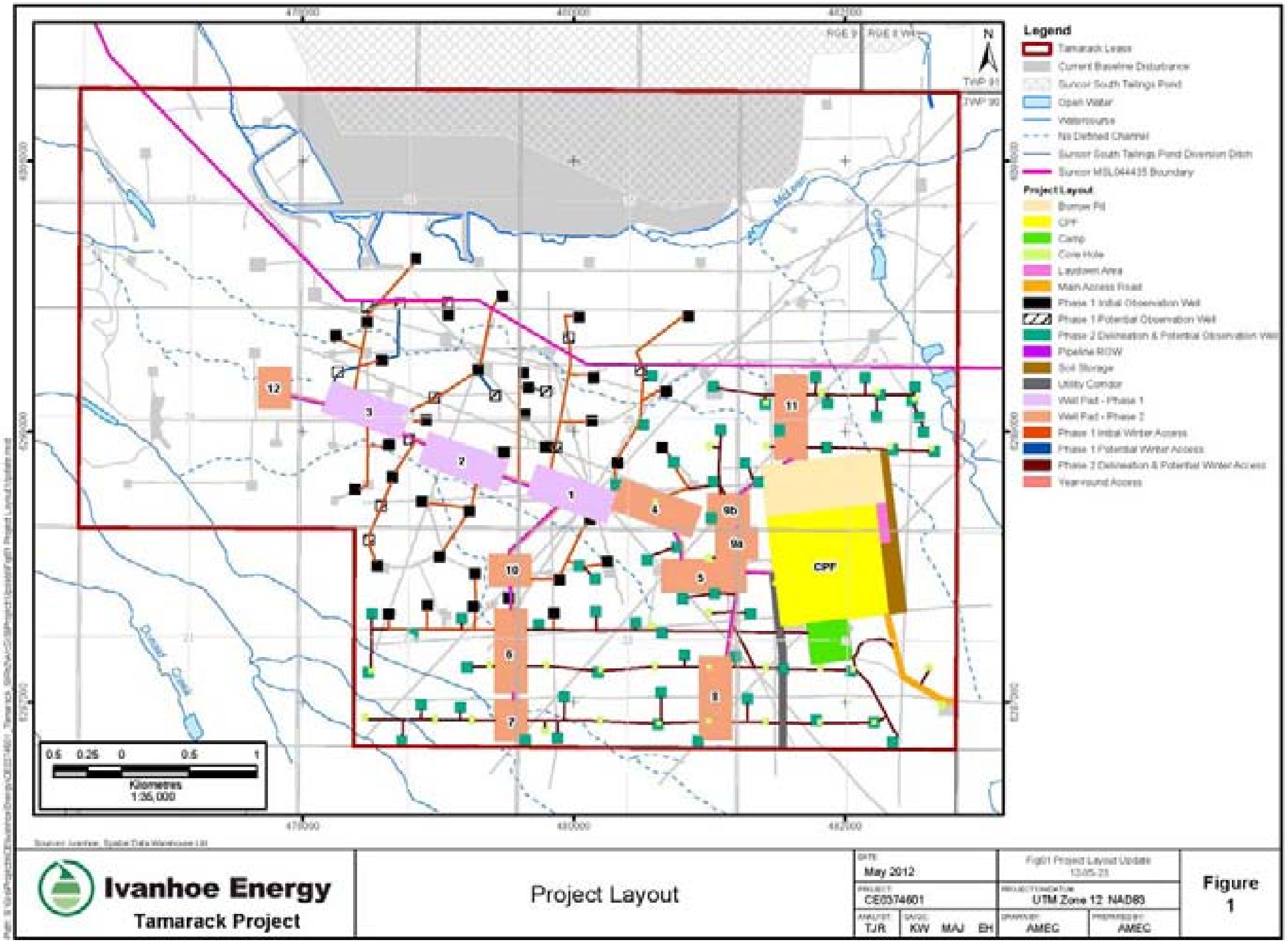
The Conceptual Spill Response Plan covers the Tamarack Project Area provided in Figure 1.

Figure 1 – Project Location



The current conceptual Project Layout is provided in Figure 2.

Figure 2 – Project Layout



SECTION 2.0 - RISK ASSESSMENT

Prior to finalizing its Spill Response Plan, Ivanhoe will undertake a complete Risk Assessment for the Tamarack project, identifying the potential Risk Events, the Frequency of Occurrence and Consequence of those Risk Events. Risk will be identified using the following formula:

Risk = Frequency x Consequence

The following provides a series of tables and matrices referenced from WCSS (not dated) that may be used to assess risk associated with a Project.

The following steps will be used to assess a risk:

1) Identify the hazards.
2) Determine the risk.
3) Evaluate the risk and decide whether the existing precautions are adequate or whether more should be done.
4) Record and maintain your findings along with risk control measures that were implemented above and beyond those required by the regulator.
5) Review your initial risk assessment and revise it following the implementation of control strategies.
6) Conduct a new risk assessment following any significant changes (company or external) changes at this location or following an incident.

The risk assessment tool is also used to prioritize the risks presented from all the potential hazards in your operations. The resulting risk prioritization can aid in determining where to concentrate resources to prevent or reduce the frequency or consequences that are considered unacceptable should an event occur.

To use these tables, a Frequency Level (Table 1) and Consequence Level (Table 2) are chosen for a particular operational spill hazard. These two Levels are compared in Table 3 to get a Risk Level. Table 4 provides a Preliminary Risk Assessment for the Tamarack Project. This assessment is not exhaustive and will be updated once the plan is past the conceptual level.

Table 1 – Frequency of Hazard
Source: WCSS, *Liquid Hydrocarbon Spills – Risk Assessment Guide*

Level	Descriptor	Description	Probability
5 (High)	Almost certain to occur	Event is expected to occur	Could occur within the next year
4 (Moderate to High)	Likely to occur	Event will probably occur based on current practices	Could occur within the next 10-years
3 (Moderate)	May occur	Event could occur at some time based on current practices	Could occur within the next 10 to 20-years
2 (Moderate to Low)	Unlikely to occur	Event could occur at some time based on current practices	Could occur within the next 20 to 100-years
1 (Low)	Rare occurrence	Event unlikely to occur based on current practices	Not likely to occur within the next 100-years

Table 2 – Consequence of Hazard
Source: WCSS, *Liquid Hydrocarbon Spills – Risk Assessment Guide*

Level	Descriptor	Example Detail Description
1 (Low)	Insignificant	No environmental impact, spill contained immediately.
2 (Moderate to Low)	Minor	Limited on-site environmental impact, insignificant financial loss, and no public or media interest. Land spill quickly contained. Public somewhat concerned.
3 (Moderate)	Moderate	Any liquid spill within 100 metres of a named water body that has the potential for off-site impacts. Land based spill. Public complain of odours or potential health concerns or restricted use of recreational facilities. Potential public safety issue.
4 (Moderate to High)	Major	Spill of less than 20 cubic metres enters a named water body and there is a potential for negative impact to downstream wildlife/fisheries and downstream water users. Local-to-regional public and media interest. Impacts other licensed water users. Public complains of health concerns. Flammable or explosive atmosphere. Spill will impact an environmentally sensitive area.
5 (High)	Catastrophic	Spill of more than 20 cubic metres enters a named water body, wildlife/fisheries and downstream water users impacted, large financial impact, regional to national public and media interest. Spill enters a waterway with a velocity >3Km/Hr

Table 3 – Risk = Frequency x Consequence
Source: WCSS, *Liquid Hydrocarbon Spills – Risk Assessment Guide*

Probability	Consequences				
	Catastrophic (5)	Major (4)	Moderate (3)	Minor (2)	Insignificant (
Almost Certain (High) (5)	**Severe (25)**	**Severe (20)**	**High (15)**	**Major (10)**	**Significant (5)**
Likely (Moderate-High) (4)	**Severe (20)**	**High (16)**	**Major (12)**	**Significant (8)**	**Moderate (4)**
May (Moderate to Low) (3)	**High (15)**	**Major (12)**	**Significant (9)**	**Moderate (6)**	**Low (3)**
Unlikely (Low) (2)	**Major (10)**	**Significant (8)**	**Moderate (6)**	**Low (4)**	**Trivial (2)**
Rare (1)	**Significant (5)**	**Moderate (4)**	**Low (3)**	**Trivial (2)**	**Trivial (1)**

The risk levels as identified in the above table have been colour coded to assist in setting priorities. Those risk levels based upon probability and consequences that are defined in the:

- **Red** shaded areas require risk control actions;
- **Yellow** shaded areas deserve to be considered for risk control actions or be closely monitored; and
- **Green** shaded areas require no follow up activities at this time.

The following tables provide examples of qualitative risk levels and ratings for four general areas of concern:

- Health and safety;
- Environment and property;
- Lifestyle disruptions; and
- Public perception and confidence.

The health and safety of people is the primary importance for Ivanhoe's operations.

The protection of the environment and of private and public property is also extremely important. With enhanced awareness and concern over environmental issues, negatively impacting the environment can result in costly cleanup operations and possibly impacting endangered species.

The area of public perception and confidence is often overlooked when conducting a risk assessment. This is an area that can eventually restrict present and future operations not only for your organization but also for the industry in general.

There may be other areas of concern for each location than those identified above. The following tables contain space to add additional hazard/risk events.[1]

[1] Western Canadian Spill Services Ltd., *Liquid Hydrocarbon Spills – Risk Assessment Guide, http://www.wcss.ab.ca/archive/publications/pdf/WCSSRISKASSESSMENTGUIDE.pdf*

Table 4 – Preliminary Risk Assessment

Source: WCSS, *Liquid Hydrocarbon Spills – Risk Assessment Guide*

Hazard	Risk Event	Frequency / Consequence	Risk Level	Qualitative Risk Assessment
Hydrocarbon spill into natural environment	Spill impacts waterfowl nesting area, species at risk or other sensitive habitat	3/5	High	**15**
Land spill of hydrocarbon	Spill emits unpleasant odours due to sour constituents	3/5	High	**15**
Diluent spill	Spill emits flammable vapours presenting fire & explosion hazard in confined areas	3/4	Major	**12**
Hydrocarbon spill	Public backlash extends to industry and government	2/5	Major	**10**
Hydrocarbon ignites and burns	Spill burns and releases black smoke	3/3	Significant	**9**
Hydrocarbon spill	Increased traffic as a result of spill response	3/3	Significant	**9**
Hydrocarbon spill	Loss of public trust and damage to reputation	3/3	Significant	**9**
Hydrocarbon spill	Poor public relations and media communications	2/4	Significant	**9**
Diluent spill	Spill emits odours and some people complain of feeling ill	2/4	Major	**8**
Hydrocarbon spill	Spilled product likely impacts industrial water users	2/4	Significant	**8**
Hydrocarbon spill	Use of night time lighting for response operations	3/2	Moderate	**6**
Hydrocarbon spill	Spilled product likely impacts community water supply	1/5	Significant	**5**
Hydrocarbon spill	Spill into a river with velocity > 3Km/Hr	1/4	Low	**4**
Hydrocarbon spill	Spill into a fish habitat	1/4	Low	**4**

A range of possible additional spill scenarios will be developed from an analysis of construction and operational related activities and the types of products handled or transported through the area.

SECTION 3.0 - RESOURCES AT RISK AND PRIORITIES FOR PROTECTION

Amenity areas and ecologically sensitive areas, water bodies and other resources likely to be threatened by a spill will be identified. Ivanhoe has undertaken a Constraints Mapping exercise as part of its Tamarack Project Application, which identifies sensitive areas (historical sites, old growth forests, water bodies, sensitive plant areas, etc.) and this information will be incorporated into the analysis. Since it will not be possible to give equal protection to all sensitive resources, priorities will need to be determined. Account will be taken of the practical problems as well as the relative economic and environmental values of each resource and their sensitivity to pollution. Seasonal variations, e.g., of breeding areas, will be noted.

SECTION 4.0 - RESPONSE STRATEGIES & OPERATIONAL PLAN

Clean-up strategies will be determined in relation to the perceived risk and agreed response priorities. Account will be taken of the limitations of spill control techniques and the most appropriate equipment chosen for the anticipated weather conditions and pollutant types.

Methods for trajectory modelling, procedures for aerial and terrestrial surveillance, for the identification of threatened resources and for notifying pre-identified parties likely to be affected will be included.

The plan will allow for the consideration of various response options according to the situation. Procedures for placing manpower and equipment on standby prior to mobilisation will be included.

The operational procedures can be divided into six main parts, generally following the chronological order of occurrence during a spill:

- Notification;
- Evaluation;
- Response;
- Clean-up;
- Communication; and
- Termination.

WCSS (no date) provides a series of checklists that Ivanhoe will adopt and tailor to suit its operations so that actions are taken to properly assess, contain, respond to and clean up a spill event. These checklists include:

- Contact Checklists, which are currently provided in Section 4.0 of the CCERP;
- Spill Assessment Checklist including spill prevention, initial actions, safety & hazard assessment, land assessment, water courses assessment and ice-covered water courses assessment;
- Containment and Recovery Checklist including safety, establishing command centres (provided in CCERP, Section 7.1), establishing decontamination centres, land containment & recovery, water courses, containment & recovery, ice-covered water courses containment & recovery, evaluation of containment & recovery operations and waste disposal at the spill site;
- Wildlife Recovery;
- In-Situ Burning Guidelines including introduction, purpose, considerations for in-situ burning, regulatory approval, safety considerations, spill site assessment, burn plan preparation, and post burn activities;
- Job Descriptions, which are currently provided in Section 3.0 of the CCERP;
- Public Relations Checklist, which is currently provided in Section 7.0 of the CCERP. These checklists will be updated, as required, to include managing media relations, media fact sheets, and key messages;
- Documentation, which is currently provided in Section 10.0 of the CCERP. These checklists will be updated, as required, to include spill site sketches, spill site photographs, record of key events, safety aspects, environmental aspects, negotiations and agreements; and
- Maps including control points, access maps, waste storage sites, and other key locations. Predetermined temporary waste storage sites and disposal routes will be detailed.

Depending upon the size, extent and potential impact of any spill event, Ivanhoe will implement a Monitoring Program, as required. Final monitoring plans will be developed on an event specific basis and could include:

- Ground or aerial investigations, with special attention paid to sensitive or priority areas (e.g., water bodies, old growth forest, sensitive plant locations, historical resources, etc.);
- Water, soil and air sampling and analysis to identify areas of impact;
- Wildlife and fish monitoring; and
- Health and safety monitoring of workers and contractors.

SECTION 5.0 - ORGANIZATION & MANAGEMENT

The CCERP outlines the organization and management structure for all incident responses, including spill response. Central coordination under a single organisation which has complete responsibility for handling the operation will be implemented in order to minimise confusion. This will be based on Ivanhoe's CCERP. The final Spill Response Plan will be consistent and compatible with the CCERP.

Ivanhoe has a responsibility to ensure that it is fully prepared and capable of responding to any level of emergency, including a spill event. In order to allow for appropriate response, Ivanhoe has prepared a CCERP to;

- identify hazards;
- outline emergency response procedures;
- ensure sufficient resources are available; and
- personnel are suitably trained as Spill Responders as well as the use of the ERP and Contingency Spill plan.

The purpose of the CCERP is to establish a decision framework and action plan so that Ivanhoe Energy can quickly and effectively respond to an Emergency. The overall goal is to protect employee, contractor and public safety and minimize impacts to the environment through implementation of the CCERP.

This CCERP helps Ivanhoe Energy to:

- Protect human health, safety and welfare;
- Determine the appropriate responses to Emergency situations;
- Provide personnel with established procedures and guidelines to;
- Notify the appropriate Ivanhoe Energy field and corporate Emergency Response Team Members and Government Agencies;
- Manage communications with all appropriate audiences, including the public and the media;
- Notify the next of kin;
- Promote continuous and sustained communications to ensure a "company-wide" co-ordinated emergency response; and
- Minimize the effects disruptive events can have on company operations by reducing recovery times and costs.

Procedures for coordination between organisations will be outlined. The size of the response organisation will depend on the area covered by the plan, the severity of the threat and the sensitivity of any threatened resources.

SECTION 6.0 - COMMUNICATIONS & CONTROL

The CCERP provides details of Ivanhoe's requirements for communications and control during an incident, including a spill. Section 3.0 provides the Roles & Responsibilities. Section 4.0 provides Emergency Telephone Numbers. Section 7.0 provides a detailed discussion on Communications, both internal and external. Section 9.0 provides information on Government Roles and Responsibilities. Figure 3 provides the Communications Flowchart for Ivanhoe's Alberta operations.

The establishment of a fully equipped communications centre will be predetermined to ensure that the correct information is passed to the correct people. The centre will act as a central channel for all information.

The Primary On-Site Command Post will be positioned in a safe area at or near the incident site. This location will serve as the centre for communication and coordination of all activities to control the spill response and to manage the initial public protection measures.

Upon notification of a spill, required key company personnel will report to the On-Site Command Post. Depending on the nature of the emergency, the Primary On-Site Command Post may be established by an operator equipped with a cell phone and vehicle.

The nature of the spill may also require that an alternate command post be established off-site. The Off-Site Command Centre, if required, will be established in a suitable location in the local area and will be able to accommodate response teams, media crews, multiple telephones, etc., for use in an spill response situation.

The regional emergency operations centre (REOC) is an operations centre that would be established in a suitable location to manage the larger aspects of the spill response that is manned jointly by governmental and Ivanhoe Energy staff. The REOC will be established by the Off-Site Emergency Response Manager. The ERCB, Local Authority and Alberta Health Services will be invited to attend this centre to assist in the response. Notification, evacuation, air monitoring and roadblock activities will be coordinated from this location. The REOC will also serve as a mustering location for additional equipment and personnel required to respond to the incident.

A corporate emergency operations centre will be established by the Corporate Emergency Response Manager, at the Ivanhoe Energy Head Office where personnel will locate to provide direction to company personnel at the On-Site Command Post, and REOC.

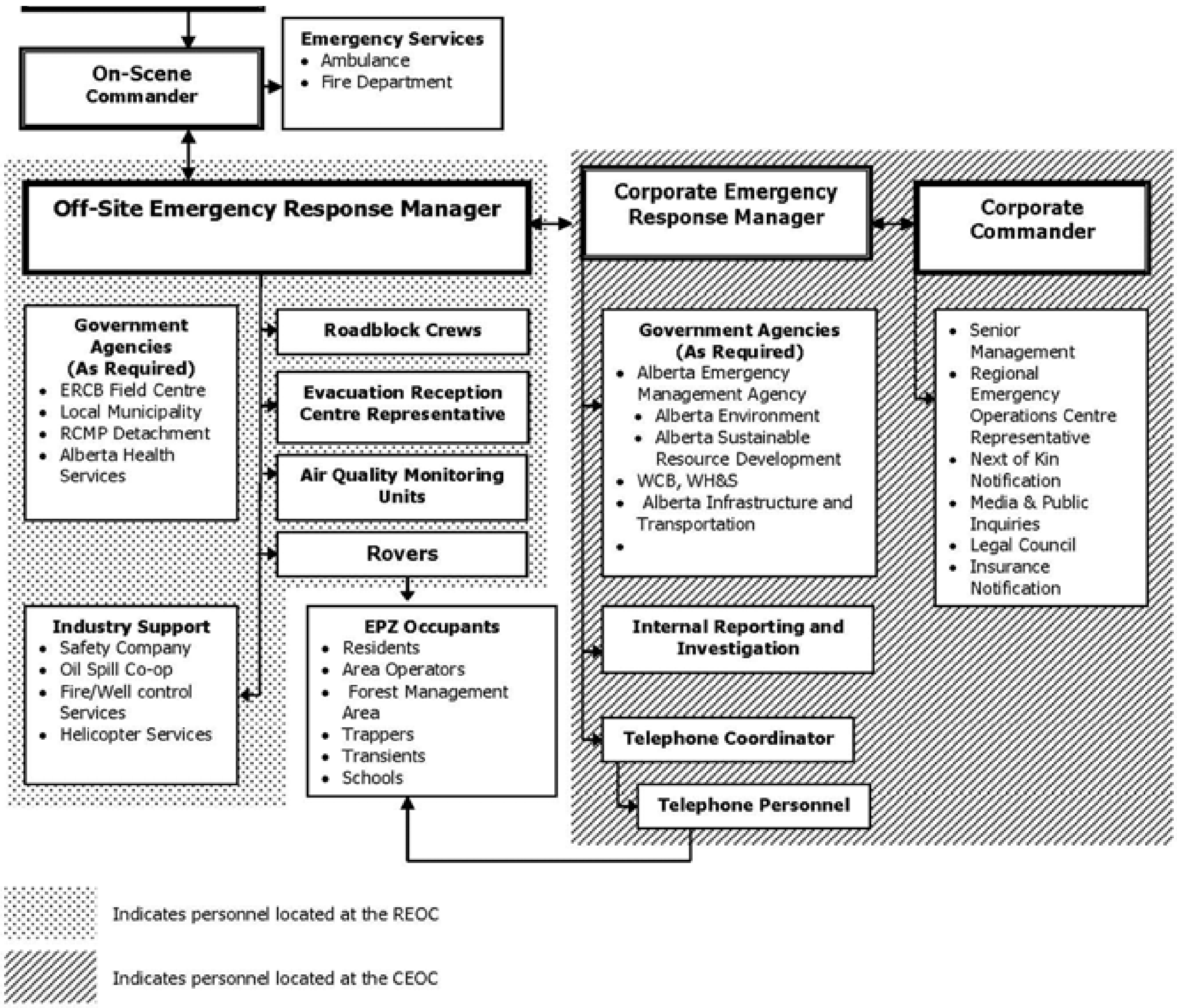
Communication equipment, such as telephones (land line and cellular), mobile radios, walkie-talkies, etc., will be available to ensure direct communications between the field Emergency Response Team personnel and Emergency Operations Centres.

Communication materials will be available to provide information regarding the operation of emergency control equipment. Maps will be available to provide information showing facilities, roads, and directional access to location. Materials containing technical support information are provided in operations manual, Material Safety Data Sheet (MSDS), cleanup procedure manuals, disposal guidelines, etc. Further communication materials such as Emergency telephone numbers, as well as key company, contractor, and government personnel will be identified.

Accurate recording of all actions and maintenance of appropriate documentation related to the use of manpower, equipment and materials as well as expenditure is vital for future reference and the submission of claims for compensation.

Figure 3 – Communications Flowchart – Alberta

Source: Ivanhoe's Canadian Corporate Emergency Response Plan, p. 3-3



SECTION 7.0 - EQUIPMENT, SUPPLIES, SERVICES & MANPOWER

It is anticipated that Ivanhoe Energy will become members of the Western Canadian Spill Services Ltd (WCSS) Zone 5 Area Y. This will provide access to necessary containment and clean up equipment including:

- OSCAR Trailer (1) (1 ton truck)
- Aqua-Dek Workboat (1/2 ton truck with 2" ball hitch)
- Boom Vane
- Barge (3/4-ton truck with 2 5/16" ball hitch)
- Skid Unit (1)

In addition, each well pad and the Central Processing Facility will be equipped with a spill response area, which will store booms, absorbents, shovels, containers and other equipment to respond to any spill incident. The siting of response equipment and the procedures for mobilisation are yet to be determined. Provision for food, clothing, shelter, medical facilities and other logistics support will be also detailed. The availability of back-up support will be recorded.

The manpower required to respond to a spill will be estimated. Additional manpower may be required in the case of large spills. Contractors and other sources of manpower will be identified and appended.

SECTION 8.0 - TRAINING, EXERCISES & UPDATING PROCEDURES

Training programs will be developed in conjunction with Western Canadian Spill Services (WCSS) for all levels of response personnel. Exercises will be held at regular intervals to ensure the plan functions correctly and to familiarise all participants with its contents.

All responders in the Spill Response Plan will be trained on how to use the final document.

An annual Emergency simulation, designed to test the ERP, will be conducted, and may include spill response. All personnel with emergency responsibilities will participate in the simulations to ensure a complete understanding of their response duties. Detailed equipment will be mobilised and deployed to test its actual availability and performance. Designated personnel will also participate in spill containment and clean up training through WCSS on a regular basis.

Any spills identified as a level 2 or 3 emergency, defined in Section 2.3 of the CCERP, will require formal investigation and follow up through the incident reporting process (form provided in CCERP Section 10.0, Company Emergency Report Forms).

The CCERP and Spill Response Plan will be reviewed and updated annually, after any simulation exercise or incident that requires activation of the procedures, or as required, by the Director, Regulatory & Consultation. All amendments will be distributed to each individual plan holder who will be responsible for incorporating them as they are received. A record of all amendments will be maintained utilizing a Revision Log.

Post-incident reviews will be conducted to evaluate the effectiveness of the Spill Response Plan and to ensure proper documentation and that community follow up is completed as necessary.

Ivanhoe Energy

Appendix SIR2 I

Base Cation Concentrations

Table SIR2 I-1: Maximum, Minimum and Median Values for Lakes in the ALSA, ARSA and AQRSA

Lake Identifier	Easting	Northing	Specific Conductivity (uS/cm)			TDS (Mg/L)			Total Alkalinity (mg/L $CaCO_3$)			pH (pH Units)			Calcium (mg/L)			Magnesium (mg/L)			Potassium (mg/L)			Sodium (mg/L)		
			Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
2	510499	6163433	223	184	197	130	119	125	124	69	104	8.2	7.4	7.9	32	16	25	9	6	7.5	1	0.8	1	8	4	6.3
42	479375	6142060	164	164	164	106	106	106	88	88	88	8.2	8.2	8.2	23	23	23	7.4	7.4	7.4	0.7	0.7	0.7	2.8	2.8	2.8
43	496692	6127900	136	136	136	67	67	67	67	67	67	7.5	7.5	7.5	17	17	17	5.4	5.4	5.4	0.4	0.4	0.4	1.5	1.5	1.5
44	491437	6137987	142	142	142	82	82	82	70	70	70	8	8	8	18	18	18	6.4	6.4	6.4	0.6	0.6	0.6	2.3	2.3	2.3
45	497711	6132160	80	80	80	55	55	55	38	38	38	7.3	7.3	7.3	10	10	10	3.7	3.7	3.7	0.4	0.4	0.4	1	1	1
46	498367	6133579	178	178	178	121	121	121	89	89	89	7.9	7.9	7.9	22	22	22	8.5	8.5	8.5	0.5	0.5	0.5	2	2	2
47	493933	6132222	106	106	106	80	80	80	52	52	52	7.7	7.7	7.7	13	13	13	4.9	4.9	4.9	0.6	0.6	0.6	1	1	1
48	491151	6134421	94	94	94	45	45	45	43	43	43	7.4	7.4	7.4	11	11	11	4.4	4.4	4.4	0.6	0.6	0.6	1.3	1.3	1.3
49	493107	6134651	96	96	96	45	45	45	46	46	46	7.4	7.4	7.4	11	11	11	4.3	4.3	4.3	0.4	0.4	0.4	0.5	0.5	0.5
50	489844	6137549	35	35	35	17	17	17	13	13	13	6.5	6.5	6.5	4	4	4	1.5	1.5	1.5	0.4	0.4	0.4	<0.1	<0.1	<0.1
122	448014	6170896	25	25	25	43	43	43	7	7	7	6.6	6.6	6.6	2	2	2	0.9	0.9	0.9	1.6	1.6	1.6	0.8	0.8	0.8
131	446510	6167454	129	129	129	69	69	69	62	62	62	7.6	7.6	7.6	17	17	17	4.9	4.9	4.9	0.8	0.8	0.8	1.9	1.9	1.9
132	533788	6137575	222	222	222	119	119	119	117	117	117	8.5	8.5	8.5	30	30	30	8.5	8.5	8.5	0.9	0.9	0.9	4	4	4
138	457796	6141365	100	100	100	52	52	52	50	50	50	7.7	7.7	7.7	12	12	12	4.3	4.3	4.3	0.9	0.9	0.9	0.8	0.8	0.8
146	448271	6183205	32	32	32	107	107	107	11	11	11	6.8	6.8	6.8	3	3	3	1.4	1.4	1.4	1.1	1.1	1.1	1.5	1.5	1.5
147	515689	6179208	48	48	48	75	75	75	19	19	19	7.3	7.3	7.3	6	6	6	1.7	1.7	1.7	1.1	1.1	1.1	1.3	1.3	1.3
167	466149	6224878	13	13	13	36	36	36	3	3	3	5.8	5.8	5.8	1.4	1.4	1.4	0.5	0.5	0.5	0.3	0.3	0.3	0.9	0.9	0.9
168	483758	6235155	16	16	16	54	54	54	31	31	31	4.9	4.9	4.9	1.6	1.6	1.6	0.5	0.5	0.5	0.4	0.4	0.4	0.8	0.8	0.8
169	484261	6230771	15	15	15	44	44	44	16	16	16	4.7	4.7	4.7	0.9	0.9	0.9	0.4	0.4	0.4	0.4	0.4	0.4	0.7	0.7	0.7
170	489580	6230843	14	14	14	49	49	49	72	72	72	5.6	5.6	5.6	1.9	1.9	1.9	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.7	0.7
175	415829	6353313	114	114	114	144	144	144	47	47	47	7.8	7.8	7.8	13	13	13	5	5	5	0.7	0.7	0.7	9	9	9
182	508983	6346815	60	60	60	59	59	59	27	27	27	7.1	7.1	7.1	9	9	9	2	2	2	0.08	0.08	0.08	1.3	1.3	1.3
185	509201	6334194	23	23	23	66	66	66	4	4	4	5.3	5.3	5.3	4	4	4	1.0	1.0	1.0	0.05	0.05	0.05	0.5	0.5	0.5
199	446802	6395072	25	25	25	32	32	32	9	9	9	6.7	6.7	6.7	3	3	3	1.3	1.3	1.3	0.4	0.4	0.4	0.9	0.9	0.9
201	413544	6197673	78	78	78	-	-	-	34	34	34	7.5	7.5	7.5	12	12	12	2.7	2.7	2.7	1.1	1.1	1.1	3.7	3.7	3.7
203	432308	6198262	73	73	73	-	-	-	14	14	14	6.9	6.9	6.9	7	7	7	2.1	2.1	2.1	0.6	0.6	0.6	4.7	4.7	4.7
204	437499	6197260	70	70	70	-	-	-	29	29	29	7.5	7.5	7.5	10	10	10	2.3	2.3	2.3	0.5	0.5	0.5	2	2	2
205	426862	6184436	201	201	201	-	-	-	98	98	98	8.8	8.8	8.8	30	30	30	7.1	7.1	7.1	1	1	1	3.7	3.7	3.7
206	425742	6179813	213	213	213	-	-	-	97	97	97	8.5	8.5	8.5	30	30	30	7.1	7.1	7.1	1	1	1	5.1	5.1	5.1
207	429371	6177905	172	172	172	-	-	-	85	85	85	8.1	8.1	8.1	28	28	28	5.6	5.6	5.6	0.9	0.9	0.9	1.1	1.1	1.1
208	414088	6172614	73	73	73	-	-	-	29	29	29	7.3	7.3	7.3	11	11	11	2.7	2.7	2.7	0.7	0.7	0.7	1.4	1.4	1.4
209	515366	6343123	25	25	25	53	53	53	8	8	8	6.4	6.4	6.4	4	4	4	1.2	1.2	1.2	0.07	0.07	0.07	0.6	0.6	0.6
218	452595	6196133	68	68	68	-	-	-	31	31	31	7.1	7.1	7.1	11	11	11	2.7	2.7	2.7	0.5	0.5	0.5	1.6	1.6	1.6
219	444220	6193451	86	86	86	-	-	-	41	41	41	7.3	7.3	7.3	13	13	13	2.7	2.7	2.7	0.3	0.3	0.3	1.1	1.1	1.1
220	448879	6190611	68	68	68	-	-	-	32	32	32	7.5	7.5	7.5	10	10	10	2.4	2.4	2.4	0.6	0.6	0.6	1.7	1.7	1.7
221	458295	6193292	47	47	47	-	-	-	50	50	50	7.3	7.3	7.3	6	6	6	2.1	2.1	2.1	0.6	0.6	0.6	1.2	1.2	1.2
222	438372	6185182	95	95	95	-	-	-	46	46	46	7.9	7.9	7.9	16	16	16	2.5	2.5	2.5	0.7	0.7	0.7	0.8	0.8	0.8
223	440822	6334920	119	119	119	165	165	165	41	41	41	7.4	7.4	7.4	13	13	13	6	6	6	1.5	1.5	1.5	7	7	7
224	443436	6173058	33	33	33	-	-	-	13	13	13	7.1	7.1	7.1	4	4	4	1.3	1.3	1.3	0.9	0.9	0.9	0.8	0.8	0.8
225	443913	6295483	79	79	79	92	92	92	34	34	34	7.4	7.4	7.4	11	11	11	4	4	4	0.9	0.9	0.9	0.9	0.9	0.9
226	455811	6296483	44	44	44	86	86	86	15	15	15	6.8	6.8	6.8	6	6	6	2	2	2	0.8	0.8	0.8	1.2	1.2	1.2
227	451914	6292827	82	82	82	110	110	110	35	35	35	7.4	7.4	7.4	12	12	12	4	4	4	0.5	0.5	0.5	1.2	1.2	1.2
230	533411	6186731	112	112	112	-	-	-	58	58	58	7.9	7.9	7.9	15	15	15	5.9	5.9	5.9	0.5	0.5	0.5	2.1	2.1	2.1
231	516751	6175506	59	59	59	67	67	67	28	28	28	7.6	7.6	7.6	8	8	8	2.5	2.5	2.5	0.7	0.7	0.7	1.8	1.8	1.8
232	528841	6167222	85	85	85	65	65	65	43	43	43	7.8	7.8	7.8	12	12	12	3.9	3.9	3.9	0.4	0.4	0.4	1.4	1.4	1.4
233	502625	6165269	105	105	105	-	-	-	50	50	50	7.8	7.8	7.8	14	14	14	4.5	4.5	4.5	0.8	0.8	0.8	3.5	3.5	3.5
234	547077	6178511	152	152	152	-	-	-	82	82	82	8.1	8.1	8.1	22	22	22	7.3	7.3	7.3	0.7	0.7	0.7	5	5	5
235	548176	6173881	142	142	142	-	-	-	73	73	73	8.3	8.3	8.3	20	20	20	7.5	7.5	7.5	0.4	0.4	0.4	1.4	1.4	1.4
236	558657	6173086	97	97	97	-	-	-	49	49	49	7.9	7.9	7.9	13	13	13	4.4	4.4	4.4	0.3	0.3	0.3	1.3	1.3	1.3
237	531585	6150547	190	190	190	125	125	125	104	104	104	8.4	8.4	8.4	27	27	27	7	7	7	0.9	0.9	0.9	3.5	3.5	3.5
238	544256	6146950	144	144	144	-	-	-	77	77	77	9	9	9	21	21	21	6.4	6.4	6.4	1.1	1.1	1.1	2.8	2.8	2.8
239	525364	6133813	208	208	208	-	-	-	108	108	108	8.3	8.3	8.3	30	30	30	8.8	8.8	8.8	1.8	1.8	1.8	2	2	2

Lake Identifier	Easting	Northing	Specific Conductivity (uS/cm)			TDS (Mg/L)			Total Alkalinity (mg/L $CaCO_3$)			pH (pH Units)			Calcium (mg/L)			Magnesium (mg/L)			Potassium (mg/L)			Sodium (mg/L)		
			Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
240	514750	6146752	228	228	228	-	-	-	123	123	123	8.6	8.6	8.6	32	32	32	10.1	10.1	10.1	1.1	1.1	1.1	3.6	3.6	3.6
241	510533	6149522	198	198	198	-	-	-	101	101	101	8.2	8.2	8.2	28	28	28	8.5	8.5	8.5	0.7	0.7	0.7	3.3	3.3	3.3
242	464179	6147797	87	87	87	-	-	-	43	43	43	8.3	8.3	8.3	11	11	11	4	4	4	0.7	0.7	0.7	1.3	1.3	1.3
243	475751	6144012	68	68	68	-	-	-	52	52	52	7.7	7.7	7.7	14	14	14	2.7	2.7	2.7	0.4	0.4	0.4	2.4	2.4	2.4
244	492606	6137452	128	128	128	-	-	-	64	64	64	8	8	8	17	17	17	6.4	6.4	6.4	0.5	0.5	0.5	1.6	1.6	1.6
245	468315	6136636	66	66	66	-	-	-	30	30	30	7.6	7.6	7.6	8	8	8	3.7	3.7	3.7	0.7	0.7	0.7	1.6	1.6	1.6
246	452463	6135855	70	70	70	-	-	-	32	32	32	7.7	7.7	7.7	8	8	8	3.5	3.5	3.5	1.5	1.5	1.5	0.9	0.9	0.9
247	467222	6132003	120	120	120	-	-	-	57	57	57	7.8	7.8	7.8	13	13	13	7.4	7.4	7.4	1.3	1.3	1.3	1.9	1.9	1.9
248	470369	6128275	159	159	159	-	-	-	79	79	79	8.1	8.1	8.1	22	22	22	6.8	6.8	6.8	1	1	1	2.5	2.5	2.5
249	465073	6127390	118	118	118	-	-	-	58	58	58	8.2	8.2	8.2	15	15	15	5.8	5.8	5.8	1.1	1.1	1.1	1.9	1.9	1.9
250	475613	6118973	135	135	135	-	-	-	66	66	66	8.7	8.7	8.7	17	17	17	6.8	6.8	6.8	0.5	0.5	0.5	2.1	2.1	2.1
251	458671	6121881	114	114	114	-	-	-	54	54	54	7.9	7.9	7.9	15	15	15	4.8	4.8	4.8	2.4	2.4	2.4	1.7	1.7	1.7
253	444801	6114608	285	285	285	-	-	-	148	148	148	8.7	8.7	8.7	30	30	30	15.2	15.2	15.2	4.8	4.8	4.8	7.7	7.7	7.7
254	446862	6106018	200	200	200	-	-	-	106	106	106	9.5	9.5	9.5	26	26	26	8	8	8	2.1	2.1	2.1	7.9	7.9	7.9
255	443614	6104417	289	289	289	-	-	-	143	143	143	8.5	8.5	8.5	35	35	35	11.3	11.3	11.3	3	3	3	13.3	13.3	13.3
258	470756	6106015	315	315	315	-	-	-	162	162	162	8.5	8.5	8.5	39	39	39	17	17	17	2.8	2.8	2.8	5.9	5.9	5.9
259	476591	6104122	267	267	267	-	-	-	147	147	147	9.2	9.2	9.2	33	33	33	12	12	12	1.7	1.7	1.7	14.1	14.1	14.1
267	442016	6292310	93	93	93	77	77	77	44	44	44	7.8	7.8	7.8	13	13	13	4	4	4	0.9	0.9	0.9	1.8	1.8	1.8
268	506038	6305518	60	60	60	145	145	145	23	23	23	7.2	7.2	7.2	8	8	8	1.8	1.8	1.8	0.5	0.5	0.5	4	4	4
270	505535	6291503	157	157	157	138	138	138	80	80	80	8.3	8.3	8.3	23	23	23	8	8	8	0.3	0.3	0.3	2	2	2
271	549089	6277344	155	155	155	111	111	111	77	77	77	8.7	8.7	8.7	19	19	19	6	6	6	1.4	1.4	1.4	6	6	6
287	487639	6229621	14	14	14	54	54	54	2	2	2	5.2	5.2	5.2	1.2	1.2	1.2	0.3	0.3	0.3	0.5	0.5	0.5	0.6	0.6	0.6
289	477290	6228615	16	16	16	32	32	32	5	5	5	6.5	6.5	6.5	1.8	1.8	1.8	0.5	0.5	0.5	0.4	0.4	0.4	0.6	0.6	0.6
290	486777	6225668	20	20	20	56	56	56	4	4	4	5.8	5.8	5.8	2	2	2	0.8	0.8	0.8	0.5	0.5	0.5	0.8	0.8	0.8
400	535757	6424369	29	29	29	53	53	53	11	11	11	6.8	6.8	6.8	3	3	3	1.3	1.3	1.3	0.5	0.5	0.5	3	3	3
418	485483	6349719	164	164	164	146	146	146	79	79	79	7.9	7.9	7.9	17	17	17	7	7	7	0.9	0.9	0.9	8	8	8
436	401451	6367978	62	62	62	40	40	40	21	21	21	7.1	7.1	7.1	6	6	6	2	2	2	1.1	1.1	1.1	2	2	2
442	417807	6396547	25	25	25	41	41	41	9	9	9	6.7	6.7	6.7	3	3	3	1	1	1	0.4	0.4	0.4	0.9	0.9	0.9
448	425851	6434953	19	19	19	41	41	41	0	0	0	4.2	4.2	4.2	0.6	0.6	0.6	0.2	0.2	0.2	0.1	0.1	0.1	0.8	0.8	0.8
452	509272	6334266	23	23	23	61	61	61	5	5	5	5.9	5.9	5.9	3	3	3	1.0	1.0	1.0	0.1	0.1	0.1	0.6	0.6	0.6
454	416897	6403945	62	62	62	84	84	84	15	15	15	6.9	6.9	6.9	6	6	6	2	2	2	0.8	0.8	0.8	4	4	4
455	396645	6395455	59	59	59	82	82	82	13	13	13	6.8	6.8	6.8	6	6	6	1.9	1.9	1.9	0.8	0.8	0.8	3	3	3
457	405861	6403338	61	61	61	81	81	81	8	8	8	6.5	6.5	6.5	6	6	6	2	2	2	0.8	0.8	0.8	4	4	4
464	403497	6391393	58	58	58	74	74	74	14	14	14	6.9	6.9	6.9	6	6	6	2	2	2	0.6	0.6	0.6	3	3	3
470	463209	6365821	30	30	30	81	81	81	9	9	9	6.4	6.4	6.4	5	5	5	1.4	1.4	1.4	0.3	0.3	0.3	0.7	0.7	0.7
471	463189	6365801	49	49	49	72	72	72	21	21	21	7.0	7.0	7.0	6	6	6	2	2	2	0.1	0.1	0.1	2	2	2
609	520557	6172578	152	152	152	137	137	137	75	75	75	8.1	8.1	8.1	18	18	18	6.7	6.7	6.7	1.7	1.7	1.7	3.7	3.7	3.7
610	509795	6169983	69	69	69	78	78	78	33	33	33	7.8	7.8	7.8	9	9	9	2.7	2.7	2.7	0.8	0.8	0.8	2	2	2
611	527280	6170976	81	81	81	93	93	93	40	40	40	7.8	7.8	7.8	11	11	11	3.3	3.3	3.3	0.6	0.6	0.6	1.4	1.4	1.4
612	508500	6170350	84	84	84	61	61	61	43	43	43	7.8	7.8	7.8	11	11	11	3.7	3.7	3.7	0.8	0.8	0.8	2.3	2.3	2.3
613	509779	6174077	68	68	68	111	111	111	31	31	31	7.5	7.5	7.5	11	11	11	3	3	3	0.6	0.6	0.6	0.8	0.8	0.8
614	513212	6167678	148	148	148	143	143	143	76	76	76	8	8	8	20	20	20	7	7	7	0.2	0.2	0.2	2.5	2.5	2.5
615	513525	6175472	53	53	53	71	71	71	25	25	25	7.6	7.6	7.6	8	8	8	2.3	2.3	2.3	0.5	0.5	0.5	0.8	0.8	0.8
616	514431	6168793	134	134	134	124	124	124	68	68	68	8	8	8	18	18	18	6.3	6.3	6.3	0.4	0.4	0.4	3	3	3
617	515450	6170023	69	69	69	90	90	90	32	32	32	7.6	7.6	7.6	8	8	8	4.3	4.3	4.3	0.5	0.5	0.5	1.7	1.7	1.7
618	515711	6168936	123	123	123	143	143	143	61	61	61	7.9	7.9	7.9	17	17	17	6	6	6	0.5	0.5	0.5	2.7	2.7	2.7
620	522016	6168496	102	102	102	92	92	92	51	51	51	8	8	8	14	14	14	5	5	5	0.5	0.5	0.5	1.2	1.2	1.2
621	523415	6162401	180	180	180	149	149	149	98	98	98	8.8	8.8	8.8	25	25	25	8.3	8.3	8.3	0.8	0.8	0.8	3.3	3.3	3.3
A1	467296	6340324	-	-	-	197	197	197	138	138	138	8.0	8.0	8.0	37	37	37	9	9	9	2	2	2	11	11	11
A100	480014	6371239	-	-	-	-	-	-	128	128	128	8.4	8.4	8.4	24	24	24	15	15	15	3	3	3	4	4	4
A101	559459	6228753	-	-	-	-	-	-	134	134	134	8.5	8.5	8.5	-	-	-	-	-	-	-	-	-	-	-	-
A104	489502	6230877	-	-	-	56	56	56	9	9	9	6.5	6.5	6.5	4	4	4	0.9	0.9	0.9	0.6	0.6	0.6	0.9	0.9	0.9
A11	493516	6226026	-	-	-	46	46	46	42	42	42	7.3	7.3	7.3	10	10	10	2	2	2	0.3	0.3	0.3	2	2	2
A119	505830	6347137	-	-	-	-	-	-	51	51	51	7.8	7.8	7.8	18	18	18	3	3	3	0.1	0.1	0.1	0.5	0.5	0.5

Lake Identifier	Easting	Northing	Specific Conductivity (uS/cm)			TDS (Mg/L)			Total Alkalinity (mg/L $CaCO_3$)			pH (pH Units)			Calcium (mg/L)			Magnesium (mg/L)			Potassium (mg/L)			Sodium (mg/L)		
			Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
A12	554892	6301050	-	-	-	-	-	-	90	90	90	9.6	9.6	9.6	22	22	22	7	7	7	0.5	0.5	0.5	8	8	8
A127	424693	6435793	-	-	-	-	-	-	0	0	0	4.5	4.5	4.5	0.5	0.5	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.5	0.5	0.5
A131	464280	6323724	-	-	-	261	261	261	179	179	179	8.2	8.2	8.2	54	54	54	15	15	15	1	1	1	23	23	23
A134	509160	6422381	-	-	-	84	84	84	81	81	81	7.8	7.8	7.8	20	20	20	7	7	7	0.6	0.6	0.6	0.5	0.5	0.5
A135	501166	6427071	-	-	-	104	104	104	100	100	100	8.1	8.1	8.1	24	24	24	9	9	9	0.6	0.6	0.6	0.5	0.5	0.5
A136	499704	6419587	-	-	-	89	89	89	81	81	81	8.0	8.0	8.0	19	19	19	8	8	8	0.5	0.5	0.5	0.5	0.5	0.5
A137	494569	6419374	-	-	-	92	92	92	99	99	99	8.7	8.7	8.7	16	16	16	10	10	10	0.5	0.5	0.5	0.5	0.5	0.5
A144	392147	6393781	-	-	-	-	-	-	26	26	26	7.0	7.0	7.0	7	7	7	4	4	4	0.2	0.2	0.2	3	3	3
A145	399507	6338927	-	-	-	66	66	66	57	57	57	8.5	8.5	8.5	14	14	14	5	5	5	1	1	1	6	6	6
A146	399323	6341684	-	-	-	81	81	81	58	58	58	7.4	7.4	7.4	14	14	14	4	4	4	3	3	3	6	6	6
A147	396114	6344270	-	-	-	228	228	228	105	105	105	7.4	7.4	7.4	44	44	44	12	12	12	2	2	2	17	17	17
A148	391449	6339131	-	-	-	213	213	213	157	157	157	7.6	7.6	7.6	43	43	43	13	13	13	2	2	2	15	15	15
A149	393657	6384985	-	-	-	-	-	-	18	18	18	7.3	7.3	7.3	6	6	6	2	2	2	0.4	0.4	0.4	2	2	2
A15	538195	6200993	-	-	-	87	87	87	84	84	84	8.9	8.9	8.9	17	17	17	6	6	6	0.9	0.9	0.9	7	7	7
A155	514035	6443734	-	-	-	46	46	46	50	50	50	7.9	7.9	7.9	12	12	12	3	3	3	0.4	0.4	0.4	1	1	1
A156	515504	6436008	-	-	-	41	41	41	42	42	42	7.3	7.3	7.3	8	8	8	1.6	1.6	1.6	1	1	1	2	2	2
A157	539134	6441490	-	-	-	24	24	24	25	25	25	7.8	7.8	7.8	4	4	4	2	2	2	0.4	0.4	0.4	1	1	1
A158	536958	6436149	-	-	-	31	31	31	34	34	34	7.7	7.7	7.7	5	5	5	3	3	3	0.5	0.5	0.5	1	1	1
A16	530780	6261842	-	-	-	-	-	-	141	141	141	8.4	8.4	8.4	24	24	24	10	10	10	1.8	1.8	1.8	21	21	21
A164	448002	6287963	-	-	-	62	62	62	61	61	61	7.5	7.5	7.5	16	16	16	5	5	5	1.1	1.1	1.1	<1	<1	<1
A165	423003	6353012	-	-	-	63	63	63	47	47	47	7.7	7.7	7.7	10	10	10	4	4	4	0.9	0.9	0.9	10	10	10
A167	418303	6353462	-	-	-	104	104	104	65	65	65	7.6	7.6	7.6	22	22	22	7	7	7	0.8	0.8	0.8	9	9	9
A168	427803	6363462	-	-	-	73	73	73	23	23	23	7.7	7.7	7.7	15	15	15	4	4	4	0.9	0.9	0.9	5	5	5
A169	428803	6363212	-	-	-	100	100	100	52	52	52	7.7	7.7	7.7	21	21	21	6	6	6	1.8	1.8	1.8	7	7	7
A17	559468	6264932	-	-	-	-	-	-	123	123	123	8.9	8.9	8.9	19	19	19	18	18	18	1.6	1.6	1.6	5	5	5
A170	429003	6364212	-	-	-	78	78	78	39	39	39	8.0	8.0	8.0	15	15	15	5	5	5	2	2	2	5	5	5
A171	481401	6362412	-	-	-	155	155	155	148	148	148	8.1	8.1	8.1	42	42	42	12	12	12	0.7	0.7	0.7	1	1	1
A172	438802	6390961	-	-	-	34	34	34	29	29	29	7.8	7.8	7.8	9	9	9	3	3	3	<0.1	<0.1	<0.1	1	1	1
A174	505000	6342512	-	-	-	32	32	32	30	30	30	7.0	7.0	7.0	10	10	10	3	3	3	<0.1	<0.1	<0.1	<1	<1	<1
A175	510500	6340812	-	-	-	58	58	58	55	55	55	6.9	6.9	6.9	17	17	17	4	4	4	0.1	0.1	0.1	2	2	2
A176	508300	6333712	-	-	-	10	10	10	5	5	5	6.0	6.0	6.0	4	4	4	1.1	1.1	1.1	<0.1	<0.1	<0.1	<1	<1	<1
A178	483501	6360762	-	-	-	179	179	179	173	173	173	7.7	7.7	7.7	50	50	50	11	11	11	1	1	1	6	6	6
A179	498500	6314212	-	-	-	56	56	56	50	50	50	6.9	6.9	6.9	13	13	13	4	4	4	0.3	0.3	0.3	5	5	5
A18	548243	6260150	-	-	-	-	-	-	133	133	133	7.9	7.9	7.9	33	33	33	10	10	10	1.8	1.8	1.8	8	8	8
A180	514199	6382911	-	-	-	85	85	85	83	83	83	7.8	7.8	7.8	20	20	20	11	11	11	<0.1	<0.1	<0.1	<1	<1	<1
A181	510100	6378311	-	-	-	71	71	71	73	73	73	8.1	8.1	8.1	17	17	17	8	8	8	0.3	0.3	0.3	<1	<1	<1
A182	518699	6364212	-	-	-	46	46	46	43	43	43	7.9	7.9	7.9	12	12	12	4	4	4	<0.1	<0.1	<0.1	1	1	1
A183	479201	6352812	-	-	-	198	198	198	185	185	185	8.0	8.0	8.0	41	41	41	14	14	14	1.1	1.1	1.1	18	18	18
A184	512450	6345512	-	-	-	40	40	40	39	39	39	7.5	7.5	7.5	12	12	12	3	3	3	0.2	0.2	0.2	<1	<1	<1
A185	522999	6333312	-	-	-	131	131	131	126	126	126	8.8	8.8	8.8	26	26	26	10	10	10	0.8	0.8	0.8	15	15	15
A186	529099	6334462	-	-	-	151	151	151	144	144	144	7.9	7.9	7.9	38	38	38	12	12	12	1.6	1.6	1.6	4	4	4
A187	500600	6320312	-	-	-	112	112	112	111	111	111	7.5	7.5	7.5	30	30	30	8	8	8	<0.1	<0.1	<0.1	4	4	4
A188	502300	6317712	-	-	-	77	77	77	73	73	73	6.7	6.7	6.7	21	21	21	6	6	6	<0.1	<0.1	<0.1	3	3	3
A189	447802	6388211	-	-	-	62	62	62	41	41	41	7.8	7.8	7.8	12	12	12	5	5	5	0.4	0.4	0.4	6	6	6
A19	526688	6259959	-	-	-	-	-	-	79	79	79	9.1	9.1	9.1	17	17	17	9	9	9	1.1	1.1	1.1	3	3	3
A190	446002	6394961	-	-	-	13	13	13	9	9	9	8.1	8.1	8.1	2	2	2	1.2	1.2	1.2	0.4	0.4	0.4	1	1	1
A192	444752	6392311	-	-	-	123	123	123	118	118	118	7.8	7.8	7.8	30	30	30	11	11	11	0.5	0.5	0.5	3	3	3
A193	451552	6394711	-	-	-	66	66	66	34	34	34	7.7	7.7	7.7	12	12	12	5	5	5	2	2	2	3	3	3
A194	461501	6391111	-	-	-	251	251	251	180	180	180	7.7	7.7	7.7	32	32	32	28	28	28	14	14	14	17	17	17
A195	451302	6395711	-	-	-	56	56	56	44	44	44	7.9	7.9	7.9	11	11	11	5	5	5	0.8	0.8	0.8	2	2	2
A196	512600	6343712	-	-	-	66	66	66	64	64	64	7.4	7.4	7.4	20	20	20	4	4	4	0.2	0.2	0.2	1	1	1
A197	437402	6398711	-	-	-	58	58	58	50	50	50	7.4	7.4	7.4	14	14	14	6	6	6	0.6	0.6	0.6	3	3	3
A198	425103	6385111	-	-	-	40	40	40	35	35	35	7.6	7.6	7.6	11	11	11	3	3	3	0.5	0.5	0.5	<1	<1	<1
A199	427503	6387611	-	-	-	27	27	27	23	23	23	8.3	8.3	8.3	8	8	8	3	3	3	0.2	0.2	0.2	1	1	1

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			Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
A2	467424	6339125	-	-	-	298	298	298	272	272	272	6.8	6.8	6.8	83	83	83	10	10	10	4	4	4	5	5	5
A201	429803	6377461	-	-	-	18	18	18	14	14	14	8.0	8.0	8.0	6	6	6	1.8	1.8	1.8	0.2	0.2	0.2	<1	<1	<1
A202	428903	6400411	-	-	-	29	29	29	8	8	8	7.8	7.8	7.8	4	4	4	2	2	2	0.3	0.3	0.3	4	4	4
A203	438202	6391811	-	-	-	32	32	32	28	28	28	7.8	7.8	7.8	10	10	10	3	3	3	<0.1	<0.1	<0.1	<1	<1	<1
A204	438752	6392211	-	-	-	31	31	31	26	26	26	7.8	7.8	7.8	10	10	10	3	3	3	<0.1	<0.1	<0.1	<1	<1	<1
A205	516249	6343212	-	-	-	28	28	28	25	25	25	7.4	7.4	7.4	9	9	9	2	2	2	0.2	0.2	0.2	<1	<1	<1
A206	416203	6370462	-	-	-	37	37	37	31	31	31	7.5	7.5	7.5	10	10	10	3	3	3	0.5	0.5	0.5	<1	<1	<1
A207	422403	6371812	-	-	-	39	39	39	29	29	29	7.6	7.6	7.6	11	11	11	3	3	3	0.2	0.2	0.2	<1	<1	<1
A208	411153	6350112	-	-	-	208	208	208	139	139	139	7.9	7.9	7.9	39	39	39	11	11	11	2	2	2	22	22	22
A209	426003	6373212	-	-	-	38	38	38	33	33	33	7.5	7.5	7.5	11	11	11	3	3	3	<0.1	<0.1	<0.1	<1	<1	<1
A21	546271	6252707	-	-	-	-	-	-	145	145	145	8.5	8.5	8.5	27	27	27	13	13	13	3	3	3	12	12	12
A210	524699	6341212	-	-	-	77	77	77	75	75	75	7.9	7.9	7.9	23	23	23	5	5	5	0.2	0.2	0.2	2	2	2
A211	436852	6332462	-	-	-	129	129	129	122	122	122	7.3	7.3	7.3	24	24	24	9	9	9	3	3	3	13	13	13
A212	433852	6330512	-	-	-	163	163	163	156	156	156	7.2	7.2	7.2	33	33	33	12	12	12	2	2	2	14	14	14
A213	425403	6344062	-	-	-	81	81	81	61	61	61	7.6	7.6	7.6	16	16	16	6	6	6	0.9	0.9	0.9	6	6	6
A215	443552	6301613	-	-	-	92	92	92	79	79	79	7.3	7.3	7.3	22	22	22	7	7	7	0.5	0.5	0.5	10	10	10
A218	451762	6293513	-	-	-	40	40	40	35	35	35	7.5	7.5	7.5	11	11	11	4	4	4	0.5	0.5	0.5	<1	<1	<1
A219	451402	6281113	-	-	-	76	76	76	75	75	75	7.5	7.5	7.5	23	23	23	4	4	4	0.7	0.7	0.7	<1	<1	<1
A22	554473	6254660	-	-	-	-	-	-	133	133	133	8.7	8.7	8.7	30	30	30	13	13	13	3	3	3	6	6	6
A220	445481	6278365	-	-	-	164	164	164	163	163	163	7.4	7.4	7.4	53	53	53	7	7	7	0.5	0.5	0.5	2	2	2
A221	493296	6259805	-	-	-	33	33	33	22	22	22	7.7	7.7	7.7	9	9	9	3	3	3	1.3	1.3	1.3	<1	<1	<1
A222	495869	6259633	-	-	-	19	19	19	10	10	10	7.4	7.4	7.4	5	5	5	2	2	2	0.7	0.7	0.7	<1	<1	<1
A223	500505	6255692	-	-	-	15	15	15	9	9	9	7.3	7.3	7.3	5	5	5	1.3	1.3	1.3	0.4	0.4	0.4	<1	<1	<1
A224	498560	6265951	-	-	-	103	103	103	99	99	99	7.5	7.5	7.5	25	25	25	8	8	8	0.4	0.4	0.4	5	5	5
A225	448416	6280450	-	-	-	137	137	137	136	136	136	7.5	7.5	7.5	43	43	43	6	6	6	0.3	0.3	0.3	2	2	2
A226	442406	6276535	-	-	-	133	133	133	130	130	130	7.6	7.6	7.6	42	42	42	6	6	6	0.6	0.6	0.6	2	2	2
A227	446055	6279117	-	-	-	202	202	202	199	199	199	7.4	7.4	7.4	64	64	64	10	10	10	0.5	0.5	0.5	2	2	2
A228	451429	6268553	-	-	-	112	112	112	111	111	111	7.7	7.7	7.7	34	34	34	7	7	7	0.8	0.8	0.8	1	1	1
A229	450033	6268135	-	-	-	91	91	91	89	89	89	7.8	7.8	7.8	29	29	29	5	5	5	0.4	0.4	0.4	<1	<1	<1
A23	536020	6248898	-	-	-	-	-	-	160	160	160	8.7	8.7	8.7	19	19	19	14	14	14	2	2	2	29	29	29
A230	479616	6256890	-	-	-	103	103	103	83	83	83	7.4	7.4	7.4	21	21	21	10	10	10	0.5	0.5	0.5	8	8	8
A231	471630	6268385	-	-	-	107	107	107	67	67	67	7.8	7.8	7.8	14	14	14	5	5	5	3	3	3	20	20	20
A232	488074	6256727	-	-	-	53	53	53	32	32	32	7.6	7.6	7.6	12	12	12	4	4	4	0.5	0.5	0.5	3	3	3
A233	505194	6347380	-	-	-	1	1	1	3	3	3	4.3	4.3	4.3	<0.5	<0.5	<0.5	<0.1	<0.1	<0.1	0.3	0.3	0.3	<1	<1	<1
A234	507264	6347115	-	-	-	36	36	36	35	35	35	6.5	6.5	6.5	11	11	11	3	3	3	0.2	0.2	0.2	<1	<1	<1
A235	505393	6346711	-	-	-	43	43	43	42	42	42	7.0	7.0	7.0	13	13	13	3	3	3	<0.1	<0.1	<0.1	<1	<1	<1
A236	502509	6317128	-	-	-	78	78	78	74	74	74	6.9	6.9	6.9	21	21	21	6	6	6	0.2	0.2	0.2	4	4	4
A237	429874	6398738	-	-	-	55	55	55	50	50	50	8.2	8.2	8.2	14	14	14	5	5	5	<0.1	<0.1	<0.1	<1	<1	<1
A238	430065	6401484	-	-	-	20	20	20	3	3	3	6.7	6.7	6.7	4	4	4	1.7	1.7	1.7	0.2	0.2	0.2	2	2	2
A239	433954	6393613	-	-	-	37	37	37	30	30	30	7.5	7.5	7.5	10	10	10	3	3	3	0.2	0.2	0.2	1	1	1
A24	561829	6243629	-	-	-	-	-	-	87	87	87	8.1	8.1	8.1	23	23	23	7	7	7	0.9	0.9	0.9	8	8	8
A240	438235	6392291	-	-	-	38	38	38	34	34	34	7.7	7.7	7.7	12	12	12	3	3	3	<0.1	<0.1	<0.1	<1	<1	<1
A241	448974	6395163	-	-	-	30	30	30	28	28	28	7.9	7.9	7.9	8	8	8	3	3	3	0.5	0.5	0.5	<1	<1	<1
A242	460732	6391206	-	-	-	191	191	191	157	157	157	7.7	7.7	7.7	36	36	36	19	19	19	6	6	6	8	8	8
A243	445573	6383359	-	-	-	92	92	92	50	50	50	7.8	7.8	7.8	19	19	19	7	7	7	1.5	1.5	1.5	3	3	3
A244	436094	6371181	-	-	-	61	61	61	56	56	56	8.0	8.0	8.0	15	15	15	5	5	5	1.3	1.3	1.3	2	2	2
A245	511576	6415521	-	-	-	118	118	118	118	118	118	7.9	7.9	7.9	27	27	27	12	12	12	0.7	0.7	0.7	1	1	1
A246	495763	6333877	-	-	-	41	41	41	35	35	35	7.9	7.9	7.9	11	11	11	4	4	4	0.2	0.2	0.2	1	1	1
A247	492308	6313536	-	-	-	72	72	72	68	68	68	7.7	7.7	7.7	18	18	18	7	7	7	<0.1	<0.1	<0.1	3	3	3
A248	491531	6306260	-	-	-	71	71	71	67	67	67	7.8	7.8	7.8	20	20	20	6	6	6	0.1	0.1	0.1	2	2	2
A249	513559	6419693	-	-	-	117	117	117	116	116	116	7.8	7.8	7.8	29	29	29	11	11	11	0.5	0.5	0.5	1	1	1
A25	487105	6238562	-	-	-	-	-	-	28	28	28	7.3	7.3	7.3	9	9	9	2	2	2	0.5	0.5	0.5	1.3	1.3	1.3
A250	513190	6386987	-	-	-	131	131	131	122	122	122	7.8	7.8	7.8	29	29	29	13	13	13	1.2	1.2	1.2	5	5	5
A251	514630	6383486	-	-	-	94	94	94	92	92	92	7.5	7.5	7.5	23	23	23	11	11	11	0.3	0.3	0.3	<1	<1	<1

Lake Identifier	Easting	Northing	Specific Conductivity (uS/cm)			TDS (Mg/L)			Total Alkalinity (mg/L $CaCO_3$)			pH (pH Units)			Calcium (mg/L)			Magnesium (mg/L)			Potassium (mg/L)			Sodium (mg/L)		
			Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
A252	511202	6379065	-	-	-	106	106	106	105	105	105	7.8	7.8	7.8	24	24	24	14	14	14	<0.1	<0.1	<0.1	<1	<1	<1
A253	510279	6375937	-	-	-	67	67	67	65	65	65	7.9	7.9	7.9	16	16	16	9	9	9	<0.1	<0.1	<0.1	<1	<1	<1
A254	495957	6334968	-	-	-	52	52	52	47	47	47	8.0	8.0	8.0	13	13	13	4	4	4	0.5	0.5	0.5	2	2	2
A255	414747	6351741	-	-	-	77	77	77	38	38	38	7.5	7.5	7.5	14	14	14	6	6	6	1.6	1.6	1.6	7	7	7
A256	419555	6351513	-	-	-	136	136	136	113	113	113	7.7	7.7	7.7	26	26	26	9	9	9	1.1	1.1	1.1	17	17	17
A257	412268	6345506	-	-	-	61	61	61	54	54	54	7.7	7.7	7.7	13	13	13	4	4	4	4	4	4	2	2	2
A258	494650	6362557	391	391	391	260	260	260	217	217	217	8.3	8.3	8.3	-	-	-	-	-	-	-	-	-	-	-	-
A259	499429	6365047	233	233	233	165	165	165	121	121	121	8.1	8.1	8.1	-	-	-	-	-	-	-	-	-	-	-	-
A26	513417	6236708	-	-	-	-	-	-	155	155	155	8.4	8.4	8.4	42	42	42	12	12	12	1.6	1.6	1.6	10	10	10
A260	485427	6357465	364	364	364	235	235	235	192	192	192	8.2	8.2	8.2	-	-	-	-	-	-	-	-	-	-	-	-
A264	510357	6325686	106	106	106	56	56	56	52	52	52	7.7	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-
A265	515418	6327897	28	28	28	64	64	64	10	10	10	6.7	6.7	6.7	-	-	-	-	-	-	-	-	-	-	-	-
A266	455932	6365954	372	372	372	230	230	230	198	198	198	7.9	7.9	7.9	-	-	-	-	-	-	-	-	-	-	-	-
A267	457730	6374675	1360	1360	1360	955	955	955	739	739	739	9.2	9.2	9.2	-	-	-	-	-	-	-	-	-	-	-	-
A268	455211	6364522	255	255	255	185	185	185	130	130	130	7.7	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-
A269	507163	6322123	59	59	59	33	33	33	31	31	31	7.0	7.0	7.0	-	-	-	-	-	-	-	-	-	-	-	-
A27	525807	6235838	-	-	-	-	-	-	96	96	96	7.9	7.9	7.9	22	22	22	6	6	6	0.5	0.5	0.5	15	15	15
A270	453963	6363973	460	460	460	335	335	335	177	177	177	8.0	8.0	8.0	-	-	-	-	-	-	-	-	-	-	-	-
A272	543213	6362606	23	23	23	60	60	60	8	8	8	6.1	6.1	6.1	-	-	-	-	-	-	-	-	-	-	-	-
A273	524421	6322560	45	45	45	75	75	75	18	18	18	7.0	7.0	7.0	-	-	-	-	-	-	-	-	-	-	-	-
A274	491985	6411122	141	141	141	91	91	91	75	75	75	8.0	8.0	8.0	-	-	-	-	-	-	-	-	-	-	-	-
A275	445617	6381379	124	124	124	91	91	91	35	35	35	7.4	7.4	7.4	-	-	-	-	-	-	-	-	-	-	-	-
A276	444669	6379654	183	183	183	115	115	115	61	61	61	7.6	7.6	7.6	-	-	-	-	-	-	-	-	-	-	-	-
A277	444494	6382690	177	177	177	110	110	110	60	60	60	7.6	7.6	7.6	-	-	-	-	-	-	-	-	-	-	-	-
A278	440554	6382003	30	30	30	55	55	55	10	10	10	6.7	6.7	6.7	-	-	-	-	-	-	-	-	-	-	-	-
A279	548424	6332450	101	101	101	57	57	57	26	26	26	7.5	7.5	7.5	-	-	-	-	-	-	-	-	-	-	-	-
A28	489154	6232991	-	-	-	-	-	-	11	11	11	6.9	6.9	6.9	3	3	3	1	1	1	0.4	0.4	0.4	0.4	0.4	0.4
A280	425152	6365352	261	261	261	148	148	148	134	134	134	8.2	8.2	8.2	-	-	-	-	-	-	-	-	-	-	-	-
A281	433256	6399419	83	83	83	57	57	57	37	37	37	7.4	7.4	7.4	-	-	-	-	-	-	-	-	-	-	-	-
A282	429234	6396488	114	114	114	59	59	59	58	58	58	7.4	7.4	7.4	-	-	-	-	-	-	-	-	-	-	-	-
A283	432607	6405152	81	81	81	55	55	55	34	34	34	7.5	7.5	7.5	-	-	-	-	-	-	-	-	-	-	-	-
A284	420463	6379855	142	142	142	72	72	72	69	69	69	7.6	7.6	7.6	-	-	-	-	-	-	-	-	-	-	-	-
A285	418473	6380141	202	202	202	107	107	107	104	104	104	8.3	8.3	8.3	-	-	-	-	-	-	-	-	-	-	-	-
A286	418436	6390659	105	105	105	55	55	55	52	52	52	8.0	8.0	8.0	11	11	11	4	4	4	0.8	0.8	0.8	2	2	2
A288	410108	6374038	109	109	109	57	57	57	53	53	53	7.6	7.6	7.6	14	14	14	4	4	4	0.8	0.8	0.8	2	2	2
A289	410556	6378483	117	117	117	61	61	61	53	53	53	7.8	7.8	7.8	15	15	15	4	4	4	0.8	0.8	0.8	2	2	2
A290	410374	6386066	106	106	106	56	56	56	44	44	44	7.9	7.9	7.9	14	14	14	4	4	4	1	1	1	2	2	2
A292	419593	6414486	230	230	230	124	124	124	109	109	109	8.0	8.0	8.0	-	-	-	-	-	-	-	-	-	-	-	-
A293	407519	6391915	62	62	62	33	33	33	21	21	21	7.2	7.2	7.2	7	7	7	2	2	2	0.5	0.5	0.5	2	2	2
A295	413279	6411462	40	40	40	25	25	25	11	11	11	6.9	6.9	6.9	-	-	-	-	-	-	-	-	-	-	-	-
A297	501467	6264562	179	179	179	146	146	146	87	87	87	7.7	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-
A298	489731	6258033	126	126	126	71	71	71	51	51	51	8.1	8.1	8.1	17	17	17	4.5	4.5	4.5	1	1	1	3	3	3
A299	498210	6257515	88	88	88	101	101	101	40	40	40	7.1	7.1	7.1	-	-	-	-	-	-	-	-	-	-	-	-
A3	468396	6341424	-	-	-	275	275	275	237	237	237	8.0	8.0	8.0	74	74	74	13	13	13	1	1	1	9	9	9
A300	499562	6256374	188	188	188	141	141	141	97	97	97	7.8	7.8	7.8	-	-	-	-	-	-	-	-	-	-	-	-
A301	504488	6254133	177	177	177	163	163	163	91	91	91	7.7	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-
A302	505212	6252653	163	163	163	151	151	151	91	91	91	7.7	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-
A303	508895	6252653	56	56	56	29	29	29	24	24	24	7.1	7.1	7.1	-	-	-	-	-	-	-	-	-	-	-	-
A304	502017	6251357	75	75	75	93	93	93	32	32	32	7.2	7.2	7.2	-	-	-	-	-	-	-	-	-	-	-	-
A305	507487	6251545	199	199	199	144	144	144	104	104	104	7.7	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-
A306	504672	6250565	92	92	92	83	83	83	44	44	44	7.5	7.5	7.5	-	-	-	-	-	-	-	-	-	-	-	-
A307	502570	6249730	37	37	37	69	69	69	10	10	10	6.2	6.2	6.2	-	-	-	-	-	-	-	-	-	-	-	-
A309	502641	6249587	28	28	28	66	66	66	10	10	10	6.1	6.1	6.1	-	-	-	-	-	-	-	-	-	-	-	-
A310	503226	6248721	83	83	83	93	93	93	40	40	40	7.7	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-

Lake Identifier	Easting	Northing	Specific Conductivity (uS/cm)			TDS (Mg/L)			Total Alkalinity (mg/L $CaCO_3$)			pH (pH Units)			Calcium (mg/L)			Magnesium (mg/L)			Potassium (mg/L)			Sodium (mg/L)		
			Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
A311	482249	6246921	45	45	45	61	61	61	19	19	19	7.0	7.0	7.0	-	-	-	-	-	-	-	-	-	-	-	-
A312	509942	6244399	83	83	83	41	41	41	39	39	39	7.4	7.4	7.4	-	-	-	-	-	-	-	-	-	-	-	-
A313	481229	6244129	43	43	43	53	53	53	19	19	19	7.1	7.1	7.1	-	-	-	-	-	-	-	-	-	-	-	-
A314	480727	6243329	59	59	59	34	34	34	28	28	28	8.1	8.1	8.1	-	-	-	-	-	-	-	-	-	-	-	-
A315	489222	6240033	219	219	219	151	151	151	112	112	112	7.9	7.9	7.9	-	-	-	-	-	-	-	-	-	-	-	-
A316	490427	6237963	38	38	38	95	95	95	7	7	7	5.6	5.6	5.6				-	-	-	-	-	-	-	-	-
A32	487068	6226504	-	-	-	-	-	-	2	2	2	5.2	5.2	5.2	1	1	1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
A329	598819	6389537	42	42	42	30	30	30	19	19	19	6.9	6.9	6.9	-	-	-	-	-	-	-	-	-	-	-	-
A33	480352	6228385	-	-	-	-	-	-	3	3	3	5.6	5.6	5.6	1.4	1.4	1.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
A334	573917	6468241	218	218	218	-	-	-	106	106	106	7.3	7.3	7.3	-	-	-	-	-	-	-	-	-	-	-	-
A335	592417	6259032	229	229	229	190	190	190	119	119	119	8.1	8.1	8.1	-	-	-	-	-	-	-	-	-	-	-	-
A336	595873	6468054	155	155	155	-	-	-	74	74	74	8.1	8.1	8.1	-	-	-	-	-	-	-	-	-	-	-	-
A35	491198	6222320	-	-	-	-	-	-	7	7	7	6.6	6.6	6.6	3	3	3	1.3	1.3	1.3	0.3	0.3	0.3	0.9	0.9	0.9
A36	474058	6213578	-	-	-	-	-	-	31	31	31	7.5	7.5	7.5	10	10	10	2	2	2	0.6	0.6	0.6	2	2	2
A37	540312	6230385	-	-	-	-	-	-	102	102	102	7.9	7.9	7.9	29	29	29	7	7	7	1.3	1.3	1.3	9	9	9
A38	559898	6234325	-	-	-	-	-	-	97	97	97	8.1	8.1	8.1	27	27	27	7	7	7	0.7	0.7	0.7	8	8	8
A4	468346	6341324	-	-	-	145	145	145	131	131	131	8.1	8.1	8.1	36	36	36	7	7	7	3	3	3	5	5	5
A40	543469	6224850	-	-	-	-	-	-	90	90	90	8.6	8.6	8.6	25	25	25	7	7	7	1.1	1.1	1.1	7	7	7
A41	554877	6223126	-	-	-	-	-	-	69	69	69	7.9	7.9	7.9	17	17	17	6	6	6	0.5	0.5	0.5	6	6	6
A42	521815	6208917	-	-	-	-	-	-	104	104	104	8.1	8.1	8.1	24	24	24	8	8	8	1.5	1.5	1.5	16	16	16
A43	420104	6242074	-	-	-	-	-	-	22	22	22	7.5	7.5	7.5	5	5	5	1.3	1.3	1.3	0.6	0.6	0.6	8	8	8
A44	422698	6242954	-	-	-	-	-	-	22	22	22	7.2	7.2	7.2	5	5	5	1.3	1.3	1.3	0.8	0.8	0.8	8	8	8
A45	423113	6237380	-	-	-	-	-	-	21	21	21	7.2	7.2	7.2	6	6	6	1.5	1.5	1.5	0.2	0.2	0.2	8	8	8
A46	413272	6235713	-	-	-	-	-	-	21	21	21	7.1	7.1	7.1	5	5	5	1.2	1.2	1.2	0.3	0.3	0.3	10	10	10
A47	432713	6224230	-	-	-	-	-	-	23	23	23	7.1	7.1	7.1	6	6	6	1.4	1.4	1.4	0.3	0.3	0.3	8	8	8
A48	420620	6214232	-	-	-	-	-	-	17	17	17	7.0	7.0	7.0	7	7	7	1.4	1.4	1.4	0.2	0.2	0.2	4	4	4
A49	413542	6197669	-	-	-	-	-	-	34	34	34	7.5	7.5	7.5	12	12	12	3	3	3	1.1	1.1	1.1	4	4	4
A5	468546	6341424	-	-	-	284	284	284	238	238	238	7.9	7.9	7.9	73	73	73	13	13	13	1	1	1	8	8	8
A50	435471	6200997	-	-	-	-	-	-	19	19	19	7.2	7.2	7.2	9	9	9	3	3	3	1.2	1.2	1.2	15	15	15
A51	432306	6198262	-	-	-	-	-	-	14	14	14	6.9	6.9	6.9	7	7	7	2	2	2	0.6	0.6	0.6	5	5	5
A52	437499	6197257	-	-	-	-	-	-	29	29	29	7.5	7.5	7.5	10	10	10	2	2	2	0.5	0.5	0.5	2	2	2
A55	444222	6193454	-	-	-	-	-	-	41	41	41	7.3	7.3	7.3	13	13	13	3	3	3	0.3	0.3	0.3	1.1	1.1	1.1
A57	458297	6193296	-	-	-	-	-	-	20	20	20	7.3	7.3	7.3	6	6	6	2	2	2	0.6	0.6	0.6	1.2	1.2	1.2
A58	471892	6199679	-	-	-	-	-	-	31	31	31	7.6	7.6	7.6	10	10	10	3	3	3	0.6	0.6	0.6	1.5	1.5	1.5
A59	438646	6204661	-	-	-	-	-	-	50	50	50	7.9	7.9	7.9	16	16	16	5	5	5	0.7	0.7	0.7	4	4	4
A6	468946	6341924	-	-	-	295	295	295	240	240	240	8.2	8.2	8.2	71	71	71	13	13	13	1	1	1	14	14	14
A60	520834	6196855	193	193	193	-	-	-	101	101	101	8.7	8.7	8.7	26	26	26	8	8	8	1.4	1.4	1.4	8	8	8
A61	530203	6197838	-	-	-	-	-	-	81	81	81	8.0	8.0	8.0	21	21	21	6	6	6	1.6	1.6	1.6	10	10	10
A63	534391	6195087	143	143	143	-	-	-	74	74	74	9.1	9.1	9.1	19	19	19	6	6	6	0.9	0.9	0.9	6	6	6
A64	458576	6424286	-	-	-	-	-	-	135	135	135	8.0	8.0	8.0	50	50	50	14	14	14	3	3	3	10	10	10
A65	460558	6425194	-	-	-	-	-	-	137	137	137	8.0	8.0	8.0	43	43	43	12	12	12	3	3	3	14	14	14
A66	463959	6419595	-	-	-	-	-	-	119	119	119	7.9	7.9	7.9	37	37	37	10	10	10	3	3	3	10	10	10
A67	467960	6426055	-	-	-	-	-	-	122	122	122	8.1	8.1	8.1	34	34	34	10	10	10	1.2	1.2	1.2	6	6	6
A68	484230	6426886	-	-	-	-	-	-	92	92	92	8.0	8.0	8.0	26	26	26	6	6	6	1.2	1.2	1.2	2	2	2
A69	486195	6425023	-	-	-	-	-	-	80	80	80	8.1	8.1	8.1	22	22	22	7	7	7	0.5	0.5	0.5	1.7	1.7	1.7
A7	469046	6341224	-	-	-	250	250	250	173	173	173	8.2	8.2	8.2	50	50	50	11	11	11	1	1	1	8	8	8
A70	492115	6426862	-	-	-	-	-	-	46	46	46	7.9	7.9	7.9	12	12	12	4	4	4	0.5	0.5	0.5	3	3	3
A71	499014	6425927	-	-	-	-	-	-	66	66	66	8.1	8.1	8.1	17	17	17	6	6	6	0.7	0.7	0.7	1.3	1.3	1.3
A72	503945	6424692	-	-	-	-	-	-	98	98	98	8.3	8.3	8.3	26	26	26	9	9	9	0.8	0.8	0.8	1.2	1.2	1.2
A73	505917	6424694	-	-	-	-	-	-	97	97	97	8.3	8.3	8.3	26	26	26	9	9	9	0.7	0.7	0.7	1.1	1.1	1.1
A74	498025	6419433	-	-	-	-	-	-	83	83	83	8.1	8.1	8.1	22	22	22	8	8	8	0.6	0.6	0.6	1.3	1.3	1.3
A76	511855	6417594	-	-	-	-	-	-	121	121	121	8.4	8.4	8.4	30	30	30	12	12	12	0.9	0.9	0.9	1.2	1.2	1.2
A77	519237	6423190	-	-	-	-	-	-	57	57	57	7.9	7.9	7.9	17	17	17	4	4	4	0.7	0.7	0.7	1	1	1
A78	522664	6427847	-	-	-	-	-	-	99	99	99	8.4	8.4	8.4	31	31	31	8	8	8	0.8	0.8	0.8	1.2	1.2	1.2

Lake Identifier	Easting	Northing	Specific Conductivity (uS/cm)			TDS (Mg/L)			Total Alkalinity (mg/L $CaCO_3$)			pH (pH Units)			Calcium (mg/L)			Magnesium (mg/L)			Potassium (mg/L)			Sodium (mg/L)		
			Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
A79	521709	6422275	-	-	-	-	-	-	78	78	78	8.2	8.2	8.2	23	23	23	6	6	6	0.6	0.6	0.6	0.9	0.9	0.9
A8	477667	6342728	-	-	-	125	125	125	51	51	51	7.4	7.4	7.4	18	18	18	4	4	4	0.3	0.3	0.3	2	2	2
A80	522212	6420422	-	-	-	-	-	-	134	134	134	8.3	8.3	8.3	34	34	34	9	9	9	0.6	0.6	0.6	1	1	1
A82	541491	6417792	-	-	-	-	-	-	15	15	15	7.2	7.2	7.2	4	4	4	1.6	1.6	1.6	0.8	0.8	0.8	2	2	2
A83	519740	6421337	-	-	-	-	-	-	99	99	99	8.3	8.3	8.3	29	29	29	7	7	7	0.6	0.6	0.6	1	1	1
A84	513888	6400901	-	-	-	-	-	-	47	47	47	8.7	8.7	8.7	14	14	14	4	4	4	0.5	0.5	0.5	1.3	1.3	1.3
A95	544199	6350092	-	-	-	-	-	-	44	44	44	9.6	9.6	9.6	11	11	11	4	4	4	0.3	0.3	0.3	4	4	4
A96	546218	6349186	-	-	-	-	-	-	38	38	38	7.5	7.5	7.5	10	10	10	3	3	3	0.3	0.3	0.3	1.7	1.7	1.7
A97	548250	6347354	-	-	-	-	-	-	63	63	63	8.6	8.6	8.6	18	18	18	5	5	5	0.6	0.6	0.6	3	3	3
L1	548272	6347468	187	187	187	132.5	132.5	132.5	103	103	103	7.5	7.5	7.5	27	27	27	7	7	7	1.2	1.2	1.2	2	2	2
L2	532582	6336811	233	233	233	154	154	154	134	134	134	7.7	7.7	7.7	33	33	33	9	9	9	0.7	0.7	0.7	8	8	8
L3	521045	6334999	201	201	201	165	165	165	111	111	111	7.7	7.7	7.7	26	26	26	8	8	8	<0.5	<0.5	<0.5	6	6	6
L4	549160	6336712	213	213	213	160	160	160	119	119	119	7.4	7.4	7.4	27	27	27	11	11	11	0.6	0.6	0.6	3	3	3
L5	538207	6329618	84	84	84	70	70	70	32	32	32	7.1	7.1	7.1	4	4	4	1.5	1.5	1.5	0.6	0.6	0.6	10	10	10
Lake 1	504611	6348971	28.5	28.5	28.5	46	46	46	6	6	6	6.4	6.4	6.4	2	2	2	0.9	0.9	0.9	0.4	0.4	0.4	1	1	1
Lake 3	503115	6346030	89.6	89.6	89.6	68.3	68.3	68.3	42	42	42	7.6	7.6	7.6	12	12	12	3	3	3	0.3	0.3	0.3	1.9	1.9	1.9
MARG-10	514206	6386908	472	472	472	-	-	-	176	176	176	8.0	8.0	8.0	61	61	61	21	21	21	0.6	0.6	0.6	7	7	7
MARG-11	514804	6379194	241	241	241	-	-	-	130	130	130	7.8	7.8	7.8	31	31	31	13	13	13	0.7	0.7	0.7	1.3	1.3	1.3
MARG-12	506731	6375307	280	280	280	-	-	-	88	88	88	7.7	7.7	7.7	42	42	42	16	16	16	0.4	0.4	0.4	0.5	0.5	0.5
MARG-13	508943	6386459	307	307	307	-	-	-	160	160	160	8.0	8.0	8.0	40	40	40	14	14	14	1.1	1.1	1.1	6	6	6
MARG-14	505834	6388522	264	264	264	-	-	-	137	137	137	7.9	7.9	7.9	33	33	33	13	13	13	1.1	1.1	1.1	5	5	5
MARG-4	537856	6391632	504	504	504	-	-	-	166	166	166	7.8	7.8	7.8	75	75	75	20	20	20	1.1	1.1	1.1	7	7	7
MARG-5	529365	6384964	383	383	383	-	-	-	134	134	134	8.0	8.0	8.0	51	51	51	17	17	17	0.6	0.6	0.6	6	6	6
MARG-6	533551	6369446	197	197	197	-	-	-	64	64	64	7.6	7.6	7.6	28	28	28	8	8	8	1.7	1.7	1.7	1.3	1.3	1.3
MARG-7	527691	6391094	428	428	428	-	-	-	155	155	155	8.0	8.0	8.0	62	62	62	21	21	21	0.7	0.7	0.7	3	3	3
MARG-8	527122	6386669	284	284	284	-	-	-	100	100	100	7.7	7.7	7.7	38	38	38	15	15	15	1.8	1.8	1.8	2	2	2
MARG-9	520754	6384785	248	248	248	-	-	-	104	104	104	7.7	7.7	7.7	31	31	31	14	14	14	1.2	1.2	1.2	1.3	1.3	1.3
P1	485815	6301144	142	142	142	128	128	128	202	202	202	7.9	7.9	7.9	20	20	20	7	7	7	0.8	0.8	0.8	1.6	1.6	1.6
P2	482247	6300238	142	142	142	128	128	128	202	202	202	7.9	7.9	7.9	20	20	20	7	7	7	0.8	0.8	0.8	1.6	1.6	1.6
P3	482636	6299586	142	142	142	128	128	128	202	202	202	7.9	7.9	7.9	20	20	20	7	7	7	0.8	0.8	0.8	1.6	1.6	1.6
P4	482738	6299381	142	142	142	128	128	128	202	202	202	7.9	7.9	7.9	20	20	20	7	7	7	0.8	0.8	0.8	1.6	1.6	1.6
P5	477192	6296814	439	439	439	314	314	314	232	232	232	8.3	8.3	8.3	58	58	58	16	16	16	0.68	0.68	0.68	23	23	23
UFR-4	506016	6347135	76.8	76.8	76.8	68	68	68	34	34	34	7.2	7.2	7.2	11	11	11	2	2	2	0.3	0.3	0.3	1	1	1

Ivanhoe Energy

Appendix J

Acidifying Emissions Assessment

Table SIR2 J-1: Calculated Lake Critical Loads and Predicted Acid Deposition in the ALSA, ARSA and AQRSA (keq H+/ha/yr)

Area	Lake Identifier	Easting	Northing	Critical Load [CL] (keq H+/ha/yr)	Baseline			Application			Planned Development			Baseline	Application	Planned Development
					PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	Critical Load minus Deposition	Critical Load minus Deposition	Critical Load minus Deposition
ALSA	P1	485815	6301144	1.13	0.516	0.075	0.439	0.613	0.127	0.528	0.669	0.143	0.588	0.610	0.495	0.430
ALSA	P2	482247	6300238	3.23	0.670	0.076	0.591	0.759	0.135	0.675	0.817	0.151	0.729	2.561	2.449	2.387
ALSA	P3	482636	6299586	3.23	0.615	0.076	0.530	0.730	0.153	0.645	0.789	0.168	0.699	2.619	2.472	2.408
ALSA	P4	482738	6299381	3.23	0.607	0.075	0.522	0.726	0.155	0.643	0.784	0.170	0.697	2.627	2.474	2.411
ALSA	P5	477192	6296814	4.05	0.620	0.066	0.534	0.634	0.082	0.571	0.692	0.095	0.615	3.435	3.405	3.347
AQRSA	L1	548272	6347468	2.01	0.217	0.028	0.109	0.219	0.029	0.112	0.237	0.034	0.131	1.829	1.826	1.806
AQRSA	L2	532582	6336811	2.68	0.283	0.047	0.169	0.288	0.049	0.173	0.316	0.057	0.201	2.422	2.417	2.385
AQRSA	L3	521045	6334999	2.16	0.343	0.058	0.237	0.349	0.060	0.241	0.386	0.070	0.277	1.836	1.830	1.789
AQRSA	L4	549160	6336712	2.34	0.191	0.025	0.089	0.193	0.026	0.091	0.208	0.031	0.109	2.179	2.176	2.158
AQRSA	L5	538207	6329618	0.70	0.223	0.035	0.120	0.227	0.036	0.123	0.247	0.042	0.144	0.506	0.502	0.478
AQRSA	185	509201	6334194	0.22	0.357	0.061	0.278	0.363	0.064	0.283	0.402	0.075	0.323	**-0.124**	**-0.131**	**-0.175**
AQRSA	209	515366	6343123	0.26	0.409	0.069	0.318	0.414	0.071	0.322	0.452	0.082	0.364	**-0.135**	**-0.140**	**-0.185**
AQRSA	452	509272	6334266	0.21	0.355	0.061	0.277	0.361	0.063	0.282	0.400	0.074	0.322	**-0.139**	**-0.145**	**-0.189**
AQRSA	A95	544199	6350092	0.96	0.224	0.030	0.118	0.226	0.031	0.120	0.245	0.037	0.141	0.770	0.767	0.745
AQRSA	A96	546218	6349186	0.77	0.222	0.029	0.116	0.225	0.030	0.118	0.243	0.036	0.139	0.576	0.573	0.552
AQRSA	A97	548250	6347354	1.40	0.217	0.028	0.110	0.220	0.029	0.112	0.237	0.035	0.131	1.213	1.210	1.190
AQRSA	A175	510500	6340812	1.18	0.366	0.069	0.354	0.370	0.071	0.357	0.402	0.080	0.394	0.791	0.787	0.749
AQRSA	A176	508300	6333712	0.23	0.366	0.063	0.285	0.373	0.065	0.290	0.413	0.077	0.332	**-0.129**	**-0.136**	**-0.182**
AQRSA	A184	512450	6345512	0.77	0.489	0.080	0.383	0.493	0.082	0.387	0.532	0.093	0.430	0.291	0.286	0.240
AQRSA	A185	522999	6333312	2.68	0.315	0.054	0.210	0.321	0.056	0.215	0.355	0.066	0.249	2.391	2.384	2.346
AQRSA	A186	529099	6334462	3.04	0.271	0.044	0.169	0.275	0.046	0.172	0.303	0.054	0.201	2.798	2.793	2.762
AQRSA	A196	512600	6343712	1.28	0.390	0.066	0.328	0.394	0.068	0.332	0.430	0.079	0.372	0.892	0.887	0.845
AQRSA	A205	516249	6343212	0.58	0.420	0.070	0.319	0.424	0.072	0.323	0.463	0.084	0.365	0.175	0.170	0.124
AQRSA	A210	524699	6341212	1.57	0.365	0.060	0.241	0.370	0.062	0.245	0.407	0.073	0.283	1.236	1.230	1.188
AQRSA	A265	515418	6327897	0.27	0.366	0.064	0.258	0.373	0.067	0.264	0.411	0.078	0.304	**-0.079**	**-0.087**	**-0.130**
AQRSA	A273	524421	6322560	0.43	0.333	0.066	0.216	0.342	0.070	0.223	0.382	0.080	0.262	0.120	0.110	0.066
AQRSA	UFR-4	506016	6347135	0.72	0.489	0.077	0.457	0.493	0.079	0.461	0.542	0.094	0.515	0.215	0.210	0.152
AQRSA	MARG-14	505834	6388522	2.87	0.418	0.033	0.307	0.420	0.034	0.309	0.460	0.043	0.345	2.484	2.482	2.439
AQRSA	MARG-4	537856	6391632	5.68	0.223	0.021	0.115	0.225	0.022	0.117	0.244	0.027	0.136	5.492	5.491	5.470
AQRSA	MARG-13	508943	6386459	3.39	0.426	0.033	0.311	0.428	0.034	0.312	0.469	0.044	0.350	2.995	2.993	2.949
AQRSA	MARG-11	514804	6379194	2.61	0.416	0.036	0.305	0.418	0.037	0.307	0.461	0.047	0.346	2.228	2.225	2.180
AQRSA	MARG-12	506731	6375307	3.35	0.602	0.041	0.488	0.605	0.043	0.490	0.658	0.055	0.540	2.777	2.774	2.717
AQRSA	MARG-10	514206	6386908	5.06	0.378	0.031	0.262	0.380	0.033	0.264	0.417	0.041	0.300	4.716	4.713	4.674
AQRSA	MARG-9	520754	6384785	2.73	0.347	0.031	0.234	0.349	0.032	0.236	0.384	0.041	0.269	2.416	2.414	2.376
AQRSA	MARG-7	527691	6391094	4.90	0.281	0.026	0.167	0.282	0.027	0.168	0.309	0.033	0.194	4.661	4.659	4.630
AQRSA	MARG-8	527122	6386669	3.19	0.295	0.028	0.184	0.296	0.029	0.186	0.326	0.036	0.214	2.927	2.925	2.894
AQRSA	MARG-5	529365	6384964	4.13	0.270	0.027	0.163	0.272	0.028	0.164	0.298	0.034	0.189	3.891	3.889	3.861
AQRSA	MARG-6	533551	6369446	2.10	0.277	0.035	0.172	0.280	0.036	0.174	0.306	0.043	0.201	1.855	1.853	1.823
AQRSA	182	508983	6346815	0.99	0.443	0.084	0.445	0.447	0.086	0.448	0.489	0.099	0.495	0.513	0.508	0.459
AQRSA	A84	513888	6400901	1.02	0.309	0.026	0.198	0.310	0.027	0.199	0.340	0.034	0.227	0.746	0.744	0.712
AQRSA	A180	514199	6382911	1.87	0.397	0.033	0.280	0.399	0.034	0.282	0.438	0.043	0.319	1.513	1.510	1.468
AQRSA	A181	510100	6378311	1.46	0.485	0.037	0.369	0.487	0.039	0.371	0.534	0.049	0.415	1.012	1.010	0.960
AQRSA	A182	518699	6364212	0.93	0.376	0.044	0.265	0.379	0.045	0.268	0.420	0.055	0.307	0.581	0.578	0.534
AQRSA	A233	505194	6347380	-0.03	0.561	0.077	0.481	0.565	0.079	0.486	0.622	0.096	0.546	**-0.589**	**-0.594**	**-0.659**
AQRSA	A234	507264	6347115	0.70	0.457	0.076	0.424	0.461	0.078	0.428	0.507	0.092	0.479	0.228	0.223	0.170
AQRSA	A235	505393	6346711	0.86	0.504	0.077	0.466	0.508	0.079	0.470	0.560	0.094	0.525	0.341	0.336	0.277
AQRSA	A250	513190	6386987	2.67	0.376	0.031	0.261	0.378	0.032	0.263	0.414	0.041	0.298	2.327	2.325	2.285
AQRSA	A251	514630	6383486	2.02	0.392	0.033	0.275	0.393	0.034	0.277	0.432	0.043	0.314	1.666	1.664	1.622
AQRSA	A252	511202	6379065	2.30	0.475	0.037	0.359	0.477	0.038	0.361	0.523	0.049	0.405	1.863	1.860	1.810
AQRSA	A253	510279	6375937	1.46	0.501	0.040	0.390	0.504	0.041	0.393	0.553	0.053	0.438	0.985	0.982	0.929
AQRSA	A259	499429	6365047	2.71	1.449	0.057	1.456	1.453	0.059	1.459	1.525	0.074	1.523	1.229	1.225	1.150
AQRSA	A272	543213	6362606	0.22	0.256	0.033	0.143	0.258	0.034	0.145	0.280	0.040	0.168	0.000	**-0.002**	**-0.028**
AQRSA	Lake1	504611	6348971	0.18	0.616	0.079	0.516	0.620	0.082	0.521	0.683	0.099	0.586	**-0.433**	**-0.438**	**-0.509**

Area	Lake Identifier	Easting	Northing	Critical Load [CL] (keq H+/ha/yr)	Baseline PAI (keq/ha/yr)	Baseline Sulphur Deposition (keq/ha/yr)	Baseline Total Nitrogen Deposition (keq/ha/yr)	Application PAI (keq/ha/yr)	Application Sulphur Deposition (keq/ha/yr)	Application Total Nitrogen Deposition (keq/ha/yr)	Planned Development PAI (keq/ha/yr)	Planned Development Sulphur Deposition (keq/ha/yr)	Planned Development Total Nitrogen Deposition (keq/ha/yr)	Baseline Critical Load minus Deposition	Application Critical Load minus Deposition	Planned Development Critical Load minus Deposition
AQRSA	Lake3	503115	6346030	0.88	0.598	0.079	0.514	0.602	0.082	0.519	0.664	0.099	0.582	0.284	0.279	0.209
AQRSA	167	466149	6224878	0.10	0.194	0.021	0.085	0.196	0.022	0.087	0.234	0.028	0.131	**-0.060**	**-0.062**	**-0.106**
AQRSA	168	483758	6235155	0.07	0.235	0.034	0.131	0.240	0.036	0.134	0.298	0.047	0.197	**-0.140**	**-0.145**	**-0.210**
AQRSA	169	484261	6230771	0.05	0.215	0.030	0.108	0.219	0.031	0.111	0.264	0.040	0.163	**-0.136**	**-0.140**	**-0.192**
AQRSA	170	489580	6230843	0.07	0.229	0.034	0.118	0.233	0.035	0.121	0.290	0.046	0.190	**-0.128**	**-0.133**	**-0.199**
AQRSA	175	415829	6353313	1.29	0.214	0.025	0.108	0.216	0.026	0.110	0.237	0.032	0.131	1.113	1.111	1.087
AQRSA	199	446802	6395072	0.22	0.232	0.032	0.111	0.234	0.032	0.113	0.260	0.039	0.137	0.022	0.020	**-0.009**
AQRSA	223	440822	6334920	1.30	0.531	0.043	0.439	0.534	0.045	0.442	0.604	0.056	0.517	0.793	0.789	0.712
AQRSA	225	443913	6295483	0.79	0.461	0.067	0.345	0.469	0.071	0.352	0.534	0.087	0.410	0.354	0.344	0.275
AQRSA	226	455811	6296483	0.44	0.629	0.101	0.494	0.642	0.106	0.505	0.720	0.128	0.573	**-0.172**	**-0.186**	**-0.269**
AQRSA	227	451914	6292827	0.91	0.519	0.080	0.394	0.530	0.085	0.404	0.594	0.103	0.461	0.411	0.399	0.331
AQRSA	267	442016	6292310	0.85	0.367	0.054	0.263	0.373	0.057	0.268	0.421	0.070	0.313	0.508	0.501	0.449
AQRSA	268	506038	6305518	0.56	0.358	0.065	0.266	0.383	0.075	0.285	0.435	0.087	0.337	0.213	0.186	0.129
AQRSA	270	505535	6291503	1.40	0.347	0.062	0.243	0.368	0.071	0.262	0.418	0.083	0.313	1.067	1.043	0.987
AQRSA	271	549089	6277344	1.33	0.216	0.033	0.102	0.222	0.035	0.106	0.249	0.041	0.133	1.145	1.139	1.110
AQRSA	287	487639	6229621	0.04	0.217	0.031	0.109	0.221	0.033	0.112	0.270	0.042	0.173	**-0.147**	**-0.151**	**-0.209**
AQRSA	289	477290	6228615	0.11	0.207	0.026	0.099	0.210	0.027	0.102	0.250	0.034	0.146	**-0.063**	**-0.066**	**-0.110**
AQRSA	290	486777	6225668	0.12	0.200	0.027	0.093	0.203	0.028	0.096	0.239	0.035	0.144	**-0.047**	**-0.050**	**-0.094**
AQRSA	400	535757	6424369	0.26	0.219	0.019	0.109	0.220	0.020	0.110	0.239	0.025	0.128	0.080	0.079	0.059
AQRSA	418	485483	6349719	1.74	1.570	0.075	1.523	1.574	0.077	1.526	1.663	0.101	1.633	0.162	0.158	0.052
AQRSA	436	401451	6367978	0.57	0.148	0.015	0.039	0.149	0.016	0.039	0.157	0.018	0.048	0.463	0.461	0.452
AQRSA	442	417807	6396547	0.19	0.161	0.019	0.044	0.162	0.020	0.045	0.172	0.023	0.055	0.069	0.068	0.057
AQRSA	448	425851	6434953	0.01	0.144	0.012	0.036	0.144	0.012	0.037	0.152	0.015	0.044	**-0.095**	**-0.096**	**-0.104**
AQRSA	454	416897	6403945	0.51	0.151	0.016	0.039	0.152	0.016	0.039	0.160	0.018	0.047	0.400	0.399	0.390
AQRSA	455	396645	6395455	0.55	0.143	0.012	0.030	0.143	0.012	0.030	0.150	0.014	0.037	0.448	0.447	0.440
AQRSA	457	405861	6403338	0.48	0.143	0.013	0.032	0.144	0.013	0.033	0.150	0.015	0.040	0.382	0.381	0.374
AQRSA	464	403497	6391393	0.52	0.151	0.015	0.036	0.152	0.015	0.037	0.160	0.018	0.044	0.412	0.411	0.402
AQRSA	470	463209	6365821	0.31	2.360	0.116	2.289	2.364	0.118	2.293	2.561	0.137	2.498	**-2.069**	**-2.074**	**-2.283**
AQRSA	471	463189	6365801	0.45	2.364	0.116	2.294	2.369	0.118	2.298	2.566	0.138	2.503	**-1.929**	**-1.934**	**-2.143**
AQRSA	A1	467296	6340324	3.05	2.136	0.109	2.319	2.142	0.112	2.325	2.400	0.255	2.646	0.797	0.790	0.445
AQRSA	A2	467424	6339125	5.27	2.049	0.110	2.246	2.055	0.113	2.252	2.292	0.257	2.578	3.091	3.084	2.749
AQRSA	A3	468396	6341424	5.10	1.877	0.102	1.928	1.883	0.105	1.934	2.136	0.220	2.220	3.162	3.155	2.841
AQRSA	A4	468346	6341324	2.58	1.890	0.103	1.945	1.896	0.105	1.951	2.149	0.222	2.239	0.625	0.618	0.302
AQRSA	A5	468546	6341424	4.94	1.859	0.102	1.904	1.864	0.105	1.910	2.117	0.219	2.195	3.023	3.016	2.703
AQRSA	A6	468946	6341924	5.13	1.750	0.099	1.769	1.756	0.102	1.775	2.005	0.208	2.051	3.330	3.323	3.018
AQRSA	A7	469046	6341224	3.69	1.815	0.101	1.847	1.821	0.104	1.853	2.072	0.216	2.136	1.819	1.812	1.502
AQRSA	A8	477667	6342728	1.25	1.619	0.081	1.661	1.623	0.083	1.665	1.708	0.118	1.789	**-0.417**	**-0.422**	**-0.538**
AQRSA	A11	493516	6226026	0.69	0.223	0.033	0.109	0.227	0.034	0.112	0.286	0.045	0.180	0.497	0.493	0.426
AQRSA	A12	554892	6301050	1.92	0.219	0.031	0.092	0.224	0.034	0.096	0.247	0.039	0.117	1.741	1.736	1.712
AQRSA	A15	538195	6200993	1.60	0.201	0.026	0.091	0.204	0.028	0.093	0.236	0.033	0.127	1.436	1.433	1.398
AQRSA	A16	530780	6261842	2.92	0.200	0.031	0.092	0.203	0.033	0.095	0.227	0.040	0.119	2.752	2.748	2.721
AQRSA	A17	559468	6264932	2.61	0.201	0.028	0.085	0.205	0.030	0.088	0.228	0.035	0.112	2.448	2.444	2.418
AQRSA	A18	548243	6260150	2.77	0.203	0.029	0.090	0.207	0.030	0.093	0.231	0.036	0.118	2.602	2.598	2.571
AQRSA	A19	526688	6259959	1.72	0.234	0.038	0.122	0.239	0.040	0.126	0.276	0.048	0.161	1.516	1.510	1.470
AQRSA	A21	546271	6252707	3.00	0.193	0.028	0.080	0.195	0.029	0.082	0.218	0.034	0.106	2.839	2.836	2.810
AQRSA	A22	554473	6254660	2.89	0.199	0.028	0.084	0.202	0.029	0.086	0.227	0.034	0.112	2.724	2.720	2.693
AQRSA	A23	536020	6248898	3.30	0.217	0.033	0.104	0.221	0.035	0.107	0.256	0.042	0.142	3.114	3.110	3.071
AQRSA	A24	561829	6243629	1.97	0.181	0.024	0.067	0.183	0.025	0.069	0.204	0.030	0.090	1.827	1.825	1.802
AQRSA	A25	487105	6238562	0.63	0.253	0.039	0.151	0.259	0.041	0.156	0.321	0.055	0.234	0.407	0.401	0.327
AQRSA	A26	513417	6236708	3.43	0.241	0.040	0.127	0.245	0.042	0.131	0.328	0.055	0.213	3.221	3.216	3.129
AQRSA	A27	525807	6235838	2.21	0.221	0.032	0.110	0.225	0.034	0.113	0.272	0.042	0.159	2.021	2.016	1.966
AQRSA	A28	489154	6232991	0.21	0.240	0.035	0.130	0.244	0.037	0.134	0.304	0.048	0.207	0.002	**-0.003**	**-0.073**
AQRSA	A32	487068	6226504	0.02	0.202	0.028	0.095	0.205	0.029	0.098	0.242	0.036	0.147	**-0.144**	**-0.148**	**-0.193**
AQRSA	A33	480352	6228385	0.05	0.204	0.026	0.097	0.208	0.028	0.100	0.246	0.034	0.144	**-0.124**	**-0.127**	**-0.171**
AQRSA	A35	491198	6222320	0.22	0.214	0.028	0.105	0.217	0.030	0.107	0.260	0.037	0.155	0.043	0.039	**-0.009**

Area	Lake Identifier	Easting	Northing	Critical Load [CL] (keq H+/ha/yr)	Baseline			Application			Planned Development			Baseline	Application	Planned Development
					PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	Critical Load minus Deposition	Critical Load minus Deposition	Critical Load minus Deposition
AQRSA	A36	474058	6213578	0.70	0.179	0.019	0.070	0.181	0.020	0.071	0.210	0.025	0.114	0.559	0.557	0.519
AQRSA	A37	540312	6230385	2.38	0.205	0.028	0.095	0.209	0.029	0.098	0.247	0.036	0.136	2.205	2.201	2.160
AQRSA	A38	559898	6234325	2.23	0.185	0.024	0.072	0.187	0.025	0.073	0.211	0.030	0.097	2.083	2.080	2.054
AQRSA	A40	543469	6224850	2.07	0.201	0.026	0.090	0.204	0.027	0.093	0.239	0.034	0.130	1.900	1.897	1.858
AQRSA	A41	554877	6223126	1.55	0.194	0.025	0.081	0.196	0.026	0.083	0.227	0.032	0.113	1.390	1.387	1.355
AQRSA	A42	521815	6208917	2.48	0.205	0.028	0.095	0.208	0.029	0.097	0.248	0.036	0.141	2.305	2.301	2.257
AQRSA	A43	420104	6242074	0.64	0.203	0.021	0.091	0.205	0.022	0.093	0.225	0.026	0.113	0.479	0.477	0.455
AQRSA	A44	422698	6242954	0.61	0.217	0.022	0.104	0.220	0.024	0.106	0.242	0.029	0.128	0.435	0.432	0.407
AQRSA	A45	423113	6237380	0.67	0.199	0.021	0.088	0.201	0.022	0.090	0.221	0.026	0.110	0.506	0.503	0.481
AQRSA	A46	413272	6235713	0.68	0.181	0.019	0.071	0.183	0.019	0.072	0.199	0.023	0.089	0.539	0.537	0.519
AQRSA	A47	432713	6224230	0.71	0.180	0.019	0.074	0.183	0.020	0.076	0.201	0.024	0.098	0.562	0.560	0.538
AQRSA	A48	420620	6214232	0.56	0.164	0.015	0.056	0.166	0.015	0.057	0.179	0.018	0.072	0.440	0.438	0.423
AQRSA	A49	413542	6197669	0.92	0.156	0.012	0.047	0.158	0.013	0.048	0.171	0.016	0.061	0.805	0.804	0.790
AQRSA	A50	435471	6200997	1.29	0.173	0.014	0.069	0.174	0.015	0.071	0.199	0.018	0.092	1.157	1.155	1.131
AQRSA	A51	432306	6198262	0.65	0.192	0.014	0.085	0.193	0.015	0.086	0.234	0.018	0.106	0.492	0.490	0.457
AQRSA	A52	437499	6197257	0.71	0.179	0.014	0.074	0.180	0.015	0.075	0.208	0.018	0.098	0.567	0.565	0.538
AQRSA	A58	471892	6199679	0.71	0.181	0.017	0.070	0.183	0.018	0.071	0.229	0.024	0.126	0.570	0.568	0.516
AQRSA	A59	438646	6204661	1.33	0.177	0.014	0.076	0.178	0.015	0.077	0.200	0.019	0.100	1.188	1.187	1.163
AQRSA	A61	530203	6197838	1.89	0.207	0.029	0.095	0.210	0.030	0.098	0.248	0.036	0.139	1.720	1.718	1.675
AQRSA	A64	458576	6424286	4.05	0.199	0.020	0.087	0.200	0.020	0.088	0.217	0.025	0.104	3.891	3.889	3.871
AQRSA	A65	460558	6425194	3.80	0.200	0.019	0.088	0.201	0.020	0.089	0.218	0.024	0.105	3.638	3.637	3.618
AQRSA	A66	463959	6419595	3.13	0.234	0.023	0.118	0.235	0.024	0.119	0.258	0.029	0.139	2.933	2.931	2.907
AQRSA	A67	467960	6426055	2.70	0.223	0.020	0.110	0.225	0.020	0.112	0.245	0.025	0.129	2.520	2.518	2.497
AQRSA	A68	484230	6426886	1.87	0.258	0.020	0.145	0.260	0.021	0.147	0.282	0.026	0.167	1.652	1.650	1.627
AQRSA	A69	486195	6425023	1.69	0.268	0.021	0.155	0.270	0.022	0.157	0.293	0.027	0.178	1.460	1.458	1.433
AQRSA	A70	492115	6426862	0.98	0.266	0.021	0.154	0.268	0.022	0.155	0.292	0.027	0.177	0.750	0.749	0.724
AQRSA	A71	499014	6425927	1.32	0.261	0.021	0.150	0.262	0.022	0.151	0.286	0.027	0.173	1.101	1.099	1.074
AQRSA	A72	503945	6424692	2.02	0.260	0.021	0.148	0.261	0.022	0.150	0.285	0.027	0.171	1.799	1.797	1.772
AQRSA	A73	505917	6424694	2.01	0.260	0.021	0.149	0.262	0.022	0.150	0.286	0.027	0.172	1.785	1.784	1.758
AQRSA	A74	498025	6419433	1.75	0.283	0.023	0.173	0.285	0.024	0.175	0.312	0.030	0.199	1.502	1.500	1.471
AQRSA	A76	511855	6417594	2.52	0.261	0.022	0.153	0.263	0.023	0.154	0.288	0.028	0.177	2.298	2.296	2.270
AQRSA	A77	519237	6423190	1.15	0.243	0.020	0.133	0.245	0.021	0.134	0.268	0.026	0.155	0.941	0.939	0.915
AQRSA	A78	522664	6427847	2.18	0.235	0.020	0.124	0.236	0.020	0.125	0.258	0.025	0.145	1.986	1.985	1.962
AQRSA	A79	521709	6422275	1.59	0.239	0.020	0.128	0.240	0.021	0.130	0.262	0.026	0.150	1.389	1.387	1.364
AQRSA	A80	522212	6420422	2.39	0.240	0.021	0.132	0.242	0.021	0.133	0.263	0.027	0.154	2.191	2.189	2.165
AQRSA	A82	541491	6417792	0.40	0.218	0.020	0.105	0.219	0.020	0.106	0.236	0.025	0.124	0.219	0.218	0.198
AQRSA	A83	519740	6421337	2.01	0.245	0.021	0.136	0.246	0.021	0.137	0.269	0.027	0.158	1.802	1.801	1.776
AQRSA	A100	480014	6371239	2.66	0.717	0.053	0.595	0.720	0.055	0.597	0.792	0.071	0.664	1.971	1.967	1.891
AQRSA	A101	559459	6228753	2.99	0.189	0.025	0.076	0.192	0.026	0.078	0.219	0.031	0.105	2.840	2.837	2.808
AQRSA	A104	489502	6230877	0.27	0.229	0.034	0.119	0.233	0.035	0.122	0.290	0.046	0.191	0.076	0.072	0.005
AQRSA	A127	424693	6435793	0.02	0.144	0.012	0.036	0.144	0.012	0.036	0.151	0.014	0.043	**-0.085**	**-0.086**	**-0.094**
AQRSA	A131	464280	6323724	4.90	0.781	0.141	0.822	0.787	0.144	0.828	0.850	0.169	0.915	4.043	4.036	3.953
AQRSA	A164	448002	6287963	1.16	0.412	0.061	0.294	0.419	0.064	0.301	0.468	0.078	0.346	0.775	0.767	0.713
AQRSA	A165	423003	6353012	1.27	0.250	0.031	0.148	0.253	0.032	0.150	0.279	0.039	0.178	1.049	1.046	1.017
AQRSA	A167	418303	6353462	2.00	0.223	0.027	0.118	0.226	0.028	0.120	0.247	0.034	0.143	1.811	1.809	1.784
AQRSA	A168	427803	6363462	1.24	0.255	0.034	0.138	0.257	0.035	0.140	0.285	0.042	0.166	1.023	1.021	0.991
AQRSA	A169	428803	6363212	1.80	0.256	0.034	0.140	0.259	0.036	0.142	0.287	0.043	0.168	1.575	1.572	1.542
AQRSA	A170	429003	6364212	1.30	0.255	0.035	0.139	0.257	0.036	0.141	0.286	0.043	0.167	1.083	1.080	1.049
AQRSA	A171	481401	6362412	3.05	0.800	0.051	0.687	0.804	0.053	0.690	0.881	0.070	0.764	2.272	2.268	2.184
AQRSA	A172	438802	6390961	0.70	0.210	0.030	0.093	0.212	0.030	0.094	0.234	0.036	0.115	0.526	0.524	0.500
AQRSA	A174	505000	6342512	0.66	0.406	0.067	0.369	0.411	0.070	0.373	0.456	0.083	0.420	0.238	0.232	0.181
AQRSA	A178	483501	6360762	3.62	0.669	0.047	0.577	0.672	0.048	0.579	0.731	0.063	0.639	2.968	2.964	2.900
AQRSA	A179	498500	6314212	1.17	0.502	0.092	0.371	0.531	0.102	0.392	0.597	0.121	0.458	0.683	0.653	0.579
AQRSA	A183	479201	6352812	3.99	1.309	0.069	1.213	1.313	0.071	1.217	1.417	0.098	1.337	2.693	2.688	2.566
AQRSA	A187	500600	6320312	2.27	0.527	0.104	0.385	0.547	0.112	0.401	0.612	0.131	0.466	1.762	1.741	1.667

Area	Lake Identifier	Easting	Northing	Critical Load [CL] (keq H+/ha/yr)	Baseline			Application			Planned Development			Baseline	Application	Planned Development
					PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	Critical Load minus Deposition	Critical Load minus Deposition	Critical Load minus Deposition
AQRSA	A188	502300	6317712	1.57	0.475	0.091	0.341	0.495	0.099	0.357	0.556	0.116	0.417	1.116	1.095	1.027
AQRSA	A189	447802	6388211	1.18	0.274	0.036	0.150	0.276	0.037	0.152	0.313	0.045	0.185	0.946	0.943	0.905
AQRSA	A190	446002	6394961	0.20	0.231	0.031	0.110	0.233	0.032	0.112	0.259	0.039	0.136	0.006	0.004	**-0.024**
AQRSA	A192	444752	6392311	2.47	0.230	0.032	0.110	0.232	0.032	0.112	0.259	0.039	0.136	2.273	2.271	2.243
AQRSA	A193	451552	6394711	1.09	0.267	0.035	0.143	0.270	0.036	0.144	0.304	0.044	0.174	0.865	0.862	0.827
AQRSA	A194	461501	6391111	4.90	0.369	0.039	0.239	0.372	0.040	0.241	0.418	0.050	0.281	4.568	4.564	4.517
AQRSA	A195	451302	6395711	1.00	0.264	0.035	0.140	0.267	0.036	0.141	0.300	0.043	0.171	0.777	0.775	0.740
AQRSA	A197	437402	6398711	1.22	0.192	0.025	0.077	0.193	0.026	0.078	0.211	0.031	0.094	1.068	1.067	1.047
AQRSA	A198	425103	6385111	0.81	0.175	0.023	0.061	0.177	0.024	0.062	0.190	0.028	0.075	0.675	0.674	0.659
AQRSA	A199	427503	6387611	0.59	0.177	0.023	0.063	0.178	0.024	0.064	0.192	0.028	0.077	0.449	0.448	0.433
AQRSA	A201	429803	6377461	0.39	0.202	0.029	0.088	0.203	0.030	0.089	0.222	0.035	0.107	0.226	0.224	0.203
AQRSA	A202	428903	6400411	0.50	0.170	0.021	0.056	0.171	0.021	0.057	0.184	0.025	0.069	0.366	0.364	0.351
AQRSA	A203	438202	6391811	0.66	0.206	0.029	0.089	0.208	0.030	0.090	0.229	0.035	0.111	0.492	0.490	0.467
AQRSA	A204	438752	6392211	0.64	0.208	0.029	0.091	0.210	0.030	0.092	0.232	0.035	0.113	0.473	0.471	0.448
AQRSA	A206	416203	6370462	0.73	0.181	0.022	0.067	0.182	0.022	0.068	0.196	0.026	0.081	0.587	0.585	0.570
AQRSA	A207	422403	6371812	0.76	0.205	0.028	0.088	0.207	0.029	0.089	0.226	0.034	0.107	0.587	0.585	0.565
AQRSA	A208	411153	6350112	3.78	0.200	0.025	0.099	0.202	0.026	0.100	0.220	0.031	0.119	3.607	3.605	3.585
AQRSA	A209	426003	6373212	0.77	0.207	0.030	0.089	0.208	0.030	0.091	0.228	0.036	0.109	0.600	0.598	0.577
AQRSA	A211	436852	6332462	2.48	0.466	0.041	0.367	0.468	0.042	0.370	0.531	0.053	0.434	2.043	2.039	1.972
AQRSA	A212	433852	6330512	3.24	0.416	0.040	0.316	0.419	0.042	0.319	0.474	0.052	0.375	2.852	2.848	2.789
AQRSA	A213	425403	6344062	1.54	0.264	0.033	0.178	0.267	0.035	0.180	0.297	0.042	0.213	1.302	1.299	1.265
AQRSA	A215	443552	6301613	2.05	0.514	0.074	0.402	0.521	0.077	0.407	0.598	0.097	0.476	1.551	1.543	1.462
AQRSA	A218	451762	6293513	0.82	0.526	0.082	0.401	0.537	0.086	0.411	0.602	0.104	0.469	0.316	0.304	0.234
AQRSA	A219	451402	6281113	1.47	0.337	0.048	0.230	0.343	0.050	0.235	0.382	0.060	0.272	1.157	1.151	1.108
AQRSA	A220	445481	6278365	3.24	0.347	0.049	0.229	0.353	0.051	0.234	0.395	0.062	0.272	2.926	2.920	2.875
AQRSA	A221	493296	6259805	0.63	0.285	0.051	0.180	0.296	0.056	0.189	0.342	0.066	0.234	0.369	0.357	0.307
AQRSA	A222	495869	6259633	0.40	0.292	0.051	0.183	0.303	0.055	0.191	0.354	0.066	0.240	0.134	0.122	0.067
AQRSA	A223	500505	6255692	0.30	0.318	0.071	0.199	0.327	0.075	0.206	0.386	0.086	0.265	**-0.003**	**-0.012**	**-0.076**
AQRSA	A224	498560	6265951	2.08	0.291	0.047	0.184	0.302	0.052	0.194	0.352	0.062	0.241	1.817	1.804	1.751
AQRSA	A225	448416	6280450	2.68	0.353	0.050	0.238	0.359	0.053	0.243	0.401	0.064	0.282	2.359	2.352	2.307
AQRSA	A226	442406	6276535	2.67	0.332	0.045	0.212	0.337	0.048	0.217	0.377	0.058	0.254	2.371	2.365	2.322
AQRSA	A227	446055	6279117	4.06	0.349	0.049	0.231	0.355	0.052	0.236	0.398	0.063	0.275	3.739	3.732	3.687
AQRSA	A228	451429	6268553	2.24	0.306	0.044	0.191	0.312	0.046	0.196	0.350	0.056	0.232	1.962	1.956	1.914
AQRSA	A229	450033	6268135	1.84	0.303	0.043	0.188	0.308	0.045	0.193	0.346	0.055	0.228	1.567	1.561	1.520
AQRSA	A230	479616	6256890	2.11	0.267	0.038	0.166	0.275	0.042	0.172	0.324	0.050	0.213	1.871	1.863	1.813
AQRSA	A231	471630	6268385	1.98	0.304	0.044	0.195	0.314	0.048	0.204	0.352	0.058	0.243	1.708	1.696	1.654
AQRSA	A232	488074	6256727	1.01	0.252	0.041	0.154	0.259	0.045	0.161	0.298	0.055	0.199	0.783	0.775	0.732
AQRSA	A236	502509	6317128	1.60	0.468	0.088	0.336	0.488	0.096	0.351	0.548	0.113	0.411	1.151	1.130	1.063
AQRSA	A237	429874	6398738	1.08	0.172	0.021	0.058	0.173	0.022	0.059	0.187	0.025	0.072	0.946	0.945	0.930
AQRSA	A238	430065	6401484	0.34	0.171	0.021	0.058	0.172	0.021	0.058	0.185	0.025	0.071	0.211	0.210	0.196
AQRSA	A239	433954	6393613	0.75	0.187	0.025	0.072	0.189	0.025	0.073	0.206	0.030	0.089	0.599	0.597	0.579
AQRSA	A240	438235	6392291	0.79	0.202	0.028	0.085	0.204	0.029	0.086	0.224	0.034	0.105	0.630	0.628	0.606
AQRSA	A241	448974	6395163	0.58	0.257	0.034	0.134	0.259	0.035	0.135	0.292	0.042	0.164	0.361	0.359	0.325
AQRSA	A242	460732	6391206	3.79	0.366	0.039	0.236	0.369	0.040	0.238	0.415	0.050	0.278	3.465	3.462	3.414
AQRSA	A243	445573	6383359	1.62	0.260	0.035	0.141	0.262	0.036	0.143	0.295	0.043	0.174	1.393	1.390	1.355
AQRSA	A244	436094	6371181	1.19	0.266	0.039	0.153	0.269	0.040	0.155	0.300	0.047	0.185	0.952	0.949	0.915
AQRSA	A245	511576	6415521	2.39	0.262	0.022	0.154	0.264	0.023	0.155	0.289	0.028	0.178	2.165	2.163	2.136
AQRSA	A246	495763	6333877	0.83	0.630	0.103	0.511	0.642	0.108	0.520	0.724	0.130	0.598	0.207	0.194	0.104
AQRSA	A247	492308	6313536	1.49	0.635	0.114	0.512	0.670	0.127	0.541	0.753	0.149	0.618	0.857	0.819	0.729
AQRSA	A248	491531	6306260	1.51	0.551	0.095	0.466	0.606	0.116	0.510	0.675	0.137	0.593	0.951	0.892	0.809
AQRSA	A249	513559	6419693	2.36	0.259	0.022	0.150	0.261	0.022	0.151	0.285	0.028	0.174	2.141	2.140	2.114
AQRSA	A254	495957	6334968	1.03	0.629	0.097	0.520	0.640	0.101	0.529	0.720	0.123	0.605	0.404	0.392	0.305
AQRSA	A255	414747	6351741	1.42	0.213	0.026	0.110	0.215	0.027	0.112	0.235	0.033	0.133	1.241	1.239	1.216
AQRSA	A256	419555	6351513	2.74	0.234	0.029	0.134	0.236	0.030	0.136	0.260	0.036	0.162	2.533	2.530	2.503
AQRSA	A257	412268	6345506	1.07	0.220	0.028	0.127	0.222	0.030	0.129	0.243	0.035	0.152	0.876	0.874	0.850

Area	Lake Identifier	Easting	Northing	Critical Load [CL] (keq H+/ha/yr)	Baseline			Application			Planned Development			Baseline	Application	Planned Development
					PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	Critical Load minus Deposition	Critical Load minus Deposition	Critical Load minus Deposition
AQRSA	A258	494650	6362557	4.80	2.089	0.061	2.166	2.092	0.063	2.169	2.166	0.079	2.236	2.657	2.653	2.576
AQRSA	A260	485427	6357465	4.26	1.067	0.056	0.961	1.069	0.057	0.964	1.137	0.075	1.041	3.212	3.209	3.130
AQRSA	A266	455932	6365954	4.59	0.937	0.059	0.823	0.941	0.061	0.826	1.060	0.075	0.944	3.675	3.671	3.547
AQRSA	A267	457730	6374675	16.22	0.682	0.052	0.531	0.685	0.054	0.534	0.772	0.067	0.612	15.578	15.574	15.486
AQRSA	A268	455211	6364522	2.90	0.959	0.059	0.856	0.963	0.061	0.859	1.086	0.074	0.981	1.962	1.957	1.828
AQRSA	A270	453963	6363973	3.93	0.917	0.057	0.822	0.921	0.058	0.825	1.036	0.072	0.940	3.029	3.025	2.904
AQRSA	A275	445617	6381379	0.83	0.278	0.036	0.161	0.280	0.037	0.162	0.317	0.046	0.197	0.581	0.578	0.539
AQRSA	A276	444669	6379654	1.39	0.278	0.036	0.162	0.280	0.037	0.163	0.317	0.046	0.198	1.149	1.146	1.106
AQRSA	A277	444494	6382690	1.37	0.252	0.034	0.135	0.254	0.035	0.136	0.285	0.042	0.166	1.154	1.151	1.118
AQRSA	A278	440554	6382003	0.28	0.232	0.033	0.120	0.234	0.033	0.122	0.259	0.040	0.146	0.079	0.077	0.049
AQRSA	A297	501467	6264562	1.95	0.289	0.047	0.182	0.299	0.051	0.191	0.348	0.061	0.238	1.687	1.675	1.623
AQRSA	A298	489731	6258033	1.31	0.250	0.041	0.149	0.257	0.045	0.155	0.291	0.055	0.191	1.081	1.072	1.034
AQRSA	A299	498210	6257515	0.93	0.296	0.057	0.184	0.305	0.060	0.192	0.360	0.071	0.244	0.654	0.644	0.586
AQRSA	A300	499562	6256374	2.18	0.305	0.064	0.190	0.314	0.067	0.197	0.372	0.078	0.254	1.892	1.883	1.821
AQRSA	A301	504488	6254133	2.05	0.330	0.084	0.202	0.337	0.087	0.209	0.390	0.097	0.262	1.733	1.725	1.668
AQRSA	A302	505212	6252653	2.05	0.347	0.095	0.227	0.354	0.098	0.233	0.408	0.108	0.288	1.709	1.701	1.642
AQRSA	A303	508895	6252653	0.57	0.348	0.078	0.202	0.356	0.081	0.208	0.405	0.091	0.258	0.253	0.245	0.191
AQRSA	A304	502017	6251357	0.75	0.305	0.128	0.297	0.313	0.131	0.304	0.370	0.143	0.366	0.392	0.384	0.320
AQRSA	A305	507487	6251545	2.33	0.413	0.116	0.245	0.420	0.119	0.251	0.472	0.129	0.304	1.938	1.930	1.873
AQRSA	A306	504672	6250565	1.01	0.440	0.209	0.398	0.447	0.212	0.404	0.504	0.223	0.462	0.504	0.496	0.434
AQRSA	A307	502570	6249730	0.28	0.289	0.097	0.206	0.296	0.100	0.212	0.351	0.112	0.274	**-0.017**	**-0.024**	**-0.088**
AQRSA	A309	502641	6249587	0.27	0.285	0.092	0.201	0.291	0.094	0.207	0.345	0.106	0.270	**-0.015**	**-0.022**	**-0.083**
AQRSA	A310	503226	6248721	0.93	0.306	0.091	0.195	0.312	0.094	0.200	0.360	0.105	0.263	0.629	0.623	0.564
AQRSA	A311	482249	6246921	0.48	0.275	0.045	0.166	0.283	0.048	0.172	0.355	0.061	0.240	0.229	0.220	0.145
AQRSA	A312	509942	6244399	0.91	0.278	0.054	0.154	0.283	0.056	0.159	0.343	0.066	0.219	0.663	0.657	0.593
AQRSA	A313	481229	6244129	0.46	0.262	0.042	0.164	0.268	0.044	0.170	0.338	0.060	0.243	0.226	0.218	0.140
AQRSA	A315	489222	6240033	2.50	0.259	0.042	0.156	0.265	0.044	0.161	0.335	0.059	0.247	2.267	2.260	2.177
AQRSA	A316	490427	6237963	0.21	0.259	0.041	0.153	0.264	0.043	0.157	0.334	0.057	0.246	**-0.019**	**-0.025**	**-0.109**
AQRSA	A329	598819	6389537	0.48	0.145	0.011	0.035	0.146	0.012	0.036	0.152	0.014	0.043	0.375	0.374	0.367
AQRSA	A334	573917	6468241	2.37	0.157	0.012	0.050	0.158	0.012	0.051	0.167	0.015	0.060	2.255	2.255	2.244
AQRSA	A335	592417	6259032	2.66	0.154	0.018	0.038	0.156	0.019	0.039	0.167	0.022	0.049	2.544	2.542	2.530
AQRSA	A336	595873	6468054	1.68	0.145	0.010	0.037	0.146	0.010	0.038	0.152	0.012	0.045	1.571	1.570	1.562
AQRSA	2	510499	6163433	2.10	0.208	0.050	0.081	0.209	0.051	0.082	0.230	0.057	0.109	1.924	1.922	1.896
AQRSA	42	479375	6142060	1.83	0.150	0.013	0.043	0.150	0.013	0.044	0.162	0.016	0.058	1.720	1.720	1.706
AQRSA	43	496692	6127900	1.30	0.171	0.020	0.066	0.172	0.020	0.066	0.185	0.022	0.080	1.165	1.164	1.150
AQRSA	44	491437	6137987	1.47	0.155	0.016	0.053	0.156	0.016	0.054	0.170	0.019	0.068	1.354	1.353	1.338
AQRSA	45	497711	6132160	0.79	0.171	0.031	0.103	0.172	0.031	0.103	0.185	0.034	0.118	0.631	0.631	0.616
AQRSA	46	498367	6133579	1.83	0.170	0.032	0.100	0.171	0.032	0.101	0.184	0.035	0.115	1.679	1.678	1.663
AQRSA	47	493933	6132222	1.04	0.173	0.021	0.064	0.174	0.021	0.064	0.187	0.023	0.079	0.906	0.905	0.891
AQRSA	48	491151	6134421	0.91	0.160	0.016	0.056	0.161	0.017	0.057	0.174	0.019	0.072	0.790	0.789	0.774
AQRSA	49	493107	6134651	0.87	0.166	0.018	0.063	0.166	0.018	0.064	0.179	0.021	0.078	0.735	0.734	0.720
AQRSA	50	489844	6137549	0.26	0.154	0.015	0.053	0.155	0.016	0.054	0.169	0.018	0.068	0.144	0.143	0.128
AQRSA	122	448014	6170896	0.18	0.144	0.010	0.039	0.144	0.011	0.040	0.158	0.013	0.056	0.071	0.070	0.055
AQRSA	131	446510	6167454	1.29	0.141	0.010	0.037	0.142	0.010	0.037	0.154	0.012	0.052	1.185	1.184	1.170
AQRSA	132	533788	6137575	2.33	0.167	0.017	0.056	0.167	0.017	0.057	0.179	0.020	0.070	2.203	2.202	2.188
AQRSA	138	457796	6141365	0.94	0.142	0.009	0.033	0.142	0.009	0.034	0.152	0.011	0.045	0.841	0.840	0.830
AQRSA	146	448271	6183205	0.55	0.149	0.012	0.044	0.150	0.012	0.044	0.164	0.015	0.064	0.443	0.442	0.424
AQRSA	147	515689	6179208	0.45	0.240	0.037	0.119	0.242	0.037	0.121	0.301	0.045	0.185	0.246	0.244	0.180
AQRSA	167	463161	6151511	2.12	0.142	0.021	0.085	0.143	0.022	0.087	0.153	0.028	0.131	1.998	1.996	1.969
AQRSA	201	413544	6197673	0.94	0.156	0.012	0.047	0.158	0.013	0.048	0.171	0.016	0.061	0.823	0.822	0.807
AQRSA	203	432308	6198262	0.67	0.192	0.014	0.085	0.193	0.015	0.086	0.234	0.018	0.106	0.516	0.515	0.481
AQRSA	204	437499	6197260	0.72	0.179	0.014	0.074	0.180	0.015	0.075	0.208	0.018	0.098	0.575	0.574	0.546
AQRSA	205	426862	6184436	2.20	0.162	0.012	0.058	0.163	0.013	0.059	0.189	0.016	0.074	2.079	2.078	2.056
AQRSA	206	425742	6179813	2.26	0.153	0.011	0.048	0.154	0.012	0.049	0.172	0.014	0.062	2.150	2.149	2.132
AQRSA	207	429371	6177905	1.86	0.148	0.011	0.044	0.149	0.012	0.044	0.164	0.014	0.058	1.753	1.752	1.737

Area	Lake Identifier	Easting	Northing	Critical Load [CL] (keq H+/ha/yr)	Baseline			Application			Planned Development			Baseline	Application	Planned Development
					PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	PAI (keq/ha/yr)	Sulphur Deposition (keq/ha/yr)	Total Nitrogen Deposition (keq/ha/yr)	Critical Load minus Deposition	Critical Load minus Deposition	Critical Load minus Deposition
AQRSA	208	414088	6172614	0.78	0.148	0.010	0.040	0.149	0.011	0.041	0.163	0.013	0.053	0.671	0.670	0.656
AQRSA	218	452595	6196133	0.78	0.172	0.014	0.068	0.173	0.015	0.069	0.225	0.023	0.138	0.648	0.646	0.585
AQRSA	219	444220	6193451	0.86	0.174	0.014	0.069	0.175	0.014	0.070	0.205	0.018	0.101	0.719	0.718	0.686
AQRSA	220	448879	6190611	0.71	0.166	0.013	0.059	0.167	0.014	0.060	0.195	0.018	0.093	0.587	0.586	0.554
AQRSA	221	458295	6193292	0.47	0.180	0.014	0.071	0.180	0.014	0.072	0.277	0.026	0.175	0.327	0.326	0.222
AQRSA	223	438372	6185182	0.99	0.153	0.043	0.439	0.154	0.045	0.442	0.170	0.056	0.517	0.696	0.693	0.648
AQRSA	224	443436	6173058	0.29	0.141	0.010	0.038	0.142	0.010	0.038	0.154	0.013	0.053	0.189	0.188	0.174
AQRSA	225	446589	6173942	0.29	0.143	0.067	0.345	0.144	0.071	0.352	0.157	0.087	0.410	0.039	0.034	**-0.004**
AQRSA	230	533411	6186731	1.27	0.235	0.033	0.118	0.237	0.034	0.120	0.278	0.041	0.163	1.071	1.068	1.023
AQRSA	231	516751	6175506	0.63	0.235	0.038	0.116	0.236	0.039	0.117	0.288	0.047	0.177	0.428	0.426	0.368
AQRSA	232	528841	6167222	0.92	0.227	0.034	0.106	0.228	0.034	0.107	0.262	0.041	0.139	0.730	0.729	0.693
AQRSA	233	502625	6165269	1.17	0.191	0.031	0.081	0.192	0.031	0.082	0.219	0.037	0.118	1.015	1.013	0.981
AQRSA	234	547077	6178511	1.87	0.207	0.028	0.093	0.209	0.029	0.095	0.240	0.034	0.127	1.698	1.695	1.661
AQRSA	235	548176	6173881	1.62	0.205	0.028	0.090	0.206	0.028	0.091	0.236	0.034	0.122	1.453	1.451	1.418
AQRSA	236	558657	6173086	1.01	0.185	0.023	0.073	0.187	0.023	0.074	0.211	0.028	0.100	0.858	0.856	0.830
AQRSA	237	531585	6150547	2.03	0.159	0.027	0.047	0.160	0.027	0.047	0.172	0.031	0.062	1.910	1.909	1.895
AQRSA	238	544256	6146950	1.66	0.165	0.019	0.057	0.166	0.019	0.058	0.181	0.022	0.076	1.530	1.529	1.512
AQRSA	239	525364	6133813	2.29	0.187	0.016	0.089	0.187	0.017	0.089	0.198	0.019	0.102	2.139	2.138	2.125
AQRSA	240	514750	6146752	2.55	0.193	0.029	0.080	0.194	0.029	0.081	0.211	0.033	0.101	2.393	2.392	2.373
AQRSA	241	510533	6149522	2.19	0.213	0.040	0.092	0.214	0.040	0.093	0.235	0.044	0.116	2.015	2.014	1.991
AQRSA	242	464179	6147797	0.88	0.143	0.010	0.037	0.144	0.010	0.038	0.155	0.012	0.051	0.780	0.779	0.767
AQRSA	243	475751	6144012	0.96	0.151	0.013	0.043	0.151	0.013	0.043	0.164	0.015	0.057	0.854	0.853	0.839
AQRSA	244	492606	6137452	1.39	0.158	0.017	0.057	0.159	0.018	0.057	0.173	0.020	0.072	1.267	1.267	1.252
AQRSA	245	468315	6136636	0.72	0.145	0.010	0.037	0.146	0.010	0.037	0.157	0.012	0.049	0.616	0.616	0.604
AQRSA	246	452463	6135855	0.69	0.139	0.008	0.030	0.140	0.008	0.031	0.148	0.010	0.040	0.597	0.597	0.587
AQRSA	247	467222	6132003	1.31	0.143	0.010	0.034	0.143	0.010	0.035	0.153	0.012	0.045	1.206	1.205	1.194
AQRSA	248	470369	6128275	1.73	0.142	0.010	0.033	0.142	0.010	0.034	0.152	0.012	0.044	1.625	1.625	1.614
AQRSA	249	465073	6127390	1.27	0.139	0.009	0.031	0.139	0.009	0.031	0.148	0.011	0.040	1.172	1.171	1.161
AQRSA	250	475613	6118973	1.45	0.144	0.009	0.035	0.144	0.009	0.035	0.154	0.011	0.045	1.343	1.343	1.332
AQRSA	251	458671	6121881	1.21	0.138	0.008	0.030	0.139	0.008	0.030	0.147	0.009	0.038	1.114	1.113	1.105
AQRSA	253	444801	6114608	3.15	0.138	0.006	0.029	0.139	0.007	0.029	0.146	0.008	0.035	3.054	3.053	3.046
AQRSA	254	446862	6106018	2.29	0.133	0.006	0.025	0.133	0.006	0.025	0.139	0.007	0.030	2.199	2.198	2.193
AQRSA	255	443614	6104417	3.27	0.135	0.006	0.028	0.135	0.006	0.028	0.140	0.007	0.033	3.179	3.179	3.173
AQRSA	258	470756	6106015	3.62	0.146	0.007	0.037	0.146	0.007	0.038	0.153	0.009	0.045	3.516	3.516	3.508
AQRSA	259	476591	6104122	3.23	0.134	0.007	0.026	0.135	0.007	0.026	0.141	0.009	0.033	3.139	3.139	3.132
AQRSA	609	520557	6172578	1.59	0.251	0.044	0.134	0.253	0.045	0.136	0.293	0.054	0.183	1.367	1.365	1.318
AQRSA	610	509795	6169983	0.71	0.210	0.034	0.098	0.211	0.035	0.099	0.248	0.041	0.152	0.530	0.528	0.482
AQRSA	611	527280	6170976	0.83	0.229	0.034	0.112	0.230	0.034	0.113	0.269	0.041	0.150	0.632	0.631	0.589
AQRSA	612	508500	6170350	0.90	0.213	0.033	0.101	0.214	0.034	0.102	0.258	0.040	0.160	0.724	0.722	0.670
AQRSA	613	509779	6174077	0.78	0.218	0.032	0.111	0.219	0.032	0.112	0.309	0.039	0.225	0.588	0.587	0.485
AQRSA	614	513212	6167678	1.62	0.228	0.043	0.112	0.229	0.043	0.113	0.262	0.050	0.157	1.425	1.423	1.383
AQRSA	615	513525	6175472	0.56	0.221	0.033	0.107	0.223	0.034	0.109	0.277	0.041	0.178	0.377	0.375	0.312
AQRSA	616	514431	6168793	1.49	0.224	0.040	0.114	0.225	0.040	0.115	0.259	0.048	0.158	1.296	1.295	1.254
AQRSA	617	515450	6170023	0.77	0.233	0.044	0.133	0.234	0.045	0.135	0.271	0.054	0.181	0.560	0.559	0.514
AQRSA	618	515711	6168936	1.41	0.236	0.045	0.142	0.237	0.046	0.143	0.273	0.056	0.187	1.189	1.188	1.145
AQRSA	620	522016	6168496	1.11	0.296	0.054	0.165	0.297	0.055	0.167	0.345	0.067	0.207	0.842	0.841	0.791
AQRSA	621	523415	6162401	2.03	0.240	0.039	0.118	0.241	0.040	0.120	0.273	0.046	0.151	1.825	1.823	1.789
AQRSA	A52	437499	6197257	0.71	0.179	0.014	0.074	0.180	0.015	0.075	0.208	0.018	0.098	0.567	0.565	0.538
AQRSA	A55	444222	6193454	0.87	0.174	0.014	0.069	0.175	0.014	0.070	0.205	0.018	0.101	0.738	0.737	0.705
AQRSA	A57	458297	6193296	0.49	0.180	0.014	0.071	0.180	0.014	0.072	0.277	0.026	0.175	0.346	0.345	0.241
AQRSA	A60	520834	6196855	2.26	0.195	0.026	0.083	0.197	0.027	0.085	0.232	0.034	0.124	2.103	2.100	2.061
AQRSA	A61	530203	6197838	1.89	0.207	0.029	0.095	0.210	0.030	0.098	0.248	0.036	0.139	1.720	1.718	1.675
AQRSA	A63	534391	6195087	1.65	0.204	0.028	0.093	0.207	0.029	0.095	0.241	0.035	0.132	1.481	1.478	1.441

Note:

Bolded and shaded values – deposition exceeds critical loads.

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Ivanhoe Energy

Appendix SIR2 K

Revised COPC Screening Assessment

3-Methylcholanthrene

For exposures to 3-methylcholanthrene, the incremental cancer risks, the total ILCR in the Baseline Case at MPOI receptor location is 7.7 x 10^{-5}, which is marginally higher than the maximum acceptable criterion of 1.0 x 10^{-5} (Table SIR2 K-1). All other receptor locations had ILCR lower than the criterion. The fish ingestion exposure pathways is the principle sources of risk to the adult receptor. The Project-alone had lower total ILCR values, i.e., 3.8 x 10^{-6}, with the berries ingestion exposure pathway being the most significant source of risk. Therefore, the Project-alone risks would only increase the Baseline Case risks marginally for the Application Case (i.e., Baseline plus Project-alone).

The Planned Development Case has a total ILCR value of 1.5 x 10^{-4} for the MPOI receptor locations, which exceeds the maximum acceptable criterion. In this Case, the ingestion of fish alone results in ILCR value of 1.4 x 10^{-4} at the MPOI receptor locations and is higher than the criterion.

A composite receptor, which amortizes the exposures relative to each age class, was also assessed for carcinogenic risks. Assuming an adult receptor living an entire lifetime in the AQRSA, the ILCR values for this composite receptor are presented in Table SIR2 K-2.

For the 3-methylcholanthrene exposures in the Baseline Case of the composite adult receptor, the total ILCR is 1.1 x 10^{-4} for the MPOI receptor location. This total ILCR values is higher than the maximum acceptable criterion of 1.0 x 10^{-5}. Only the ingestion of fish exposure pathway is the primary contributor to the total ILCR values at each receptor location for the Baseline Case.

With the Project-alone Case, total ILCR-A values for the Project-alone are less than 1.0 x 10^{-5} at all receptor locations.

In assessing the Application Case, summing the total ILCR values for the Baseline and Project-alone Case for most of the receptor locations does not increase the total ILCR value above the criterion of 1.0 x 10^{-5}. The only exception is the MPOI where the sum of Baseline and Project-alone total ILCR is 1.2 x 10^{-4}. However, since the MPOI may be situated in different locations for the Baseline Case and the Project-only Case, the summation of the total ILCR values is an over-estimation of the risks.

There are more receptor locations where the total ILCR values exceed 1.0 x 10^{-5} in the Planned Development Case than for the Baseline Case. The MPOI, FMM, GEC and GWC receptor locations have total ILCR values for the composite receptor in the Planned Development Case that exceeds the criterion. For these receptor locations, the predominant exposure pathway that contributes the most to the overall risk is fish ingestion. However, compared to the Project-alone total ILCR-A values, the Planned Development total ILCR-A values are orders of magnitude higher, suggesting that the Project-alone does not contribute significantly to the overall cumulative risks.

Table SIR2 K-1: Incremental Lifetime Cancer Risk Due to Chronic Exposures to 3-Methylcholanthrene for an Adult Receptor

Receptor Location	ILCR (EDI * CSF)										Total ILCR
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
MPOI	1.15E-08	1.28E-08	1.97E-18	1.55E-14	8.16E-08	2.46E-07	4.32E-09	3.77E-06	7.32E-05	1.04E-07	7.74E-05
AC	6.78E-11	7.54E-11	1.17E-20	9.13E-17	4.82E-10	2.40E-09	2.55E-11	3.68E-08	4.32E-07	3.34E-09	4.75E-07
AR	1.35E-10	1.50E-10	2.32E-20	1.82E-16	9.60E-10	3.83E-09	5.08E-11	5.88E-08	8.60E-07	3.93E-09	9.28E-07
TC1	1.49E-10	1.66E-10	2.56E-20	2.01E-16	1.06E-09	4.14E-09	5.62E-11	6.34E-08	9.51E-07	4.06E-09	1.02E-06
BL	1.40E-10	1.56E-10	2.41E-20	1.89E-16	9.97E-10	3.95E-09	5.28E-11	6.05E-08	8.93E-07	3.98E-09	9.63E-07
TC2	1.60E-10	1.78E-10	2.75E-20	2.15E-16	1.14E-09	4.36E-09	6.02E-11	6.69E-08	1.02E-06	4.15E-09	1.10E-06
TC3	1.85E-10	2.06E-10	3.18E-20	2.49E-16	1.31E-09	4.90E-09	6.96E-11	7.51E-08	1.18E-06	4.37E-09	1.26E-06
TC4	1.61E-10	1.79E-10	2.77E-20	2.17E-16	1.15E-09	4.40E-09	6.07E-11	6.74E-08	1.03E-06	4.16E-09	1.11E-06
FMK	1.46E-10	1.63E-10	2.52E-20	1.97E-16	1.04E-09	4.08E-09	5.52E-11	6.26E-08	9.34E-07	4.03E-09	1.01E-06
FMM	5.88E-10	6.54E-10	1.01E-19	7.92E-16	4.18E-09	1.35E-08	2.22E-10	2.07E-07	3.75E-06	7.93E-09	3.98E-06
FMT	1.37E-10	1.53E-10	2.36E-20	1.85E-16	9.77E-10	3.89E-09	5.18E-11	5.96E-08	8.76E-07	3.95E-09	9.45E-07
FMT1	2.79E-11	3.10E-11	4.79E-21	3.76E-17	1.98E-10	1.55E-09	1.05E-11	2.38E-08	1.78E-07	2.99E-09	2.06E-07
FMT2	1.47E-10	1.64E-10	2.53E-20	1.98E-16	1.05E-09	4.09E-09	5.54E-11	6.27E-08	9.37E-07	4.04E-09	1.01E-06
TC5	5.10E-10	5.68E-10	8.77E-20	6.87E-16	3.63E-09	1.18E-08	1.92E-10	1.82E-07	3.25E-06	7.24E-09	3.46E-06
TC6	6.46E-10	7.19E-10	1.11E-19	8.71E-16	4.60E-09	1.47E-08	2.44E-10	2.26E-07	4.12E-06	8.45E-09	4.38E-06
KL	1.90E-10	2.11E-10	3.26E-20	2.56E-16	1.35E-09	5.00E-09	7.15E-11	7.67E-08	1.21E-06	4.42E-09	1.30E-06
TC7	4.23E-10	4.71E-10	7.28E-20	5.70E-16	3.01E-09	9.98E-09	1.59E-10	1.53E-07	2.70E-06	6.48E-09	2.87E-06
TC8	2.06E-10	2.29E-10	3.53E-20	2.77E-16	1.46E-09	5.34E-09	7.74E-11	8.19E-08	1.31E-06	4.56E-09	1.40E-06
TC9	1.10E-10	1.23E-10	1.90E-20	1.49E-16	7.85E-10	3.31E-09	4.16E-11	5.08E-08	7.03E-07	3.71E-09	7.62E-07
TC10	1.89E-10	2.11E-10	3.25E-20	2.55E-16	1.35E-09	4.99E-09	7.13E-11	7.66E-08	1.21E-06	4.41E-09	1.29E-06
TC11	1.45E-10	1.62E-10	2.50E-20	1.96E-16	1.03E-09	4.06E-09	5.47E-11	6.22E-08	9.26E-07	4.02E-09	9.98E-07
MPOI	1.75E-11	1.94E-11	3.00E-21	2.35E-17	1.25E-10	2.45E-07	6.58E-12	3.75E-06	1.12E-07	7.76E-08	4.19E-06
AC	2.71E-12	3.01E-12	4.65E-22	3.65E-18	1.93E-11	2.45E-09	1.02E-12	3.76E-08	1.73E-08	3.21E-09	6.05E-08
AR	1.06E-11	1.18E-11	1.82E-21	1.42E-17	7.52E-11	4.04E-09	3.98E-12	6.20E-08	6.74E-08	3.71E-09	1.37E-07
TC1	7.00E-12	7.79E-12	1.20E-21	9.44E-18	4.98E-11	4.27E-09	2.64E-12	6.54E-08	4.47E-08	3.77E-09	1.18E-07
BL	1.43E-11	1.60E-11	2.47E-21	1.93E-17	1.02E-10	4.23E-09	5.40E-12	6.49E-08	9.14E-08	3.78E-09	1.65E-07
TC2	1.45E-11	1.61E-11	2.49E-21	1.95E-17	1.03E-10	4.65E-09	5.46E-12	7.14E-08	9.24E-08	3.91E-09	1.72E-07
TC3	1.21E-11	1.35E-11	2.09E-21	1.64E-17	8.64E-11	5.13E-09	4.58E-12	7.87E-08	7.75E-08	4.05E-09	1.65E-07
TC4	1.73E-11	1.92E-11	2.97E-21	2.33E-17	1.23E-10	4.74E-09	6.51E-12	7.27E-08	1.10E-07	3.94E-09	1.92E-07
FMK	8.02E-12	8.92E-12	1.38E-21	1.08E-17	5.70E-11	4.23E-09	3.02E-12	6.49E-08	5.11E-08	3.77E-09	1.24E-07
FMM	1.05E-11	1.17E-11	1.81E-21	1.42E-17	7.50E-11	1.36E-08	3.97E-12	2.09E-07	6.72E-08	6.66E-09	2.97E-07
FMT	1.19E-11	1.33E-11	2.05E-21	1.61E-17	8.48E-11	4.12E-09	4.49E-12	6.32E-08	7.60E-08	3.74E-09	1.47E-07
FMT1	1.62E-12	1.81E-12	2.79E-22	2.19E-18	1.15E-11	1.58E-09	6.11E-13	2.43E-08	1.03E-08	2.94E-09	3.91E-08
FMT2	8.41E-12	9.36E-12	1.45E-21	1.13E-17	5.98E-11	4.25E-09	3.17E-12	6.52E-08	5.36E-08	3.77E-09	1.27E-07
TC5	6.14E-11	6.83E-11	1.06E-20	8.27E-17	4.37E-10	1.31E-08	2.31E-11	2.01E-07	3.91E-07	6.61E-09	6.12E-07
TC6	3.28E-11	3.65E-11	5.64E-21	4.42E-17	2.33E-10	1.54E-08	1.23E-11	2.36E-07	2.09E-07	7.24E-09	4.68E-07
KL	5.10E-12	5.67E-12	8.76E-22	6.87E-18	3.63E-11	5.09E-09	1.92E-12	7.80E-08	3.25E-08	4.02E-09	1.20E-07

Receptor Location	ILCR (EDI * CSF)										Total ILCR
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
TC7	4.04E-12	4.49E-12	6.94E-22	5.44E-18	2.88E-11	1.00E-08	1.52E-12	1.54E-07	2.58E-08	5.53E-09	1.95E-07
TC8	4.46E-12	4.96E-12	7.66E-22	6.01E-18	3.17E-11	5.41E-09	1.68E-12	8.30E-08	2.84E-08	4.12E-09	1.21E-07
TC9	7.37E-12	8.20E-12	1.27E-21	9.92E-18	5.24E-11	3.45E-09	2.77E-12	5.30E-08	4.70E-08	3.52E-09	1.07E-07
TC10	5.17E-12	5.75E-12	8.89E-22	6.97E-18	3.68E-11	5.08E-09	1.95E-12	7.79E-08	3.30E-08	4.02E-09	1.20E-07
TC11	9.60E-12	1.07E-11	1.65E-21	1.29E-17	6.83E-11	4.24E-09	3.62E-12	6.51E-08	6.12E-08	3.77E-09	1.34E-07
MPOI	2.23E-08	2.48E-08	3.83E-18	3.00E-14	1.59E-07	7.22E-07	1.27E-08	1.11E-05	1.42E-04	2.79E-07	1.54E-04
AC	1.10E-10	1.22E-10	1.89E-20	1.48E-16	7.80E-10	5.70E-09	6.69E-11	8.74E-08	6.99E-07	6.90E-09	8.00E-07
AR	2.37E-10	2.64E-10	4.08E-20	3.19E-16	1.69E-09	9.85E-09	1.40E-10	1.51E-07	1.51E-06	8.47E-09	1.68E-06
TC1	2.54E-10	2.82E-10	4.36E-20	3.42E-16	1.80E-09	1.05E-08	1.52E-10	1.61E-07	1.62E-06	8.71E-09	1.80E-06
BL	2.37E-10	2.63E-10	4.07E-20	3.19E-16	1.68E-09	9.95E-09	1.42E-10	1.53E-07	1.51E-06	8.51E-09	1.68E-06
TC2	2.81E-10	3.13E-10	4.84E-20	3.79E-16	2.00E-09	1.13E-08	1.66E-10	1.74E-07	1.79E-06	9.03E-09	1.99E-06
TC3	3.52E-10	3.91E-10	6.05E-20	4.74E-16	2.50E-09	1.34E-08	2.02E-10	2.05E-07	2.24E-06	9.82E-09	2.47E-06
TC4	3.08E-10	3.43E-10	5.30E-20	4.15E-16	2.19E-09	1.19E-08	1.77E-10	1.83E-07	1.97E-06	9.28E-09	2.17E-06
FMK	2.70E-10	3.01E-10	4.65E-20	3.64E-16	1.92E-09	1.08E-08	1.57E-10	1.66E-07	1.72E-06	8.85E-09	1.91E-06
FMM	1.12E-09	1.25E-09	1.93E-19	1.52E-15	8.00E-09	3.84E-08	6.45E-10	5.90E-07	7.17E-06	1.93E-08	7.83E-06
FMT	2.80E-10	3.12E-10	4.82E-20	3.78E-16	1.99E-09	1.08E-08	1.57E-10	1.66E-07	1.79E-06	8.87E-09	1.98E-06
FMT1	5.03E-11	5.60E-11	8.65E-21	6.78E-17	3.58E-10	3.58E-09	2.95E-11	5.49E-08	3.21E-07	6.11E-09	3.86E-07
FMT2	2.58E-10	2.87E-10	4.44E-20	3.48E-16	1.83E-09	1.06E-08	1.53E-10	1.62E-07	1.64E-06	8.74E-09	1.83E-06
TC5	1.00E-09	1.12E-09	1.73E-19	1.35E-15	7.15E-09	3.42E-08	5.71E-10	5.25E-07	6.41E-06	1.78E-08	6.99E-06
TC6	1.25E-09	1.39E-09	2.14E-19	1.68E-15	8.87E-09	4.23E-08	7.13E-10	6.49E-07	7.95E-06	2.08E-08	8.67E-06
KL	2.65E-10	2.95E-10	4.56E-20	3.57E-16	1.89E-09	1.16E-08	1.71E-10	1.78E-07	1.69E-06	9.09E-09	1.89E-06
TC7	4.74E-10	5.28E-10	8.16E-20	6.39E-16	3.37E-09	2.11E-08	3.38E-10	3.23E-07	3.02E-06	1.25E-08	3.39E-06
TC8	2.72E-10	3.03E-10	4.68E-20	3.67E-16	1.94E-09	1.21E-08	1.80E-10	1.86E-07	1.74E-06	9.26E-09	1.95E-06
TC9	2.68E-10	2.98E-10	4.61E-20	3.61E-16	1.91E-09	9.98E-09	1.43E-10	1.53E-07	1.71E-06	8.58E-09	1.88E-06
TC10	2.66E-10	2.96E-10	4.57E-20	3.58E-16	1.89E-09	1.16E-08	1.71E-10	1.78E-07	1.69E-06	9.09E-09	1.90E-06
TC11	2.45E-10	2.72E-10	4.20E-20	3.29E-16	1.74E-09	1.02E-08	1.47E-10	1.57E-07	1.56E-06	8.61E-09	1.74E-06

Table SIR2 K-2: Incremental Lifetime Cancer Risks Due to Chronic Exposures to 3-Methylcholanthrene for the Composite Receptor

Receptor Location	ILCR (EDI *CSF)										Total ILCR
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
MPOI	3.17E-08	1.84E-08	3.13E-18	2.45E-14	1.13E-07	3.31E-07	5.83E-09	5.01E-06	1.08E-04	1.38E-07	1.14E-04
AC	1.87E-10	1.09E-10	1.85E-20	1.45E-16	6.66E-10	3.24E-09	3.44E-11	4.90E-08	6.40E-07	4.43E-09	6.97E-07
AR	3.73E-10	2.17E-10	3.68E-20	2.88E-16	1.33E-09	5.17E-09	6.86E-11	7.82E-08	1.27E-06	5.21E-09	1.36E-06
TC1	4.13E-10	2.39E-10	4.07E-20	3.19E-16	1.47E-09	5.58E-09	7.58E-11	8.44E-08	1.41E-06	5.38E-09	1.51E-06
BL	3.88E-10	2.25E-10	3.82E-20	3.00E-16	1.38E-09	5.32E-09	7.12E-11	8.04E-08	1.32E-06	5.27E-09	1.42E-06
TC2	4.42E-10	2.56E-10	4.36E-20	3.42E-16	1.57E-09	5.89E-09	8.12E-11	8.90E-08	1.51E-06	5.50E-09	1.61E-06
TC3	5.11E-10	2.96E-10	5.04E-20	3.95E-16	1.82E-09	6.61E-09	9.39E-11	9.98E-08	1.74E-06	5.80E-09	1.86E-06
TC4	4.46E-10	2.59E-10	4.40E-20	3.45E-16	1.58E-09	5.93E-09	8.19E-11	8.96E-08	1.52E-06	5.52E-09	1.63E-06
FMK	4.05E-10	2.35E-10	3.99E-20	3.13E-16	1.44E-09	5.50E-09	7.44E-11	8.32E-08	1.38E-06	5.35E-09	1.48E-06
FMM	1.63E-09	9.43E-10	1.60E-19	1.26E-15	5.78E-09	1.82E-08	2.99E-10	2.75E-07	5.55E-06	1.05E-08	5.86E-06
FMT	3.80E-10	2.20E-10	3.75E-20	2.94E-16	1.35E-09	5.24E-09	6.98E-11	7.93E-08	1.30E-06	5.24E-09	1.39E-06
FMT1	7.71E-11	4.47E-11	7.61E-21	5.96E-17	2.74E-10	2.09E-09	1.42E-11	3.16E-08	2.63E-07	3.96E-09	3.01E-07
FMT2	4.06E-10	2.36E-10	4.01E-20	3.14E-16	1.44E-09	5.52E-09	7.47E-11	8.34E-08	1.39E-06	5.35E-09	1.48E-06
TC5	1.41E-09	8.19E-10	1.39E-19	1.09E-15	5.01E-09	1.60E-08	2.59E-10	2.41E-07	4.82E-06	9.60E-09	5.09E-06
TC6	1.79E-09	1.04E-09	1.76E-19	1.38E-15	6.35E-09	1.99E-08	3.28E-10	3.01E-07	6.10E-06	1.12E-08	6.44E-06
KL	5.25E-10	3.04E-10	5.17E-20	4.05E-16	1.86E-09	6.75E-09	9.64E-11	1.02E-07	1.79E-06	5.85E-09	1.91E-06
TC7	1.17E-09	6.79E-10	1.15E-19	9.05E-16	4.16E-09	1.35E-08	2.15E-10	2.04E-07	4.00E-06	8.59E-09	4.23E-06
TC8	5.69E-10	3.30E-10	5.61E-20	4.39E-16	2.02E-09	7.20E-09	1.04E-10	1.09E-07	1.94E-06	6.04E-09	2.07E-06
TC9	3.05E-10	1.77E-10	3.01E-20	2.36E-16	1.08E-09	4.46E-09	5.61E-11	6.75E-08	1.04E-06	4.93E-09	1.12E-06
TC10	5.23E-10	3.04E-10	5.16E-20	4.05E-16	1.86E-09	6.73E-09	9.61E-11	1.02E-07	1.79E-06	5.85E-09	1.90E-06
TC11	4.02E-10	2.33E-10	3.96E-20	3.11E-16	1.43E-09	5.47E-09	7.38E-11	8.27E-08	1.37E-06	5.33E-09	1.47E-06
MPOI	4.83E-11	2.80E-11	4.76E-21	3.73E-17	1.73E-10	3.30E-07	8.87E-12	4.99E-06	1.66E-07	1.03E-07	5.59E-06
AC	7.49E-12	4.34E-12	7.39E-22	5.79E-18	2.66E-11	3.31E-09	1.38E-12	5.00E-08	2.56E-08	4.25E-09	8.31E-08
AR	2.93E-11	1.70E-11	2.89E-21	2.26E-17	1.04E-10	5.45E-09	5.37E-12	8.24E-08	9.99E-08	4.92E-09	1.93E-07
TC1	1.94E-11	1.12E-11	1.91E-21	1.50E-17	6.89E-11	5.76E-09	3.56E-12	8.70E-08	6.61E-08	5.00E-09	1.64E-07
BL	3.97E-11	2.30E-11	3.91E-21	3.07E-17	1.41E-10	5.71E-09	7.29E-12	8.63E-08	1.35E-07	5.01E-09	2.33E-07
TC2	4.01E-11	2.32E-11	3.95E-21	3.10E-17	1.42E-10	6.28E-09	7.36E-12	9.49E-08	1.37E-07	5.18E-09	2.43E-07
TC3	3.36E-11	1.95E-11	3.31E-21	2.60E-17	1.19E-10	6.92E-09	6.17E-12	1.05E-07	1.15E-07	5.37E-09	2.32E-07
TC4	4.78E-11	2.77E-11	4.71E-21	3.69E-17	1.70E-10	6.40E-09	8.77E-12	9.67E-08	1.63E-07	5.23E-09	2.72E-07
FMK	2.22E-11	1.29E-11	2.19E-21	1.71E-17	7.88E-11	5.71E-09	4.07E-12	8.63E-08	7.57E-08	4.99E-09	1.73E-07
FMM	2.91E-11	1.69E-11	2.87E-21	2.25E-17	1.04E-10	1.84E-08	5.35E-12	2.78E-07	9.96E-08	8.83E-09	4.05E-07
FMT	3.30E-11	1.91E-11	3.25E-21	2.55E-17	1.17E-10	5.56E-09	6.05E-12	8.41E-08	1.13E-07	4.96E-09	2.07E-07
FMT1	4.49E-12	2.60E-12	4.43E-22	3.47E-18	1.59E-11	2.13E-09	8.24E-13	3.23E-08	1.53E-08	3.89E-09	5.36E-08
FMT2	2.33E-11	1.35E-11	2.29E-21	1.80E-17	8.27E-11	5.73E-09	4.27E-12	8.67E-08	7.94E-08	5.00E-09	1.77E-07

Receptor Location	ILCR (EDI *CSF)										Total ILCR
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
TC5	1.70E-10	9.85E-11	1.67E-20	1.31E-16	6.03E-10	1.76E-08	3.12E-11	2.67E-07	5.80E-07	8.76E-09	8.74E-07
TC6	9.07E-11	5.26E-11	8.94E-21	7.01E-17	3.22E-10	2.07E-08	1.67E-11	3.13E-07	3.10E-07	9.60E-09	6.54E-07
KL	1.41E-11	8.18E-12	1.39E-21	1.09E-17	5.01E-11	6.86E-09	2.59E-12	1.04E-07	4.81E-08	5.33E-09	1.64E-07
TC7	1.12E-11	6.48E-12	1.10E-21	8.63E-18	3.98E-11	1.35E-08	2.05E-12	2.04E-07	3.82E-08	7.34E-09	2.63E-07
TC8	1.23E-11	7.15E-12	1.22E-21	9.53E-18	4.38E-11	7.30E-09	2.26E-12	1.10E-07	4.21E-08	5.46E-09	1.65E-07
TC9	2.04E-11	1.18E-11	2.01E-21	1.57E-17	7.24E-11	4.66E-09	3.74E-12	7.04E-08	6.96E-08	4.67E-09	1.49E-07
TC10	1.43E-11	8.30E-12	1.41E-21	1.11E-17	5.08E-11	6.85E-09	2.63E-12	1.04E-07	4.88E-08	5.33E-09	1.65E-07
TC11	2.65E-11	1.54E-11	2.62E-21	2.05E-17	9.43E-11	5.72E-09	4.88E-12	8.65E-08	9.06E-08	5.00E-09	1.88E-07
MPOI	6.17E-08	3.58E-08	6.08E-18	4.77E-14	2.19E-07	9.74E-07	1.72E-08	1.47E-05	2.10E-04	3.70E-07	2.27E-04
AC	3.03E-10	1.76E-10	2.99E-20	2.34E-16	1.08E-09	7.68E-09	9.02E-11	1.16E-07	1.04E-06	9.15E-09	1.17E-06
AR	6.56E-10	3.80E-10	6.47E-20	5.07E-16	2.33E-09	1.33E-08	1.89E-10	2.01E-07	2.24E-06	1.12E-08	2.47E-06
TC1	7.01E-10	4.07E-10	6.92E-20	5.42E-16	2.49E-09	1.42E-08	2.05E-10	2.14E-07	2.39E-06	1.16E-08	2.64E-06
BL	6.55E-10	3.80E-10	6.46E-20	5.06E-16	2.33E-09	1.34E-08	1.91E-10	2.03E-07	2.23E-06	1.13E-08	2.47E-06
TC2	7.79E-10	4.52E-10	7.68E-20	6.02E-16	2.77E-09	1.53E-08	2.24E-10	2.31E-07	2.66E-06	1.20E-08	2.92E-06
TC3	9.73E-10	5.64E-10	9.59E-20	7.52E-16	3.46E-09	1.80E-08	2.73E-10	2.72E-07	3.32E-06	1.30E-08	3.63E-06
TC4	8.53E-10	4.95E-10	8.41E-20	6.59E-16	3.03E-09	1.61E-08	2.39E-10	2.43E-07	2.91E-06	1.23E-08	3.19E-06
FMK	7.48E-10	4.34E-10	7.38E-20	5.78E-16	2.66E-09	1.46E-08	2.12E-10	2.20E-07	2.55E-06	1.17E-08	2.80E-06
FMM	3.11E-09	1.80E-09	3.07E-19	2.40E-15	1.11E-08	5.18E-08	8.70E-10	7.84E-07	1.06E-05	2.56E-08	1.15E-05
FMT	7.76E-10	4.50E-10	7.65E-20	5.99E-16	2.76E-09	1.46E-08	2.12E-10	2.21E-07	2.65E-06	1.18E-08	2.90E-06
FMT1	1.39E-10	8.07E-11	1.37E-20	1.08E-16	4.94E-10	4.83E-09	3.97E-11	7.30E-08	4.75E-07	8.10E-09	5.62E-07
FMT2	7.14E-10	4.14E-10	7.04E-20	5.51E-16	2.54E-09	1.42E-08	2.06E-10	2.15E-07	2.44E-06	1.16E-08	2.68E-06
TC5	2.78E-09	1.61E-09	2.74E-19	2.15E-15	9.87E-09	4.62E-08	7.70E-10	6.98E-07	9.48E-06	2.35E-08	1.03E-05
TC6	3.45E-09	2.00E-09	3.40E-19	2.66E-15	1.23E-08	5.70E-08	9.62E-10	8.62E-07	1.18E-05	2.76E-08	1.27E-05
KL	7.33E-10	4.25E-10	7.23E-20	5.67E-16	2.61E-09	1.57E-08	2.31E-10	2.37E-07	2.50E-06	1.20E-08	2.77E-06
TC7	1.31E-09	7.61E-10	1.29E-19	1.01E-15	4.66E-09	2.84E-08	4.56E-10	4.29E-07	4.48E-06	1.66E-08	4.96E-06
TC8	7.53E-10	4.37E-10	7.43E-20	5.82E-16	2.68E-09	1.63E-08	2.43E-10	2.47E-07	2.57E-06	1.23E-08	2.85E-06
TC9	7.41E-10	4.30E-10	7.31E-20	5.73E-16	2.63E-09	1.35E-08	1.92E-10	2.04E-07	2.53E-06	1.14E-08	2.76E-06
TC10	7.35E-10	4.26E-10	7.25E-20	5.68E-16	2.61E-09	1.57E-08	2.31E-10	2.37E-07	2.51E-06	1.21E-08	2.78E-06
TC11	6.76E-10	3.92E-10	6.67E-20	5.23E-16	2.40E-09	1.38E-08	1.98E-10	2.09E-07	2.31E-06	1.14E-08	2.55E-06

Because of the low contribution of the Project-alone risks to the overall total risks for the composite receptor, it is unlikely for adverse health effects to occur due to the emission of 3-methylcholanthrene from the Project.

Carbon Disulfide (CS_2):

Hazard quotients for the CS2 exposures are presented in Table SIR2 K-3. None of the HQ values for any of the receptor locations or cases exceed 1.0. Since there are no exceedances, it is unlikely that adverse human health effects will occur in the AQRSA that are associated to CS_2.

Dichlorobenzene

Hazard quotients for the Dichlorobenzene exposures are presented in Table SIR2 K-4. None of the HQ values for any of the receptor locations or cases exceed 1.0. Since there are no exceedances, it is unlikely that adverse human health effects will occur in the AQRSA that are associated to Dichlorobenzene.

Mercaptans

Hazard quotients for the Mercaptans exposures are presented in Table SIR2 K-5. None of the HQ values for any of the receptor locations or cases exceed 1.0. Since there are no exceedances, it is unlikely that adverse human health effects will occur in the AQRSA that are associated to Mercaptans.

Pyrene

For the receptor living in the AQRSA, non-carcinogenic exposures to pyrene results in total HQ values less than 1.0 in the Baseline, Project-alone, and Planned Development cases at all receptor locations (Table SIR2 K-6). These results indicate that the exposure to pyrene emissions from all scenarios will not likely cause adverse non-carcinogenic health effects for people living in the vicinity.

With respect to carcinogenic effects, Table SIR2 K-7 presents the ILCR values for pyrene exposures to the adult receptor at each location. For the Baseline Case, the total ILCR value exceeded the maximum acceptable criterion of 1.0 x 10^{-5} at the MPOI (1.9 x 10^{-4}). The fish and wildgame ingestion exposure pathway are the primary contributors to the total risks at the MPOI. However, for the Project-alone, none of the receptor locations had an ILCR greater than the criterion.

Table SIR2 K-3: Hazard Quotients Due to Chronic Exposures to Carbon Disulfide

Receptor Location	Hazard Quotient (EDI/TDI)												Total HQ
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Tap Water Ingestion	Groundwater Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
MPOI	6.77E-11	3.66E-11	4.74E-15	3.16E-03	3.48E-04	0.00E+00	0.00E+00	1.42E-10	7.99E-09	1.42E-09	2.5E-04	2.01E-08	3.76E-03
AC	2.55E-13	1.38E-13	1.79E-17	1.19E-05	1.31E-06	0.00E+00	0.00E+00	5.36E-13	3.01E-11	5.36E-12	9.5E-07	7.57E-11	1.42E-05
AR	2.49E-12	1.35E-12	1.74E-16	1.16E-04	1.28E-05	0.00E+00	0.00E+00	5.23E-12	2.94E-10	5.23E-11	9.2E-06	7.39E-10	1.38E-04
TC1	7.36E-12	3.99E-12	5.16E-16	3.44E-04	3.78E-05	0.00E+00	0.00E+00	1.55E-11	8.69E-10	1.55E-10	2.7E-05	2.19E-09	4.09E-04
BL	4.41E-12	2.39E-12	3.09E-16	2.06E-04	2.27E-05	0.00E+00	0.00E+00	9.27E-12	5.21E-10	9.27E-11	1.6E-05	1.31E-09	2.45E-04
TC2	1.06E-12	5.77E-13	7.46E-17	4.98E-05	5.47E-06	0.00E+00	0.00E+00	2.24E-12	1.26E-10	2.24E-11	4.0E-06	3.16E-10	5.92E-05
TC3	7.69E-13	4.16E-13	5.39E-17	3.59E-05	3.95E-06	0.00E+00	0.00E+00	1.62E-12	9.08E-11	1.62E-11	2.9E-06	2.29E-10	4.28E-05
TC4	1.09E-12	5.88E-13	7.61E-17	5.08E-05	5.58E-06	0.00E+00	0.00E+00	2.28E-12	1.28E-10	2.28E-11	4.0E-06	3.23E-10	6.04E-05
FMK	2.17E-12	1.18E-12	1.52E-16	1.02E-04	1.12E-05	0.00E+00	0.00E+00	4.56E-12	2.56E-10	4.56E-11	8.1E-06	6.45E-10	1.21E-04
FMM	4.54E-13	2.46E-13	3.19E-17	2.13E-05	2.34E-06	0.00E+00	0.00E+00	9.56E-13	5.37E-11	9.56E-12	1.7E-06	1.35E-10	2.53E-05
FMT	1.09E-13	5.91E-14	7.65E-18	5.10E-06	5.61E-07	0.00E+00	0.00E+00	2.29E-13	1.29E-11	2.29E-12	4.1E-07	3.24E-11	6.07E-06
FMT1	6.03E-14	3.27E-14	4.23E-18	2.82E-06	3.10E-07	0.00E+00	0.00E+00	1.27E-13	7.13E-12	1.27E-12	2.2E-07	1.79E-11	3.36E-06
FMT2	2.97E-12	1.61E-12	2.08E-16	1.39E-04	1.52E-05	0.00E+00	0.00E+00	6.24E-12	3.50E-10	6.24E-11	1.1E-05	8.82E-10	1.65E-04
TC5	3.73E-13	2.02E-13	2.61E-17	1.74E-05	1.92E-06	0.00E+00	0.00E+00	7.84E-13	4.40E-11	7.84E-12	1.4E-06	1.11E-10	2.07E-05
TC6	4.01E-13	2.17E-13	2.81E-17	1.87E-05	2.06E-06	0.00E+00	0.00E+00	8.42E-13	4.73E-11	8.42E-12	1.5E-06	1.19E-10	2.23E-05
KL	3.57E-12	1.93E-12	2.50E-16	1.67E-04	1.84E-05	0.00E+00	0.00E+00	7.51E-12	4.22E-10	7.51E-11	1.3E-05	1.06E-09	1.99E-04
TC7	1.03E-12	5.56E-13	7.19E-17	4.80E-05	5.27E-06	0.00E+00	0.00E+00	2.16E-12	1.21E-10	2.16E-11	3.8E-06	3.05E-10	5.71E-05
TC8	1.99E-12	1.08E-12	1.40E-16	9.31E-05	1.02E-05	0.00E+00	0.00E+00	4.19E-12	2.35E-10	4.19E-11	7.4E-06	5.92E-10	1.11E-04
TC9	1.05E-12	5.68E-13	7.35E-17	4.90E-05	5.39E-06	0.00E+00	0.00E+00	2.20E-12	1.24E-10	2.20E-11	3.9E-06	3.12E-10	5.83E-05
TC10	4.36E-12	2.36E-12	3.06E-16	2.04E-04	2.24E-05	0.00E+00	0.00E+00	9.17E-12	5.15E-10	9.17E-11	1.6E-05	1.30E-09	2.43E-04
TC11	2.15E-12	1.16E-12	1.50E-16	1.00E-04	1.10E-05	0.00E+00	0.00E+00	4.51E-12	2.53E-10	4.51E-11	8.0E-06	6.38E-10	1.19E-04
MPOI	1.21E-16	6.53E-17	8.45E-21	3.16E-03	1.06E-07	0.00E+00	0.00E+00	1.10E-11	1.42E-14	1.10E-10	7.64E-08	6.33E-12	3.16E-03
AC	1.99E-17	1.08E-17	1.40E-21	1.19E-05	4.98E-10	0.00E+00	0.00E+00	4.14E-14	2.36E-15	4.14E-13	3.60E-10	2.96E-14	1.19E-05
AR	6.09E-17	3.30E-17	4.27E-21	1.16E-04	4.17E-09	0.00E+00	0.00E+00	4.04E-13	7.19E-15	4.04E-12	3.02E-09	2.49E-13	1.16E-04
TC1	4.82E-17	2.61E-17	3.38E-21	3.44E-04	1.17E-08	0.00E+00	0.00E+00	1.19E-12	5.69E-15	1.19E-11	8.44E-09	6.99E-13	3.44E-04
BL	6.81E-17	3.69E-17	4.77E-21	2.06E-04	7.19E-09	0.00E+00	0.00E+00	7.16E-13	8.04E-15	7.16E-12	5.20E-09	4.30E-13	2.06E-04
TC2	7.47E-17	4.05E-17	5.24E-21	4.98E-05	2.04E-09	0.00E+00	0.00E+00	1.73E-13	8.83E-15	1.73E-12	1.47E-09	1.21E-13	4.98E-05
TC3	7.53E-17	4.08E-17	5.28E-21	3.60E-05	1.58E-09	0.00E+00	0.00E+00	1.25E-13	8.90E-15	1.25E-12	1.14E-09	9.40E-14	3.60E-05
TC4	8.32E-17	4.50E-17	5.83E-21	5.08E-05	2.11E-09	0.00E+00	0.00E+00	1.76E-13	9.82E-15	1.76E-12	1.53E-09	1.26E-13	5.08E-05
FMK	4.94E-17	2.68E-17	3.46E-21	1.02E-04	3.62E-09	0.00E+00	0.00E+00	3.52E-13	5.84E-15	3.52E-12	2.62E-09	2.17E-13	1.02E-04
FMM	5.40E-17	2.92E-17	3.79E-21	2.13E-05	9.83E-10	0.00E+00	0.00E+00	7.39E-14	6.38E-15	7.39E-13	7.11E-10	5.83E-14	2.13E-05
FMT	7.10E-17	3.85E-17	4.98E-21	5.11E-06	5.34E-10	0.00E+00	0.00E+00	1.79E-14	8.39E-15	1.79E-13	3.86E-10	3.13E-14	5.11E-06
FMT1	1.52E-17	8.23E-18	1.06E-21	2.82E-06	1.72E-10	0.00E+00	0.00E+00	9.83E-15	1.79E-15	9.83E-14	1.24E-10	1.01E-14	2.82E-06
FMT2	5.12E-17	2.77E-17	3.59E-21	1.39E-04	4.87E-09	0.00E+00	0.00E+00	4.82E-13	6.05E-15	4.82E-12	3.52E-09	2.91E-13	1.39E-04

Receptor Location	Hazard Quotient (EDI/TDI)												Total HQ
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Tap Water Ingestion	Groundwater Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
TC5	2.75E-16	1.49E-16	1.93E-20	1.74E-05	1.99E-09	0.00E+00	0.00E+00	6.11E-14	3.25E-14	6.11E-13	1.44E-09	1.17E-13	1.74E-05
TC6	1.67E-16	9.07E-17	1.17E-20	1.87E-05	1.48E-09	0.00E+00	0.00E+00	6.54E-14	1.98E-14	6.54E-13	1.07E-09	8.71E-14	1.87E-05
KL	3.62E-17	1.96E-17	2.54E-21	1.67E-04	5.73E-09	0.00E+00	0.00E+00	5.80E-13	4.27E-15	5.80E-12	4.14E-09	3.43E-13	1.67E-04
TC7	3.13E-17	1.70E-17	2.20E-21	4.80E-05	1.75E-09	0.00E+00	0.00E+00	1.67E-13	3.70E-15	1.67E-12	1.27E-09	1.05E-13	4.80E-05
TC8	2.89E-17	1.57E-17	2.03E-21	9.31E-05	3.24E-09	0.00E+00	0.00E+00	3.23E-13	3.42E-15	3.23E-12	2.34E-09	1.94E-13	9.31E-05
TC9	4.46E-17	2.42E-17	3.13E-21	4.90E-05	1.86E-09	0.00E+00	0.00E+00	1.70E-13	5.27E-15	1.70E-12	1.34E-09	1.11E-13	4.90E-05
TC10	3.68E-17	1.99E-17	2.58E-21	2.04E-04	6.96E-09	0.00E+00	0.00E+00	7.08E-13	4.34E-15	7.08E-12	5.03E-09	4.17E-13	2.04E-04
TC11	6.69E-17	3.62E-17	4.69E-21	1.00E-04	3.67E-09	0.00E+00	0.00E+00	3.48E-13	7.90E-15	3.48E-12	2.66E-09	2.20E-13	1.00E-04
MPOI	6.77E-11	3.67E-11	4.75E-15	3.17E-03	3.48E-04	0.00E+00	0.00E+00	2.85E-10	1.60E-08	2.85E-09	2.52E-04	2.03E-08	3.76E-03
AC	2.70E-13	1.46E-13	1.90E-17	1.26E-05	1.39E-06	0.00E+00	0.00E+00	1.10E-12	6.20E-11	1.10E-11	1.00E-06	8.12E-11	1.50E-05
AR	2.52E-12	1.37E-12	1.77E-16	1.18E-04	1.30E-05	0.00E+00	0.00E+00	1.05E-11	5.91E-10	1.05E-10	9.37E-06	7.58E-10	1.40E-04
TC1	7.43E-12	4.03E-12	5.21E-16	3.48E-04	3.82E-05	0.00E+00	0.00E+00	3.11E-11	1.75E-09	3.11E-10	2.76E-05	2.23E-09	4.14E-04
BL	4.43E-12	2.40E-12	3.11E-16	2.07E-04	2.28E-05	0.00E+00	0.00E+00	1.86E-11	1.04E-09	1.86E-10	1.65E-05	1.33E-09	2.47E-04
TC2	1.08E-12	5.86E-13	7.59E-17	5.06E-05	5.57E-06	0.00E+00	0.00E+00	4.52E-12	2.54E-10	4.52E-11	4.02E-06	3.25E-10	6.02E-05
TC3	7.81E-13	4.23E-13	5.48E-17	3.65E-05	4.02E-06	0.00E+00	0.00E+00	3.26E-12	1.83E-10	3.26E-11	2.90E-06	2.35E-10	4.34E-05
TC4	1.10E-12	5.96E-13	7.72E-17	5.15E-05	5.66E-06	0.00E+00	0.00E+00	4.60E-12	2.58E-10	4.60E-11	4.09E-06	3.31E-10	6.12E-05
FMK	2.26E-12	1.23E-12	1.59E-16	1.06E-04	1.16E-05	0.00E+00	0.00E+00	9.32E-12	5.24E-10	9.32E-11	8.41E-06	6.80E-10	1.26E-04
FMM	4.66E-13	2.52E-13	3.27E-17	2.18E-05	2.39E-06	0.00E+00	0.00E+00	1.94E-12	1.09E-10	1.94E-11	1.73E-06	1.40E-10	2.59E-05
FMT	1.14E-13	6.16E-14	7.97E-18	5.32E-06	5.84E-07	0.00E+00	0.00E+00	4.69E-13	2.63E-11	4.69E-12	4.23E-07	3.41E-11	6.32E-06
FMT1	6.48E-14	3.51E-14	4.54E-18	3.03E-06	3.33E-07	0.00E+00	0.00E+00	2.63E-13	1.48E-11	2.63E-12	2.41E-07	1.95E-11	3.60E-06
FMT2	3.02E-12	1.64E-12	2.12E-16	1.41E-04	1.55E-05	0.00E+00	0.00E+00	1.26E-11	7.07E-10	1.26E-10	1.12E-05	9.07E-10	1.68E-04
TC5	3.83E-13	2.07E-13	2.69E-17	1.79E-05	1.97E-06	0.00E+00	0.00E+00	1.59E-12	8.93E-11	1.59E-11	1.42E-06	1.15E-10	2.13E-05
TC6	4.11E-13	2.23E-13	2.88E-17	1.92E-05	2.11E-06	0.00E+00	0.00E+00	1.71E-12	9.59E-11	1.71E-11	1.53E-06	1.24E-10	2.29E-05
KL	3.60E-12	1.95E-12	2.52E-16	1.68E-04	1.85E-05	0.00E+00	0.00E+00	1.51E-11	8.47E-10	1.51E-10	1.34E-05	1.08E-09	2.00E-04
TC7	1.04E-12	5.64E-13	7.30E-17	4.87E-05	5.35E-06	0.00E+00	0.00E+00	4.35E-12	2.44E-10	4.35E-11	3.87E-06	3.13E-10	5.79E-05
TC8	2.02E-12	1.09E-12	1.41E-16	9.43E-05	1.04E-05	0.00E+00	0.00E+00	8.43E-12	4.73E-10	8.43E-11	7.49E-06	6.06E-10	1.12E-04
TC9	1.30E-12	7.02E-13	9.08E-17	6.06E-05	6.66E-06	0.00E+00	0.00E+00	4.93E-12	2.77E-10	4.93E-11	4.81E-06	3.88E-10	7.20E-05
TC10	4.39E-12	2.38E-12	3.08E-16	2.05E-04	2.26E-05	0.00E+00	0.00E+00	1.84E-11	1.03E-09	1.84E-10	1.63E-05	1.32E-09	2.44E-04
TC11	2.18E-12	1.18E-12	1.53E-16	1.02E-04	1.12E-05	0.00E+00	0.00E+00	9.09E-12	5.10E-10	9.09E-11	8.09E-06	6.54E-10	1.21E-04

Table SIR2 K-4: Hazard Quotients Due to Chronic Exposures to Dichlorobenzene

Receptor Location	Hazard Quotient (EDI/TDI)										Total HQ
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
MPOI	3.44E-09	1.11E-10	2.53E-12	1.22E-03	1.65E-05	1.16E-09	5.23E-08	1.16E-08	3.3E-04	4.11E-11	1.57E-03
AC	2.03E-11	6.53E-13	1.49E-14	7.21E-06	9.71E-08	6.83E-12	3.08E-10	6.83E-11	1.9E-06	2.42E-13	9.23E-06
AR	4.04E-11	1.30E-12	2.97E-14	1.44E-05	1.93E-07	1.36E-11	6.13E-10	1.36E-10	3.8E-06	4.82E-13	1.84E-05
TC1	4.46E-11	1.44E-12	3.28E-14	1.59E-05	2.14E-07	1.50E-11	6.77E-10	1.50E-10	4.2E-06	5.32E-13	2.03E-05
BL	4.19E-11	1.35E-12	3.08E-14	1.49E-05	2.01E-07	1.41E-11	6.37E-10	1.41E-10	4.0E-06	5.00E-13	1.91E-05
TC2	4.78E-11	1.54E-12	3.51E-14	1.70E-05	2.29E-07	1.61E-11	7.26E-10	1.61E-10	4.5E-06	5.71E-13	2.18E-05
TC3	5.53E-11	1.78E-12	4.07E-14	1.97E-05	2.65E-07	1.87E-11	8.40E-10	1.87E-10	5.2E-06	6.60E-13	2.52E-05
TC4	4.83E-11	1.56E-12	3.55E-14	1.72E-05	2.31E-07	1.63E-11	7.33E-10	1.63E-10	4.6E-06	5.76E-13	2.20E-05
FMK	4.38E-11	1.41E-12	3.22E-14	1.56E-05	2.10E-07	1.48E-11	6.65E-10	1.48E-10	4.2E-06	5.23E-13	1.99E-05
FMM	1.76E-10	5.68E-12	1.30E-13	6.27E-05	8.44E-07	5.94E-11	2.68E-09	5.94E-10	1.7E-05	2.10E-12	8.03E-05
FMT	4.11E-11	1.33E-12	3.02E-14	1.46E-05	1.97E-07	1.39E-11	6.25E-10	1.39E-10	3.9E-06	4.91E-13	1.87E-05
FMT1	8.34E-12	2.69E-13	6.13E-15	2.97E-06	4.00E-08	2.81E-12	1.27E-10	2.81E-11	7.9E-07	9.95E-14	3.80E-06
FMT2	4.40E-11	1.42E-12	3.23E-14	1.56E-05	2.11E-07	1.48E-11	6.68E-10	1.48E-10	4.2E-06	5.25E-13	2.00E-05
TC5	1.53E-10	4.93E-12	1.12E-13	5.44E-05	7.33E-07	5.16E-11	2.32E-09	5.16E-10	1.5E-05	1.82E-12	6.97E-05
TC6	1.94E-10	6.25E-12	1.42E-13	6.90E-05	9.28E-07	6.54E-11	2.94E-09	6.54E-10	1.8E-05	2.31E-12	8.83E-05
KL	5.67E-11	1.83E-12	4.17E-14	2.02E-05	2.72E-07	1.91E-11	8.61E-10	1.91E-10	5.4E-06	6.77E-13	2.58E-05
TC7	1.27E-10	4.08E-12	9.30E-14	4.50E-05	6.06E-07	4.27E-11	1.92E-09	4.27E-10	1.2E-05	1.51E-12	5.76E-05
TC8	6.15E-11	1.98E-12	4.52E-14	2.19E-05	2.94E-07	2.07E-11	9.33E-10	2.07E-10	5.8E-06	7.33E-13	2.80E-05
TC9	3.30E-11	1.06E-12	2.42E-14	1.17E-05	1.58E-07	1.11E-11	5.01E-10	1.11E-10	3.1E-06	3.94E-13	1.50E-05
TC10	5.66E-11	1.82E-12	4.16E-14	2.01E-05	2.71E-07	1.91E-11	8.59E-10	1.91E-10	5.4E-06	6.75E-13	2.58E-05
TC11	4.35E-11	1.40E-12	3.19E-14	1.55E-05	2.08E-07	1.47E-11	6.60E-10	1.47E-10	4.1E-06	5.19E-13	1.98E-05
MPOI	5.22E-12	1.68E-13	3.84E-15	1.23E-03	2.50E-08	1.76E-12	7.93E-11	1.76E-11	4.95E-07	6.23E-14	1.23E-03
AC	8.09E-13	2.61E-14	5.95E-16	7.50E-06	3.88E-09	2.73E-13	1.23E-11	2.73E-12	7.68E-08	9.66E-15	7.58E-06
AR	3.16E-12	1.02E-13	2.33E-15	1.55E-05	1.52E-08	1.07E-12	4.81E-11	1.07E-11	3.00E-07	3.78E-14	1.58E-05
TC1	2.09E-12	6.75E-14	1.54E-15	1.66E-05	1.00E-08	7.06E-13	3.18E-11	7.06E-12	1.99E-07	2.50E-14	1.68E-05
BL	4.29E-12	1.38E-13	3.15E-15	1.64E-05	2.05E-08	1.45E-12	6.51E-11	1.45E-11	4.07E-07	5.12E-14	1.69E-05
TC2	4.33E-12	1.40E-13	3.18E-15	1.86E-05	2.07E-08	1.46E-12	6.58E-11	1.46E-11	4.11E-07	5.17E-14	1.90E-05
TC3	3.63E-12	1.17E-13	2.67E-15	2.10E-05	1.74E-08	1.22E-12	5.51E-11	1.22E-11	3.44E-07	4.33E-14	2.13E-05
TC4	5.17E-12	1.67E-13	3.80E-15	1.90E-05	2.48E-08	1.74E-12	7.85E-11	1.74E-11	4.90E-07	6.17E-14	1.95E-05
FMK	2.40E-12	7.73E-14	1.76E-15	1.64E-05	1.15E-08	8.08E-13	3.64E-11	8.08E-12	2.27E-07	2.86E-14	1.67E-05
FMM	3.15E-12	1.02E-13	2.31E-15	6.38E-05	1.51E-08	1.06E-12	4.78E-11	1.06E-11	2.99E-07	3.76E-14	6.42E-05
FMT	3.56E-12	1.15E-13	2.62E-15	1.59E-05	1.71E-08	1.20E-12	5.41E-11	1.20E-11	3.38E-07	4.25E-14	1.63E-05
FMT1	4.85E-13	1.56E-14	3.56E-16	3.14E-06	2.32E-09	1.64E-13	7.37E-12	1.64E-12	4.60E-08	5.79E-15	3.19E-06
FMT2	2.51E-12	8.11E-14	1.85E-15	1.65E-05	1.20E-08	8.48E-13	3.82E-11	8.48E-12	2.39E-07	3.00E-14	1.68E-05

Receptor Location	Hazard Quotient (EDI/TDI)										Total HQ
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
TC5	1.83E-11	5.92E-13	1.35E-14	6.09E-05	8.79E-08	6.19E-12	2.79E-10	6.19E-11	1.74E-06	2.19E-13	6.28E-05
TC6	9.80E-12	3.16E-13	7.20E-15	7.24E-05	4.69E-08	3.30E-12	1.49E-10	3.30E-11	9.29E-07	1.17E-13	7.34E-05
KL	1.52E-12	4.91E-14	1.12E-15	2.07E-05	7.30E-09	5.14E-13	2.31E-11	5.14E-12	1.45E-07	1.82E-14	2.09E-05
TC7	1.21E-12	3.89E-14	8.87E-16	4.54E-05	5.78E-09	4.07E-13	1.83E-11	4.07E-12	1.15E-07	1.44E-14	4.56E-05
TC8	1.33E-12	4.30E-14	9.79E-16	2.23E-05	6.38E-09	4.49E-13	2.02E-11	4.49E-12	1.26E-07	1.59E-14	2.25E-05
TC9	2.20E-12	7.10E-14	1.62E-15	1.25E-05	1.05E-08	7.43E-13	3.34E-11	7.43E-12	2.09E-07	2.63E-14	1.27E-05
TC10	1.55E-12	4.98E-14	1.14E-15	2.07E-05	7.40E-09	5.21E-13	2.35E-11	5.21E-12	1.47E-07	1.84E-14	2.08E-05
TC11	2.87E-12	9.25E-14	2.11E-15	1.65E-05	1.37E-08	9.67E-13	4.36E-11	9.67E-12	2.72E-07	3.42E-14	1.68E-05
MPOI	6.69E-09	2.16E-10	4.91E-12	2.38E-03	3.20E-05	2.13E-09	1.02E-07	3.29E-08	6.34E-04	1.04E-10	3.05E-03
AC	3.28E-11	1.06E-12	2.41E-14	1.17E-05	1.57E-07	1.03E-11	4.98E-10	1.72E-10	3.11E-06	5.34E-13	1.49E-05
AR	7.09E-11	2.29E-12	5.21E-14	2.52E-05	3.39E-07	2.25E-11	1.08E-09	3.61E-10	6.72E-06	1.13E-12	3.23E-05
TC1	7.58E-11	2.44E-12	5.57E-14	2.70E-05	3.63E-07	2.40E-11	1.15E-09	3.90E-10	7.18E-06	1.22E-12	3.45E-05
BL	7.08E-11	2.28E-12	5.20E-14	2.52E-05	3.39E-07	2.24E-11	1.08E-09	3.65E-10	6.71E-06	1.14E-12	3.23E-05
TC2	8.43E-11	2.72E-12	6.19E-14	3.00E-05	4.03E-07	2.67E-11	1.28E-09	4.29E-10	7.98E-06	1.34E-12	3.84E-05
TC3	1.05E-10	3.40E-12	7.74E-14	3.75E-05	5.04E-07	3.36E-11	1.60E-09	5.22E-10	9.98E-06	1.65E-12	4.80E-05
TC4	9.23E-11	2.98E-12	6.78E-14	3.29E-05	4.42E-07	2.94E-11	1.40E-09	4.57E-10	8.75E-06	1.44E-12	4.20E-05
FMK	8.08E-11	2.61E-12	5.94E-14	2.88E-05	3.87E-07	2.57E-11	1.23E-09	4.05E-10	7.66E-06	1.27E-12	3.68E-05
FMM	3.37E-10	1.09E-11	2.48E-13	1.20E-04	1.61E-06	1.07E-10	5.12E-09	1.67E-09	3.19E-05	5.26E-12	1.54E-04
FMT	8.39E-11	2.71E-12	6.17E-14	2.99E-05	4.02E-07	2.68E-11	1.27E-09	4.07E-10	7.95E-06	1.29E-12	3.82E-05
FMT1	1.50E-11	4.85E-13	1.11E-14	5.35E-06	7.20E-08	4.78E-12	2.28E-10	7.59E-11	1.43E-06	2.38E-13	6.85E-06
FMT2	7.71E-11	2.49E-12	5.67E-14	2.74E-05	3.69E-07	2.45E-11	1.17E-09	3.93E-10	7.31E-06	1.23E-12	3.51E-05
TC5	3.01E-10	9.71E-12	2.21E-13	1.07E-04	1.44E-06	9.61E-11	4.57E-09	1.48E-09	2.85E-05	4.67E-12	1.37E-04
TC6	3.74E-10	1.21E-11	2.75E-13	1.33E-04	1.79E-06	1.19E-10	5.68E-09	1.85E-09	3.54E-05	5.82E-12	1.70E-04
KL	7.93E-11	2.56E-12	5.82E-14	2.82E-05	3.79E-07	2.47E-11	1.20E-09	4.39E-10	7.51E-06	1.34E-12	3.61E-05
TC7	1.42E-10	4.57E-12	1.04E-13	5.04E-05	6.78E-07	4.33E-11	2.15E-09	8.60E-10	1.34E-05	2.58E-12	6.46E-05
TC8	8.14E-11	2.63E-12	5.98E-14	2.90E-05	3.89E-07	2.53E-11	1.24E-09	4.60E-10	7.71E-06	1.40E-12	3.71E-05
TC9	8.01E-11	2.58E-12	5.88E-14	2.85E-05	3.83E-07	2.58E-11	1.22E-09	3.70E-10	7.59E-06	1.19E-12	3.65E-05
TC10	7.94E-11	2.56E-12	5.84E-14	2.83E-05	3.80E-07	2.48E-11	1.21E-09	4.39E-10	7.52E-06	1.35E-12	3.62E-05
TC11	7.32E-11	2.36E-12	5.38E-14	2.60E-05	3.50E-07	2.31E-11	1.11E-09	3.78E-10	6.93E-06	1.18E-12	3.33E-05

Table SIR2 K-5: Hazard Quotients Due to Chronic Exposures to Mercaptans

Receptor Location	Hazard Quotient (EDI/TDI)										Total HQ
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
MPOI	3.98E-10	3.42E-11	3.52E-14	9.66E-03	7.72E-04	6.09E-09	9.11E-10	6.09E-08	1.8E-04	2.66E-09	1.06E-02
AC	6.05E-12	5.20E-13	5.34E-16	1.47E-04	1.17E-05	9.24E-11	1.38E-11	9.24E-10	2.7E-06	4.04E-11	1.61E-04
AR	4.63E-11	3.98E-12	4.09E-15	1.12E-03	8.98E-05	7.08E-10	1.06E-10	7.08E-09	2.1E-05	3.10E-10	1.23E-03
TC1	1.04E-10	8.93E-12	9.17E-15	2.52E-03	2.01E-04	1.59E-09	2.38E-10	1.59E-08	4.7E-05	6.95E-10	2.77E-03
BL	4.97E-11	4.27E-12	4.39E-15	1.21E-03	9.63E-05	7.59E-10	1.14E-10	7.59E-09	2.2E-05	3.32E-10	1.32E-03
TC2	1.53E-11	1.31E-12	1.35E-15	3.70E-04	2.96E-05	2.33E-10	3.49E-11	2.33E-09	6.9E-06	1.02E-10	4.06E-04
TC3	1.25E-11	1.08E-12	1.11E-15	3.04E-04	2.43E-05	1.92E-10	2.87E-11	1.92E-09	5.6E-06	8.39E-11	3.34E-04
TC4	1.59E-11	1.36E-12	1.40E-15	3.85E-04	3.07E-05	2.43E-10	3.63E-11	2.43E-09	7.1E-06	1.06E-10	4.23E-04
FMK	4.80E-11	4.13E-12	4.24E-15	1.17E-03	9.31E-05	7.34E-10	1.10E-10	7.34E-09	2.2E-05	3.21E-10	1.28E-03
FMM	8.33E-12	7.16E-13	7.36E-16	2.02E-04	1.61E-05	1.27E-10	1.91E-11	1.27E-09	3.7E-06	5.57E-11	2.22E-04
FMT	2.22E-12	1.91E-13	1.96E-16	5.38E-05	4.30E-06	3.39E-11	5.07E-12	3.39E-10	1.0E-06	1.48E-11	5.91E-05
FMT1	1.11E-12	9.57E-14	9.83E-17	2.70E-05	2.16E-06	1.70E-11	2.55E-12	1.70E-10	5.0E-07	7.45E-12	2.97E-05
FMT2	5.32E-11	4.58E-12	4.70E-15	1.29E-03	1.03E-04	8.14E-10	1.22E-10	8.14E-09	2.4E-05	3.56E-10	1.42E-03
TC5	6.94E-12	5.97E-13	6.13E-16	1.68E-04	1.34E-05	1.06E-10	1.59E-11	1.06E-09	3.1E-06	4.64E-11	1.85E-04
TC6	7.60E-12	6.53E-13	6.71E-16	1.84E-04	1.47E-05	1.16E-10	1.74E-11	1.16E-09	3.4E-06	5.08E-11	2.02E-04
KL	9.31E-11	8.01E-12	8.23E-15	2.26E-03	1.80E-04	1.42E-09	2.13E-10	1.42E-08	4.2E-05	6.23E-10	2.48E-03
TC7	2.34E-11	2.01E-12	2.06E-15	5.66E-04	4.52E-05	3.57E-10	5.34E-11	3.57E-09	1.0E-05	1.56E-10	6.22E-04
TC8	5.09E-11	4.38E-12	4.50E-15	1.23E-03	9.86E-05	7.78E-10	1.16E-10	7.78E-09	2.3E-05	3.40E-10	1.36E-03
TC9	2.33E-11	2.01E-12	2.06E-15	5.66E-04	4.52E-05	3.56E-10	5.33E-11	3.56E-09	1.0E-05	1.56E-10	6.21E-04
TC10	1.15E-10	9.88E-12	1.02E-14	2.79E-03	2.23E-04	1.76E-09	2.63E-10	1.76E-08	5.2E-05	7.69E-10	3.06E-03
TC11	3.66E-11	3.15E-12	3.23E-15	8.87E-04	7.09E-05	5.59E-10	8.37E-11	5.59E-09	1.6E-05	2.45E-10	9.75E-04
MPOI	1.55E-15	1.33E-16	1.37E-19	9.66E-03	1.99E-06	2.37E-14	3.54E-15	2.37E-13	4.61E-07	6.84E-12	9.66E-03
AC	2.94E-16	2.52E-17	2.59E-20	1.47E-04	3.07E-08	4.49E-15	6.71E-16	4.49E-14	7.12E-09	1.06E-13	1.47E-04
AR	8.56E-16	7.36E-17	7.56E-20	1.12E-03	2.33E-07	1.31E-14	1.96E-15	1.31E-13	5.39E-08	8.00E-13	1.12E-03
TC1	7.75E-16	6.66E-17	6.84E-20	2.52E-03	5.19E-07	1.18E-14	1.77E-15	1.18E-13	1.20E-07	1.78E-12	2.52E-03
BL	1.02E-15	8.77E-17	9.00E-20	1.21E-03	2.50E-07	1.56E-14	2.33E-15	1.56E-13	5.79E-08	8.58E-13	1.21E-03
TC2	1.12E-15	9.64E-17	9.91E-20	3.70E-04	7.82E-08	1.71E-14	2.56E-15	1.71E-13	1.81E-08	2.69E-13	3.70E-04
TC3	1.13E-15	9.75E-17	1.00E-19	3.04E-04	6.47E-08	1.73E-14	2.59E-15	1.73E-13	1.50E-08	2.23E-13	3.04E-04
TC4	1.13E-15	9.71E-17	9.98E-20	3.85E-04	8.13E-08	1.73E-14	2.58E-15	1.73E-13	1.89E-08	2.79E-13	3.85E-04
FMK	7.34E-16	6.31E-17	6.48E-20	1.17E-03	2.41E-07	1.12E-14	1.68E-15	1.12E-13	5.59E-08	8.28E-13	1.17E-03
FMM	8.07E-16	6.94E-17	7.13E-20	2.02E-04	4.31E-08	1.23E-14	1.85E-15	1.23E-13	9.99E-09	1.48E-13	2.02E-04
FMT	1.06E-15	9.14E-17	9.39E-20	5.38E-05	1.31E-08	1.62E-14	2.43E-15	1.62E-13	3.04E-09	4.51E-14	5.38E-05
FMT1	2.28E-16	1.96E-17	2.01E-20	2.70E-05	5.99E-09	3.48E-15	5.21E-16	3.48E-14	1.39E-09	2.06E-14	2.70E-05
FMT2	8.15E-16	7.01E-17	7.20E-20	1.29E-03	2.67E-07	1.25E-14	1.87E-15	1.25E-13	6.19E-08	9.18E-13	1.29E-03

Receptor Location	Hazard Quotient (EDI/TDI)										Total HQ
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
TC5	4.12E-15	3.54E-16	3.64E-19	1.68E-04	4.26E-08	6.30E-14	9.43E-15	6.30E-13	9.87E-09	1.46E-13	1.68E-04
TC6	2.50E-15	2.15E-16	2.21E-19	1.84E-04	4.27E-08	3.83E-14	5.73E-15	3.83E-13	9.91E-09	1.47E-13	1.84E-04
KL	5.71E-16	4.91E-17	5.04E-20	2.26E-03	4.65E-07	8.72E-15	1.31E-15	8.72E-14	1.08E-07	1.60E-12	2.26E-03
TC7	4.93E-16	4.24E-17	4.36E-20	5.66E-04	1.17E-07	7.54E-15	1.13E-15	7.54E-14	2.72E-08	4.04E-13	5.67E-04
TC8	4.08E-16	3.51E-17	3.60E-20	1.23E-03	2.55E-07	6.23E-15	9.33E-16	6.23E-14	5.90E-08	8.75E-13	1.23E-03
TC9	6.56E-16	5.64E-17	5.80E-20	5.66E-04	1.18E-07	1.00E-14	1.50E-15	1.00E-13	2.72E-08	4.04E-13	5.66E-04
TC10	5.30E-16	4.56E-17	4.68E-20	2.79E-03	5.74E-07	8.10E-15	1.21E-15	8.10E-14	1.33E-07	1.97E-12	2.79E-03
TC11	1.01E-15	8.66E-17	8.90E-20	8.87E-04	1.84E-07	1.54E-14	2.30E-15	1.54E-13	4.27E-08	6.34E-13	8.88E-04
MPOI	3.99E-10	3.43E-11	3.52E-14	9.67E-03	7.72E-04	1.22E-08	1.82E-09	1.22E-07	1.79E-04	2.68E-09	1.06E-02
AC	6.40E-12	5.51E-13	5.66E-16	1.55E-04	1.24E-05	1.90E-10	2.85E-11	1.90E-09	2.88E-06	4.30E-11	1.71E-04
AR	4.70E-11	4.04E-12	4.15E-15	1.14E-03	9.11E-05	1.43E-09	2.14E-10	1.43E-08	2.11E-05	3.16E-10	1.25E-03
TC1	1.06E-10	9.08E-12	9.33E-15	2.56E-03	2.05E-04	3.20E-09	4.79E-10	3.20E-08	4.74E-05	7.09E-10	2.81E-03
BL	5.03E-11	4.33E-12	4.44E-15	1.22E-03	9.75E-05	1.53E-09	2.29E-10	1.53E-08	2.26E-05	3.38E-10	1.34E-03
TC2	1.57E-11	1.35E-12	1.38E-15	3.80E-04	3.03E-05	4.73E-10	7.07E-11	4.73E-09	7.03E-06	1.05E-10	4.17E-04
TC3	1.28E-11	1.10E-12	1.13E-15	3.11E-04	2.48E-05	3.87E-10	5.80E-11	3.87E-09	5.75E-06	8.60E-11	3.41E-04
TC4	1.63E-11	1.40E-12	1.44E-15	3.95E-04	3.15E-05	4.91E-10	7.35E-11	4.91E-09	7.32E-06	1.09E-10	4.34E-04
FMK	5.02E-11	4.32E-12	4.44E-15	1.22E-03	9.73E-05	1.50E-09	2.25E-10	1.50E-08	2.26E-05	3.37E-10	1.34E-03
FMM	8.58E-12	7.38E-13	7.58E-16	2.08E-04	1.66E-05	2.58E-10	3.87E-11	2.58E-09	3.85E-06	5.76E-11	2.29E-04
FMT	2.31E-12	1.99E-13	2.04E-16	5.61E-05	4.48E-06	6.93E-11	1.04E-11	6.93E-10	1.04E-06	1.55E-11	6.16E-05
FMT1	1.21E-12	1.04E-13	1.07E-16	2.93E-05	2.34E-06	3.55E-11	5.31E-12	3.55E-10	5.43E-07	8.12E-12	3.22E-05
FMT2	5.45E-11	4.69E-12	4.81E-15	1.32E-03	1.06E-04	1.65E-09	2.46E-10	1.65E-08	2.45E-05	3.66E-10	1.45E-03
TC5	7.16E-12	6.16E-13	6.32E-16	1.74E-04	1.39E-05	2.15E-10	3.22E-11	2.15E-09	3.22E-06	4.81E-11	1.91E-04
TC6	7.83E-12	6.74E-13	6.92E-16	1.90E-04	1.52E-05	2.36E-10	3.53E-11	2.36E-09	3.52E-06	5.26E-11	2.09E-04
KL	9.38E-11	8.06E-12	8.28E-15	2.27E-03	1.82E-04	2.86E-09	4.27E-10	2.86E-08	4.21E-05	6.30E-10	2.50E-03
TC7	2.37E-11	2.04E-12	2.09E-15	5.74E-04	4.59E-05	7.19E-10	1.08E-10	7.19E-09	1.06E-05	1.59E-10	6.31E-04
TC8	5.14E-11	4.42E-12	4.54E-15	1.25E-03	9.96E-05	1.56E-09	2.34E-10	1.56E-08	2.31E-05	3.45E-10	1.37E-03
TC9	2.88E-11	2.48E-12	2.55E-15	6.99E-04	5.58E-05	7.97E-10	1.19E-10	7.97E-09	1.29E-05	1.93E-10	7.68E-04
TC10	1.16E-10	9.94E-12	1.02E-14	2.80E-03	2.24E-04	3.52E-09	5.27E-10	3.52E-08	5.19E-05	7.76E-10	3.08E-03
TC11	3.73E-11	3.21E-12	3.29E-15	9.04E-04	7.22E-05	1.13E-09	1.69E-10	1.13E-08	1.67E-05	2.50E-10	9.93E-04

Table SIR2 K-6: Hazard Quotients Due to Chronic Exposures to Pyrene

Receptor Location	Hazard Quotient (EDI/TDI)										Total HQ
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
MPOI	6.88E-05	7.69E-06	6.08E-09	1.86E-04	1.14E-04	3.70E-06	9.35E-08	3.70E-05	9.8E-03	8.10E-06	1.03E-02
AC	7.87E-08	8.80E-09	6.95E-12	2.13E-07	1.30E-07	1.54E-08	1.07E-10	1.54E-07	1.1E-05	3.64E-08	1.19E-05
AR	5.19E-07	5.80E-08	4.59E-11	1.40E-06	8.58E-07	3.90E-08	7.06E-10	3.90E-07	7.4E-05	8.81E-08	7.76E-05
TC1	8.65E-07	9.67E-08	7.64E-11	2.34E-06	1.43E-06	5.76E-08	1.18E-09	5.76E-07	1.2E-04	1.29E-07	1.29E-04
BL	6.19E-07	6.92E-08	5.47E-11	1.67E-06	1.02E-06	4.44E-08	8.41E-10	4.44E-07	8.8E-05	9.98E-08	9.25E-05
TC2	4.47E-07	5.00E-08	3.95E-11	1.21E-06	7.39E-07	3.52E-08	6.08E-10	3.52E-07	6.4E-05	7.97E-08	6.69E-05
TC3	6.68E-07	7.47E-08	5.90E-11	1.81E-06	1.10E-06	4.70E-08	9.09E-10	4.70E-07	9.6E-05	1.06E-07	9.98E-05
TC4	5.15E-07	5.76E-08	4.55E-11	1.39E-06	8.51E-07	3.88E-08	7.00E-10	3.88E-07	7.4E-05	8.76E-08	7.70E-05
FMK	6.13E-07	6.85E-08	5.41E-11	1.66E-06	1.01E-06	4.41E-08	8.33E-10	4.41E-07	8.8E-05	9.91E-08	9.15E-05
FMM	3.10E-06	3.46E-07	2.74E-10	8.37E-06	5.12E-06	1.77E-07	4.21E-09	1.77E-06	4.4E-04	3.91E-07	4.62E-04
FMT	3.85E-07	4.31E-08	3.40E-11	1.04E-06	6.37E-07	3.19E-08	5.24E-10	3.19E-07	5.5E-05	7.24E-08	5.76E-05
FMT1	2.95E-08	3.30E-09	2.61E-12	7.98E-08	4.88E-08	1.28E-08	4.02E-11	1.28E-07	4.2E-06	3.06E-08	4.56E-06
FMT2	6.10E-07	6.82E-08	5.39E-11	1.65E-06	1.01E-06	4.39E-08	8.29E-10	4.39E-07	8.7E-05	9.88E-08	9.11E-05
TC5	2.47E-06	2.76E-07	2.18E-10	6.67E-06	4.08E-06	1.44E-07	3.36E-09	1.44E-06	3.5E-04	3.17E-07	3.68E-04
TC6	3.33E-06	3.72E-07	2.94E-10	8.99E-06	5.50E-06	1.90E-07	4.52E-09	1.90E-06	4.8E-04	4.18E-07	4.97E-04
KL	7.54E-07	8.43E-08	6.66E-11	2.04E-06	1.25E-06	5.16E-08	1.02E-09	5.16E-07	1.1E-04	1.16E-07	1.13E-04
TC7	3.10E-07	3.47E-08	2.74E-11	8.39E-07	5.13E-07	2.79E-08	4.22E-10	2.79E-07	4.4E-05	6.36E-08	4.65E-05
TC8	6.02E-07	6.73E-08	5.32E-11	1.63E-06	9.95E-07	4.35E-08	8.19E-10	4.35E-07	8.6E-05	9.79E-08	9.00E-05
TC9	2.78E-07	3.10E-08	2.45E-11	7.50E-07	4.59E-07	2.61E-08	3.77E-10	2.61E-07	4.0E-05	5.97E-08	4.15E-05
TC10	8.85E-07	9.90E-08	7.82E-11	2.39E-06	1.46E-06	5.87E-08	1.20E-09	5.87E-07	1.3E-04	1.31E-07	1.32E-04
TC11	4.76E-07	5.33E-08	4.21E-11	1.29E-06	7.87E-07	3.67E-08	6.47E-10	3.67E-07	6.8E-05	8.31E-08	7.12E-05
MPOI	4.17E-10	4.67E-11	3.69E-14	1.13E-09	1.44E-06	2.17E-08	5.67E-13	2.17E-07	1.24E-04	3.07E-08	1.26E-04
AC	6.56E-11	7.33E-12	5.79E-15	1.77E-10	1.75E-09	1.12E-08	8.91E-14	1.12E-07	1.51E-07	2.72E-08	3.04E-07
AR	2.64E-10	2.95E-11	2.33E-14	7.12E-10	1.13E-08	1.13E-08	3.58E-13	1.13E-07	9.75E-07	2.72E-08	1.14E-06
TC1	2.11E-10	2.36E-11	1.87E-14	5.71E-10	1.84E-08	1.14E-08	2.87E-13	1.14E-07	1.59E-06	2.72E-08	1.76E-06
BL	3.29E-10	3.68E-11	2.91E-14	8.89E-10	1.35E-08	1.13E-08	4.47E-13	1.13E-07	1.16E-06	2.72E-08	1.33E-06
TC2	2.34E-10	2.61E-11	2.06E-14	6.31E-10	9.72E-09	1.13E-08	3.17E-13	1.13E-07	8.41E-07	2.72E-08	1.00E-06
TC3	3.00E-10	3.35E-11	2.65E-14	8.09E-10	1.44E-08	1.13E-08	4.07E-13	1.13E-07	1.25E-06	2.72E-08	1.42E-06
TC4	4.50E-10	5.04E-11	3.98E-14	1.22E-09	1.15E-08	1.13E-08	6.12E-13	1.13E-07	9.94E-07	2.73E-08	1.16E-06
FMK	2.19E-10	2.45E-11	1.93E-14	5.91E-10	1.31E-08	1.13E-08	2.98E-13	1.13E-07	1.14E-06	2.72E-08	1.30E-06
FMM	2.60E-10	2.91E-11	2.30E-14	7.03E-10	6.50E-08	1.17E-08	3.54E-13	1.17E-07	5.63E-06	2.74E-08	5.85E-06
FMT	2.94E-10	3.29E-11	2.60E-14	7.94E-10	8.52E-09	1.13E-08	4.00E-13	1.13E-07	7.37E-07	2.72E-08	8.99E-07
FMT1	4.09E-11	4.58E-12	3.62E-15	1.11E-10	6.84E-10	1.12E-08	5.57E-14	1.12E-07	5.92E-08	2.72E-08	2.11E-07
FMT2	2.32E-10	2.60E-11	2.05E-14	6.28E-10	1.31E-08	1.13E-08	3.16E-13	1.13E-07	1.13E-06	2.72E-08	1.30E-06

Receptor Location	Hazard Quotient (EDI/TDI)										Total HQ
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
TC5	1.28E-09	1.44E-10	1.13E-13	3.47E-09	5.36E-08	1.17E-08	1.75E-12	1.17E-07	4.64E-06	2.75E-08	4.85E-06
TC6	8.08E-10	9.03E-11	7.14E-14	2.18E-09	7.08E-08	1.18E-08	1.10E-12	1.18E-07	6.12E-06	2.74E-08	6.35E-06
KL	1.47E-10	1.65E-11	1.30E-14	3.98E-10	1.60E-08	1.13E-08	2.00E-13	1.13E-07	1.38E-06	2.72E-08	1.55E-06
TC7	1.42E-10	1.59E-11	1.26E-14	3.85E-10	6.71E-09	1.13E-08	1.94E-13	1.13E-07	5.81E-07	2.72E-08	7.39E-07
TC8	1.08E-10	1.20E-11	9.50E-15	2.90E-10	1.27E-08	1.13E-08	1.46E-13	1.13E-07	1.10E-06	2.72E-08	1.27E-06
TC9	2.12E-10	2.37E-11	1.87E-14	5.73E-10	6.14E-09	1.13E-08	2.88E-13	1.13E-07	5.31E-07	2.72E-08	6.89E-07
TC10	1.50E-10	1.67E-11	1.32E-14	4.04E-10	1.87E-08	1.14E-08	2.03E-13	1.14E-07	1.62E-06	2.72E-08	1.79E-06
TC11	2.96E-10	3.31E-11	2.62E-14	8.00E-10	1.04E-08	1.13E-08	4.03E-13	1.13E-07	9.02E-07	2.72E-08	1.07E-06
MPOI	1.34E-04	1.50E-05	1.18E-08	3.61E-04	2.21E-04	1.09E-05	2.75E-07	1.09E-04	1.91E-02	1.67E-05	2.00E-02
AC	1.11E-07	1.24E-08	9.80E-12	3.00E-07	1.83E-07	3.26E-08	2.58E-10	3.26E-07	1.59E-05	6.85E-08	1.69E-05
AR	6.98E-07	7.81E-08	6.17E-11	1.89E-06	1.15E-06	8.77E-08	1.66E-09	8.77E-07	9.99E-05	1.44E-07	1.05E-04
TC1	1.09E-06	1.22E-07	9.64E-11	2.95E-06	1.80E-06	1.27E-07	2.66E-09	1.27E-06	1.56E-04	1.95E-07	1.64E-04
BL	8.39E-07	9.38E-08	7.41E-11	2.27E-06	1.39E-06	1.01E-07	1.98E-09	1.01E-06	1.20E-04	1.62E-07	1.26E-04
TC2	8.11E-07	9.07E-08	7.17E-11	2.19E-06	1.34E-06	8.99E-08	1.71E-09	8.99E-07	1.16E-04	1.56E-07	1.22E-04
TC3	1.23E-06	1.38E-07	1.09E-10	3.34E-06	2.04E-06	1.24E-07	2.59E-09	1.24E-06	1.77E-04	2.09E-07	1.85E-04
TC4	9.13E-07	1.02E-07	8.07E-11	2.47E-06	1.51E-06	9.90E-08	1.94E-09	9.90E-07	1.31E-04	1.69E-07	1.37E-04
FMK	9.12E-07	1.02E-07	8.06E-11	2.46E-06	1.51E-06	1.04E-07	2.07E-09	1.04E-06	1.30E-04	1.70E-07	1.37E-04
FMM	5.96E-06	6.67E-07	5.27E-10	1.61E-05	9.86E-06	5.08E-07	1.23E-08	5.08E-06	8.53E-04	7.98E-07	8.92E-04
FMT	7.34E-07	8.20E-08	6.48E-11	1.98E-06	1.21E-06	8.24E-08	1.52E-09	8.24E-07	1.05E-04	1.46E-07	1.10E-04
FMT1	5.05E-08	5.65E-09	4.46E-12	1.36E-07	8.35E-08	2.67E-08	1.09E-10	2.67E-07	7.22E-06	6.07E-08	7.86E-06
FMT2	8.63E-07	9.65E-08	7.63E-11	2.33E-06	1.43E-06	1.01E-07	2.00E-09	1.01E-06	1.23E-04	1.64E-07	1.29E-04
TC5	4.76E-06	5.32E-07	4.21E-10	1.29E-05	7.87E-06	4.10E-07	9.83E-09	4.10E-06	6.81E-04	6.48E-07	7.12E-04
TC6	6.42E-06	7.17E-07	5.67E-10	1.73E-05	1.06E-05	5.45E-07	1.32E-08	5.45E-06	9.17E-04	8.55E-07	9.59E-04
KL	8.58E-07	9.59E-08	7.58E-11	2.32E-06	1.42E-06	1.09E-07	2.19E-09	1.09E-06	1.23E-04	1.66E-07	1.29E-04
TC7	3.79E-07	4.24E-08	3.35E-11	1.02E-06	6.26E-07	5.94E-08	9.37E-10	5.94E-07	5.42E-05	1.03E-07	5.70E-05
TC8	6.78E-07	7.58E-08	5.99E-11	1.83E-06	1.12E-06	9.10E-08	1.74E-09	9.10E-07	9.69E-05	1.42E-07	1.02E-04
TC9	4.38E-07	4.89E-08	3.87E-11	1.18E-06	7.23E-07	6.08E-08	9.72E-10	6.08E-07	6.26E-05	1.10E-07	6.57E-05
TC10	9.91E-07	1.11E-07	8.75E-11	2.68E-06	1.64E-06	1.23E-07	2.55E-09	1.23E-06	1.42E-04	1.83E-07	1.49E-04
TC11	6.72E-07	7.52E-08	5.94E-11	1.82E-06	1.11E-06	8.40E-08	1.56E-09	8.40E-07	9.61E-05	1.40E-07	1.01E-04

Table SIR2 K-7: Incremental Lifetime Cancer Risk Due to Chronic Exposures to Pyrene for an Adult Receptor

Receptor Location	ILCR (EDI * CSF)										Total ILCR
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
MPOI	4.52E-08	5.03E-08	5.42E-12	1.66E-07	7.46E-07	2.91E-08	0.00E+00	4.47E-07	1.7E-04	2.30E-05	1.91E-04
AC	5.17E-11	5.75E-11	6.20E-15	1.90E-10	8.54E-10	1.22E-10	0.00E+00	1.86E-09	1.9E-07	1.04E-07	2.98E-07
AR	3.41E-10	3.79E-10	4.09E-14	1.25E-09	5.63E-09	3.08E-10	0.00E+00	4.72E-09	1.3E-06	2.51E-07	1.52E-06
TC1	5.68E-10	6.32E-10	6.82E-14	2.08E-09	9.38E-09	4.53E-10	0.00E+00	6.95E-09	2.1E-06	3.66E-07	2.48E-06
BL	4.06E-10	4.52E-10	4.88E-14	1.49E-09	6.71E-09	3.50E-10	0.00E+00	5.36E-09	1.5E-06	2.84E-07	1.80E-06
TC2	2.94E-10	3.27E-10	3.53E-14	1.08E-09	4.85E-09	2.77E-10	0.00E+00	4.25E-09	1.1E-06	2.27E-07	1.32E-06
TC3	4.39E-10	4.88E-10	5.27E-14	1.61E-09	7.25E-09	3.71E-10	0.00E+00	5.68E-09	1.6E-06	3.00E-07	1.94E-06
TC4	3.38E-10	3.76E-10	4.06E-14	1.24E-09	5.58E-09	3.06E-10	0.00E+00	4.69E-09	1.2E-06	2.49E-07	1.51E-06
FMK	4.02E-10	4.48E-10	4.83E-14	1.48E-09	6.65E-09	3.47E-10	0.00E+00	5.32E-09	1.5E-06	2.82E-07	1.78E-06
FMM	2.03E-09	2.26E-09	2.44E-13	7.47E-09	3.36E-08	1.40E-09	0.00E+00	2.14E-08	7.5E-06	1.11E-06	8.70E-06
FMT	2.53E-10	2.81E-10	3.04E-14	9.29E-10	4.18E-09	2.51E-10	0.00E+00	3.85E-09	9.3E-07	2.06E-07	1.15E-06
FMT1	1.94E-11	2.16E-11	2.33E-15	7.12E-11	3.20E-10	1.01E-10	0.00E+00	1.55E-09	7.2E-08	8.73E-08	1.61E-07
FMT2	4.00E-10	4.46E-10	4.81E-14	1.47E-09	6.62E-09	3.46E-10	0.00E+00	5.30E-09	1.5E-06	2.81E-07	1.78E-06
TC5	1.62E-09	1.80E-09	1.95E-13	5.95E-09	2.68E-08	1.13E-09	0.00E+00	1.73E-08	6.0E-06	9.01E-07	6.95E-06
TC6	2.18E-09	2.43E-09	2.62E-13	8.02E-09	3.61E-08	1.49E-09	0.00E+00	2.29E-08	8.1E-06	1.19E-06	9.34E-06
KL	4.95E-10	5.50E-10	5.94E-14	1.82E-09	8.17E-09	4.06E-10	0.00E+00	6.23E-09	1.8E-06	3.29E-07	2.18E-06
TC7	2.04E-10	2.27E-10	2.45E-14	7.48E-10	3.37E-09	2.19E-10	0.00E+00	3.36E-09	7.5E-07	1.81E-07	9.42E-07
TC8	3.95E-10	4.40E-10	4.75E-14	1.45E-09	6.53E-09	3.43E-10	0.00E+00	5.25E-09	1.5E-06	2.78E-07	1.75E-06
TC9	1.82E-10	2.03E-10	2.19E-14	6.69E-10	3.01E-09	2.06E-10	0.00E+00	3.15E-09	6.7E-07	1.70E-07	8.51E-07
TC10	5.81E-10	6.47E-10	6.98E-14	2.13E-09	9.60E-09	4.62E-10	0.00E+00	7.09E-09	2.1E-06	3.73E-07	2.54E-06
TC11	3.13E-10	3.48E-10	3.75E-14	1.15E-09	5.17E-09	2.89E-10	0.00E+00	4.44E-09	1.2E-06	2.36E-07	1.40E-06
MPOI	2.74E-13	3.05E-13	3.29E-17	1.01E-12	9.43E-09	1.71E-10	0.00E+00	2.62E-09	2.11E-06	8.76E-08	2.21E-06
AC	4.30E-14	4.79E-14	5.17E-18	1.58E-13	1.15E-11	8.85E-11	0.00E+00	1.36E-09	2.57E-09	7.75E-08	8.15E-08
AR	1.73E-13	1.93E-13	2.08E-17	6.35E-13	7.39E-11	8.91E-11	0.00E+00	1.37E-09	1.65E-08	7.76E-08	9.57E-08
TC1	1.39E-13	1.54E-13	1.67E-17	5.10E-13	1.21E-10	8.95E-11	0.00E+00	1.37E-09	2.70E-08	7.77E-08	1.06E-07
BL	2.16E-13	2.40E-13	2.59E-17	7.93E-13	8.83E-11	8.93E-11	0.00E+00	1.37E-09	1.98E-08	7.77E-08	9.90E-08
TC2	1.53E-13	1.71E-13	1.84E-17	5.63E-13	6.38E-11	8.90E-11	0.00E+00	1.37E-09	1.43E-08	7.76E-08	9.34E-08
TC3	1.97E-13	2.19E-13	2.36E-17	7.22E-13	9.48E-11	8.93E-11	0.00E+00	1.37E-09	2.12E-08	7.77E-08	1.00E-07
TC4	2.96E-13	3.29E-13	3.55E-17	1.09E-12	7.54E-11	8.92E-11	0.00E+00	1.37E-09	1.69E-08	7.77E-08	9.61E-08
FMK	1.44E-13	1.60E-13	1.73E-17	5.28E-13	8.63E-11	8.92E-11	0.00E+00	1.37E-09	1.93E-08	7.76E-08	9.85E-08
FMM	1.71E-13	1.90E-13	2.05E-17	6.27E-13	4.27E-10	9.22E-11	0.00E+00	1.41E-09	9.55E-08	7.80E-08	1.75E-07
FMT	1.93E-13	2.15E-13	2.32E-17	7.08E-13	5.59E-11	8.90E-11	0.00E+00	1.36E-09	1.25E-08	7.76E-08	9.17E-08
FMT1	2.69E-14	2.99E-14	3.23E-18	9.87E-14	4.49E-12	8.84E-11	0.00E+00	1.36E-09	1.00E-09	7.75E-08	7.99E-08
FMT2	1.53E-13	1.70E-13	1.83E-17	5.60E-13	8.60E-11	8.92E-11	0.00E+00	1.37E-09	1.93E-08	7.76E-08	9.84E-08

Receptor Location	ILCR (EDI * CSF)										Total ILCR
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
TC5	8.43E-13	9.38E-13	1.01E-16	3.09E-12	3.52E-10	9.19E-11	0.00E+00	1.41E-09	7.87E-08	7.83E-08	1.59E-07
TC6	5.30E-13	5.90E-13	6.37E-17	1.95E-12	4.64E-10	9.27E-11	0.00E+00	1.42E-09	1.04E-07	7.82E-08	1.84E-07
KL	9.68E-14	1.08E-13	1.16E-17	3.55E-13	1.05E-10	8.94E-11	0.00E+00	1.37E-09	2.34E-08	7.76E-08	1.03E-07
TC7	9.35E-14	1.04E-13	1.12E-17	3.43E-13	4.40E-11	8.88E-11	0.00E+00	1.36E-09	9.85E-09	7.76E-08	8.89E-08
TC8	7.06E-14	7.85E-14	8.47E-18	2.59E-13	8.36E-11	8.92E-11	0.00E+00	1.37E-09	1.87E-08	7.76E-08	9.79E-08
TC9	1.39E-13	1.55E-13	1.67E-17	5.11E-13	4.03E-11	8.88E-11	0.00E+00	1.36E-09	9.02E-09	7.76E-08	8.81E-08
TC10	9.81E-14	1.09E-13	1.18E-17	3.60E-13	1.23E-10	8.95E-11	0.00E+00	1.37E-09	2.75E-08	7.77E-08	1.07E-07
TC11	1.94E-13	2.16E-13	2.33E-17	7.14E-13	6.84E-11	8.91E-11	0.00E+00	1.37E-09	1.53E-08	7.76E-08	9.45E-08
MPOI	8.78E-08	9.77E-08	1.05E-11	3.22E-07	1.45E-06	8.57E-08	0.00E+00	1.31E-06	3.25E-04	4.75E-05	3.75E-04
AC	7.28E-11	8.10E-11	8.74E-15	2.67E-10	1.20E-09	2.57E-10	0.00E+00	3.94E-09	2.69E-07	1.95E-07	4.70E-07
AR	4.58E-10	5.10E-10	5.50E-14	1.68E-09	7.57E-09	6.91E-10	0.00E+00	1.06E-08	1.69E-06	4.08E-07	2.12E-06
TC1	7.16E-10	7.97E-10	8.60E-14	2.63E-09	1.18E-08	1.00E-09	0.00E+00	1.54E-08	2.65E-06	5.53E-07	3.23E-06
BL	5.50E-10	6.13E-10	6.61E-14	2.02E-09	9.10E-09	7.92E-10	0.00E+00	1.21E-08	2.03E-06	4.59E-07	2.52E-06
TC2	5.33E-10	5.93E-10	6.39E-14	1.96E-09	8.80E-09	7.08E-10	0.00E+00	1.09E-08	1.97E-06	4.43E-07	2.44E-06
TC3	8.10E-10	9.02E-10	9.73E-14	2.98E-09	1.34E-08	9.80E-10	0.00E+00	1.50E-08	3.00E-06	5.93E-07	3.62E-06
TC4	5.99E-10	6.67E-10	7.20E-14	2.20E-09	9.90E-09	7.79E-10	0.00E+00	1.20E-08	2.22E-06	4.80E-07	2.72E-06
FMK	5.99E-10	6.66E-10	7.19E-14	2.20E-09	9.89E-09	8.20E-10	0.00E+00	1.26E-08	2.21E-06	4.84E-07	2.72E-06
FMM	3.92E-09	4.36E-09	4.70E-13	1.44E-08	6.47E-08	4.00E-09	0.00E+00	6.14E-08	1.45E-05	2.27E-06	1.69E-05
FMT	4.82E-10	5.36E-10	5.78E-14	1.77E-09	7.96E-09	6.49E-10	0.00E+00	9.95E-09	1.78E-06	4.15E-07	2.22E-06
FMT1	3.32E-11	3.69E-11	3.98E-15	1.22E-10	5.48E-10	2.11E-10	0.00E+00	3.23E-09	1.23E-07	1.73E-07	3.00E-07
FMT2	5.67E-10	6.31E-10	6.80E-14	2.08E-09	9.36E-09	7.99E-10	0.00E+00	1.22E-08	2.09E-06	4.67E-07	2.59E-06
TC5	3.13E-09	3.48E-09	3.75E-13	1.15E-08	5.16E-08	3.23E-09	0.00E+00	4.95E-08	1.16E-05	1.84E-06	1.35E-05
TC6	4.21E-09	4.69E-09	5.06E-13	1.55E-08	6.96E-08	4.29E-09	0.00E+00	6.58E-08	1.56E-05	2.43E-06	1.82E-05
KL	5.63E-10	6.27E-10	6.76E-14	2.07E-09	9.31E-09	8.57E-10	0.00E+00	1.31E-08	2.08E-06	4.71E-07	2.58E-06
TC7	2.49E-10	2.77E-10	2.99E-14	9.13E-10	4.11E-09	4.68E-10	0.00E+00	7.17E-09	9.19E-07	2.94E-07	1.23E-06
TC8	4.45E-10	4.95E-10	5.34E-14	1.63E-09	7.35E-09	7.17E-10	0.00E+00	1.10E-08	1.64E-06	4.05E-07	2.07E-06
TC9	2.87E-10	3.20E-10	3.45E-14	1.05E-09	4.75E-09	4.79E-10	0.00E+00	7.34E-09	1.06E-06	3.12E-07	1.39E-06
TC10	6.50E-10	7.24E-10	7.81E-14	2.39E-09	1.07E-08	9.69E-10	0.00E+00	1.49E-08	2.40E-06	5.20E-07	2.95E-06
TC11	4.41E-10	4.91E-10	5.30E-14	1.62E-09	7.29E-09	6.62E-10	0.00E+00	1.01E-08	1.63E-06	3.98E-07	2.05E-06

For the Planned Development Case, results are the similar as the Baseline Case as the total ILCR for the MPOI location is greater than the maximum acceptable criterion of 1.0×10^{-5}. However, for the PDC, three other receptor locations have ILCRs greater than the criterion; FMM, TC5 and TC6, but they were marginally higher than the criterion (1.7×10^{-5}, 1.4×10^{-5} and 1.8×10^{-5} respectively). For all four locations, the ingestion of fish exposure pathways have ILCR values greater than 1.0×10^{-5}. Although the total ILCR values for the Planned Development Case are greater than 1.0×10^{-5}, the Project-alone risks do not contribute significantly to the total cumulative risks as the Project-alone total ILCR values are at least an order of magnitude lower than the Planned Development total ILCR.

The ILCR results indicate that the pyrene emissions from the Project would not likely cause carcinogenic effects for people in the vicinity.

Similar results are observed for the composite receptor (Table SIR2 K-8). In the Baseline Case, the MPOI, FMM and TC6 have total ILCR above 1.0×10^{-5}. The total ILCR-A for the MPOI, FMM and TC6 are 2.8×10^{-4}, 1.3×10^{-5}, and 1.4×10^{-5}, respectively. All other receptor locations have total ILCR-A values less than the criterion. The risks are primarily due to the fish and Wildgame ingestion exposure pathways.

With the Project-alone Case, total ILCR-A values for the Project-alone are less than 1.0×10^{-5} at all receptor locations.

In assessing the Application Case, summing the total ILCR-A values for the Baseline and Project-alone Case for most of the receptor locations does not increase the total ILCR value above the criterion of 1.0×10^{-5}. The only exception are the MPOI, FMM, and TC6 where the sum of Baseline and Project-alone total ILCR-A are 2.8×10^{-4}, 1.3×10^{-5} and 1.4×10^{-5} respectively. However, since the MPOI may be situated in different locations for the Baseline Case and the Project-only Case, the summation of the total ILCR-A values is an over-estimation of the risks ,and the other two locations have ILCR-A marginally above criterion.

There is one more receptor locations where the total ILCR values exceed 1.0×10^{-5} in the Planned Development Case than for the Baseline Case. The MPOI, FMM, TC5 and TC6 receptor locations have total ILCR values for the composite receptor in the Planned Development Case that exceeds the criterion. For most of these receptor locations, the predominant exposure pathway that contributes the most to the overall risk is fish ingestion. However, compared to the Project-alone total ILCR values, the Planned Development total ILCR values are orders of magnitude higher, suggesting that the Project-alone does not contribute significantly to the overall cumulative risks.

Because of the low contribution of the Project-alone risks to the overall total risks for the composite receptor, it is unlikely for adverse health effects to occur due to the emission of pyrene from the Project.

Table SIR2 K-8: Incremental Lifetime Cancer Risks Due to Chronic Exposures to Pyrene for the Composite Receptor

Receptor Location	ILCR (EDI *CSF)										Total ILCR
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
MPOI	1.25E-07	7.25E-08	8.61E-12	2.63E-07	1.03E-06	3.93E-08	0.00E+00	5.94E-07	2.5E-04	3.05E-05	2.80E-04
AC	1.43E-10	8.29E-11	9.84E-15	3.01E-10	1.18E-09	1.64E-10	0.00E+00	2.48E-09	2.8E-07	1.38E-07	4.25E-07
AR	9.43E-10	5.47E-10	6.49E-14	1.99E-09	7.78E-09	4.15E-10	0.00E+00	6.27E-09	1.9E-06	3.32E-07	2.22E-06
TC1	1.57E-09	9.11E-10	1.08E-13	3.31E-09	1.30E-08	6.12E-10	0.00E+00	9.24E-09	3.1E-06	4.85E-07	3.62E-06
BL	1.12E-09	6.52E-10	7.74E-14	2.37E-09	9.28E-09	4.71E-10	0.00E+00	7.13E-09	2.2E-06	3.76E-07	2.62E-06
TC2	8.12E-10	4.71E-10	5.60E-14	1.71E-09	6.71E-09	3.74E-10	0.00E+00	5.65E-09	1.6E-06	3.01E-07	1.92E-06
TC3	1.21E-09	7.04E-10	8.36E-14	2.56E-09	1.00E-08	5.00E-10	0.00E+00	7.55E-09	2.4E-06	3.98E-07	2.82E-06
TC4	9.35E-10	5.42E-10	6.44E-14	1.97E-09	7.72E-09	4.12E-10	0.00E+00	6.23E-09	1.8E-06	3.30E-07	2.20E-06
FMK	1.11E-09	6.45E-10	7.66E-14	2.34E-09	9.18E-09	4.68E-10	0.00E+00	7.07E-09	2.2E-06	3.74E-07	2.60E-06
FMM	5.62E-09	3.26E-09	3.87E-13	1.18E-08	4.64E-08	1.88E-09	0.00E+00	2.85E-08	1.1E-05	1.47E-06	1.27E-05
FMT	6.99E-10	4.06E-10	4.82E-14	1.47E-09	5.77E-09	3.39E-10	0.00E+00	5.12E-09	1.4E-06	2.73E-07	1.67E-06
FMT1	5.36E-11	3.11E-11	3.69E-15	1.13E-10	4.43E-10	1.36E-10	0.00E+00	2.06E-09	1.1E-07	1.16E-07	2.25E-07
FMT2	1.11E-09	6.42E-10	7.63E-14	2.33E-09	9.14E-09	4.66E-10	0.00E+00	7.05E-09	2.2E-06	3.72E-07	2.59E-06
TC5	4.48E-09	2.60E-09	3.09E-13	9.44E-09	3.70E-08	1.52E-09	0.00E+00	2.30E-08	8.9E-06	1.19E-06	1.01E-05
TC6	6.04E-09	3.50E-09	4.16E-13	1.27E-08	4.99E-08	2.01E-09	0.00E+00	3.04E-08	1.2E-05	1.57E-06	1.36E-05
KL	1.37E-09	7.94E-10	9.42E-14	2.88E-09	1.13E-08	5.48E-10	0.00E+00	8.29E-09	2.7E-06	4.36E-07	3.17E-06
TC7	5.64E-10	3.27E-10	3.88E-14	1.19E-09	4.65E-09	2.96E-10	0.00E+00	4.47E-09	1.1E-06	2.40E-07	1.37E-06
TC8	1.09E-09	6.34E-10	7.53E-14	2.30E-09	9.03E-09	4.62E-10	0.00E+00	6.99E-09	2.2E-06	3.69E-07	2.55E-06
TC9	5.04E-10	2.92E-10	3.47E-14	1.06E-09	4.16E-09	2.77E-10	0.00E+00	4.19E-09	1.0E-06	2.25E-07	1.23E-06
TC10	1.61E-09	9.32E-10	1.11E-13	3.39E-09	1.33E-08	6.23E-10	0.00E+00	9.42E-09	3.2E-06	4.94E-07	3.70E-06
TC11	8.65E-10	5.02E-10	5.96E-14	1.82E-09	7.14E-09	3.90E-10	0.00E+00	5.90E-09	1.7E-06	3.13E-07	2.04E-06
MPOI	7.58E-13	4.39E-13	5.22E-17	1.60E-12	1.30E-08	2.30E-10	0.00E+00	3.48E-09	3.12E-06	1.16E-07	3.26E-06
AC	1.19E-13	6.91E-14	8.20E-18	2.51E-13	1.59E-11	1.19E-10	0.00E+00	1.80E-09	3.81E-09	1.03E-07	1.09E-07
AR	4.79E-13	2.78E-13	3.30E-17	1.01E-12	1.02E-10	1.20E-10	0.00E+00	1.82E-09	2.45E-08	1.03E-07	1.29E-07
TC1	3.84E-13	2.23E-13	2.64E-17	8.08E-13	1.67E-10	1.21E-10	0.00E+00	1.82E-09	4.00E-08	1.03E-07	1.45E-07
BL	5.97E-13	3.46E-13	4.11E-17	1.26E-12	1.22E-10	1.20E-10	0.00E+00	1.82E-09	2.93E-08	1.03E-07	1.34E-07
TC2	4.24E-13	2.46E-13	2.92E-17	8.93E-13	8.82E-11	1.20E-10	0.00E+00	1.81E-09	2.11E-08	1.03E-07	1.26E-07
TC3	5.44E-13	3.15E-13	3.75E-17	1.15E-12	1.31E-10	1.20E-10	0.00E+00	1.82E-09	3.14E-08	1.03E-07	1.36E-07
TC4	8.18E-13	4.74E-13	5.63E-17	1.72E-12	1.04E-10	1.20E-10	0.00E+00	1.82E-09	2.50E-08	1.03E-07	1.30E-07
FMK	3.97E-13	2.31E-13	2.74E-17	8.37E-13	1.19E-10	1.20E-10	0.00E+00	1.82E-09	2.86E-08	1.03E-07	1.34E-07
FMM	4.72E-13	2.74E-13	3.25E-17	9.95E-13	5.90E-10	1.24E-10	0.00E+00	1.88E-09	1.41E-07	1.03E-07	2.47E-07
FMT	5.34E-13	3.10E-13	3.68E-17	1.12E-12	7.73E-11	1.20E-10	0.00E+00	1.81E-09	1.85E-08	1.03E-07	1.23E-07
FMT1	7.43E-14	4.31E-14	5.12E-18	1.57E-13	6.20E-12	1.19E-10	0.00E+00	1.80E-09	1.49E-09	1.03E-07	1.06E-07
FMT2	4.22E-13	2.45E-13	2.91E-17	8.89E-13	1.19E-10	1.20E-10	0.00E+00	1.82E-09	2.85E-08	1.03E-07	1.34E-07

Receptor Location	ILCR (EDI *CSF)										Total ILCR
	Soil Ingestion	Soil Dermal	Soil Inhalation	Air Inhalation	Surface Water Ingestion	Lab Tea Ingestion	Cattail Ingestion	Berries Ingestion	Fish Ingestion	Wild Game Ingestion	
TC5	2.33E-12	1.35E-12	1.61E-16	4.91E-12	4.86E-10	1.24E-10	0.00E+00	1.87E-09	1.17E-07	1.04E-07	2.23E-07
TC6	1.47E-12	8.51E-13	1.01E-16	3.09E-12	6.42E-10	1.25E-10	0.00E+00	1.89E-09	1.54E-07	1.04E-07	2.60E-07
KL	2.68E-13	1.55E-13	1.84E-17	5.64E-13	1.45E-10	1.21E-10	0.00E+00	1.82E-09	3.47E-08	1.03E-07	1.40E-07
TC7	2.59E-13	1.50E-13	1.78E-17	5.45E-13	6.09E-11	1.20E-10	0.00E+00	1.81E-09	1.46E-08	1.03E-07	1.19E-07
TC8	1.95E-13	1.13E-13	1.34E-17	4.11E-13	1.16E-10	1.20E-10	0.00E+00	1.82E-09	2.77E-08	1.03E-07	1.33E-07
TC9	3.85E-13	2.23E-13	2.65E-17	8.11E-13	5.57E-11	1.20E-10	0.00E+00	1.81E-09	1.34E-08	1.03E-07	1.18E-07
TC10	2.71E-13	1.57E-13	1.87E-17	5.72E-13	1.70E-10	1.21E-10	0.00E+00	1.82E-09	4.07E-08	1.03E-07	1.46E-07
TC11	5.38E-13	3.12E-13	3.70E-17	1.13E-12	9.46E-11	1.20E-10	0.00E+00	1.82E-09	2.27E-08	1.03E-07	1.28E-07
MPOI	2.43E-07	1.41E-07	1.67E-11	5.11E-07	2.00E-06	1.16E-07	0.00E+00	1.75E-06	4.81E-04	6.30E-05	5.48E-04
AC	2.01E-10	1.17E-10	1.39E-14	4.24E-10	1.66E-09	3.46E-10	0.00E+00	5.24E-09	3.98E-07	2.59E-07	6.65E-07
AR	1.27E-09	7.36E-10	8.73E-14	2.67E-09	1.05E-08	9.32E-10	0.00E+00	1.41E-08	2.51E-06	5.42E-07	3.08E-06
TC1	1.98E-09	1.15E-09	1.36E-13	4.17E-09	1.64E-08	1.35E-09	0.00E+00	2.04E-08	3.92E-06	7.33E-07	4.70E-06
BL	1.52E-09	8.83E-10	1.05E-13	3.21E-09	1.26E-08	1.07E-09	0.00E+00	1.61E-08	3.01E-06	6.09E-07	3.66E-06
TC2	1.47E-09	8.54E-10	1.01E-13	3.10E-09	1.22E-08	9.55E-10	0.00E+00	1.44E-08	2.92E-06	5.88E-07	3.54E-06
TC3	2.24E-09	1.30E-09	1.54E-13	4.72E-09	1.85E-08	1.32E-09	0.00E+00	2.00E-08	4.44E-06	7.86E-07	5.27E-06
TC4	1.66E-09	9.61E-10	1.14E-13	3.49E-09	1.37E-08	1.05E-09	0.00E+00	1.59E-08	3.28E-06	6.36E-07	3.95E-06
FMK	1.66E-09	9.61E-10	1.14E-13	3.49E-09	1.37E-08	1.11E-09	0.00E+00	1.67E-08	3.28E-06	6.41E-07	3.96E-06
FMM	1.08E-08	6.28E-09	7.46E-13	2.28E-08	8.94E-08	5.40E-09	0.00E+00	8.16E-08	2.14E-05	3.01E-06	2.47E-05
FMT	1.33E-09	7.73E-10	9.18E-14	2.81E-09	1.10E-08	8.75E-10	0.00E+00	1.32E-08	2.64E-06	5.50E-07	3.22E-06
FMT1	9.17E-11	5.32E-11	6.32E-15	1.93E-10	7.57E-10	2.84E-10	0.00E+00	4.29E-09	1.82E-07	2.29E-07	4.17E-07
FMT2	1.57E-09	9.09E-10	1.08E-13	3.30E-09	1.29E-08	1.08E-09	0.00E+00	1.63E-08	3.10E-06	6.19E-07	3.76E-06
TC5	8.64E-09	5.01E-09	5.95E-13	1.82E-08	7.14E-08	4.35E-09	0.00E+00	6.58E-08	1.71E-05	2.44E-06	1.97E-05
TC6	1.16E-08	6.76E-09	8.02E-13	2.45E-08	9.62E-08	5.78E-09	0.00E+00	8.74E-08	2.31E-05	3.22E-06	2.65E-05
KL	1.56E-09	9.04E-10	1.07E-13	3.28E-09	1.29E-08	1.16E-09	0.00E+00	1.75E-08	3.08E-06	6.24E-07	3.74E-06
TC7	6.88E-10	3.99E-10	4.74E-14	1.45E-09	5.68E-09	6.31E-10	0.00E+00	9.54E-09	1.36E-06	3.89E-07	1.77E-06
TC8	1.23E-09	7.14E-10	8.47E-14	2.59E-09	1.02E-08	9.67E-10	0.00E+00	1.46E-08	2.43E-06	5.37E-07	3.00E-06
TC9	7.94E-10	4.61E-10	5.47E-14	1.67E-09	6.56E-09	6.45E-10	0.00E+00	9.76E-09	1.57E-06	4.13E-07	2.01E-06
TC10	1.80E-09	1.04E-09	1.24E-13	3.79E-09	1.48E-08	1.31E-09	0.00E+00	1.97E-08	3.56E-06	6.90E-07	4.29E-06
TC11	1.22E-09	7.08E-10	8.41E-14	2.57E-09	1.01E-08	8.92E-10	0.00E+00	1.35E-08	2.42E-06	5.28E-07	2.97E-06