VISUALISING THE INDUSTRIAL NORTH: EXPLORING NEW WAYS TO ENGAGE AND INFORM THE PUBLIC ON THE PHYSICAL FOOTPRINT AND SCALE OF VERY LARGE RESOURCE EXTRACTION PROJECTS SUCH AS THE ALBERTA TAR SANDS OPEN PIT MINES AND ASSOCIATED PIPELINES

by

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ABSTRACT

Using the Alberta tar sands open pit mines and associated pipelines as a case study, the effectiveness of maps and landscape visualisation displayed within virtual globes in informing public perception of large-scale landscape disturbance and associated impacts is evaluated. While controversy swirls around the tar sands, this proposed “gigaproject” has never been assessed, mapped, or visualised in its totality.

Comprehensive mapping and landscape visualisation of this “gigaproject” may be essential for the public and practitioners to understand, debate, and discuss the full scope and scale of this “gigaproject”. Focus groups with a total of 32 members of the general public were conducted in Vancouver and Edmonton. In a typical computer lab setting, participants viewed a Google Earth project showing the cumulative development of the scale and physical footprint of tar sands open pit mines on individual computers. Participants completed an initial and follow up questionnaire as well as engaged in discussion and presentations that were facilitated by the researcher.

Based on the results of the focus group study, after viewing using interactive multi-scale media, participants experienced significant learning; perceived the geographic area of the projects as larger than before viewing; in some cases over-estimated the spatial extent and growth of the projects; became significantly more opposed to future projects but not to existing projects; and expressed emotional reactions due to disclosure of key aspects of the project enhanced by the benefits of the display medium. Significantly more participants found 2D maps to be more believable than 3D visualisations. Most participants found interacting with Google Earth virtual globes to be useful in displaying the tar sands project. Major implications of this study are that using virtual globes, such as Google Earth, that allow for seamless transition between multiple scales to visualize very large but poorly understood projects, can increase people's awareness of scale and other environmental implications and may affect peoples’ perception and opinion of those projects negatively. The study suggests that visualization of large irregular disturbances may lead to some overestimation of actual spatial extent, but this does not appear to be related to the negativity of opinions.

PREFACE

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DEDICATION

To Linda, who has always been there right from the beginning.

CHAPTER 1: INTRODUCTION

Using the Alberta tar sands[3] open pit mines and associated pipelines as a case study, this research evaluates the effectiveness of maps and landscape visualisation displayed within virtual globes in informing public perception (cognition, attitude, and affect) of large-scale landscape disturbance and associated impacts. The Alberta tar sands open pit mines and associated pipelines projects have the potential to cause the world's largest landscape and ecological disturbance, second only to the deforestation of the Brazilian Amazon, of as much as 33,000 km^2 per year (Food and Agriculture Organization, 2006). At an estimated total capital cost of $272 billion, it may become largest integrated industrial complex ever to be constructed (Flyvbjerg, Bruzelius, & Rothengatter, 2003), which requires the coining of a new word – "gigaproject." While controversy swirls around the tar sands, this proposed gigaproject has never been assessed, mapped, or visualised in its totality.

The state of the art of cumulative effects assessment in Canada has been described as "impotent" (Duinker & Greig, 2006) and it has been recommended that more emphasis needs to be placed on systems analysis in the context of "Regional Environmental Effects Frameworks" (Gunn & Noble, 2009). Yet before such systems analysis can be undertaken, comprehensive mapping and landscape visualisation of this "gigaproject" may be vital so that the public and practitioners can understand its full scope and scale and so that meaningful public debate and discussion can take place.

There is a long tradition of visualising large-scale landscapes through elevated "bird's eye views" (Dubbini, 2002). Public agencies have expended considerable resources in attempting to communicate global change issues such as land-cover change, deforestation, and climate change through satellite-based atlases and digital visualisations (United Nations Environment Programme, 2005; National Aeronautics and Space Administration, n.d.). The mass popularity of on-line virtual globes such as Google Earth that combine satellite imagery and three-dimensional (3D) topography, which has been downloaded over 1 billion times (Google Corporation, 2011), indicates the demand for and compelling nature of this medium.

It is hypothesized that the use of virtual globe technologies such as Google Earth, which allow for seamless transitions from the global to the local and vice-versa, might educate and empower individual users and civil society regarding opinions and decision-making in the particular case of Alberta tar sands open pit mines and associated pipelines. It is also hypothesized that in addition to using two-dimensional (2D) maps, using landscape visualisation to depict in 3D the excavated pits, tailings ponds, overburden mounds, forests, and deforestation may be important to communicate the scale of the tar sands open pit mines. Landscape visualisations "attempt to represent actual places and on-the-ground conditions in three dimensional (3D) perspective views, with varying degrees of realism" (Sheppard & Salter, 2004).

[3] This study uses the term "tar sands" because there is no naturally occurring crude oil in the resource. The tar-like bitumen must be highly processed and upgraded to create synthetic crude oil. Both industry and government originally used the term "tar sands" but now only use the term "oil sands" to promote the development of the resource (Nikiforuk, 2008).

However, the effectiveness of landscape visualisation to inform public perception at cognitive and affective levels has largely focused on the aesthetic aspects of visual resource management (Sheppard & Harshaw, 2000). It has been recommended that more studies evaluating various human perceptions with landscape visualisation be conducted (Lange, 2011). In the few instances where the scholarly literature on environmental communication has addressed visual imagery, it has been based in cultural theory instead of empirical psychology (Seppanen & Vallevironnen, 2003; Scott, 2003; Bouse, 1991; Burgess, 1990). Thus, the central question that remains unanswered is whether or not landscape visualisation in combination with other digital media such as 2D maps and a virtual globe interface can be at all effective in informing public perception about large scale projects, possibly influencing government policy as a result.

This dissertation empirically evaluates cognitive and affective user-response to maps and landscape visualisations of existing conditions and potential landscape changes from the largest industrial complex on the planet. This study deploys recent digital technologies that systematically depict proposed industrial activities at multiple scales and from multiple viewpoints over a very large study area, integrating vector-based cartography, raster-based satellite imagery, and realistic/semi-realistic three-dimensional (3D) landscape visualisations. The major technical research issues are to explore within a virtual globe environment effective ways to:

1) Depict proposed industrial activities at multiple scales and from multiple viewpoints over a very large study area;

2) Move seamlessly between multiple scales and viewpoints, allowing users to comprehend the implications of past, existing, and proposed infrastructure and landscape change ranging from macro-regional to site-specific scales;

3) Integrate realistic and semi-realistic ground-based 3D landscape visualisations into virtual globes such as Google Earth; and

4) Depict proposed industrial infrastructure and landscape change in a largely forested landscape with low topographic relief.

As discussed in more detail in Section 1.4, the major theoretical research questions are:

1) What are people's cognitive, attitudinal, and affective responses before and after viewing very large resource extraction complexes such as the tar sands complex represented in interactive multi-scale media as described above? How are these responses related to people's socio-demographic characteristics and their perceptions and opinions of the tar sands open pit mines?

2) Can interactive, multi-scale visualisation using virtual globes affect peoples' cognitive and affective responses to existing and future development of a very large resource extraction project or linked large projects, as in the case examined here?

3) How effective are these new tools (2D maps, static and interactive 3D visualisations) and different viewpoints (i.e. plan view, oblique, and ground-based) presented in virtual globes in meaningfully informing the general public about very large resource extraction projects?

1.1. The Alberta Tar Sands, Arctic Natural Gas, and Associated Pipelines

In this section, the historical background and recent development context of the Alberta tar sands are discussed. The need to supply energy with arctic natural gas is outlined. The recently constructed and proposed downstream pipelines to deliver synthetic crude oil and bitumen to the United States and Asia are listed. Finally, the total estimated cost of the tar sand and arctic natural gas gigaproject is calculated.

Faced with the reality of "Hubbert's Peak" in global conventional oil supplies, the world's largest multi-national energy corporations have been forced to squeeze oil out of tar in northern Alberta (Rubin & Buchanan, 2006; Mawdsley, Mikhareva, & Tennison, 2005). Due to the decline of global conventional oil production since 2005, the development of the Alberta tar sands is taking place alongside the exploitation of other non-conventional sources of oil such as high arctic, deepwater offshore, oil shale, and coal-to-liquids (Klare, 2012).

Along the Athabasca River near Fort McMurray, a sub-arctic town almost 1,000 kilometres north of the U.S. border, the tar-like bitumen literally seeps out of the riverbanks where aboriginal peoples once used it to patch their birch-bark canoes. But most of the tar sands lie hidden below northern Alberta's boreal forest, in an area larger than the state of Florida (Government of Alberta, 2013a), as shown in Figure 1.

Figure 1 Location Map of Tar Sands in Alberta

1.1.1. Historical Background

The first serious effort to strip-mine tar along the Athabasca River and steam out the oil started in 1963 with the "Great Canadian Oil Sands Company" developed by Sun Oil Ltd., later to become Sunoco, and eventually Suncor. By 1967, the company had spent $240 million (over $1 billion in today's currency) on this project due to the personal quest of its president J. Howard Pew to gain North American energy independence as a "bulwark against godless Communism" (Laird, 2002) . However, this project was less than successful since separating the tar from the sand and then turning it into crude oil requires huge amounts of energy, steam, and water. Even after the tar is melted down into bitumen, it still has to be "upgraded" into synthetic crude oil by adding hydrogen, usually made from natural gas (Woynillowicz, Severson-Baker, & Raynolds, 2005).

Starting in the1970's, the Canadian federal government and Alberta provincial government provided tax breaks and research subsidies, invested in a joint-venture corporation called Syncrude, and even significantly lowered the royalty rate in the tar sands in 1997. Between 1996 and 2002, the federal government alone provided approximately $1.2 billion (2000$) in subsidies to the tar sands (Taylor, Bramley, & Winfield, 2005).

In the mid-eighties, new "in-situ" technologies such as "Steam-Assisted Gravity Drainage" (SAGD) were developed, which steamed the tar from deposits around Cold Lake and Peace River that were too far below the surface to strip-mine. By the turn of the millennium, dozens of multi-nationals had invested over $24 billion in the tar sands, which finally began to yield huge profits with the explosive increase in the price of oil in the late 1990's (Laird, 2002).

1.1.2. Recent Growth of Tar Sands Production

Between 1995 and 2004, tar sands production doubled to more than 1.1 million barrels per day, 16 years ahead of schedule. In 2003, the United States Energy Information Administration recognized that 175 billion of the total 1.7 trillion barrels of oil in the tar sands were "economically recoverable", placing Alberta third only to Saudi Arabia and Venezuela in the world's list of oil reserves (Alberta Department of Energy, 2013a).

"Oil Sands Fever", a report released in November 2005 by the Pembina Institute, a Calgary-based energy think-tank, was among the first reports to describe the massive environmental impact of the tar sands (Woynillowicz et al., 2005):

- About half of Canada's oil production currently comes from the tar sands. Oil production from the tar sands is predicted to quintuple from 1 million barrels per day to 5 million barrels per day between 2003 and 2030, representing over three-quarters of Canada's oil production, 70% of which is destined for export to the United States.

- In the "Surface Mineable Area" north of Fort McMurray, over 430 square kilometers of boreal forest has been strip-mined, there is an approved disturbance of 950 square kilometers, and a planned total disturbance of 2,000 square kilometers, as estimated by the Pembina Institute in 2005 (Woynillowicz et al., 2005). Not including the loss and fragmentation of boreal forest from "in-situ" operations in Cold Lake and Peace River, this will be 2.5 times the urban footprint of Calgary and three times the urban footprint of Edmonton. In 2008, Alberta issued its first-ever reclamation certificate for 104 hectares. As of 2012, there were 77 km^2 under active reclamation (Government of Alberta, 2013a).

- To produce one barrel of oil, 4 tonnes of material is mined, 2-5 barrels of water are used to extract the bitumen, and enough gas to heat 1.5 homes for a day is required. Oil sands producers move enough overburden and oil sands every two days to fill Toronto's Skydome or New York's Yankee Stadium.

- In 2005, the tar sands industry consumed 0.6 billion cubic feet of natural gas per day, enough natural gas to heat 3.2 million Canadian homes for a day. Currently they consume just over one billion cubic feet of natural gas per day, which is fourteen percent of all Canadian natural gas consumption (Canadian Association of Petroleum Producers, 2013a). In 2010, unconventional natural gas production, including shale gas, tight gas, and coal-bed methane, represented 41% of all Canadian natural gas production and is forecast to keep rising (Office of the Auditor General, 2013).

- By 2030, the tar sands are forecast to consume over 5 billion cubic feet per day of natural gas (Canadian Association of Petroleum Producers, 2011), representing more than the combined output of the planned Mackenzie Valley and Alaska gas pipelines, which will induce exploration and development of thousands of natural gas wells and feeder pipelines spanning the Northwest Territories, Yukon, and Alaska (Cizek, 2005).

- The greenhouse gas intensity of tar sands production is almost triple that of conventional oil, largely due to the vast amounts of natural gas consumed. Even before the actual produced oil is burned, carbon emissions from the tar sands are forecast to increase from 23.3 million tonnes per year in 2003 to between 83 and 175 million tonnes per year by 2030. This might represent almost two-thirds of Canada's 2005 "Kyoto Gap" of 270 million tonnes. The tar sands have been a major contributing factor to doubling Canada's "Kyoto Gap"[4] from 138 million tonnes in 1997 to 270 million tonnes in 2005 (Bramley, Neabel, & Woynillowicz, 2005).

- Approved oil sands mining operations are already licensed to divert 349 million cubic metres of water per year from the Athabasca River. This is approximately three times the volume of water required to meet the municipal needs of Calgary, a city of almost one million people, for a year. Planned projects will increase water diversions to almost 500 million cubic metres of water per year, representing almost half of the river's winter low flow (Schindler & Donahue, 2006).

[4] The "Kyoto Gap" is the difference between a nation's commitments to reduce carbon emissions under the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the nation's actual carbon emissions.

- Syncrude and Suncor are the top two air polluters in Alberta, which have already degraded the once-pristine air quality of Fort McMurray, a small northern city of 73,000, to that of metropolitan areas like Edmonton and Calgary with populations of close to a million each. Air quality modelling for approved projects predicts that national, provincial, and international guidelines for sulphur dioxide and nitrogen oxide will all be exceeded (Woynillowicz et al., 2005).

More recent developments reinforce and amplify all these facts. Multi-national corporations, including major players such as ExxonMobil, ConocoPhillips, and Shell, have confirmed a grand total planned investment of $218 billion in the tar sands in the next twenty-five years (Government of Alberta, 2013b) . This makes it the largest mega-project complex in the world, growing to a total of $272.25 billion when all the required arctic natural gas supplies from the Mackenzie Valley and Alaska pipelines are added (Imperial Oil Resource Ventures Ltd., 2005; Austen, 2006).

As far back as 2005, brokers such as Raymond James Ltd. and Canadian Imperial Bank of Commerce advised investors about the realities of "Peak Oil" and counselled them to invest in the tar sands, which they describe as the planet's last new significant oil supply addition whose total predicted output will rival Saudi Arabia by 2030 (Mawdsley et al., 2005). When interviewed by CBS 60 Minutes in January 2006 about the confirmed tar sands reserves of 175 billion barrels, Clive Mather, CEO of Shell Canada, thought that the confirmed reserves were too conservative: "We know there's much, much more there. The total estimates could be two trillion or even higher." – eight times the reserves of Saudi Arabia (CBS News, 2006).

Early in 2006, a bidding war took place for new tar sands leases, where energy corporations spent almost twice as much cash in one month than had ever been spent in a whole year (McKinnon, 2006). During the months of January and February 2006, the Alberta government raised $850 million for selling 4,000 square kilometres of new tar sands leases, adding this block to the grand total of 24,000 square kilometres of boreal forest available for extracting oil from tar, a combined area almost as big as Vancouver Island (Alberta Department of Energy, 2006b). Through its "Mineable Oil Sands Strategy" (MOSS), planned to re-zone the entire Fort McMurray region as a permanent industrial landscape, effectively abandoning the strategy of multiple-use through "integrated resource management" that balances resource extraction with wildlife and other ecological values (Alberta Department of Energy, 2006a).

1.1.3. Pipelines Associated with the Tar Sands

1.1.3.1. Mackenzie Gas Project

In the future, most of the energy to fuel oil extraction from the tar sands may come from the Mackenzie Gas Project, which was approved by the Canadian federal government in March 2011 (National Energy Board, 2011b). However, the project is now on hold due to low natural gas prices and negotiations of a "fiscal framework" with the government of Canada (Imperial Oil, 2013). For the time being, most of the natural gas being supplied to the tar sands comes from shale gas formations in north-western Alberta and north-eastern British Columbia via the North-Central Corridor pipeline (TransCanada Pipelines Ltd., 2011). However, due to the steep production decline rates associated with unconventional (i.e. hydraulically fractured) shale gas wells (D. Hughes, 2013), arctic natural gas may be required to fuel the tar sands sooner than expected.

The Mackenzie Gas Project involves the development of three anchor fields in the Mackenzie Delta and the construction of a 1,220 kilometre pipeline, which would ship natural gas south up the Mackenzie River valley to Alberta. The pipeline is designed to carry 1.2 billion cubic feet per day of natural gas and can be expanded up to 1.8 billion cubic feet per day with additional compressor stations (Imperial Oil Resource Ventures Ltd., 2004), as shown in Figure 2.

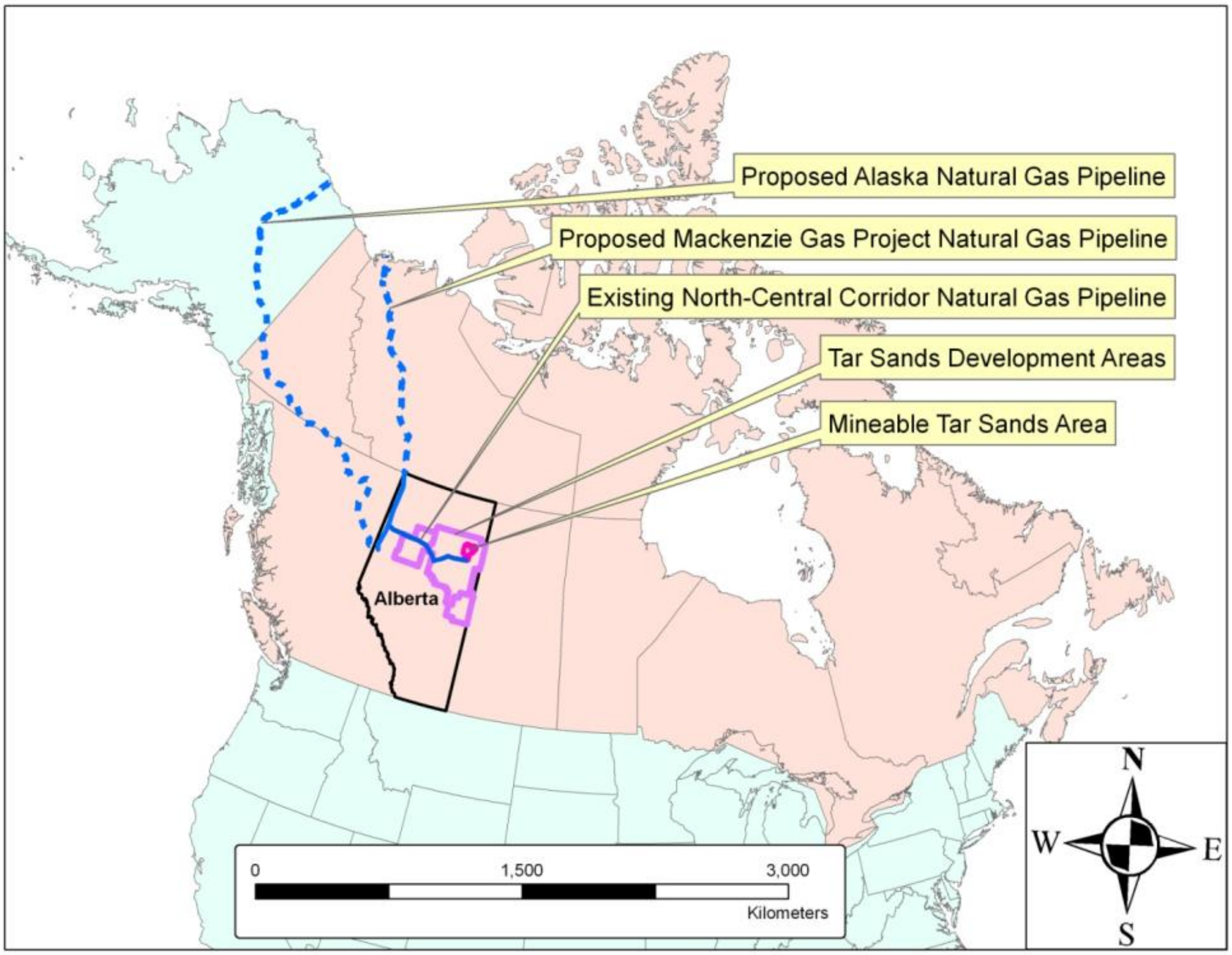


Figure 2 Proposed Arctic Natural Gas Pipelines to Alberta Tar Sands

The Mackenzie Gas Project is specifically designed to induce further petroleum exploration and extraction, which will bring the stranded natural gas from the Mackenzie Valley and Beaufort Sea to North American markets. In 2002, Imperial Oil posted an "open season" requesting expressions of interests from other potential gas shippers. Expressions of interest from 19 companies were received who wished to ship as much as 2 billion cubic feet of natural gas per day, but the detailed results remain confidential (Imperial Oil Resource Ventures Ltd., 2004) .

According to the Mackenzie Gas Project's submission to the National Energy Board, the three anchor fields can fill the pipeline with natural gas only for 4.7 years at 1.2 billion cubic feet per day and only for 3.1 years at 1.8 billion cubic feet per day. Over the anticipated 40-year lifetime of the Project, the anchor fields can supply only 33% of the total required gas production of 16 trillion cubic feet at either 1.2 or 1.8 billion cubic feet per day. The remaining gas must be supplied from both discovered and undiscovered gas fields in the Mackenzie Delta, Beaufort Sea, and Colville Hills geological plays. Discovered gas fields can supply 25% of total gas production while 42% of total gas production must come from undiscovered gas fields, which will require considerable exploration such as drilling and seismic to actually discover (Gilbert, Laustsen, Jung Associates Inc., 2004).

The original environmental impact statement submitted by the Proponent (i.e. Imperial Oil) in October 2004 did not quantitatively describe or map the induced cumulative impacts of the project. Indeed, the Proponent referred to induced petroleum exploration and development as "hypothetical projects" that "might" be encouraged by the Mackenzie Gas Project. With the exception of increases to grizzly bear mortality that "could be addressed through diligent monitoring and management", the Proponent claimed that there would be no significant cumulative effects (Imperial Oil Resource Ventures Ltd., 2004).

On December 3, 2004, the Joint Review Panel requested that the Proponent map the foreseeable land uses and provide a quantitative assessment of the geographic area that could be disturbed by the natural gas extraction and associated pipelines. In addition, the Joint Review Panel requested that the Proponent "provide a description of a production, transportation, development and gathering system that would require the Mackenzie Valley Pipeline to operate at its maximum capacity and to provide an assessment of the resulting impacts" (Hornal, 2004).

Since then, five separate cumulative impact mapping exercises have been carried out for the Mackenzie Gas Project:

1) On January 5, 2005, the Canadian Arctic Resources Committee (CARC) released its initial cumulative impact mapping of the Mackenzie Gas Project (Cizek & Montgomery, 2005). This study assumed that all the potential undiscovered gas fields identified in the Proponent's submission to the National Energy Board (Gilbert, Laustsen, Jung Associates Inc., 2004).

2) On March 31, 2005, the Proponent submitted its additional information including maps on cumulative impacts as requested by the Joint Review Panel in its letter of December 3, 2004. This information did not include exploration wells, seismic lines, and roads (Imperial Oil Resource Ventures Ltd., 2005b).

3) On June 6, 2005, the Pembina Institute released non-spatial modelling of terrestrial landscape impacts of northern gas development using the Hubbard-Naill approach for drilling and depletion of conventional natural gas fields. This modelling did not include any activities in the Beaufort Sea offshore (Holroyd & Retzer, 2005).

4) On September 11, 2005, CARC submitted modelling, including maps, of five pipeline capacity scenarios (Cizek, 2005) based on a resource assessment submitted to the National Energy Board by the Mackenzie Explorers Group, which claimed that the Mackenzie Gas Project could be expanded up to 3 billion cubic feet per day (Sproule Associates Ltd., 2005).

5) On September 21, 2005, the Proponent submitted its response, including maps, to the Round 2 Information Request from the Joint Review Panel, which required an assessment of the cumulative impacts of exploration wells, seismic lines, and roads (Imperial Oil Resource Ventures Ltd., 2005c).

Based on their forecasts of induced development and exploration, the proponent also submitted the following estimates of required capital expenditures over the next 25 years (Imperial Oil Resource Ventures Ltd., 2005a; Imperial Oil Resource Ventures Ltd., 2005b), as shown in Table 1.

Table 1 Estimated Cost of Mackenzie Gas Project Components

Component	**Estimated Capital Cost**
Pipeline and Anchor Fields	$7.00 Billion
Induced Exploration	$6.25 Billion
Induced Production Fields and Feeder Pipelines	$20.00 Billion
TOTAL	**$33.25 Billion**

The MGP extends only 10 metres across the northern Alberta corner in the extreme north-western end of Alberta. The remaining 103 kilometre section required to connect it to the Alberta gas pipeline grid will be constructed by NOVA Gas Transmission Ltd., a wholly owned subsidiary of TransCanada Pipelines Ltd. at an additional cost of $193 million (Imperial Oil Resource Ventures Ltd., 2004b).

1.1.3.2. Alberta North-Central Corridor Pipeline

In February 2004, TransCanada Pipelines forecast that the tar sands at Fort McMurray and Cold Lake would require a total of 2.3 billion cubic feet per day of natural gas by 2015, exceeding the planned capacity of the Mackenzie Gas Project at 1.8 billion cubic feet per day. Thus, TransCanada Pipelines proposed to build the "north-central corridor" pipeline that would allow an additional 1.5 billion cubic feet per day of gas to be shipped directly from the north-western corner of Alberta to the tar sands at Fort McMurray and Cold Lake in north-eastern Alberta. TransCanada Pipelines was anticipating that an additional 4.0 billion cubic feet per day of natural gas would be shipped through its Alberta grid from the Alaska pipeline terminus in north-eastern British Columbia (Clark, 2004). The map showing these pipelines is not displayed since TransCanada Pipelines did not respond to requests for permission to include it in this dissertation. In early 2010, TransCanada Pipelines announced that they had completed construction of the $800 million north-central corridor (TransCanada Pipelines Ltd., 2011).

1.1.3.3. Alaska Natural Gas Pipeline

After years of negotiations, the State of Alaska announced a conditional agreement on February 22, 2006 with British Petroleum, ConocoPhillips, and ExxonMobil to build the $20 billion Alaska natural gas pipeline in exchange for the state lowering the tax and royalty rates. The pipeline is to run from Prudhoe Bay to Fairbanks and then along the Alaska Highway to north-eastern British Columbia. It will transport 4.5 to 6 billion cubic feet of natural gas per day (Austen, 2006). Since there are 35 trillion cubic feet of discovered natural gas in Prudhoe Bay and along the Alaska North Slope, extracting this resource would require minimal additional exploration and development (Northern Alaska Environment Center, 2006). Since the completion of the Trans-Alaska Pipeline System (TAPS) in 1978 that ships oil south to Valdez, extensive infrastructure, with its associated cumulative environmental impacts, has already been built in Prudhoe Bay and along the Alaska North Slope (National Research Council, 2003).

1.1.3.4. Pipelines Downstream from the Tar Sands

In 2008, there were thirty-six (36) new or expanded downstream pipelines proposed to ship oil and bitumen from the tar sands to the United States or Asia (Canadian Association of Petroleum Producers, 2008). Since then, five of these pipelines (TransCanada Keystone, Enbridge Alberta Clipper, Enbridge Southern Access, Enbridge Spearhead North, and TransCanada Gulf Coast) have been constructed. An additional five pipelines (Enbridge Gateway, Kinder Morgan Trans Mountain Expansion, Enbridge Line 9 Reversal, and TransCanada Keystone XL) are under review by the Canadian or United States governments (Canadian Association of Petroleum Producers, 2013b).[5]

1.1.4. Estimated Costs for Alberta Tar Sands and Arctic Natural Gas Supplies

In summary, the total capital costs of the tar sands/arctic natural gas industrial complex, not including the downstream pipelines required for shipping the tar sands products to the United States or Asia, is estimated at $272.25 Billion, as shown in Table 2.

Table 2 Estimated Costs of Tar Sands Projects and Arctic Natural Gas Projects

Component	**Estimated Capital Cost**
Tar Sands Projects	$218.00 Billion
Mackenzie Gas Project including Induced Exploration/Development	$33.25 Billion
Northwestern Interconnect to the MGP and the North Central Corridor (Nova Gas Transmission Ltd)	$1.0 Billion
Alaska Pipeline Project	$20.00 Billion
TOTAL	**$272.25 Billion**

At a total potential cost of $272.25 billion, the tar sands/arctic natural gas industrial complex is the largest industrial complex ever proposed on the planet, far exceeding the magnitude of the $25 billion Twin Gorges Dam in China, the largest hydro-electric project in the world, and even exceeding the improbable $50 billion Bering Strait transportation link between Alaska and Siberia touted by its promoters as "biggest project in history" (Flyvbjerg et al., 2003).

[5] Most recently, TransCanada Pipelines has proposed the "Energy East Pipeline" from the Alberta tar sands to New Brunswick (TransCanada Pipelines Ltd., 2013). This pipeline is outside the scope of this project.

The tar sands/arctic natural gas industrial complex goes beyond the scope of a “mega-project” and calls for the coining of a new word – “gigaproject.” In addition to its water usage, toxic emissions, and carbon output, the combined tars sands/arctic natural gas gigaproject has the potential to cause one of the largest ecological and landscape disturbances on the planet. The only larger landscape disturbance is in the Brazilian Amazon, where as much as 31,000 km2 of land has been deforested per year (Food and Agriculture Organization, 2006).

Yet the planned or potential tar sands developments, combined with their ancillary energy sources, have not been comprehensively mapped, much less realistically visualised in three-dimensional format, as an integrated industrial complex. This makes it difficult, if not impossible, for the public to understand, debate, or decide whether or not these projects are desirable or acceptable.

1.2. Study Need

There is limited knowledge about the effectiveness of landscape visualisation and virtual globes in influencing public understanding or attitudes regarding environmental issues. Furthermore, very large-scale projects that have the potential for landscape disruption on a macro-regional scale have not been visualised. In comparison, the largest known study areas where realistic three-dimensional landscape visualization has thus far been conducted are a 2,880 square kilometre forest in north-eastern British Columbia (Seely et al., 2004) and a 400 square kilometer landscape unit in the Arrow Forest District in south-eastern British Columbia (Sheppard & Meitner, 2005).

As discussed in Sections 1.2.1 and 1.2.2 below, the following factors also severely limit opportunities for public understanding, debate, and transparent decision-making regarding the specific tar sands/natural gas gigaproject case study:

1) The gigaproject has not been verbally or quantitatively described in its totality.

2) No regional cumulative or strategic environmental effects assessment of the entire gigaproject is contemplated.

3) There are no readily available comprehensive and/or detailed maps showing the gigaproject in its totality or even major components.

4) The available three-dimensional visualisations are limited to artist’s impressions of individual project components and ground-level landscape visualisations of post restoration landscapes in the distant future. Photographs of existing activities are presented without any reference to geographical location.

5) Overall mapping and landscape visualisation communication to the public by government, industry, and even environmental organizations of the scope and scale of this gigaproject has been extremely limited.

Therefore, it is argued that, in relation to the tar sands, providing more effective maps and landscape visualisations may improve:

1) Scientific understanding of the cumulative environmental impacts;

2) Communication with the public on many key issues regarding the tar sands; and

3) Informed and transparent decision-making.

In the absence of efforts to enable effective public communication, it is possible that the tar sands gigaproject will continue to expand to a maximum build-out limited only by physical and economic constraints (i.e. the "Business as Usual" scenario).

1.2.1. Cumulative Effects Assessment Practice

With regard to environmental assessment, governments are not contemplating any cumulative, regional, or strategic environmental assessments for the entire industrial complex. While a cumulative effects assessment is required as part of an application, each tar sands development proposal is assessed individually by the Alberta Energy and Utilities Board (AEUB)[6] (Kennett & Wenig, 2005). Where federal regulatory approval is required – most commonly under the federal Fisheries Act to destroy or alter fish habitat – sometimes a Joint Review Panel between the AEUB and CEAA is formed (Woynillowicz et al., 2005).

Under a Regional Sustainable Development Strategy for the Athabasca Oil Sands Area (the mineable tar sands area around Fort McMurray) a voluntary Cumulative Environmental Management Association (CEMA), comprised of industry, government, aboriginal groups, and environmental non-government organizations was formed in 2000 (Spaling, Zwier, Ross, & Creasey, 2000). The CEMA was tasked with completing management plans for twenty-two (22) high-priority issues within two years. As of late 2005, only four (4) management plans had been completed (Woynillowicz et al., 2005):

1) Landscape design checklist (05/05)
2) Ecosystem Management Tools Recommendation (02/04)
3) Acid Deposition Management Framework Recommendation (02/04)
4) Trace Metals Management Recommendation (05/02)

Although a similar arrangement was suggested for the Cold Lake area in a CEAA-sponsored research project (Braat, 2001), no organizations such as CEMA exist for the Cold Lake or Peace River "in situ" tar sands development areas.

[6] The "Alberta Energy and Utilities Board" was renamed the "Energy Resource Conservation Board" and most recently the "Alberta Energy Regulator".

The Mackenzie Gas Project (MGP) was assessed by a Joint Review Panel composed of representative from three affected jurisdictions in the Northwest Territories:

1) Canadian Environmental Assessment Agency (Environment Canada)
2) Mackenzie Valley Environmental Impact Review Board (Indian and Northern Affairs Canada)
3) Inuvialuit Game Council (pursuant to land claims legislation under the Inuvialuit Final Agreement).

However, the scope of the Joint Review Panel's assessment extended only 10 metres past the NWT border into Alberta. The additional 103 kilometres of pipeline to connect the MGP into the Alberta natural gas pipeline system was reviewed separately by the Alberta Energy and Utilities Board (AEUB) (Imperial Oil Resource Ventures Ltd., 2004).

The MGP was also simultaneously reviewed and regulated by the National Energy Board (NEB). It has been suggested that, under the NEB's broad "public interest" mandate, there is legal precedent that the NEB should review both the upstream and the downstream cumulative effects of the project. The upstream effects are the additional natural gas fields required to supply the pipeline and the downstream effects are the ultimate use of the natural gas at the tar sands (Wenig & Sutherland, 2004). However, the National Energy Board decided that the cumulative effects of the upstream natural gas fields would be assessed in the future on a case-by-case basis. As well, the National Energy Board decided that there was no direct connection between the Mackenzie Gas Project and the Alberta tar sands (National Energy Board, 2012).

Regarding Canadian downstream pipelines such as the Enbridge Northern Gateway, the Kinder Morgan TransMountain Expansion, and the Enbridge Line 9 Reversal, the Joint Review Panel or the National Energy Board have ruled in all three cases that the upstream effects of tar sands expansion or the downstream effects of oil consumption would not be considered (National Energy Board, 2013a; National Energy Board, 2013b; Enbridge Northern Gateway Project Joint Review Panel, 2011).

In contrast, under the United States National Environmental Policy Act, the environmental impact statement for the American portion of the TransCanada Keystone XL pipeline considers cumulative effects "including impacts on resources within the United States, lifecycle GHG [Greenhouse Gas] emissions of WCSB [Western Canadian Sedimentary Basin] activities, and impacts on resources in Canada" (United States Department of State, 2013).

Overall, the cumulative effects of open pit tar sands projects are evaluated on a project-by-project basis by individual proponents rather than through a strategic or regional environmental effects process. In the case of Canadian upstream and downstream pipelines related to the Alberta tar sands, the National Energy Board has refused to consider any cumulative effects linkages to induced upstream development or the greenhouse gas emissions from petroleum consumption. While there may be disagreement over the conclusions, in the United States the National Environmental Policy Act requires consideration of all these cumulative effects.

1.2.2. Publicly-Available Maps and Data

There are few publicly-available maps and very limited data showing the physical footprints of the tar sands and associated pipelines. None of these maps and data show the tar sands and associated pipelines in a comprehensive and integrated way.

1.2.2.1. Government of Alberta

The official Alberta Department of Energy web-site provides three small-scale maps about the tar sands in Acrobat "pdf" format, which are updated on an annual basis (Alberta Department of Energy, 2013):

1) Alberta's Oil Sands Leased Area
2) Alberta's Oil Sands Projects and Upgraders
3) ERCB [Energy Resource Conservation Board] Designated Oil Sands Area

These small-scale maps do not state the actual scale and cover most of northern Alberta. The map "Alberta's Oil Sands Projects and Upgraders" lists 198 existing, approved, and proposed open pit mining and *in-situ* tar sand projects as point data only (i.e. it does not show the physical footprints). Interestingly, the first of these maps issued in 2006 did show the physical footprint polygons of existing, approved, and planned open pit mines at very small scale, as shown in the map excerpt in Figure 3. In all following annual updates, the open pit mines were only shown as point data, as shown in the excerpt from the 2013 map in Figure 4. Overall, these maps provide very low disclosure and transparency about the tar sands open pit mines.

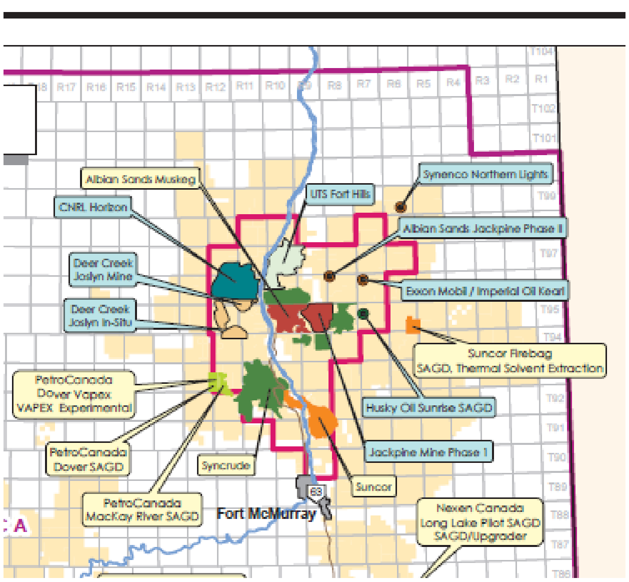


Figure 3 Open Pit Mines 2006 (Original map cropped to area north of Fort McMurray),
Source: Alberta Department of Energy (2006c)

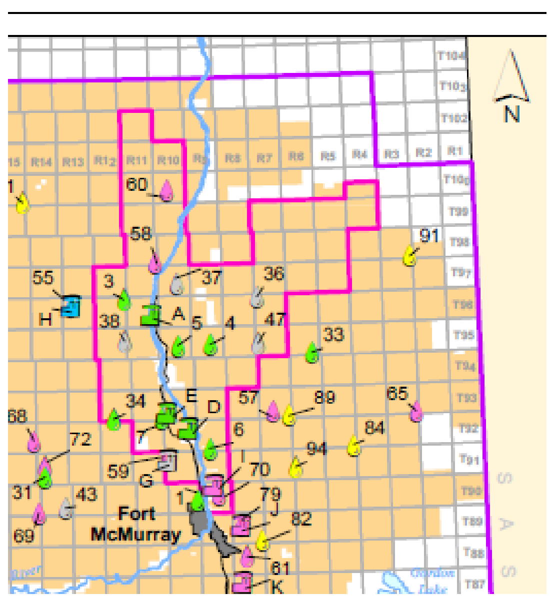


Figure 4 Open Pit Mines 2013 (Original map cropped to area north of Fort McMurray), Source: Alberta Department of Energy (2013b)

In November 2011, the Government of Alberta released the "Oilsands Information Portal" (Alberta Environment and Sustainable Resource Development, 2013), which is an on-line mapping service that includes data about:

1) Climate Change;
2) Water;
3) Land Disturbance and Reclamation;
4) Tailings Ponds;
5) Air; and
6) Wildlife and Biodiversity.

The "Land Disturbance and Reclamation" map layers only show the physical footprint polygons of ***existing*** open pit mines. The approved and proposed open pit mines are again shown as point data. This dataset is also available as an on-line image-based "web map service" that can be displayed in GIS software (Government of Alberta, 2013c), but actual GIS data are not available for download.

In February 2012, the governments of Canada and Alberta announced a "Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring", which also includes an on-line interactive map (Government of Canada and Government of Alberta, 2013). This map only includes point data for the monitoring stations. It does not show any of the tar sand projects at all, either as point data or physical footprints.

1.2.2.2. Alberta Regulatory Authorities

In 2006, the Alberta Energy and Utilities Board[7] provided maps of physical footprints of tar sands development, but the hard-copy maps or digital data in DXF format had to be purchased at considerable cost. In the Athabasca mineable oil sands area around Fort McMurray the following maps were available at a total cost of $1,680 for the digital data and $240 for the hard-copies (Alberta Energy and Utilities Board, 2005):

> **Mineable Oil Sands Regional Development Status Maps**
>
> The EUB, in cooperation with the mineable oil sands industry, has compiled 8 status maps showing the expected status of development in the surface mineable area of the Athabasca oil sands at 5-year intervals from 2000 to 2035. The development status maps have been compiled to assist in the assessment of regional issues and are based on the best available information as of December 31, 2001.
>
> Scale 1:100 000 ; Size 94x57 cm
> Paper $30 each
> Digital (DXF format) $210 per set

[7] The "Alberta Energy and Utilities Board" was renamed the "Energy Resource Conservation Board" and most recently the "Alberta Energy Regulator".

In 2007, these digital DXF data were purchased and loaded into ArcGIS software, where it was discovered that these data were already out of date and are missing six approved and proposed open pit mining projects. The "Mineable Oil Sands Development Status Maps" are no longer available for purchase from the AEUB, which has since been renamed the "Alberta Energy Regulator".

The "Alberta Energy Regulator" also provides "Mineable Oil Sands Project Scheme Approvals" and "Active Oil Sands Schemes" for purchase as GIS shapefiles for $218 each. These data can also be viewed using an on-line map viewer (Alberta Energy Regulator, 2013b). These data appear to show the sub-surface leases for the existing and approved projects, not the actual physical footprints.

1.2.2.3. Cumulative Environmental Management Association

The Cumulative Environmental Management Association (CEMA) is a voluntary organization comprised of industry, government, aboriginal groups, and environmental non-governmental organizations for the mineable tar sand area around Fort McMurray. CEMA's web-site also does not provide any maps showing the cumulative physical footprint of existing, approved, and proposed tar sands projects (Cumulative Environmental Management Association, 2013). The industry-sponsored Athabasca Regional Issues Working Group web-site (Oil Sands Developers Group, 2013) only provides a link to the previously-mentioned Government of Alberta "Oil Sands Information Portal".

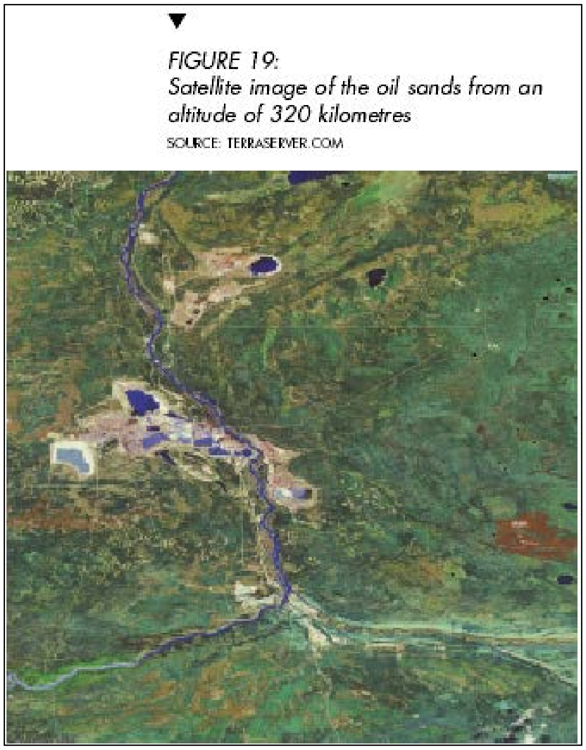
1.2.2.4. Environmental Non-Governmental Organisations

The report "Oil Sands Fever" from the non-government organization the Pembina Institute (Woynillowicz et al., 2005) is illustrated with ground-based and aerial oblique photographs of existing tar sands projects but does not provide any maps or visualisations of future planned or potential projects. Examples of ground-based and aerial oblique photographs are shown in Figure 5 and Figure 6.

Figure 5 Ground-Based Photograph of Existing Tar Sands Tailing Pond, Source: Woynillowicz et al. (2005)

Figure 6 Aerial Oblique Photograph of Existing Tar Sands Open Pit Mine, Source: Woynillowicz et al. (2005)

As shown in Figure 7 and Figure 8, the only maps of existing projects that are provided in this report are Landsat satellite images of development around Fort McMurray and Cold Lake taken from the Terraserver.com web-site (Woynillowicz et al., 2005) . These satellite images are shown without any labels, legends, scale bars, or contextual geographic references.



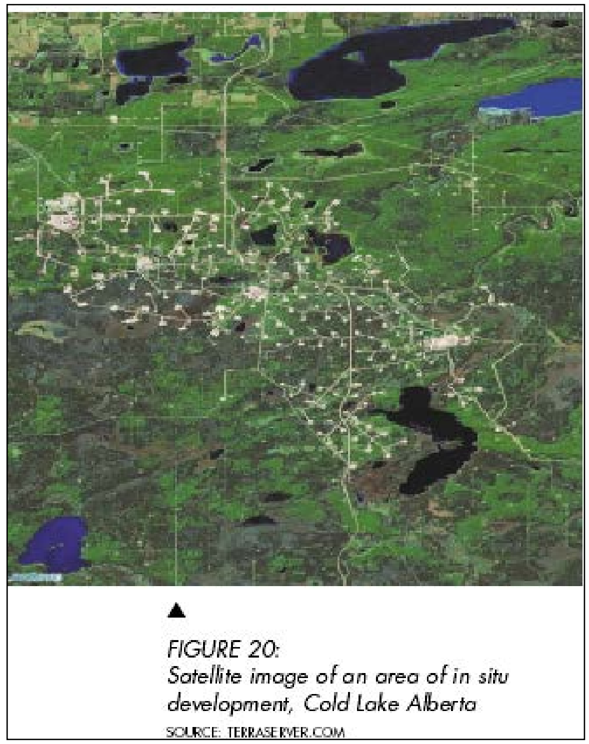
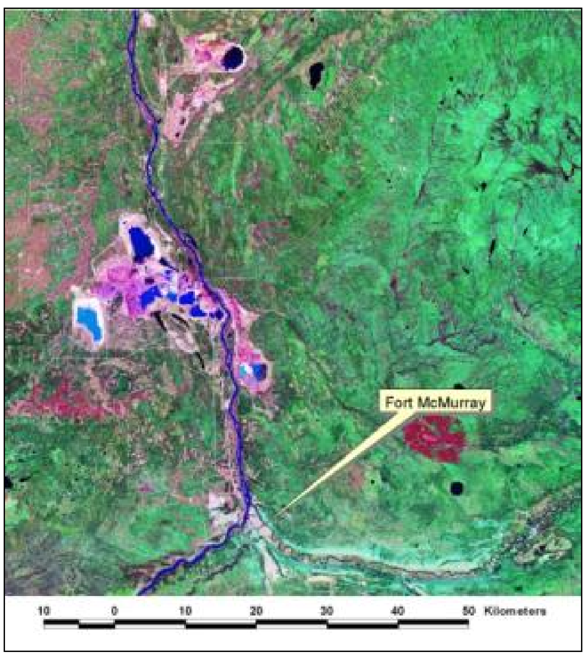


Figure 7 Terraserver Satellite Images of Oil Sands from an altitude of 320 kilometers.
Source: Woynillowicz et al. (2005)



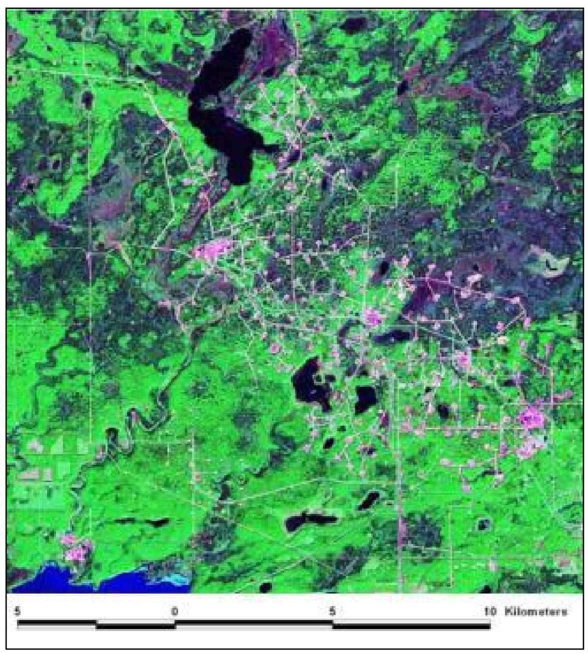


Figure 8 Landsat7 Images of the Tar Sands projected to UTM12 with scale bars.
Source: University of Maryland (n.d.)

Furthermore, these images appear to be unprojected where the latitude and longitude coordinates are treated as if they were x and y co-ordinates. This results in considerable distortion exaggerating the distance along the x-axis while reducing the distance along the y-axis, as shown in Figure 7. For comparison, the same Landsat7 images downloaded from the Global Land Cover Facility (University of Maryland, n.d.) in UTM Zone 12 projection are shown in Figure 8. As displayed in Pembina's "Oil Sands Fever Report", as shown in right side of Figure 7, the Cold Lake image has been flipped upside down, apparently by mistake, so that south is at the top and north is at the bottom. Finally, with the addition of a scale bar, it is clear that the image of the surface mining at Fort McMurray actually covers a much greater area than the image from Cold Lake.

With regard to planned and potential projects, the "Oil Sands Fever" report includes only two maps of current leases – north and south of Fort McMurray (Woynillowicz et al., 2005), as shown in Figure 9.

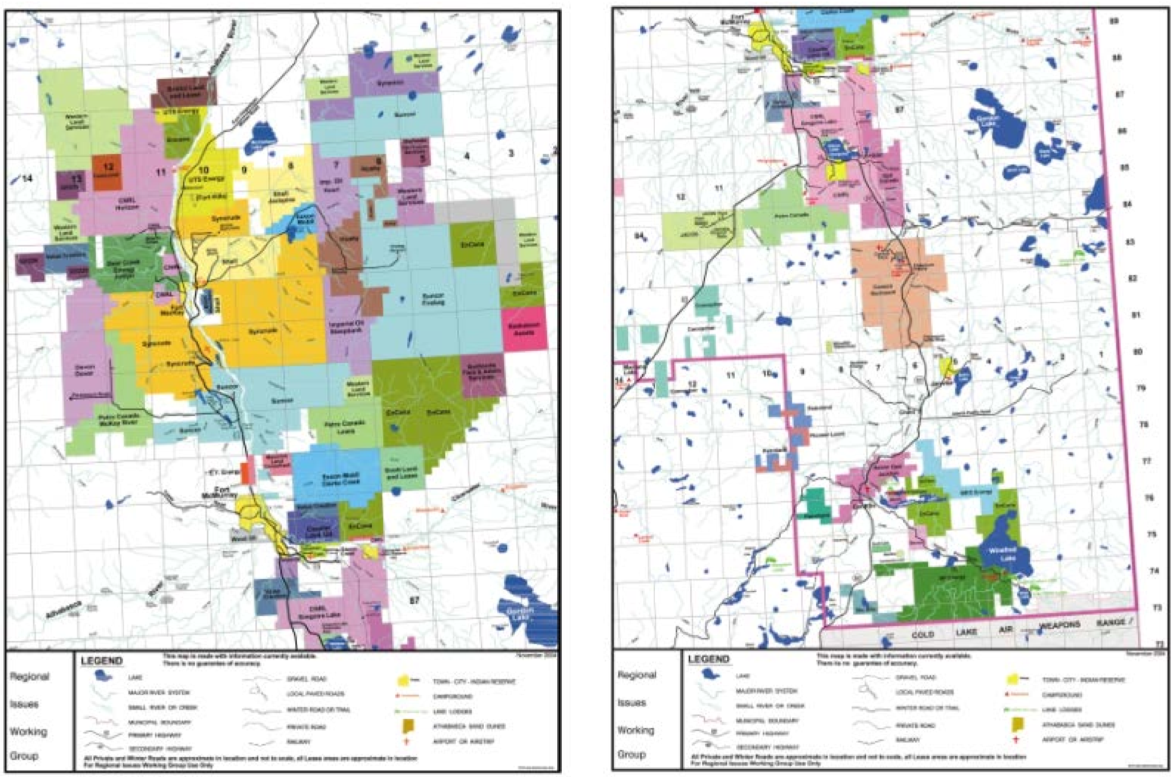


Figure 9 Oil Sands Leases North and South of Fort McMurray. Source: Woynillowicz et al. (2005)

The follow-up Pembina Institute report "Death by a Thousand Cuts" (Schneider & Dyer, 2006) evaluates the cumulative impacts of ***in-situ*** projects, which inject steam to melt the bitumen that is too deep to mine.   This report only provides a small-scale map illustrating the potential SAGD disturbance footprint across existing leases in northern Alberta, as shown in Figure 10.

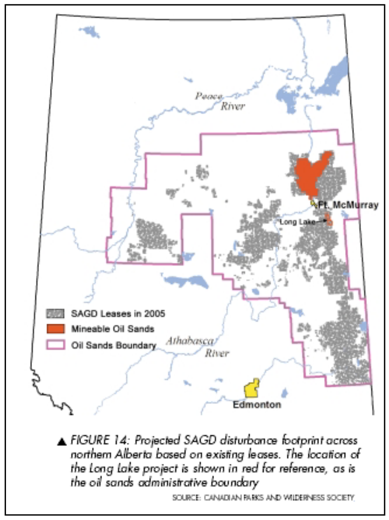


Figure 10 Projected SAGD disturbance footprint across northern Alberta based on existing leases, Source: Schneider & Dyer (2006)

1.2.2.5. Industry Public Communications Material

There are no maps showing the physical footprint of existing, approved, and future tar sands projects on the public communications web-site of the Canadian Association of Petroleum Producers (Canadian Association of Petroleum Producers, 2013c). Only one industry-sponsored report about the cumulative impacts of the tar sands was located. Figure xx shows the cover-page from communication material dealing with cumulative effects of SAGD projects south of Fort McMurray prepared by industry that is targeted at an aboriginal audience (Highwood Environmental Management Ltd., 2003). The only "map" in this publication is the drawing on the cover-page as shown, as shown in Figure 11.

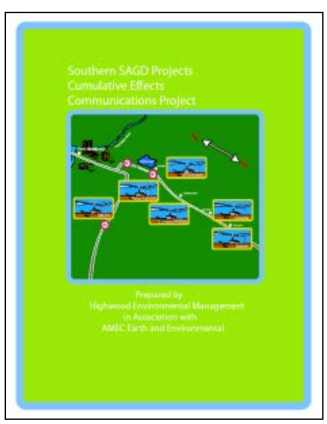


Figure 11 Cover Page of Southern SAGD Cumulative Effects Communication Project, Source: Highwood Environmental Management Ltd. (2003)

1.2.2.6. Environmental Impact Statements Prepared by Industry

There are some maps of existing, approved, and planned tar sands projects within environmental impact statements prepared by industry for individual open pit mining projects, which can be found at the Canadian Environmental Assessment Agency's on-line public registry for Alberta (Canadian Environmental Assessment Agency, 2013b). However, finding these maps requires searching through multi-volume environmental impact statements that span thousands of pages. None of these maps are available for download as GIS data.

For example, the Albian Sands Energy Inc. (Shell) Muskeg River Mine Expansion environmental impact statement includes a map in "Volume 4: Terrestrial Resources and Human Environment" (Albian Sands Energy Inc., 2005, p. 1-36), which is a 472 page document out of a seven volume environmental impact statement. This map appears to use the same kind of lease areas as "Mineable Oil Sands Project Scheme Approvals" and "Active Oil Sands Schemes" (Alberta Energy Regulator, 2013b) instead of actual physical footprints. This map is not displayed because Shell Canada Ltd. did not respond to requests for permission to include the map in this dissertation.

In 2007, an updated map of existing, approved, and planned tar sand projects was included in "Application for Approval of the Jackpine Mine Expansion Project and Pierre River Project, Environmental Impact Assessment, Volume 5: Terrestrial Resources and Human Environment" (Shell Canada Ltd., 2007, p. 1-32), which is 852 page document out of a five volume environmental impact statement. This map includes several new projects compared to the earlier 2005 map (Albian Sands Energy Inc., 2005, p. 1-36). Again, the 2007 map appears to use the same kind of lease areas as "Mineable Oil Sands Project Scheme Approvals" and "Active Oil Sands Schemes" (Alberta Energy Regulator, 2013b) instead of actual physical footprints. Compared to the previous Albian Sands Energy map from 2005, additional open pit mining projects such as the Shell Pierre River Mine and the Suncor Voyageur South project have been added. Again, this map is not displayed because Shell Canada Ltd. did not respond to requests for permission to include the map in this dissertation.

In its 2011 application for the "Frontier Oil Sands Mining Project", Teck Resources Ltd. showed the physical footprint of existing, approved, and planned tar sand mining and *in-situ* projects in "Volume 3: EIA Methods", which is an 82 page document in an eight volume environmental impact statement (Teck Resources Ltd., 2011, p. 1-11). While the physical footprints are smaller than the lease areas in the previous maps by Albian Sands in 2005 and Shell Canada in 2007, the physical footprints show the actual area of landscape disturbance while the lease areas only show property ownership. This map is not displayed because Teck Resources Ltd. did not respond to requests for permission to include the map in this dissertation.

As this environmental impact statement was submitted after the maps and visualizations had been completed, the "Frontier Oil Sands Mining Project" is outside the scope of this study.

1.2.2.7. Mackenzie Gas Project

In the Northwest Territories, the Joint Review Panel has required project proponents to map the cumulative impacts of the proposed Mackenzie Gas Project at its maximum capacity of 1.8 billion cubic feet per day (Hornal, 2004). Contrasting forecasts of the additional natural gas fields required to supply the Mackenzie Gas Project for the next forty years were developed by the proponent and a non-governmental organization. The forecast developed by Imperial Oil, the project proponent[8], is shown in Figure 12. For comparative purposes, Imperial Oil's GIS data was imported into the same scale and map format. The forecast developed for the Canadian Arctic Resources Committee (CARC), a non-government organization is shown in Figure 13. Unlike the proponent's forecast, the CARC forecast includes exploration wells, winter roads, and seismic cut-lines.

Based on further requests from the Joint Review Panel to identify the cumulative impacts of exploration wells, winter roads, and seismic cut-lines the proponent submitted additional information providing quantitative estimates for cumulative exploration activities, but only added exploration wells to their maps. The proponent contended that these projects were not "reasonably foreseeable" but only "hypothetical" projects (Imperial Oil Resource Ventures Ltd., 2005b), even though additional exploration and development is required to keep the pipeline full over its lifespan of about forty years.

[8] The project proponent originally prepared two separate maps, one for 2016 and another for 2030 where the infrastructure from 2015 based on the assumption that the physical footprint of the infrastructure would be reclaimed to a natural state once the gas fields were exhausted. As no petroleum infrastructure has ever been reclaimed to a natural state in the NWT, the map shown in Figure 12 combines the GIS shapefiles submitted by the proponent into one map.

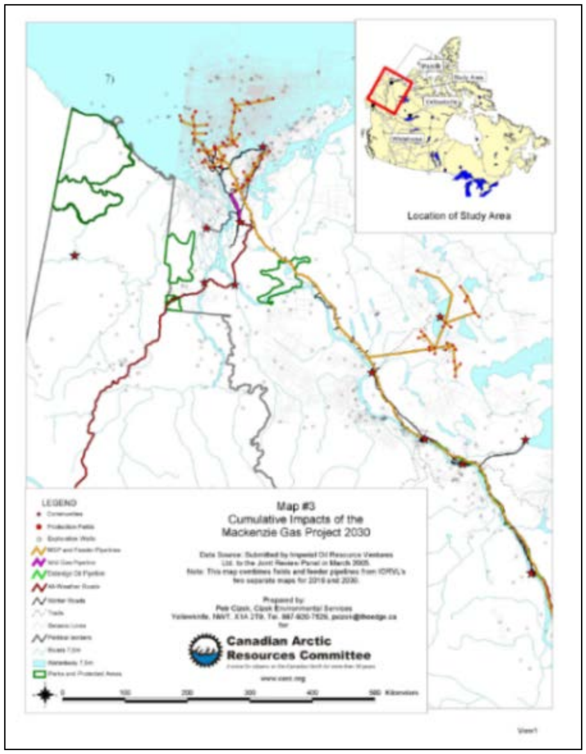


Figure 12 Cumulative Impacts of the Mackenzie Gas Project 2030 modelled by Imperial Oil Ltd., Source: Cizek (2005).

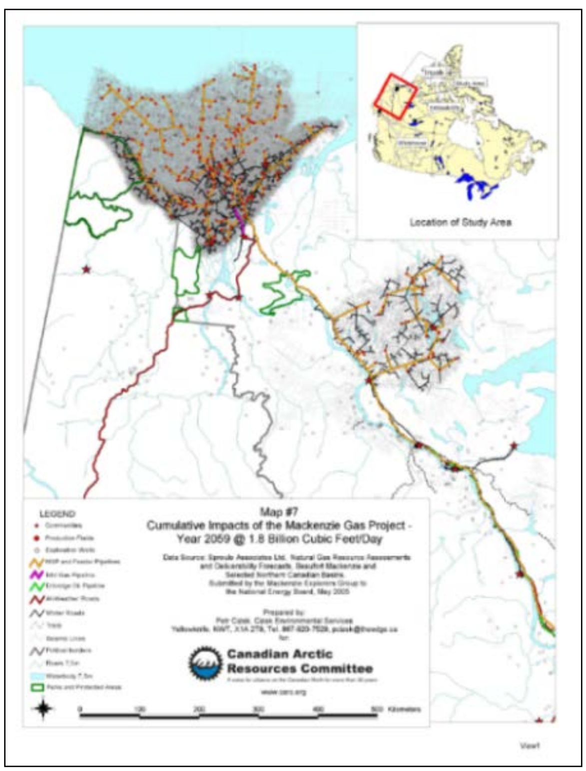


Figure 13 Cumulative Impacts of the Mackenze Gas Project 2030 modelled by Canadian Arctic Resources Committee, Source: Cizek (2005).

The proponent of the Mackenzie Gas Project has largely relied on planimetric maps and vertical aerial photographs to depict the pipeline route and its associated infrastructure such as camps, barge landings, staging areas, gravel pits, compressor stations, and conditioning facilities all shown as point symbols. The original Project Description from August 2004 contains a series of maps using National Topographic Series base data at 1:250,000 and 1:50,000 while the Environmental Alignment Sheets show the proposed project superimposed on black and white vertical aerial photographs at 1:30,000 (Imperial Oil Resource Ventures Ltd., 2004).

However, the Project Description also contains a series of sixteen "artist's impressions" of the project's associated infrastructure (Imperial Oil Resource Ventures Ltd., 2004), as shown in four examples in Figure 14. The purpose of these images does not appear to be to describe technical processes, but to show what the infrastructure looks like within the landscape. The images are oblique aerial views without any scale bars and without any link to their location in the actual landscape. The artist used a square piece of the earth's surface floating in space showing a cross section of the earth underground, which further dissociates these images from the context of the landscape.

Figure 14 Sample Artist's Impressions of Mackenzie Gas Project Infrastructure, Source: Imperial Oil Resource Ventures Ltd. (2004)

As shown in Figure 15, the only 3D landscape visualisation of the proposed MGP and its associated infrastructure was produced by the Canadian Arctic Resources Committee (CARC), a non-government organization. This visualisation is a 7.5 minute fly-though the Dehcho territory in the southern portion of the Mackenzie Gas Project using 5m resolution IRS satellite imagery draped over the National Topographic Series “1:250,000” Digital Elevation Model (Post Spacing of 3 x 3 arc seconds or approximately 93 m (North-South) and 65-35 m (East-West) (Cizek & Booth, 2004).

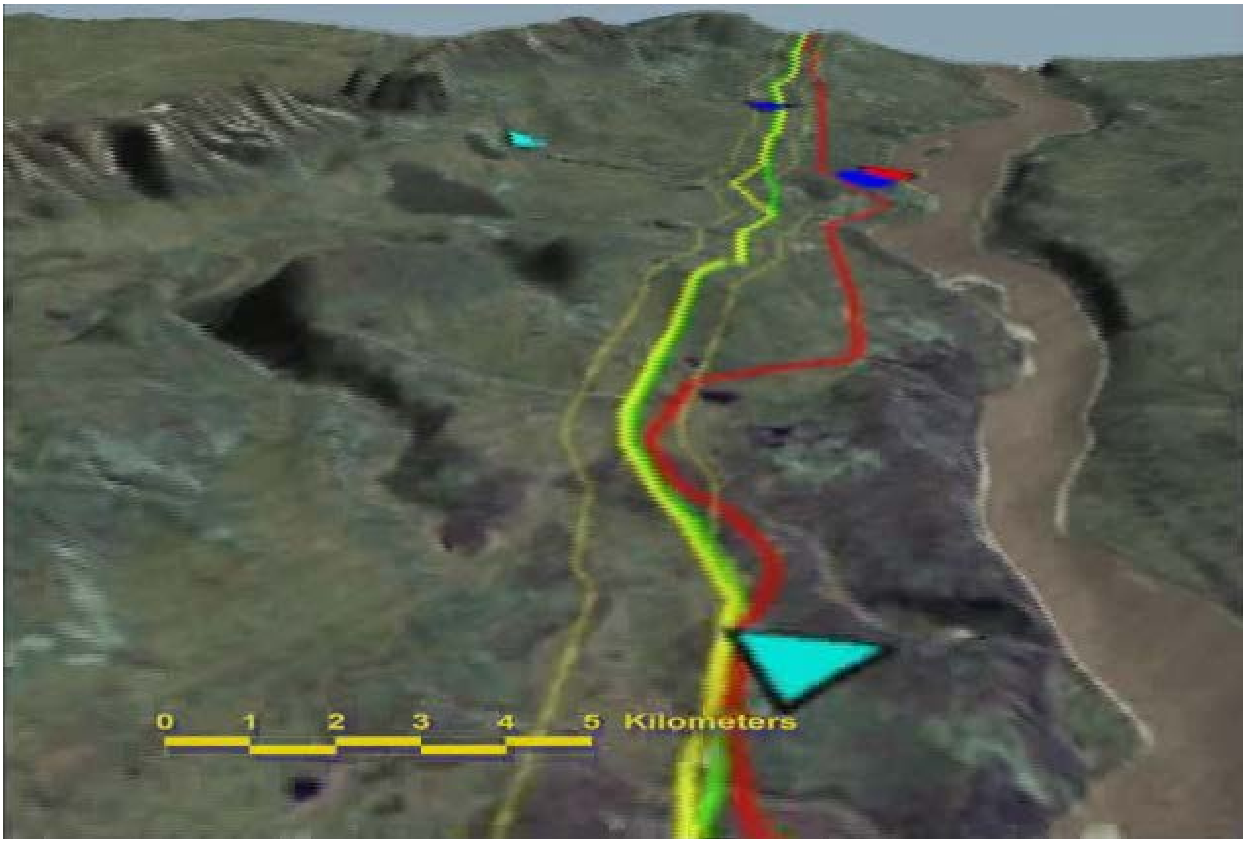


Figure 15 Screenshot from "Proposed Mackenzie Gas Project Pipeline in the Dehcho Territory: A Computer-Generated Flythrough", Source: Cizek & Booth (2004).

User response to this visualisation was not formally evaluated. However, upon viewing the animation, one member of the Dehcho First Nations thought that it was a real landscape filmed from helicopter. Also, the animation was used by at least one First Nation in negotiating modifications to the pipeline route with the developer.

1.3. Study Objectives

This study is divided into three phases:

Phase 1: Develop and test a procedure for visualising and viewing existing, approved and proposed developments in a seamless range from the macro-region to the site scale.

Tasks:

1) Prepare comprehensive maps showing the cumulative ***physical*** footprint of existing and planned tar sands open pit mining projects combined with associated pipelines. The ***physical*** footprint is defined as the geographic area where natural tree, plant, or water cover has been removed through the construction of open-pit mines, tailings ponds, roads, pipelines, well pads, or other industrial buildings/structures. This study is limited to showing the physical footprint of fourteen existing, approved, and proposed open pit mines.[9] The remaining 183 existing, approved, and proposed ***in-situ*** tar sands projects (Alberta Department of Energy, 2013b) are beyond the scope of this study. An analysis of the ecological footprint, zones of influence, and a systems analysis of all the cumulative environmental effects are also beyond the scope of this study;

2) Prepare a series of scenarios including “Existing”, “Approved”, and “Proposed” tar sand open pit mines;

3) Prepare semi-realistic and fully realistic three-dimensional landscape visualisations of site-specific infrastructure and landscape disturbance spatially linked to the comprehensive maps on a selective basis (i.e. not all sites at all scales);

4) Develop and adapt computerized products that allow the public to interact dynamically with maps and three-dimensional landscape visualisations based primarily on existing tools and technologies; and

5) Pre-test product usability and response (both cognitive and affective, but not including behavioral[10]) with a sample of potential users and make appropriate modifications.

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[9] This study does not include the proposed Teck Resources Ltd. Frontier open pit mining project (Teck Resources Ltd., 2011), which was submitted to regulators in November, 2011 after the maps and 3D visualizations had already been prepared.

[10] There is likely a long time lag between cognitive and affective changes, and actual behavioural change such as political action. Therefore, behavioural change will not be studied, but any political actions resulting from the public dissemination of this product will be reported in future papers.

Phase 2: Evaluate the user responses to the developed procedure.

Tasks:

1) Disseminate the modified products in hard-copy and electronic formats to a sample of members of the public to better inform them and to address key gaps in public information. Products are designed following ethical principles (Sheppard & Cizek, 2009; Sheppard, 2001) only to engage and inform (i.e. cognition), while measuring other responses (e.g. affect and behavioral intent); and

2) Evaluate modified product usability and measure public response (cognitive, affective, behavioral intent but not including actual behavioral responses).

Phase 3: Make recommendations to practitioners and public agencies on effective and ethical ways to communicate cumulative effects of extremely large projects and for further research in this area. Topics addressed include:

1) Comparison of the scope and detail between existing publicly accessible information available in government registries or from private developers and the generated cumulative physical footprint maps and landscape visualisations;

2) Public policy implications of continuing to restrict or beginning to enhance public access to comprehensive cumulative impact mapping and landscape visualisations;

3) Opportunities and limitations of the technical methods that public agencies and private developers can or should use to communicate cumulative environmental impacts; and

4) Opportunities and limitations of public participation by using 2D maps and 3D landscape visualisations displayed in a virtual globe distributed through the Internet.

1.4. Research Questions, Hypotheses, and Theoretical Contributions

As rapid expansion of the Alberta tar sands is a central part of the twin crises of our time – climate change and peak oil (Gonick, 2008), spatial representation of their existing status and planned growth is essential so that informed and democratic choices can be made about the future. Yet neither governments nor industry have made such basic information publicly and comprehensively available. The practice of cumulative impact assessment has remained largely non-spatial and no comprehensive regional or strategic cumulative effects assessment has been conducted for the arctic natural gas and tar sands gigaproject.

Therefore, it is hypothesized that the use of virtual globe technologies such as Google Earth, which allow for seamless transitions from the global to the local and vice-versa, if populated with comprehensive and spatial data of existing, approved, and planned development might educate and empower individual users and civil society regarding the particular case of arctic natural gas and the Alberta tar sands.

Once again, the major theoretical research questions are:

1) What are people's cognitive, attitudinal, and affective responses before and after viewing very large resource extraction complexes such as the tar sands complex represented in interactive multi-scale media as described above? How are these responses associated with people's socio-demographic characteristics?

2) Can interactive, multi-scale visualisation using virtual globes affect peoples' cognitive and affective responses to very large resource extraction projects?

3) How effective are these new tools (i.e. 2D maps, static and interactive 3D visualisations) and different viewpoints (i.e. plan view, oblique, and ground-based) presented in virtual globes in meaningfully informing the general public about very large resource extraction projects? The criteria for user evaluation of usefulness of virtual globes include sense/idea of scale, accurate idea of scale, difference between existing, approved, and planned projects scenarios, proximity to sensitive features such as rivers, and ability of users to maintain orientation within the landscape.

This study breaks new ground by empirically evaluating cognitive and affective user-response to visualisations of potential landscape changes from the largest industrial complex on the planet. This study deploys new digital technologies that depict proposed industrial activities at multiple scales and from multiple viewpoints over a very large study area, integrating vector-based cartography, raster-based satellite imagery, and realistic three-dimensional visualisations. The principal technical challenge is devising ways to move seamlessly between multiple scales and viewpoints, allowing users to comprehend the implications of past, existing, and proposed infrastructure and landscape change ranging from macro-regional to site-specific scales. Google Earth (Google Corporation, 2007) appears to be well-suited as a platform for the interactive on-line delivery of satellite imagery overlaid with vector data, but its ability to incorporate realistic ground-based visualisations, for example through the use of the "Visual Nature Studio, Scene Express export module" remains untested (3D Nature LLC, n.d.).

The second, more cognitive, design challenge will be how to depict proposed industrial infrastructure and landscape change in a largely forested landscape with low topographic relief in order to effectively communicate the scale and geographic area of ecological and landscape changes caused by the tar sands/arctic natural gas gigaproject. A variety of visualisations were prepared ranging from ground-based views to oblique aerial views at varying viewpoints, tilts, and elevations. While there is some evidence showing increased user response and preference for ground-based realistic three-dimensional visualisation compared to planimetric maps among indigenous communities (Lewis & Sheppard, 2005), user response to variations in the elevation and tilt of viewpoints have not yet been tested.

This study has the potential to make significant contributions to both theory and practice of geographic information science, landscape visualisation, cumulative impact assessment, and regional planning, as it will be among the first to ask users themselves about their reactions, both positive and negative, to the application of virtual globe technologies in illuminating a massive project and major environmental issue of our time. It is hoped that this knowledge will help guide future projects to more effectively communicate geographic, landscape, and environmental information in the digital age.

In Chapter 2, the conceptual and practical background is reviewed in the fields of cumulative impact assessment, geographical information science and regional planning, and landscape visualisation and imagery.

In Chapter 3, the mapping and landscape visualisation methods that were used to prepare the Google Earth project are described.

In Chapter 4, the social research methods used are explained.

In Chapter 5, the social research results are presented using descriptive statistics.

In Chapter 6, the quantitative social research results are analysed by calculating the statistical significance of:

1) User responses to the tar sands projects before and after viewing;
2) Believability of maps and visualisations;
3) Correlations among user characteristics and their responses; and
4) Frequency of screenshots taken by users according to viewpoints and topics.

In Chapter 7, the qualitative social research results are analysed by grouping comments into thematic categories and sub-categories.

In Chapter 8, the study conclusions are discussed.

CHAPTER 2: CONCEPTUAL AND PRACTICAL BACKGROUND

Having introduced the issues raised with respect to the tar sands "gigaproject", including the lack of adequate cumulative effects assessment, the limited availability of integrated and detailed maps, and the potential of using landscape visualisation and virtual globes to improve communication and public understanding, in this chapter the conceptual and practical issues are focussed on three topic areas:

1) Cumulative Effects Assessment;
2) Geographic Information Science and Regional Planning; and
3) Landscape Visualisation and Virtual Globes.

Based on the following rationale, other related topic areas such as cartographic design, environmental communications, and human-computer interaction are addressed but not discussed in detail. Cartographic design theory concerns itself almost entirely with the design of semiotic (i.e. symbolic) maps (Bertin, 2011; MacEachren, 1995), whereas this study focusses on how realistic 2D maps and 3D landscape visualisations can be integrated into interactive virtual globes. Environmental communications theory concerns itself almost entirely with text (International Environmental Communications Association, 2013) and the few studies dealing with environmental or landscape imagery are almost all non-empirical. Human-computer interaction theory is concerned primarily with evaluating the use of specific software functions (Tversky & Morrison, 2002), while this study is focussed on participants' use and perception of the contents of the virtual globe application (i.e. the tar sands open pit mines and associated pipelines) rather than the usability of Google Earth software itself.

In addition, the field of landscape visualisation is a small and mostly technical field where there is limited theory that has so far been largely outstripped by technology (Lange, 2011; Sheppard, 2005; Sheppard, 2001). Due to the limited number of actual user evaluation studies with the fields of cartography and landscape visualisation, this study takes a strongly empirical approach guided by the conceptual and practical framework of the three core topic areas.

2.1. Cumulative Effects Assessment

In the United States, the requirement to assess the cumulative effects of a project date back to the 1969 National Environmental Policy Act where the regulations promulgated by the Council on Environmental Quality define a cumulative effect as (MacDonald, 2000):

> the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 C.F.R. 1508.7)

In Canada, cumulative effects assessment did not become mandatory under federal law until the implementation of the Canadian Environmental Assessment Act in 1995, which required cumulative effects to be considered in addition to direct project effects (Government of Canada, 2003):

> **16.** (1) Every screening or comprehensive study of a project and every mediation or assessment by a review panel shall include a consideration of the following factors:
>
> (*a*) the environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out

Faced with two major court challenges related to the cumulative effects of logging (Sunpine) and coal mining (Cheviot) (Duinker & Greig, 2006), the Canadian Environmental Assessment Agency (CEAA) sought to clarify what was meant by "projects that….will be carried out" by issuing an Operational Policy Statement (Canadian Environmental Assessment Agency, 1999):

> …the Act refers to the consideration of "any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that ... will be carried out". Accordingly, in identifying future projects to include in the CEA [Cumulative Effects Assessment], RAs [Responsible Authorities] should consider projects that are "certain" and "reasonably foreseeable", as recommended by the Guide. The Act does not require consideration of hypothetical projects**,** but RAs may chose to do so at their discretion. Information concerning the cumulative effects of the project under assessment combined with hypothetical projects may contribute to future environmental planning. However, it should not be the determining factor in the environmental assessment decision under the Act.

The Operational Policy Statement further defined "certain", "reasonably foreseeable", and "hypothetical" as (Canadian Environmental Assessment Agency, 1999):

- Certain:
  - The action will proceed or there is a high probability the action will proceed.
- Reasonably Foreseeable:
  - The action may proceed, but there is some uncertainty about this conclusion.
- Hypothetical:
  - There is considerable uncertainty whether the action will ever proceed.
  - Conjectural based on currently available information.

Despite the clarification provided, since then Canadian cumulative effects assessment has been described as "impotent" due to the following reasons (Duinker & Greig, 2006):

1) application of CEA [cumulative effects assessment] in project-level environmental assessments [rather than in regional or strategic environmental assessments]
2) an EIA [environmental impact assessment] focus on project approval instead of environmental sustainability
3) general lack of understanding of ecological impact thresholds
4) separation of cumulative effects from project-specific impacts
5) weak interpretation of cumulative effects by practitioners and analysts
6) inappropriate handling of potential future developments

As a solution, Duinker and Greig (2006, p.159) propose that the primary application of cumulative effects assessment "…really should be in the realm of regional environmental assessments (REA's) or regional environmental effects frameworks (REEF's)."[11] For example, a regional effects assessment was conducted for the Beaufort Sea over twenty years ago in 1984 (Duinker & Greig, 2006). While these are not cumulative effects assessments *per se*, "Integrated Management Initiatives" that include considerations of offshore energy development are also underway in the Beaufort Sea and the Eastern Scotia Shelf under Canada's Oceans Strategy spearheaded by the federal Department of Fisheries and Oceans (Canada Department of Fisheries and Oceans, 2005). More concretely as a matter of policy direction from government, the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) now requires strategic environmental assessments that consider potential cumulative effects *prior* to issuing a call for bids to lease any new offshore areas for exploration. To date, three such strategic environmental assessments have now been completed (Canada-Nova Scotia Offshore Petroleum Board, 2005). In Alberta and the Northwest Territories, no such assessments have yet been conducted as part of the oil and gas leasing process (Holroyd, Dyer, & Woynillowicz, 2007).

While environmental organizations may dispute the conclusions (Northern Alaska Environment Center, 2006), the U.S. federal Bureau of Land Management also routinely prepares environmental impact statements that include consideration of cumulative effects prior to leasing public lands for arctic oil and gas development (United States Bureau of Land Management, 2006) as well as for oil shale and tar sands in Colorado, Utah, and Wyoming (United States Bureau of Land Management, 2012). Norway is conducting regional/strategic environmental assessments "to determine where offshore hydrocarbon activity can be permitted without threatening its fishing industry or biodiversity." (Leaton & Grant-Suttie, 2005).

In developing and post-communist countries, no oil and gas projects have been subject to strategic environmental assessment, despite the policies of the World Bank and the European Bank for Reconstruction and Development (EBRD) that require strategic environmental assessment prior to the financing of extractive industries (Leaton & Grant-Suttie, 2005). Furthermore, a review of the state of the art of environmental impact assessment for oil and gas pipelines concluded that none of the environmental impact assessments in ten case studies from Africa, South America, or Asia included a cumulative effects assessment for these projects (Goodland, 2005).

Regardless of the legal or institutional issues, the question still remains *how* to conduct a practical strategic, regional, and/or cumulative environmental assessment. Holistic systems analysis has long been advocated as a viable approach to cumulative effects assessment (Dube, 2003; Smit & Spaling, 1995; Odum, 1982). Despite their disappointment with the track record of cumulative effects assessment in Canada, Duinker and Greig (2006, p.157) continue to advocate a systems analysis approach:

[11] REA's or REEF's overlap with "Strategic Environmental Assessment", which the Canadian Environmental Assessment Agency defines as: "..reviewing policy, plan and program proposals to incorporate environmental considerations into the development of public policies."

> For us, the missing factor is incisive impact-oriented systems analysis of the kind long advocated under the aegis of adaptive environmental assessment and management (Holling 1978). In other words, if each EIA practitioner were competent to undertake explicit, quantitative systems analysis of the interactions between specific proposed developments and specific VECs [Valued Ecosystem Components], then cumulative effects would not be vexing at all, and strong CEA [Cumulative Effects Assessment] practice would prevail.

However, practical examples of such approaches are few and far between, especially for the oil and gas sector. Moreover, they are usually unrelated to actual legally mandated or institutional cumulative effects assessment processes and/or have been carried out *ex post facto*, only after projects have actually been constructed. With regard to oil and gas, the American National Research Council carried out the most comprehensive and detailed cumulative effects assessment for the petroleum complex in the Alaska North Slope developed since 1968 (National Research Council, 2003), which included the cumulative impacts of the Alaska North slope oil field complex on caribou herds (Nelleman & Cameron, 1998). Using the non-spatial landscape stratification model “A Landscape Cumulative Effects Simulator” (ALCES), the cumulative impacts of existing and future oil/gas and forestry development were modeled in Alberta-Pacific’s Forest Management Agreement area in north-eastern Alberta (Schneider, Stelfox, Boutin, & Wase, 2003). The Wilderness Society assessed the cumulative impacts of an existing gas field in Wyoming using a density analysis of fragmentation and an ecological disturbance buffer analysis (Weller, Thompson, Morton, & Aplet, 2002). Finally, a reconnaissance level GIS analysis of historical and current cumulative effects of oil/gas, forestry, and recreation in the southern east slopes of the Rocky Mountains in Alberta was conducted in a report commissioned by Morrison Petroleum Ltd. (Sawyer et al., 1998).

Other modeling of cumulative effects has focused on forestry, mining, and urban development. Existing cumulative effects of forestry operations have been analyzed using GIS and remote sensing techniques in the San Juan Mountains of Colorado (McGarigal, Romme, Crist, & Roworth, 2001) while a predictive modeling approach also using GIS and remote sensing has been applied in the Foothills Model Forest of Alberta (Huettmann, Franklin, & Stenhouse, 2005). In the Northwest Territories central arctic region, population viability models were used to predict the cumulative impacts of additional diamond mining on caribou, grizzly bear, wolverine, and wolves, but only after two diamond mines had already been constructed, two other diamond mines approved, and a fifth diamond mine proposed (Johnson et al., 2005). In Summit County, Colorado, the cumulative impacts of urban development on wildlife habitat were modeled using a simple GIS and disturbance zone model (Theobald, Miller, & Hobbs, 1997). Finally, experiments have been conducted with “self-organizing” maps using principal components analysis to understand existing cumulative effects within the mid-Atlantic region of the United States (Tran, Knight, O’Neill, Smith, & O’Connell, 2003). Overall, regional mapping and scenario analysis is advocated for effective cumulative effects assessment as the basis for making societal choices about the future (Hegmann & Yarranton, 2011). However, almost all the methodological literature about cumulative effects assessment is focussed on biophysical rather than socio-economic effects.

While modeling and scenario analysis is desirable in the long-term, in the meantime there are no comprehensive maps, much less realistic three-dimensional landscape visualisations, showing the cumulative physical footprint of the existing, approved, or planned tar sands/arctic natural gas gigaproject readily available to the public. Therefore, communicating the physical footprint and scale of industrial activities where the natural land-cover is eliminated may be an important first step in motivating public support for a more comprehensive cumulative effects assessment.

2.2. Geographical Information Science and Regional Planning

The theory and practice of regional geography and planning stem from a positivist, humanist, and radically democratic tradition propounded in France and Britain at the turn of the 20th Century by geographer Elisée Reclus and town-planner Patrick Geddes (Steele, 2003; Chabard, 2001; Matless, 1992). In turn, both Reclus and Geddes inspired the inter-war regional planning and conservation work of theorists and practitioners such as Lewis Mumford (Luccarelli, 1995) and Benton Mackaye (MacKaye, 1940) under the auspices of the "New Deal" in the United States. In the 1960's, Ian McHarg formalized the application of the "overlay method" for impact assessment and regional planning (Steiner, 2000; McHarg, 1969), which soon became computerized with the advent of Geographic Information Systems (GIS) (Ndubisi, 2002).

In Canada, most regional planning is undertaken within metropolitan areas (Hodge & Gordon, D., 2008). Since the 1980's, large-area regional planning began to be carried out in the resource hinterlands of western and northern Canada (Dunster, 1988; Fenge & Rees, 1987). Despite over twenty-five years of effort, only a handful of regional plans have been completed for parts of the Yukon, Northwest Territories, and Nunavut (Berger, Kennett, & King, 2010). In contrast, twenty-five (25) "Strategic Land and Resource Plans" have been completed for most of British Columbia since the 1990's (Government of British Columbia, n.d.). In Saskatchewan, there are also ten (10) forestry-based regional plans covering parts of the province that have been completed or are underway (Government of Saskatchewan, 2013).

In 2008, the government of Alberta established a "Land-use Framework" to conduct regional planning within seven large regions with an average size of 96,654 km^2 encompassing the whole province ; Alberta Environment and Sustainable Resource Development, 2008). The "Lower Athabasca" region (93,258 km^2), which includes the open pit tar sands north of Fort McMurray as well as *in-situ* tar sands elsewhere in the region, was the first plan to be completed and approved in September 2012 (Alberta Environment and Sustainable Resource Development, 2012). The "Lower Athabasca Regional Plan" established six new conservation areas, increasing the size of conserved land to 22% of the region. However, these conservation areas are concentrated in the northern part of the region, along the Northwest Territories border. Also, all the conservation areas are outside the tar sands development area and concentrated in the northern part of the region. The "Lower Athabasca Regional Plan" also set cumulative effects limits for air and surface water quality and set up a regional groundwater management framework with interim limits. However, cumulative effects limits for surface disturbance, tailings management, and surface water quality remain to be established. The plan was not developed in a transparent manner and there is no evidence of any systematic methodologies being used and no cumulative assessment of tar sands development (Cizek, 2011).

As GIS became pervasive in the 1990's and widely applied by the military-industrial complex (Klinkenberg, 2007), the social implications of GIS became widely criticized for, especially by post-modern cultural theorists for the ways it further sustained the powerful and marginalized the powerless (Pickles, 1995). Indeed, some post-modern cultural theorists criticize the very foundations of cartography, stating that the "Apollonian" elevated view of the earth is part of the domineering master narrative in the service of imperialism, which reached its apogee with the Apollo 17 photographs of the whole earth (Cosgrove, 1994). Other post-modern cultural critiques are leveled at the use of Radarsat satellite imagery in tracking the disintegration of the Larsen B ice-shelf in Antarctica due to global warming, claiming the satellite imagery "anaesthetizes the event through distance and trivializes it as a mere media spectacle" (Yusoff, 2005). The theme of distance in cartography is further expanded by relating Foucault's panoptic discourse to de Certeau's "Practice of Everyday Life" and suggesting that walking in the city at ground level is the only means of "transgressing the boundaries imposed by totalizing systems" (Reynolds & Fitzpatrick, 1999).

In contrast, Goodchild anticipates an optimistic "Second Age of Geographic Discovery" where GIS and Digital Earth will enable unmediated personal discovery of new geographic knowledge (Goodchild, 2000; 1998). Since the early 1990's, GIS has become widely applied by grassroots groups in community-based activism (Sieber, 2000) and is now becoming more widely disseminated under the rubric of "Public Participation GIS" (PPGIS) (Sieber, 2006). The modification of on-line maps by non-professionals through "mash-ups" or "hacks" (Klinkenberg, 2007) has resulted in the coining of a new word – neogeography (Goodchild, 2009).

It has been noted that virtual globes such as Google Earth have limited spatial analysis functions compared to costly professional-level GIS software (Goodchild, 2008). However, the ability of virtual globes such as Google Earth to combine data from a wide variety of sources and overlaying the layers to show the cumulative effects of individual projects may be a significant and empowering feature for the public. Until recently, this task could only be accomplished by skilled technicians using costly professional-level software.

2.3. Landscape Visualisation and Virtual Globes

It has been proposed that the use of three-dimensional landscape visualisation in virtual globes crosses new thresholds "in communicating scientific and environmental information, taking it well beyond the realm of conventional spatial data and geographic information science, and engaging more complex dimensions of human perception and aesthetic preference" (Sheppard & Cizek, 2009).

While realistic three-dimensional landscape visualisation has been widely applied to forestry (Sheppard & Meitner, 2005; Seely et al., 2004), agriculture (Bishop, Hull IV, & Stock, 2005; Tress & Tress, 2003), and urban development (Al-Kodmany, 2002), application to the mining and petroleum sectors has been far more limited.

Three-dimensional visualisation techniques are widely used by geologists and mining engineers for examining sub-surface mineral and petroleum deposits. In the tar sands, a virtual reality visualisation system was developed to conduct remote-controlled excavation (Boulanger, Lapointe, & Wong, 2000). Tar sands developers are using "Visual Nature Studio" software as part of "visual resource management" (Fairhurst, 2003) to depict site-specific and ground level impacts of individual mining projects such as the approved Muskeg River Mine Expansion (Albian Sands Energy Inc., 2005) and the Jackpine Mine Expansion (Shell Canada Ltd., 2007).

There are few documented digital visualisation studies related to the surface landscape impacts of mining projects. One was conducted for the Rosia Montana open pit gold mine in Romania (Barton, Bodis, & Geczi, 2005), a second for an open pit coal mine near Berlin, Germany (Buhmann, 2002), and a third for open pit coal mining in Pennsylvania (Hill, 2004). However, these studies simply overlaid satellite imagery or aerial photography over digital elevation models and thus did not produce realistic three-dimensional visualisations. There are only two known published studies of realistic landscape visualisation of open-pit mining projects (Ellsworth, Medina, & Hammud, 2005; Sheppard & Tetherow, 1983). Other sample images of realistic landscape visualisations of petroleum development and open pit mining, including some for the Alberta tar sands, have been provided on-line as part of the Visual Nature Studio featured artist gallery (Graham, 2006). When additional landscape visualisations of the Alberta tar sands were requested, the consultant (Golder Associates Ltd.) was not able to provide any more due to confidentiality restrictions with the tar sands developer clients.

In the petroleum sector, Sheppard (2013) conducted several site-specific visualisations for the oil and gas sector using a combination of analog and digital photo-montage techniques based on digital elevation models. There are probably many specific visual impact assessments of petroleum projects across North America, but never collated or documented in peer-reviewed journals. Other three-dimensional visualisations for the oil and gas sector are known to be available showing future development footprints on Landsat7 satellite imagery overlaid on digital elevation models, primarily in the western United States, again with limited realism (Skytruth, n.d.).

Therefore, this may be the first study to apply 3D modelling and realistic landscape visualisation to the petroleum sector as well as to open pit mining for bitumen over an extremely large area. The tar sands development area is estimated at 140,022 square kilometers (Alberta Department of Energy, 2013) while the natural gas development areas in the Northwest Territories and Yukon are estimated at a total of 286,496 square kilometers (Cizek, 2005), not including Alaska. Thus, the total size of the proposed study area is estimated at over 400,000 square kilometres. In comparison, the largest known study areas where realistic three-dimensional landscape visualisation has thus far been conducted are a 2,880 square kilometre forest in north-eastern British Columbia (Seely et al., 2004) and a 400 square kilometer landscape unit in the Arrow Forest District in south-eastern British Columbia (Sheppard & Meitner, 2005).

The total size of the proposed study area at over 400,000 square kilometres presents unique challenges and opportunities that will enable a better understanding of the interplay between cartographic representation and realistic three-dimensional visualisation. In theory, cartographic techniques can represent infinitely large geographic areas, but only with increased levels of symbolic abstraction and generalization (MacEachren, 1995). Furthermore, the tacit foundation of cartography is the imaginary position of an observer in an elevated vertical viewpoint hovering above the earth (Cosgrove, 2001).

In contrast, the starting point of realistic three-dimensional visualisation is to accurately simulate the actual view from the perspective of an observer positioned usually on the ground

(Sheppard, 1989). However, the geographic scope of a ground-based observer's view is determined and limited by the topography and land-cover (i.e. vegetation and buildings) of the surrounding landscape and the observer's position within that landscape. Simply put, an observer located on a hilltop or mountain peak sees a greater geographic area than an observer located in a valley or in a flat landscape. Similarly, a ground-based observer in a closed (i.e. forested or built-up) landscape will see a smaller geographic area than an observer in an open (i.e. barren, tundra, prairie, or agricultural) landscape (Unwin, 1975).

The evolving use of an imaginary elevated oblique viewpoint (i.e. "bird's eye view") as a means of increasing the geographic scope and "gestalt" of the observer's view is historically related to the cultural transformation from a mediaeval flat-earth geocentric cosmography to a modern round-earth heliocentric cosmography (Rees, 1980). With the invention of linear perspective in the Renaissance, landscape artists began to accurately depict landscapes as seen from towers or hilltops. As mathematical sophistication increased, artists then began to accurately depict landscapes from an imaginary "bird's eye view," long before the invention of human flight. In the nineteenth century, balloon flight coupled with aerial photography, led to wide popularization of the "bird's eye view" in landscape art, including immersive panoramic dioramas and stereoscopes (Dubbini, 2002).

In North America, panoramic "bird's-eye views" of growing nineteenth century cities were widely used, primarily as commercial promotional devices (Library of Congress, 1998). At the turn of the century, the Scottish town-planner, Patrick Geddes, used the "Outlook Tower" as an educational device, which immersed visitors in historical landscape panoramas as they climbed the stairs leading to a "camera obscura" and a panoramic view of Edinburgh at the top (Chabard, 2001); Matless, 1992) .

J.B. Jackson stressed his fascination in first viewing the landscape from the air in 1920's, when "fewer than eight thousand people per year were bold enough to go out to a grass field and entrust themselves to a one-propeller plane flown by a young pilot wearing goggles" (Jackson, 1994). At the same time, the airplane-based landscape view became the core of Italian Futurism and synonymous with modernity. Starting in the 1930's, the Los Angeles newspaper illustrator Charles Owen used oblique aerial drawings combined with maps to great popular effect in depictions of proposed large-scale infrastructure in southern California, early scenic auto-touring routes, as well as battles during World War II (Cosgrove, 2005).

There is also a long European-influenced tradition of "bird's-eye view" cartography/landscape art, especially in mountain regions intended for tourism promotion (Z-Point Graphics, n.d.a) The foremost exponent of this style, Heinrich Berann of Austria, produced 566 such images between 1934 and 1999 (Troyer, n.d.), including several works for the U.S. National Parks Service (Patterson, 2000). This tradition is continued by the émigré Czech cartographer Milos Drtina based in Saskatchewan (L. Hughes, 2004) and graphic designer Eckhard Zeidler based in Whistler, British Columbia (Z-Point Graphics, n.d.b), who sell their own work as prints and wall-posters.

Since the first international survey of oblique aerial photography (Gutkind, 1952), ongoing public fascination with the oblique "bird's eye view" is evident in the publication of dozens of

"From the Air" coffee-table books, covering major cities and regions across the world (Stonehouse, 1982). There is now even an air traveler's guide-book series called "Window Seat: Reading the Landscape from the Air" (Dicum, 2004). The French oblique aerial photographer, Yann Arthus-Bertrand has applied this style of photography to environmental education and advocacy through public exhibits and school curricula (Arthus-Bertrand, n.d.).

In the context of urban architecture, the following propositions have been suggested regarding the perceptual effects of the oblique aerial view (Schwartzer, 2004):

- Because oblique perception encompasses building height and mass, streets and low-lying areas are usually obscured by taller buildings.
- Structures in the foreground are prominent; buildings towards the background look smaller and smaller.
- Because of the scale change, comparative measurements of buildings are difficult to calculate.
- While the dimension of height is compressed in the bird's eye view, we often see far greater lengths of cityscape, than we see on the ground.
- The bird's-eye view allows us to observe a greater scale in the depth dimension – to see things behind things, features obscured to travelers on the ground, because they are blocked by intervening buildings.
- In aerial distance there thus emerges a radical reorientation of the senses and a relationship to the land. Oblique aerial perception positions us in a distanced and sometimes dominating relationship to what lies below.

The elevated landscape view reached its zenith in 1972 with the widely reproduced photographs of the whole earth floating in space taken from Apollo 17, which allegedly played a major cultural and cognitive role in spawning the contemporary environmental movement (Cosgrove, 1994; Goldberg, 1991). In the same year, the launch of Landsat, the world's first public remote sensing satellite, eventually led to the recent free public availability of a 30+ year time series of world-wide moderate resolution satellite imagery in plan-view (≥14.25 metre pixel) (Tucker, Grant, & Dykstra, 2004), downloadable through the Internet from the Global Land Cover Facility (University of Maryland, n.d.).

These data, as well as some higher resolution imagery (≥0.6 metre pixel) are now publicly viewable on-line using three-dimensional digital globes such as Google Earth (Google Corporation, 2007), World Wind (National Aeronautics and Space Administration, 2006), and ArcGIS Explorer (Environmental Systems Research Institute, 2006). Google Corporation's announcement that over 1 billion copies of Google Earth had been downloaded and installed (Google Corporation, 2011), indicates the mass scale of public interest in viewing such imagery. This mass popularity of Google Earth has been attributed to "emotionally centered design" enabled by "Rich Internet Applications" that allow fluid and dynamic displays while the user zooms in and out or moves across a landscape (Norman, 2006).

However, the cultural or cognitive implications of user-response to satellite imagery have hardly been explored (Jiang, 2003). While conventional cartography is inherently semiotic (i.e. symbolic) (MacEachren, 1995), satellite imagery can be realistic, especially at very high levels of resolution (i.e. ≤1.0 metre pixel). It has been speculated that recent widespread availability of such imagery through Google Earth may be allowing the public to better understand their environment (cognition) and may be provoking emotional (affective) response as the public sees realistic imagery of widespread landscape disruption, especially in three-dimensional topographies (Jones, 2007).

Indeed, the United Nations Environment Programme's satellite imagery atlas "One Planet, Many People", which features side-by-side "multiples" (Tufte, 1990) as diptychs or triptychs of changes to land-cover through time, is explicitly intended "…for sensitizing policy makers, non-governmental organizations, the private sector, and provide one-stop-shopping resources on global change to academics, teachers and citizens" (United Nations Environment Programme, 2005). As well, the National Aeronautics and Space Administration's (NASA) Scientific Visualisation Studio has created over 2,700 visualisations using satellite imagery dealing with topics such as climate change, tropical storms, and land-cover change with the aim "to promote a greater understanding of Earth and Space Science research activities at Goddard Space Flight Center and within the NASA research community" (National Aeronautics and Space Administration, n.d.).

Despite such widespread historical and contemporary interest in the use of visualisation as a communications medium, there is little empirical evidence demonstrating its effectiveness in influencing public understanding (cognition), emotional response (affect), or actual behaviour with respect to environmental issues such as land-cover change or global warming (Lange, 2011; Sheppard, 2005). It is popularly accepted that "seeing is believing" or that "a picture is worth a thousand words" (Burkhard, 2004). There is some empirical evidence about the usefulness of visual literacy in education using controlled studies (SEG Research, 2009; Stokes, 2002). However, these propositions have seldom been tested regarding viewer response to actual environmental issues. While controlled studies may be desirable in the future, few exploratory studies with actual users have been conducted.

Google Earth has developed an "Outreach Showcase" of geographic data. These data are generated primarily by civil society and feature topics spanning (Google Corporation, n.d.a):

1) Current affairs, public safety and disaster relief;
2) Education, culture, arts and the humanities;
3) Education & Culture;
4) Environment & Science;
5) Global development;
6) Public Health; and
7) Social Services.

Notable early "Global Awareness" projects created using Google Earth (Moore, 2007) included:

1) United States Holocaust Museum: Crisis in Darfur;
2) United Nations Environment Programmme: Atlas of Our Changing Environment;
3) Jane Goodall Institute: Gombe Chimpanzee Blog;
4) Appalachian Voices: Mountain Top Removal Coal Mining; and
5) Neighbors Against Irresponsible Logging: Community Action in the Santa Cruz Mountains.

Since then, over a dozen "success stories" have been added to this list (Google Corporation, n.d.a), However, there are no publicly available user evaluation studies for these projects.

Sheppard and Cizek (2009) suggest the following key benefits of using virtual globes to present landscape visualisations:

1) Access to visual information – Open free access for all Internet users with high-speed connections and reasonably up-to-date computers;

2) Interest – More meaningful and enjoyable engagement in viewing or manipulating information, plus increased interest with viewing familiar locations; and

3) Representativeness – Freedom to view places or features from any angle or height, and from any number of views[12], instead of the more conventional limited selection of static views determined by the creator of the visualisations.

However, Sheppard and Cizek (2009) also caution about the following risks:

1) Emotional meanings (valid or invalid) may overwhelm valid cognitive responses;

2) Low data resolution in low-elevation or on-the ground visualisations affecting clarity, accuracy, and perceived realism;

3) Mismatch of screen size and image resolution;

4) Unsettling mis-matches (inaccuracies) between 3D forms and draped satellite or orthophotographic imagery; and

5) Visualisation inaccuracy, unrepresentativeness, poor clarity, low credibility, and biased responses.

As of June 2013, ISI Web of Science (Thomson Reuters, n.d.) listed 708 academic articles published about Google Earth software. However, only nine academic papers that include user evaluations of virtual globes or Google Earth were found, as summarized below:

1) Bleisch and Dykes (2006) evaluated the use of “Genova AG” 3D visualisation software with 99 hikers for planning hikes in Switzerland. They found that most hikers preferred 3D visualisation over 2D maps for “getting an overview or an impression of an unknown region”, “virtually revisiting a known region”, and for “helping with the decision as to whether to visit the region for hiking.” Where information could not be extracted directly from the 3D visualisation, “tasks like estimating the length of a hike section or finding the steepest section of the hike were rarely solved satisfactorily in the 3D visualization.” (Bleisch & Dykes, 2006, p. 6). For selecting specific routes, most hikers said that they preferred a 2D map. Most hikers suggested that additional “abstract height, time and/or distance information in forms such as labels, contour lines, reference grids or measuring tools” be added to the 3D visualisation software to support specific tasks.

2) Clough & Read (2008) evaluated the use of “Panoramio” image browsing software (Google Maps, n.d.) that geo-references photographic images in Google Earth as well as two other prototype image browsers with 10 students in library and information science.

[12] The original text states “except absolute ground-based as the lowest viewing height is often about 20 m”. Since the article was submitted in 2006, Google Earth software has been updated to allow ground-based viewing.

They found that most users of Panoramio prefer “searching places visited in real life”, “expressed the belief that local knowledge is needed to search effectively”, and had a “tendency to browse pics not directly relevant to the task at hand”. The most common Panoramio functionality issued were “time lag before Panoramio thumbnails appear”, “not a big enough selection of pics available”, and “zoomed in on remote area (or body of water) and no pics available”. The most common issue for the two prototype image browsers were “lack of text/numeric options for selecting dates.”

3) Schoning et al., (2008) surveyed 120 participants randomly selected in a pedestrian area in Munster, Germany. More participants were aware of 2D digital maps than 3D virtual globes. More participants used 2D digital maps more frequently than 3D virtual globes. 2D digital maps were used most frequently for “navigation” and “finding a business”. 3D virtual globes were used most frequently for “looking at my house” and “looking at other individual places”.

4) Schroth, Pond, Muir-Owen, Campbell, and Sheppard (2009) asked 38 open house participants at community workshops about local impacts of climate change in Kimberly, British Columbia to rank the importance of posters, virtual globe (Google Earth), presentation, and 2D maps. The virtual globe “was ranked first 16 times and ranked last 11 times, showing a bimodal distribution.” Overall, both the mean and median ranking of 2D maps was higher than of virtual globes. It was suggested “although a virtual globe was favoured by a large proportion of respondents, an additional presentation form is needed to meet the learning styles of all respondents. In comparison, the average ranking of the posters was very good, making them a suitable complement to the virtual globe.” (Schroth et al., 2009). This study also documented how a Google Earth animation of a fire spread model had the most emotional impact on workshop participants.

5) Bos (2010) developed a 3D zoning plan in Google Earth for Groenigen, Netherlands and surveyed 28 users out of which five were from the department of geo-information of the municipality of Groenigen and the rest were “randomly picked”. Most participants thought navigating Google Earth was user-friendly but that the legend was unclear. Most participants though that 3D zoning plan was useful and easier to interpret than the 2D zoning plan. User suggestions included adding photos on existing buildings, adding shadows, and being able to measure heights.

6) Van Lammeren, Houtkamp, Colijn, Hilferink, & Bouwman (2010) compared the use of coloured raster cells, 2D icons, and 3D icons in Google Earth depicting current future land use in the Netherlands with 45 participants who either were master’s students in human geography and planning or employees of the Netherlands Environmental Assessment Agency. Most users thought the Google Earth application was easy to learn, functionalities easy to use, and information was deemed reliable. Most users thought that future land use was considered more beautiful with 3D icons than with 2D icons or raster cells. The researchers found 3D-icon visualisation “elicited the highest affective appraisals and positively influenced perception of the environmental quality”. However they also found that “2D icons and 3D icons, compared with coloured raster cells, did not

improve the efficiency or accuracy of participants in the experiment." (van Lammeren et al., 2010)

7) Pettit, Raymond, Bryan, & Lewis (2011) assessed strengths and weaknesses of the "Lower Murray Landscape Futures" integrated modelling and analysis project in Southern Australia displayed in Google Earth software using both 2D maps and 3D visualisations with 12 current users (government scientists and officials) and 89 future users (students in spatial information sciences). The strengths most frequently mentioned by current users were accessibility, planning and investment, and learning concepts. The weaknesses most frequently mentioned by current users were "lack of explanation about model assumptions, limitations, the methods used for map interpretation, and the lack of promotion of the landscape visualisation products to different users." (Pettit et al., 2011) Future users "appreciated the website functionality, particularly the way in which information was presented on the screen, the amount of information available on the publications page, and the potential use of the visualisation products as a planning and management tool."(Pettit et al., 2011) The weaknesses most frequently mentioned by future users were "visual clarity, communication, and presentation elements; particularly the size of text, the detail in the colour maps, the pixelation of the landscape visualisation products, lack of communication about the intended audience of the visualisation products, and the amount of technical information on the home page." (Pettit et al., 2011)

8) Stocker, Burke, Kennedy, & Wood (2012) tested a participatory mapping methodology using Google earth to develop climate change adaptation strategies for Rottnest Island, off the West Australian Coast with "around 50" participants The study concluded that "the Google Earth mapping activities were also popular as a workshop process: different stages interested different participants…it also underscores what is known well in educational theory, which is that people learn in different ways. It is thus important to have visual, aural and interactive dimensions in a workshop where a range of learning styles is likely to be present." (Stocker et al., 2012).

9) Bishop, Pettit, Sheth, and Sharma (2013) evaluated a Google Earth visualisation related to climate change in Victoria, south-western Australia, with 26 rural extension workers and research scientists. After viewing the visualisation, concerns about climate change increased slightly. Answers to questions about finding information on climate change such as finding the place with the lowest temperature, identification of climate change projections at a specific location, search for a silage pit, and degree of inundation were overall 77% correct. During "free exploration" where "participants could explore the whole region of a self-selected subregion" (Bishop et al., 2013) most participants selected a specific location while eight chose to look at the whole region. All visualisations such as animated mapping, array of point data, pasture-yield projection hyperlink, "where is my farm", photorealistic flyover and panoramas, and inundation simulations were found to be helpful. Participants also stated (Bishop et al., 2013):

    1) Scenarios should be available side-by-side (rather than sequentially) to make comparisons easier;
    2) Maps (including GE-based mapping) need more reference points in the form of towns and roads;
    3) More access to underlying data layers might aid interpretation (eg, soils); and
    4) More contextual information should accompany the pictures.

While few empirical studies have been conducted, there has been much cultural theorizing about the use of mass media in environmental campaigns such as Greenpeace's original and later widely-copied use of dramatic television imagery based on Bob Hunter's concept of the "mind bomb" (Weyler, 2011; Hunter, 1971), a mass-media image event "that explodes into the public consciousness that transforms the way people see their world" (Delicath & Deluca, 2003). Despite widespread use of photography, film, and video by environmental advocacy organizations (Dunaway, 2005), visual media have received surprisingly little attention in the emerging field of environmental communications. None of the 963 journal articles that were published between the years 1945 and 2001 contain key-words related to imagery, photography, film, or visualisation (Pleasant, Good, Shanahan, & Cohen, 2002). The web-site of the scholarly International Environmental Communications Association is almost entirely devoted to the study of linguistic rhetoric (International Environmental Communications Association, 2013). The few available studies concerning visual environmental communication use an analytical framework based on post-modern cultural theory rather than empirical psychology (Seppanen & Vallevironnen, 2003; Scott, 2003; Bouse, 1991; Burgess, 1990).

The limited empirical evidence about actual viewer response to visual communication concerning environmental issues indicates that imagery has little influence on changing perceptions. In a study of corporate "greenwashing," it was found that advertising texts had more influence on public attitudes than landscape photographs, while landscape photographs were found to influence politicians more than text because politicians believed that the imagery was having a significant impact on public perception (Jenner, 2005). In contrast, a study exposing undergraduate college students to two texts with no photographs arguing for and against drilling in the Arctic National Wildlife Refuge found no significant change due to evidence of "biased processing – the processing of incoming information in such a way that it confirms and protects existing beliefs and attitudes" (Teel, Bright, Manfredo, & Brooks, 2006). Finally, a content analysis of thirty-one (31) photographs used in articles about biodiversity in the London Times between 1990 and 1997 found that there were no photographs of either pristine or destroyed landscapes. Thirteen out of 31 photographs showed humans, while the overwhelming majority of the photographs showed animal species (Seppanen & Vallevironnen, 2003). This content analysis suggests that the newspaper editors may have selected photographs based on their belief or experience that emotional viewer response to images of landscapes is marginal and insignificant compared to images of animals or indeed images of other humans.

Recent studies have shown that 3D landscape visualisations can be effective at changing perception and opinion as part of community engagement processes (Sheppard, Shaw, Flanders, Burch, & Schroth, 2013; Sheppard, 2012; Cohen et al., 2012; Sheppard et al., 2011; Schroth et al., 2009). Additional research is valuable to determine if landscape visualisation can be effective on its own in meaningfully informing the public, changing public perception, possibly influencing government policy as a result.

2.4. Summary and Implications for Research Approach

As discussed above, the literature in the three topic areas points towards the following propositions:

1) Prior to conducting modelling and scenario analysis, it is desirable to produce detailed comprehensive maps and realistic three-dimensional landscape visualisations showing the cumulative physical footprint of the existing, approved, or planned tar sands/arctic natural gas gigaproject available to the public.

2) The ability of the public to select and view data from a variety of sources in virtual globes such as Google Earth, showing cumulative development of individual projects, is a significant and empowering feature of this software.

3) Having members of the public view maps and landscape visualisations of the cumulative physical footprint of the tar sands and associated pipelines interactively within a virtual globe environment may meaningfully inform the public, change public perception, and possibly influence government policy as a result.

In order to test the third proposition and address the related Research Question on **effectiveness** of new visualisation tools in **meaningfully informing** the general public about very large extraction projects, it is necessary to define how effectiveness will be assessed. Based on the above literature review (in particular Sheppard & Cizek, 2009; Sheppard, 2012; Bishop et al., 2013), the following criteria are proposed.

Being "meaningfully informed" is here taken as the first step in informing and empowering people with clear, salient, and understandable information about the physical footprint and scale of tar sands open pit mines, enabling them subsequently to formulate opinions, contribute to discourse, make decisions, and possibly influence government policy. It is accepted that this step may also engage the emotions and motivate behaviour, but these are not seen as requirements for being "meaningfully informed". In this study the most in-depth focus was on meaningfully informing the public of the scale and cumulative physical footprint of the tar sands open pit mines. While other cumulative effects such as wildlife, vegetation, air, water, and socio-economics deserve attention, within the scope of this study it is only feasible to compile the physical footprint of the tar sands as a starting point towards such a comprehensive cumulative effects assessment.

These propositions form the basis of the research design, which is described in the following two chapters. Chapter 3 "Mapping and Landscape Visualisation Methods" describes how map data and landscape visualisations of the tar sands gigaproject were created and displayed in Google Earth software. Chapter 4 "Social Research Methods" describes how exploratory research was conducted with focus groups to document in-depth quantitative and qualitative viewer responses to the maps and landscape visualisations of the tar sands gigaproject as well as participants' use of the Google Earth software.

CHAPTER 3: MAPPING AND LANDSCAPE VISUALISATION METHODS

Maps and landscape visualisations were prepared to address the following hypothesis and research questions as identified in Chapter 1 "Introduction":

> It is hypothesized that the use of virtual globe technologies such as Google Earth, which allow for seamless transitions from the global to the local and vice-versa, if populated with comprehensive and spatial data of existing, approved, and planned development, might educate and empower individual users and civil society regarding the particular case of arctic natural gas and the Alberta tar sands.

The major theoretical research questions are:

1) What are people's cognitive, attitudinal, and affective responses before and after viewing very large resource extraction complexes such as the tar sands complex represented in interactive multi-scale media as described above?

2) Can interactive, multi-scale visualisation using virtual globes affect peoples' cognitive and affective responses to existing and future development of a very large resource extraction project?

3) How effective are these new tools (i.e. 2D maps, static and interactive 3D visualisations) and different viewpoints (i.e. plan view, oblique, and ground-based) presented in virtual globes in meaningfully informing the general public about very large resource extraction projects?

This chapter describes the methods used to develop maps and landscape visualisations that can be viewed using Google Earth software at different scales and formats, including:

1) Continental Pipeline Maps;
2) Provincial Tar Sands Lease Maps;
3) Regional Maps of Tar Sands Open Pit Mines;
4) Static Landscape Visualisations of Tar Sands Open Pit Mines; and
5) Interactive Landscape Visualisations of Sample Tar Sands Open Pit Mines.

In order to be able to test public response to viewpoints of 2D maps and 3D visualisation the following maps and landscape visualisations that could be served through the internet were developed:

1) Comprehensive maps showing the cumulative physical footprint of existing and planned tar sands projects combined with natural gas fields and pipelines. Applied similar procedures to those used in previously compiled cumulative mapping and future scenario databases (e.g. Cizek (2005)), based on published official sources and available research-based modeling;

2) Semi-realistic and fully realistic 3D visualizations of site-specific infrastructure and landscape disturbance, spatially linked to the comprehensive maps, using standard visualization programs such as “Visual Nature Studio” (3D Nature LLC, n.d.) and Google Earth (Google Corporation, 2007). Visualizations were extended over time, and included a range of plan view, aerial oblique, and ground-based visualizations, in order to test effects of chosen viewpoints on comprehension. Levels of realism depended on data availability and time available, and required selective use of high realism in limited areas. Alternative display formats (viewpoint, realism level, and labeling) were produced selectively for testing effects on responses; and

3) Developed web-compatible visual packages integrating the above material with a typical Google Earth-style interface that allowed the user to interact dynamically with the visualizations (e.g. to navigate over space and select ground views, turn on/off simple information and labeling and other functions). The materials were developed with input and review from an advisory group composed of the dissertation committee and Collaborative for Advanced Landscape Planning researchers (CALP) with experience in validating similar visualization/interfaces.

The following sections describe the compilation and production of the maps and visualisations as well as the techniques use to represent and display the data

3.1. Continental Pipeline Maps

The objective was to compile a clear and legible map of pipelines at the continental scale that show the role of the tar sands in the larger system. The only publicly GIS data for continental pipelines were for the Mackenzie Gas Project (Imperial Oil, 2005) and for the existing trans-Alaska oil pipeline (University of Alaska, Fairbanks, n.d.), which has much of the same route as the proposed Alaska natural gas pipeline. However, governments and private corporations do not make GIS data for most pipelines available to the public, sometimes claiming that it cannot be released due to national security concerns (Bachand, n.d.).

As shown in Figure 16, a topological (i.e. diagrammatic) map of existing, approved, and planned oil pipelines related to the expanding production from the Alberta tar sands (Canadian Association of Petroleum Producers, 2008) was used as a base map for digitizing pipelines using ArcGIS software (Environmental Systems Research Institute, 2008).

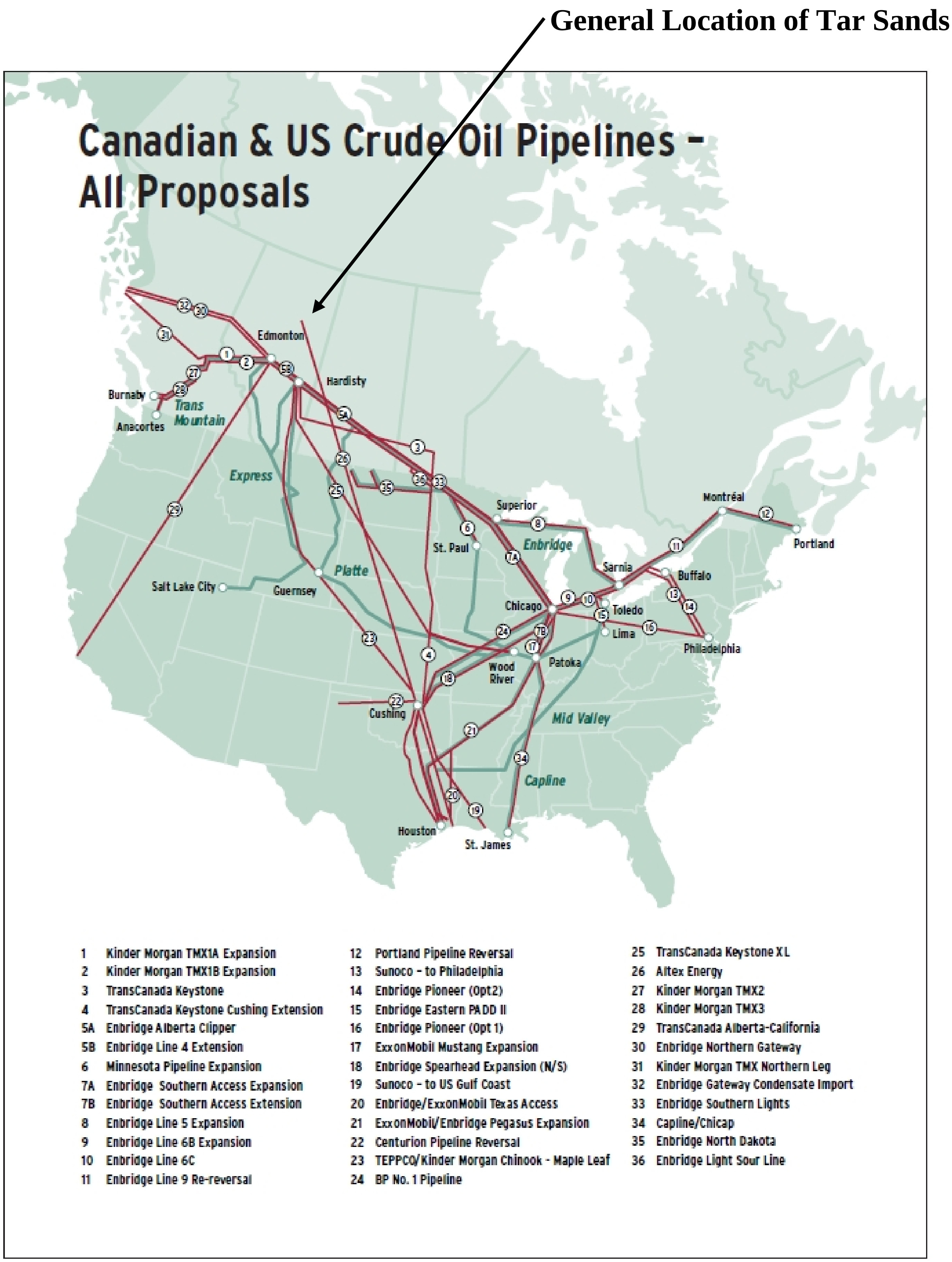


Figure 16 Canadian and US Crude Oil Pipelines All Proposals Related to Tar Sands
Source: Canadian Association of Petroleum Producers (2008)

The following procedures were carried out to assemble map data at a continental scale that could be loaded into Google Earth software. As the projection from this map is unknown and the pipelines shown are only diagrammatic, the pipelines were digitized in ArcGIS software (Environmental Systems Research Institute, 2008) by creating line segments that join up the point data for the cities, as shown in Figure 16. The publicly available GIS data for the Mackenzie Gas Project and the Trans-Alaska pipeline were added to this map. Since the Mackenzie Gas Project GIS data end at the Northwest Territories border, the “western leg” and the “north-central corridor” of TransCanada Pipelines’ NOVA gas pipeline system in Alberta were digitized based on the “Alberta Demand Growth and Location” map (Clark, 2004).

The proposed Alaska natural gas pipeline would follow the Alaska Highway through Yukon and British Columbia to Alberta and this segment was digitized in ArcGIS along the Alaska Highway. In 2006, the tar sand producer Syncrude purchased leases for natural gas discoveries in the Sverdrup basin as a hedge against natural gas prices (Syncrude, 2006). A liquefied natural gas (LNG) tanker route was digitized from the Sverdrup basin through the north-west passage to a possible LNG port feeding into the Mackenzie Gas Project at Tuktoyaktuk (Chan, Eynon, & McColl, 2005). Refineries in the United States known to have used tar sands crude oil or planning to use tar sands crude oil were digitized to point data for cities (Burnham, 2010). To highlight the Alberta tar sands and natural gas fields at the continental scale, they were shown as large asterisk symbols.

To improve legibility of the map at a continental scale, thick line data and large point symbols were used in ArcGIS. These vector data were then imported into Google Earth software (Google Corporation, 2007). However, it was discovered that Google Earth software does not clearly display thick line vector data and large point symbols at the continental scale. Instead, the ArcGIS map was exported as a GeoTiff image. This GeoTiff image was processed in Adobe Photoshop software (Adobe Corporation, 2013) to create a transparent alpha band so that the Google Earth satellite image data could be viewed underneath the line and point data. The resulting GeoTiff images were almost 100MB, so they were processed using MapTiler software (Pridal, 2008) to created tiled superoverlays that could be served efficiently through the internet using a Keyhole Markup Language (kml) “network” link.

The continental pipelines are shown in Figure 18, Figure 19, and Figure 20 for the years 2011, 2019, and 2035 for the existing, approved, and planned scenarios respectively. The dates were selected to span about twenty-five years into the future, which is the end-date of the National Energy Board’s annual forecast for all energy use in Canada (National Energy Board, 2011a). The mid-point of ~2019 was selected because the year 2020 is the end-point of the Canadian Association of Petroleum Producers annual “crude oil, markets, and pipelines” forecast (Canadian Association of Petroleum Producers, 2011). In the legend, the volume of tar sands production (synthetic crude oil and bitumen), natural gas consumption to process the tar sands, and the greenhouse gas emissions resulting from the burning of the natural gas are summarized in Table 3.

Table 3 Tar Sands Production and Pipeline Scenarios

Estimated Year and Scenario	**Estimated Tar Sands Production (Synthetic Crude Oil and Bitumen)** Canadian Association of Petroleum Producers, 2011) and (National Energy Board, 2011a)	**Estimated Natural Gas Consumption** (National Energy Board, 2006) and (Woynillowicz, Severson-Baker, & Raynolds, 2005)	**Estimated Greenhouse Gas Emissions** Calculated from factors listed in Bramley, Neabel, & Woynillowicz (2005)
2011 – Existing Pipelines	~ 1.5 million barrels per day	~ 1 billion cubic feet per day	~ 45 million tonnes per year
~ 2019 – Existing and Proposed Pipelines	~ 3.0 million barrels per day	~ 2.1 billion cubic feet per day	~ 108 million tonnes per year
~ 2035 – Existing, Proposed, and Conceptual Pipelines	~ 5.0 million barrels per day	~ 5.9 billion cubic feet per day[13]	~ 147 million tonnes per year

The three tar sands production and pipeline scenarios are shown as Google Earth screenshots in Figure 18, Figure 19, and Figure 20. Upon clicking the folder "Continental Pipelines", Google Earth is set to automatically zoom in to a vertical view at the continental scale. The three different scenarios appear by selecting one of the three round "radio" buttons labelled "Existing Pipelines", "Proposed Pipelines", and "Conceptual Pipelines". Each pipeline has a "placemark" label in a small font to avoid clutter at the continental scale. As the viewer zooms in, the "placemark" labels for the pipelines become larger and more legible.

At a continental scale, the upstream and downstream transport systems for the tar sands were represented as lines using a graphical semiotic structure (Bertin, 2011). The following symbols were used to indicate what petroleum products are transported and whether they are transported in existing, proposed, or conceptual pipelines or ocean tanker routes.

[13] Using forecasts and natural gas intensity factors from (Alberta Chamber of Resources, 2004), (Woynillowicz, Severson-Baker, & Raynolds, 2005) predict that as much as 5.9 billion cubic feet of natural gas per day would be required to produce 5 million barrels per day of bitumen and synthetic crude oil. In contrast, the National Energy Board (2011) assumes that natural gas use intensity will improve by 0.5 percent annually for open pit extraction and will improve by 1.5 percent annually for *in-situ* extraction, resulting in natural gas consumption of 3.7 billion cubic feet per day to produce 5 million barrels of tar sands oil in 2035.

To indicate greater uncertainty and a longer future time frame, lines representing future pipelines and tanker routes have lighter colour values and softer textures, as shown in Table 4, Table 5, and Table 6.

Table 4 Graphical Semiotic Structure of Oil Pipelines

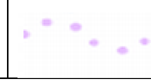
	Existing Oil Pipelines	**Expanded Capacity or Reversed Oil Pipelines**	**Proposed Oil Pipelines**	**Conceptual Oil Pipelines**
Symbol				
Retinal Variables				
Colour	Purple	Purple	Purple	Purple
Texture	Solid	Solid	Dashed	Dotted
Value	Dark	Medium	Light	Very Light

Table 5 Graphical Semiotic Structure of Natural Gas Pipelines

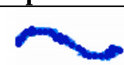
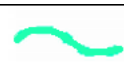
	Existing Natural Gas Pipelines	**Proposed Natural Gas Pipelines**
Symbol		
Retinal Variables		
Colour	Blue	Blue
Texture	Solid	Dashed
Value	Dark	Medium

Table 6 Graphical Semiotic Structure of Ocean Tanker Routes

	Existing Oil Tanker Route	**Proposed Oil Tanker Route**	**Conceptual Liquefied Natural Gas Tanker Route**
Symbol			
Retinal Variables			
Colour	Aquamarine	Aquamarine	Blue
Texture	Solid	Dashed	Dotted
Value	Dark	Medium	Light

As shown in Figure 17, a point symbol of a tanker alongside each of the tanker route lines is used to further distinguish between the ocean tanker routes and the land-based oil pipelines.

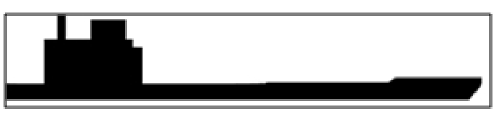


Figure 17 Symbol for Ocean Tanker

To indicate greater uncertainty and a longer future time frame, point symbols representing major oil refineries in the United States planning to take tar sands oil in the future have lighter values, as shown in Table 7.

Table 7 Graphical Semiotic Structure of Oil Refineries

	Existing refinery known to have used tar sands oil	Existing refinery planning to take tar sands oil	New refinery planning to take tar sands oil
Symbol			
Retinal Variables			
Colour	Purple	Purple	Purple
Value	Dark	Medium	Light

The general location of the Alberta tar sands and natural gas fields are represented with asterisk point symbols that have the same colour as the oil pipelines and natural gas pipelines respectively, as shown in Table 8.

Table 8 Graphical Semiotic Structure of Tar Sands and Natural Gas Fields

	Alberta Tar Sands	Natural Gas Fields
Symbol		
Retinal Variables		
Colour	Purple	Blue
Value	Dark	Dark

As shown in Figure 18, Figure 19, and Figure 20, the final images of the three scenarios for the continental pipeline map can be viewed sequentially in Google Earth software by clicking one of the “round” radio buttons. This allows the viewer see the pipeline network grow or contract and thereby interact with the Google Earth software.

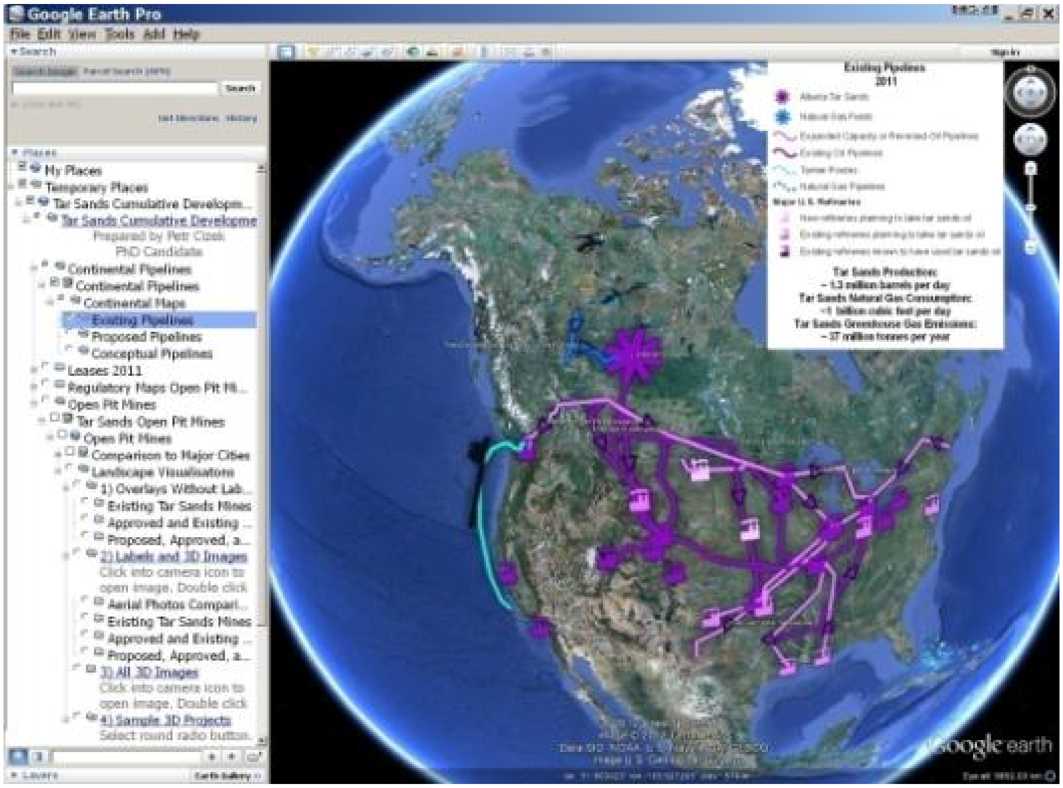


Figure 18 Continental Pipelines - Existing 2011

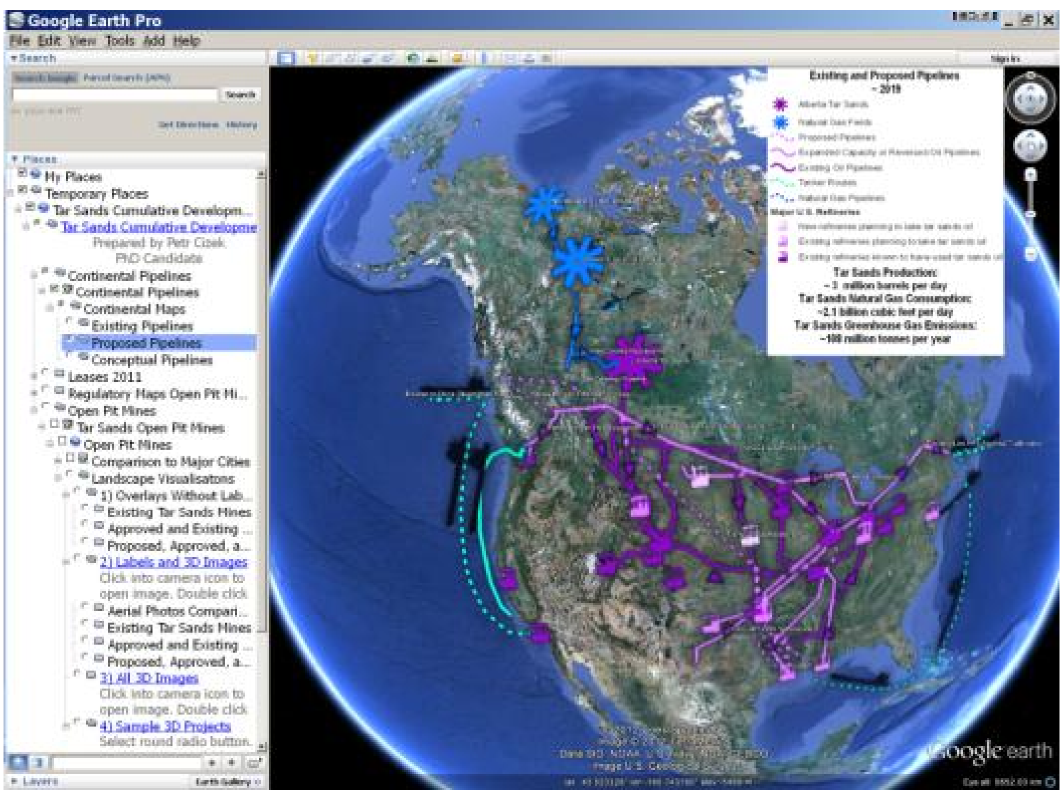


Figure 19 Continental Pipelines - Existing and Proposed ~ 2019

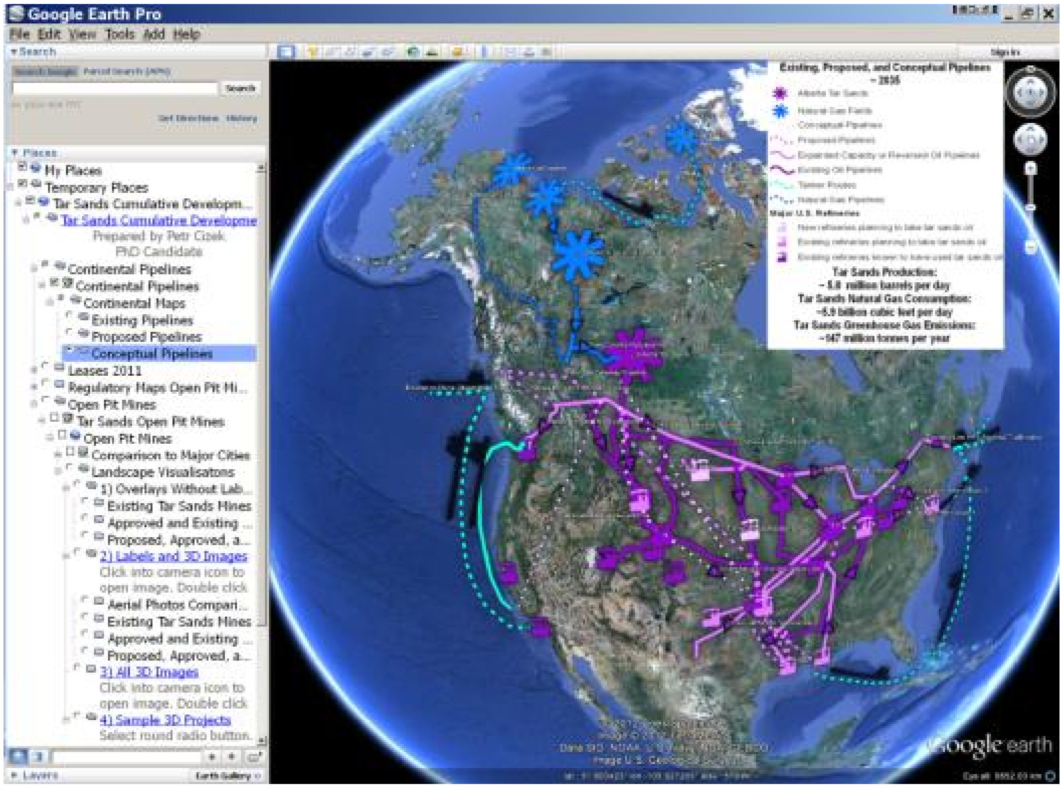


Figure 20 Continental Pipelines - Existing, Approved, and Conceptual ~ 2035

3.2. Provincial Tar Sands Lease Maps

The main objective of creating this map was to show the extent of leases issued for future tar sands development at the next level of detail, which is at the provincial scale. The extent of these leases is visually compared to the outline of the State of Florida, which is commonly used as a verbal scale comparison by both governments (Government of Alberta, 2013a) and environmental organisations (Woynillowicz et al., 2005), but has not previously been overlaid with the leases on a map. A secondary objective of creating this map was to explain the difference in scale between the open pit mining area and the in-situ production areas.

The tar sands development areas and tar sands lease GIS data were requested from the Alberta Energy and Utilities Board (now called the Alberta Energy Regulator) and the Alberta Department of Energy. Both replied that they do not provide these GIS data to the public. Instead, the 2011 tar sands lease map in pdf format (Alberta Department of Energy, 2013b) was georeferenced and digitized, as shown in Figure 21. As this map was in a known custom projection (Alberta TM) and included the surveyed sections, it was possible to georeference these maps to the Alberta Survey Grid Sections shapefile purchased from Abacus Datagraphics (Abacus Datagraphics Ltd., n.d.). Using the “Make ¼ Sections” Avenue script (Henszey, 2002), the Alberta Survey Sections shapefile was converted into quarter sections in Arcview 3.3 software (Environmental Systems Research Institute, 2001). It was then possible to digitize the tar sands leases on-screen in ArcGIS software (Environmental Systems Research Institute, 2008) by snapping to the vertices of the quarter sections. The “oil sands development areas” (Peace River, Athabasca, Cold Lake, and the Surface Mineable Area) were digitized by snapping to the vertices of the survey sections.

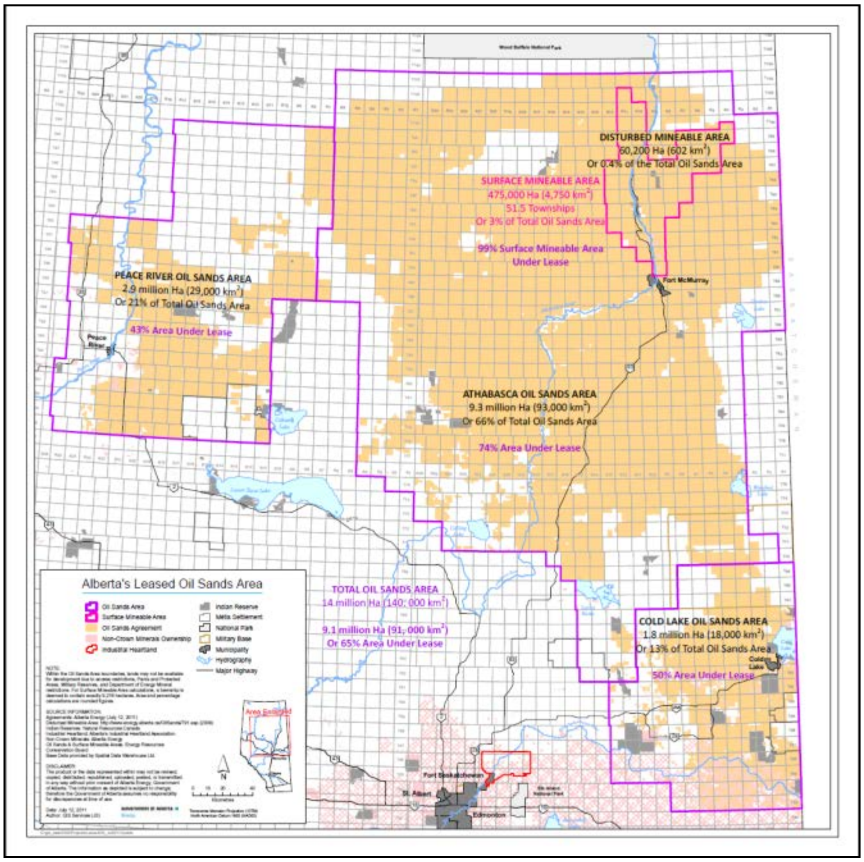


Figure 21 Alberta's Leased Oil Sands Area, Source: Alberta Department of Energy (2013b)

Google Earth software does not properly display filled colour polygons over large areas. Therefore, the resulting lease shapefile was not loaded into Google Earth. Instead, a map showing the 2011 leases and the tar sands development areas was exported from ArcGIS as a GeoTiff image. Again, this GeoTiff image was processed in Adobe Photoshop software (Adobe Corporation, 2013) to create a transparent alpha band so that the Google Earth satellite image data could be viewed underneath the line and point data. The resulting GeoTiff image was over 250MB, so it was processed using MapTiler software (Pridal, 2008) to create a tiled superoverlay that could be served efficiently through the internet using a Keyhole Markup Language (kml) "network" link.[14]

Upon clicking into the "Leases 2011" round radio button, Google Earth displays the tar sands leases within the context of the province of Alberta, showing the cities of Calgary, Edmonton, and Fort McMurray as "placemarks" for context. The total area available for leasing as well as the surface mineable area north of Fort McMurray is also shown in Figure 22.

[14] As mentioned in the acknowledgements, Google Earth Outreach only provided the researcher with a free licence of Google Earth Pro software. Google Earth Outreach did not have a contractual relationship with or other influence on this study.

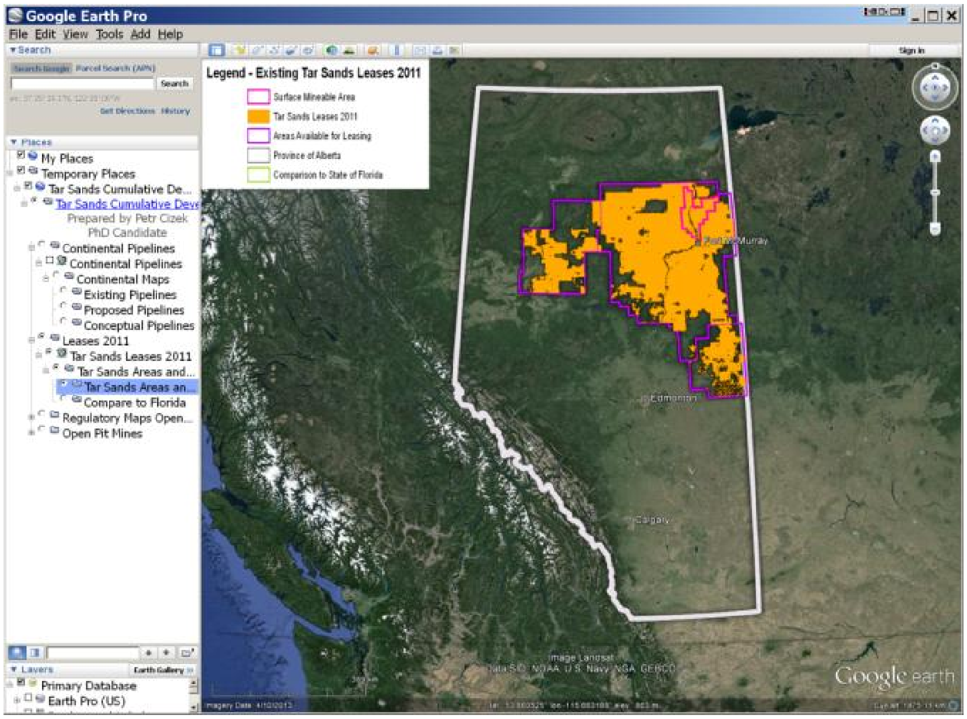


Figure 22 Tar Sands Leases 2011

Since the area of the tar sands, including both the surface mineable area and the *in-situ* area, are often compared to the state of Florida (Government of Alberta, 2013a), an outline of the state of Florida is superimposed to scale upon the tar sands lease area when the round radio button "Compare to Florida" is selected, as shown in Figure 23.

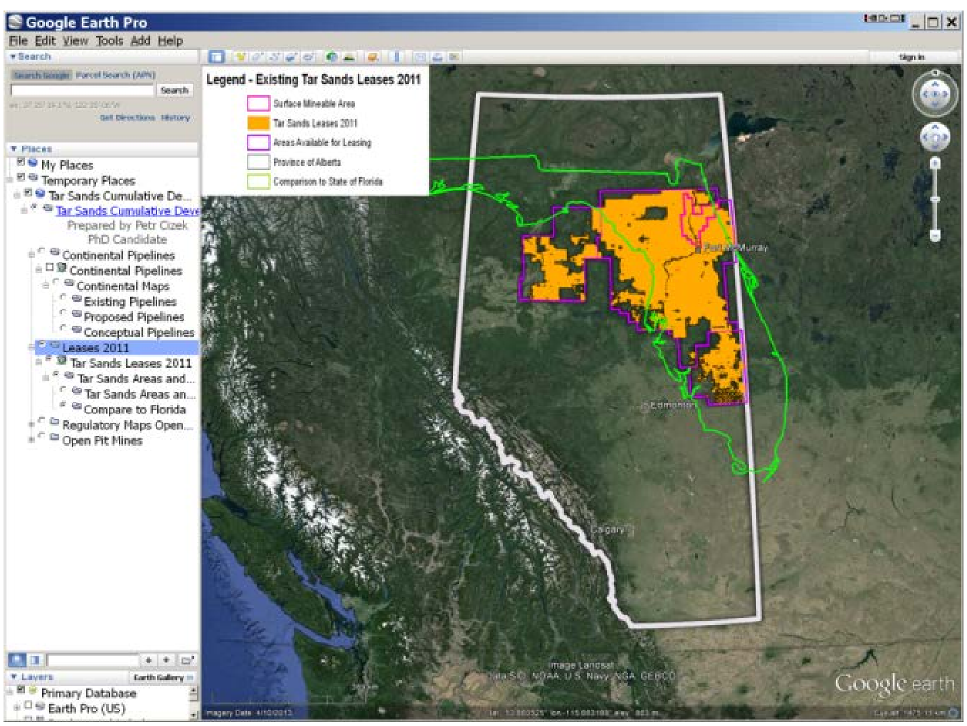


Figure 23 Tar Sands Leases 2011 compared to the State of Florida

3.3. Regional Maps of Tar Sands Open Pit Mines

There are no publicly available GIS data showing the physical footprint of existing, approved, and proposed tar sands open pit mining projects, which was confirmed when the Sierra Club of Canada made formal information requests as part of the environmental assessment of the TOTAL Joslyn North Project (Cizek, 2010). Industry and the Alberta government responded that the GIS data could not be provided to the public because they were "proprietary" (Joint Review Panel Established to Review the Joslyn North Mine Project, 2010). Therefore, two methods were used to create GIS data for the physical footprint of the open pit mines. Firstly, the existing physical footprint of existing open pit mines was extracted from the most recent publicly available LANDSAT satellite imagery. Secondly, the approved and proposed open pit mines were digitized from georeferenced images of individual projects available from government regulators and industry reports.[15] As described in detail in the following sections, the workflow for creating the regional 2D maps of the tar sands open pit mine scenarios is summarized in the flowchart shown in Figure 24. Showing the restoration that would take place after the mining has been completed in each project was outside the scope of this study.

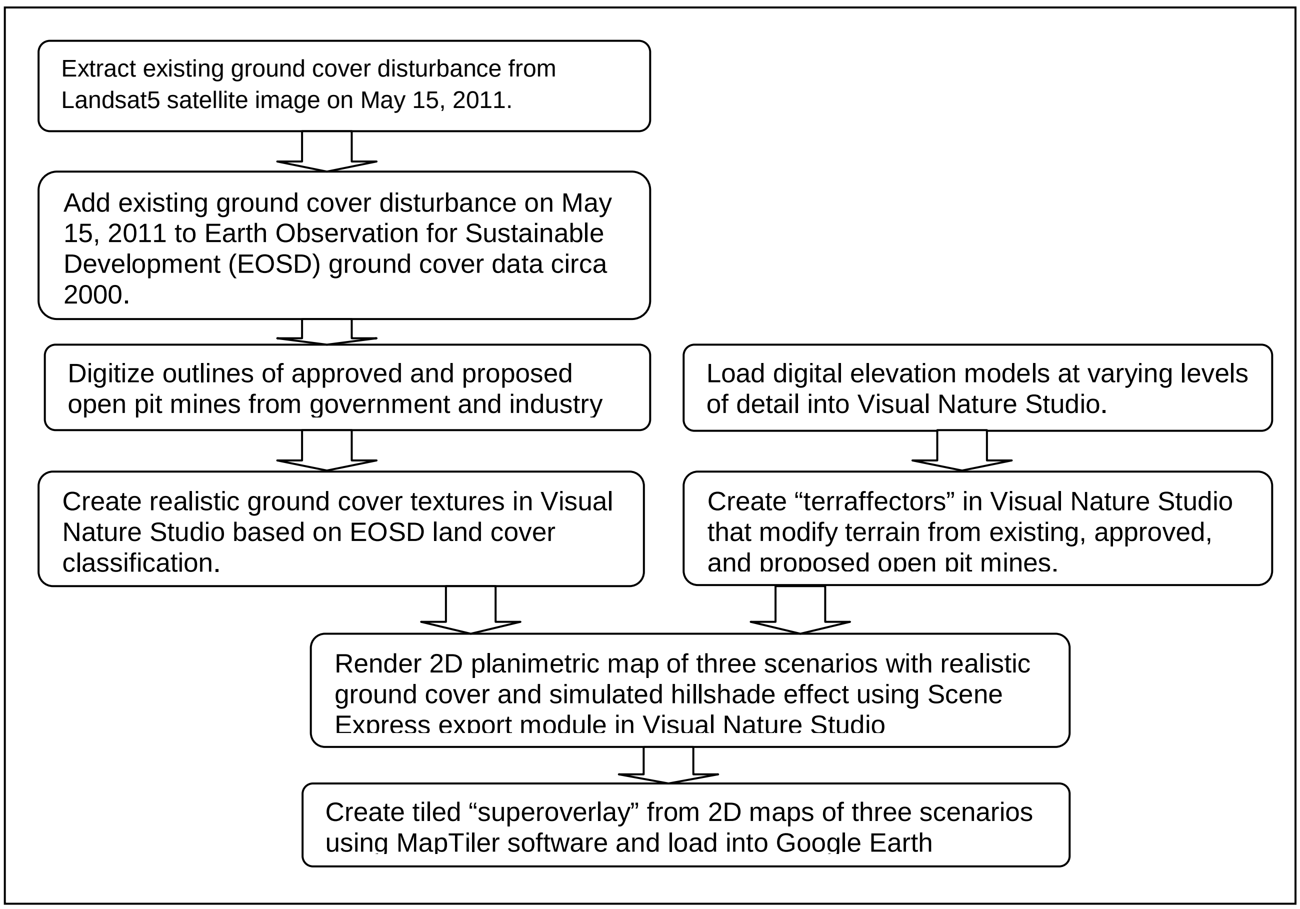


Figure 24 Workflow for Creating Realistic 2D Maps of Open Pit Scenarios

[15] As mentioned in the acknowledgements, OilSandsTruth.org paid for this digitizing work through a separate contract with the researcher to produce 2D maps independently of this study. OilSandsTruth.org did not have a contractual relationship with or other influence on this study.

3.3.1. Existing Tar Sands Open Pit Mines

The existing tar sands open pit mines could not be extracted from Google Earth since it displays a mosaic of satellite images taken on different years ranging from 2008 to 2010, where one scene may show a portion of a constructed mine while an adjacent scene shows undisturbed forest. Therefore, the most recent (at that time) cloud-free Landsat5 image (May 15, 2011) at 30m pixel resolution was downloaded from the "USGS Global Visualization" viewer (United States Geological Survey, n.d.). As shown in Figure 25, a cropped portion of this Landsat satellite image is shown in a red, blue, and green band combination that is stretched in ArcGIS software (Environmental Systems Research Institute, 2008) using the standard deviation function (Environmental Systems Research Institute, 2013), to brighten the image and increase the colour contrast for improved viewing in this sample figure only.

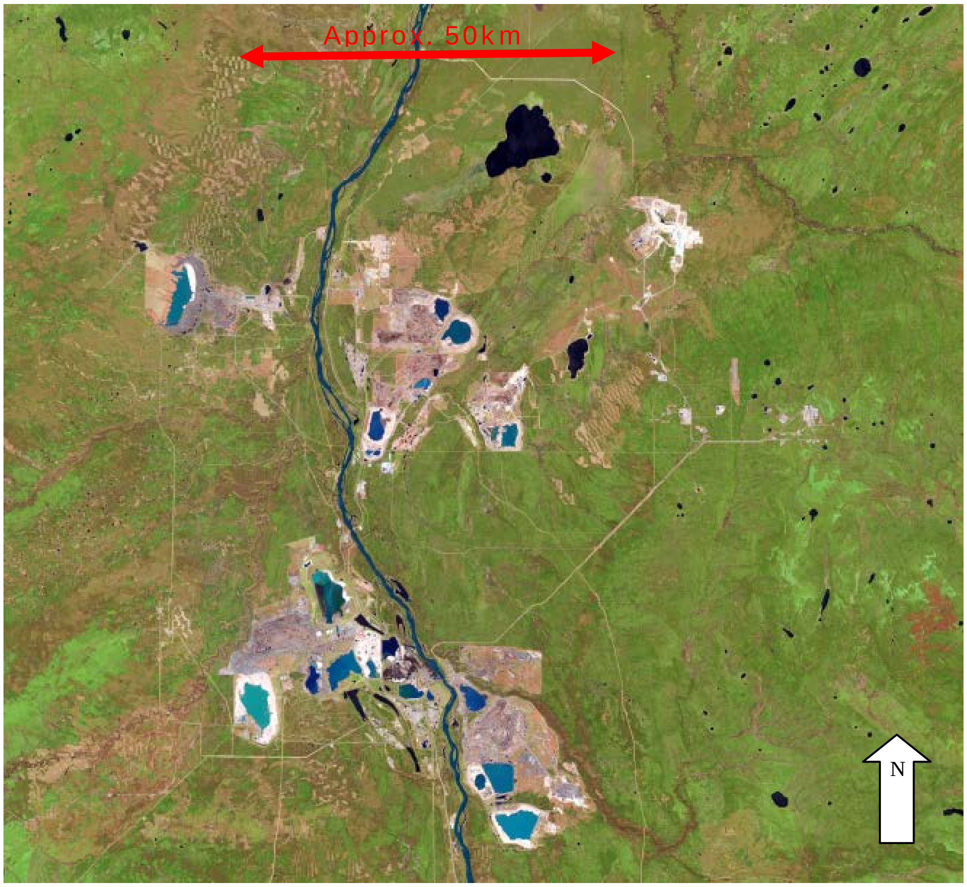


Figure 25 Landsat5 Satellite Image May 15, 2011

The next step was to identify an outline of the disturbed landscape. Using IDRISI GIS and Image Processing software (Clark Labs, n.d.), unsupervised image classification of the infrared, blue, and green bands in the original image was conducted using the CLUSTER command with the maximum number of classification clusters set to four.[16] As shown in Figure 26, the classified image shows the open pit mines and deforested lands (yellow), the tailings ponds (green), lakes and rivers (red), and undisturbed forest (blue). This classified image was exported from IDRISI software in GeoTiff format.

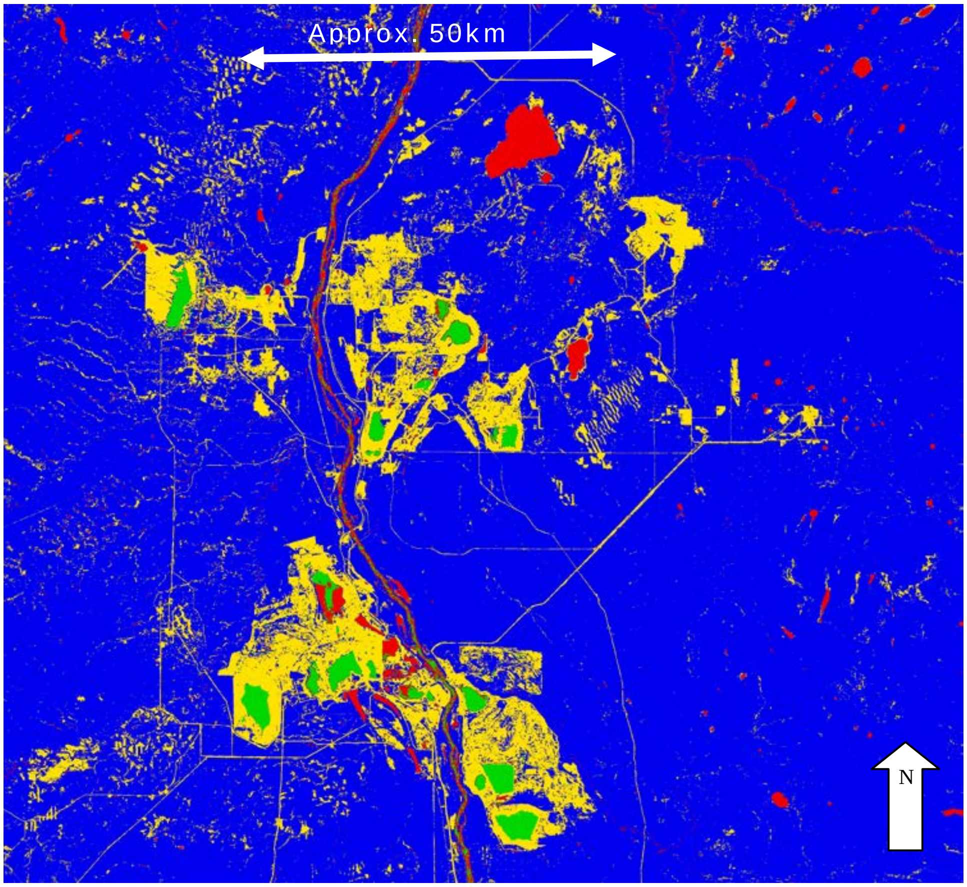


Figure 26 Classified Landsat5 Image (May 15, 2011) of Existing Tar Sands Open Pit Mines

3.3.2. Approved and Proposed Tar Sands Open Pit Mines

The outlines of the physical footprints of approved open pit mines were manually digitized from map images in government regulatory decision documents that were downloaded from the decision databases of the former Alberta Energy and Utilities Board (now renamed the Alberta Energy Regulator) decision database (Alberta Energy Regulator, 2013a) and the public registry of the Canadian Environmental Assessment Agency (Canadian Environmental Assessment Agency, 2013a). The outlines of the physical footprints of proposed open pit mines were also manually digitized from environmental impact statements or public disclosure documents at industry web-sites.

[16] Different numbers of clusters were tried until it was determined, using visual inspection of the "natural colour" Landsat image, that four clusters represented the landscape disturbance most accurately.

As these maps were all in a known custom projection (Alberta TM) and included the survey grid sections, it was possible to georeference these maps to the Alberta Survey Grid Sections shapefile purchased from Abacus Datagraphics (Abacus Datagraphics Ltd., n.d.). Once these maps were georeferenced in ArcGIS software, they were exported as GeoTiff images and processed using MapTiler software (Pridal, 2008) to create tiled superoverlays that could be served efficiently through the internet using a Keyhole Markup Language (kml) “network” link. Two examples of the approved and proposed open pit mines as displayed in Google Earth software are shown in Figure 27 and Figure 28.[17] For the purposes of showing the different types of land uses larger legends are added below the images in these example figures. The complete set of georeferenced images as displayed in Google Earth are shown in Appendix “A”. In the focus groups, these are referred to as the “Regulatory Maps”.

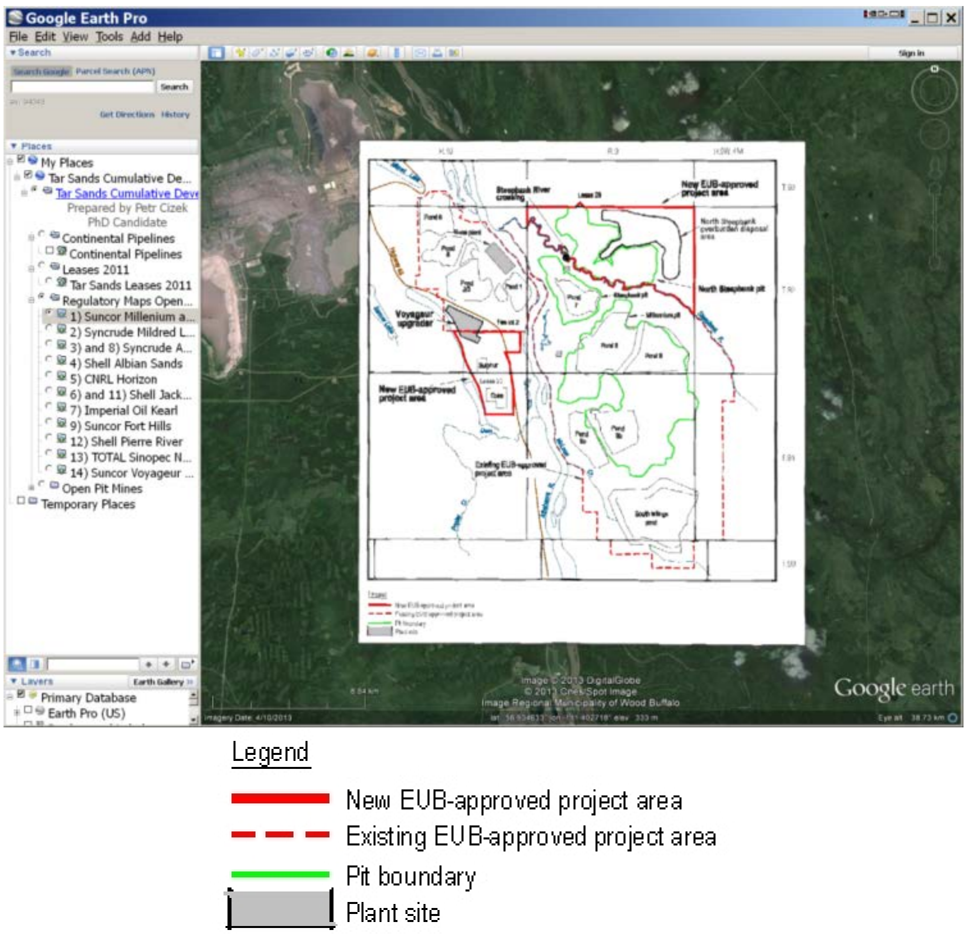


Figure 27 Approved Suncor Millenium and Steepbank Expansion, Alberta Energy and Utilities Board Decision 2006-112 (November 14, 2006)

[17] The maps of proposed tar sand open pit mines do not include the physical footprint of the Teck Frontier project (Teck Resources Ltd., 2011) since the environmental impact statement was released after the mapping had been completed.

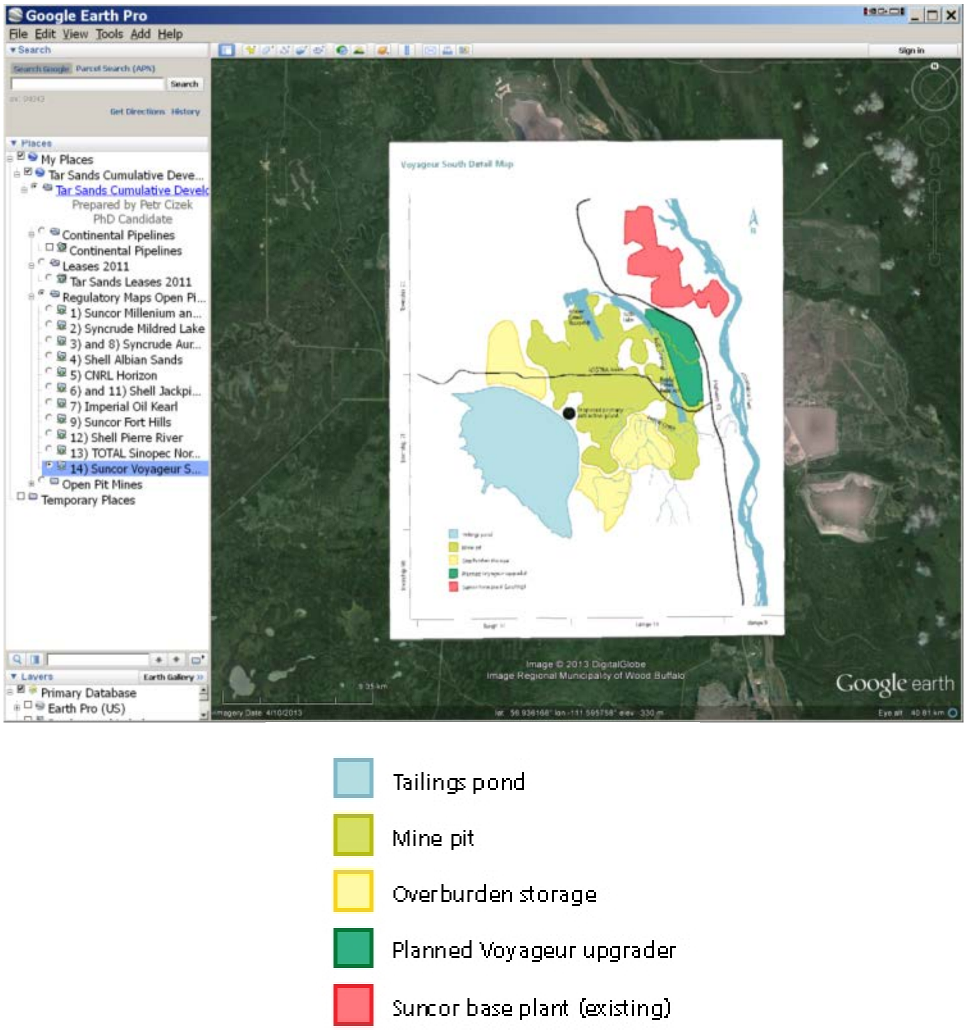


Figure 28 Proposed Suncor Voyageur South Mine, Suncor Energy Ltd., Public Disclosure Document, 2007

3.3.3. Forest and Vegetation Inventory Data

In order to produce a regional map and realistic 3D visualisations of the existing, approved, and proposed open pit mines using Visual Nature Studio (3D Nature LLC, n.d.), a vegetation inventory for the tar sands open pit mining area was required. It was discovered that the Alberta government does not have recent forest inventory data for this area, as it is part of the Alpac Forest Products Inc. Forest Management Agreement, where forest inventory has been privatized. Forest inventory data at 1:20,000 scale can be purchased from Alpac Resources Ltd. at $5,000 per surveyed township (approx. 6 miles x 6 miles). As the "mineable oil sands area" covers twenty four surveyed townships, these data would have cost $120,000 and were therefore effectively unavailable for this study.

Instead, “Earth Observation for Sustainable Development” (EOSD) data covering National Topographic Series map sheets 74E and 74D were freely downloaded from the Canadian Forest Service (Natural Resources Canada, 2013). EOSD is a land cover classification based on Landsat data from circa year 2000 at 30m resolution. The land cover class legend for EOSD is shown in Figure 29 and EOSD maps covering National Topographic Series map sheets 74E and 74D are shown in Figure 30.

Figure 29 Land Cover Class Legend for EOSD, Source: Natural Resources Canada (2013)

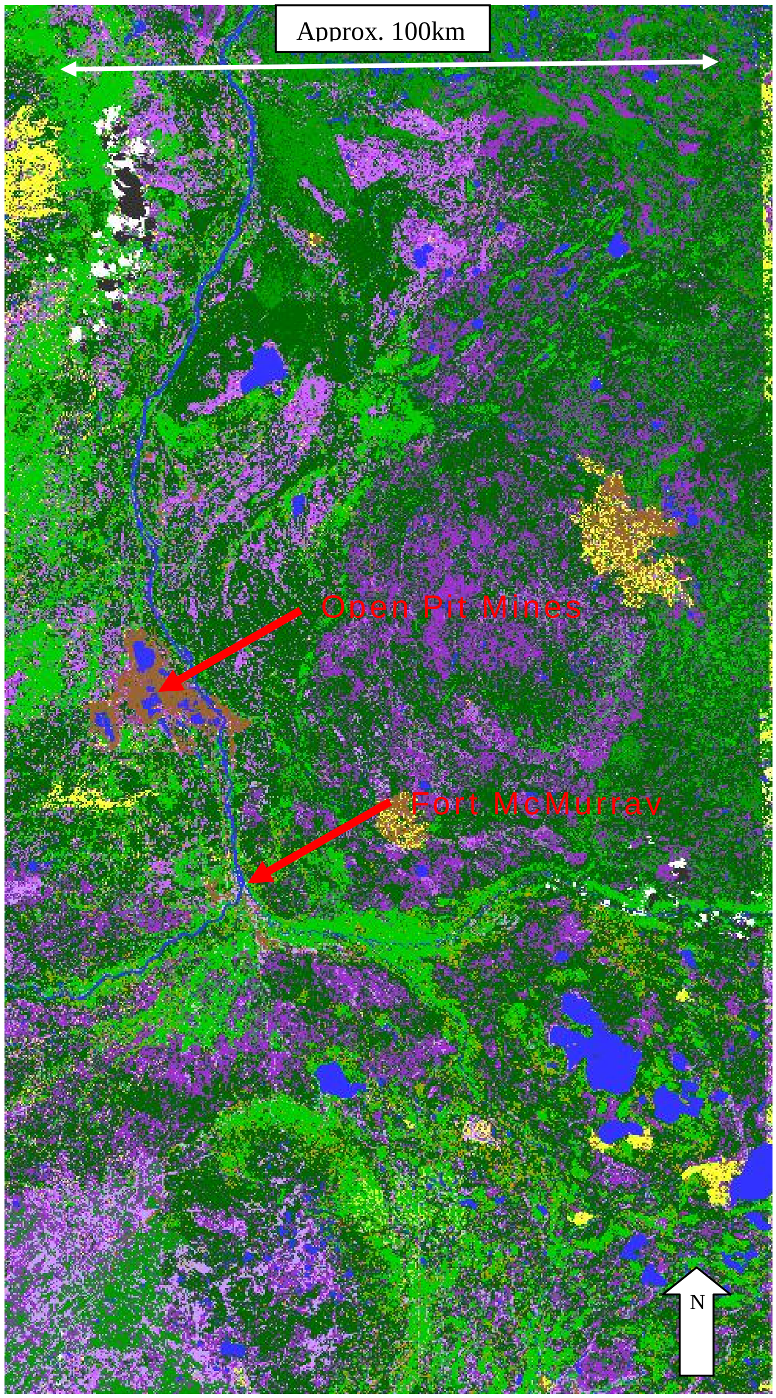


Figure 30 National Topographic Series Map Sheets 74D and 74E EOSD circa year 2000, Source: Natural Resources Canada (2013)

The EOSD data and the existing open pit mines and other deforested lands data extracted from the May 15, 2011 Landsat satellite image were converted from GeoTiffs to ArcGrid format using ArcView 3.3 Spatial Analyst software (Environmental Systems Research Institute, 2001) and the two ArcGrid files were merged using the Grid Pig extension (Hare, 2007), as shown in Figure 31. This is an interim map that was later used to generate realistic ground cover.

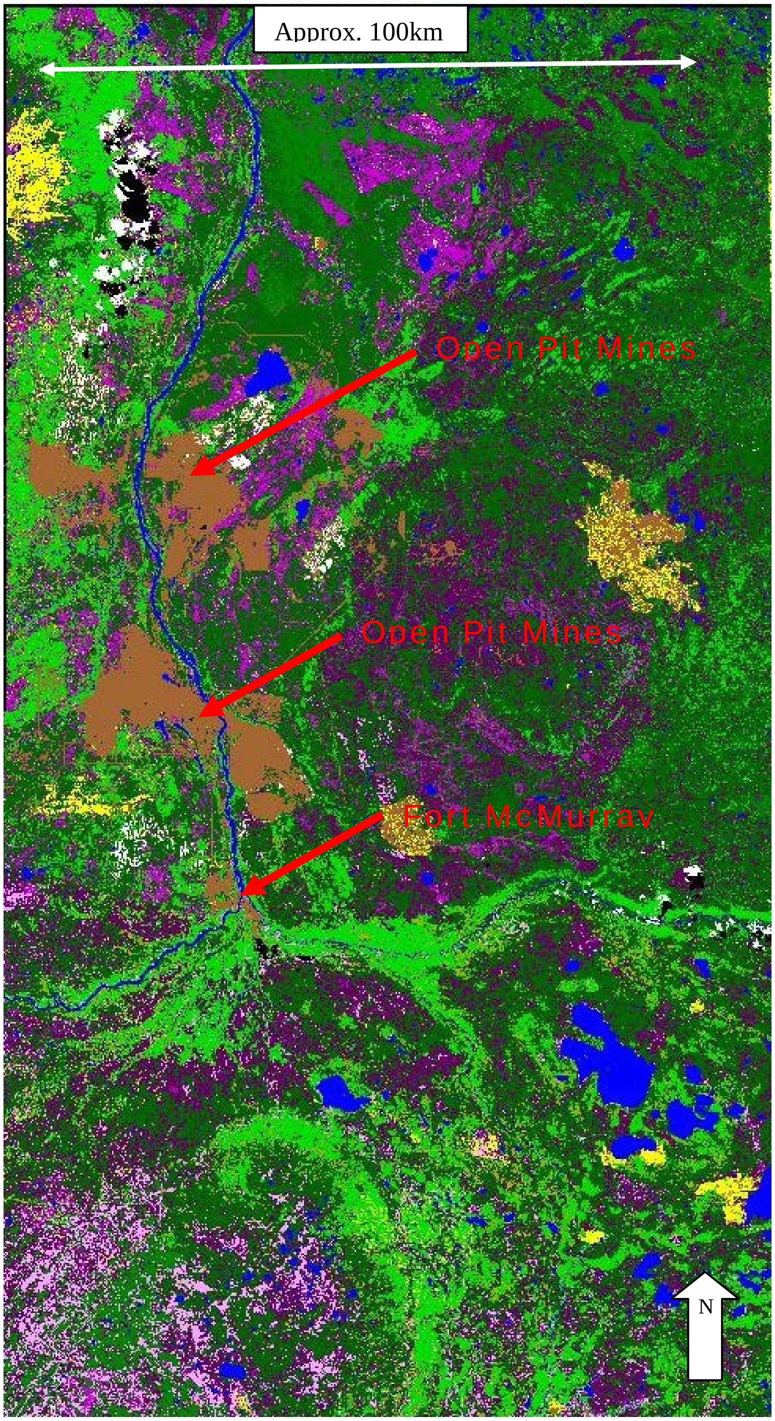


Figure 31 EOSD data from circa 2000 updated with Existing Tar Sands Projects and Other Deforested Lands Extracted from May 15, 2011 Landsat5 Satellite Image

3.3.4. Ground Cover Settings for Regional Maps

Although the standard Google Earth satellite images are at very high resolution (≤ 1 m), their colours are not realistic compared to oblique aerial photographs. Also, when zoomed in, Google Earth also displays a mosaic of satellite images from different dates which show different stages of tar sands development. Therefore, Visual Nature Studio software (3D Nature LLC, n.d.) was used to create more realistic and up-to-date ground textures of natural vegetation and disturbed ground cover for regional maps of open pit mines.

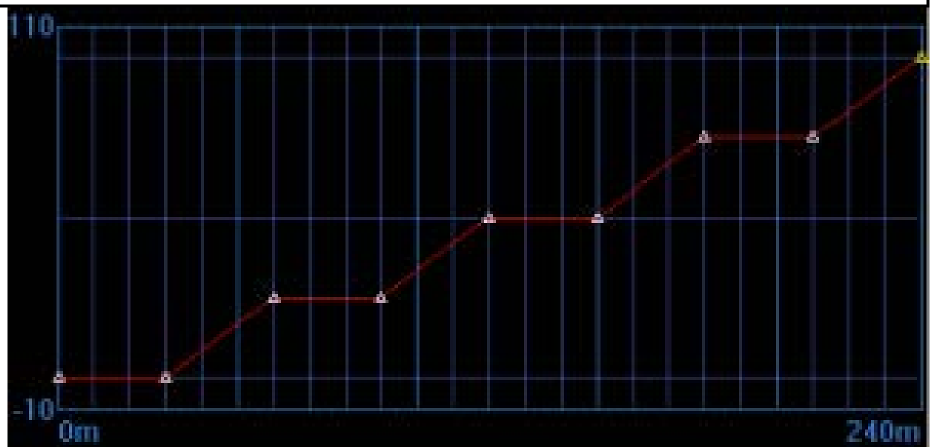
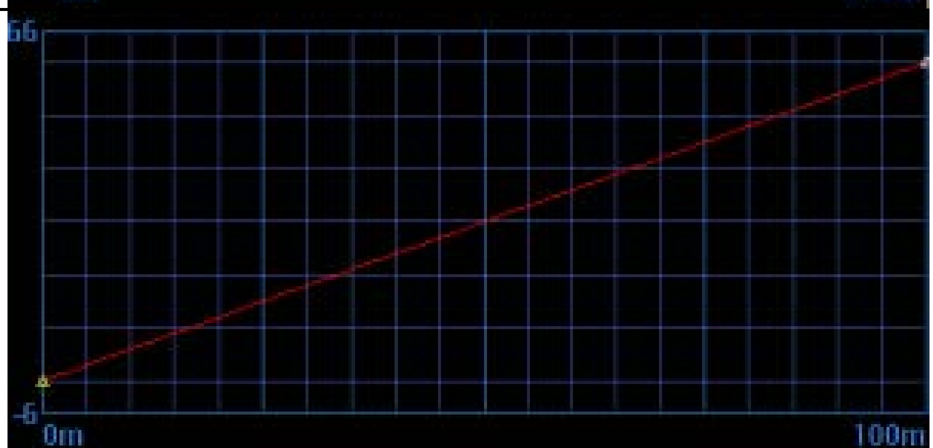
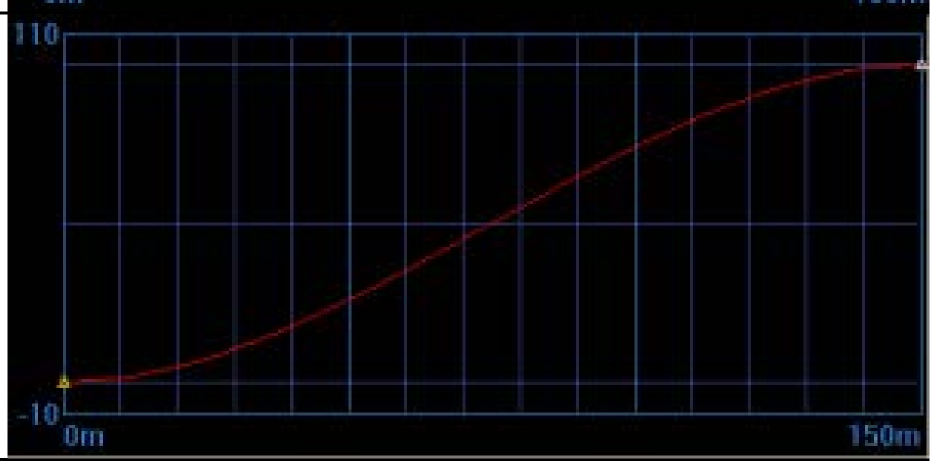
The merged EOSD land cover file updated with existing open pit mines and other deforested lands from May 15, 2011 was converted to GeoTiff format so that it could be used as a colour map in Visual Nature Studio to drive "ecosystem" ground cover textures in Visual Nature Studio (3D Nature LLC, n.d.). As shown in Appendix "B", ground cover colours and textures were assigned to each EOSD class based on oblique aerial photography, as discussed in the following section. The EOSD ground-cover colours and textures were only visible in the far horizon of the static 3D visualisations where the vegetation was dissolved to speed up rendering. Therefore, the ground-cover settings were simplified into three groups of colours and textures – primarily deciduous ecosystems, primarily coniferous ecosystems, and rock rubble/exposed/barren land. Areas for the existing open pit mines were left transparent so that the most recent May 15, 2011 Landsat satellite image blended with panchromatic 10m resolution SPOT satellite imagery from circa 2006 (Geobase, 2009) would be visible underneath. As shown in Appendix "C", vector data for roads, cut-lines, pipelines, rivers, lakes, tailings ponds, and open pit mines were overlaid on the EOSD ground cover map using Visual Nature Studio "ecosystem" ground cover settings based on sampling the colours and textures from oblique aerial photographs.

3.3.5. Digital Elevation Data and "Area Terraffectors"

A digital elevation model was used to enable 3D landscape visualisation and ground-level view in the open pit mines. The Canadian Digital Elevation Data (Natural Resources Canada, n.d.) at 20m grid cell resolution from twelve (12) National Topographic Series 1:50,000 map sheets covering an area of approximately 90km x 110km centered around the tar sands open pit mining area were downloaded and imported into Visual Nature Studio software. Lower resolution Shuttle Radar Topography Mission (SRTM) elevation data (Consortium for Spatial Information, n.d.) with a grid cell resolution of 90m as well as GTOPO30 data (United States Geological Survey, 1998) with a grid cell resolution of approximately 1km were used to fill in a larger area of 350km x 350km surrounding the tar sands open pit mining area. Along with surrounding EOSD land cover data, these lower resolution elevation data were imported into Visual Nature Studio to create a horizon for the static landscape visualisations.

Within Visual Nature Studio software, "Area Terraffectors" can be used to change the shape of the terrain by excavating open pits or building overburden and disposal mounds. The edge profiles of the cross-sections of the future altered landscape for the approved and proposed mine pits, the overburden and disposal mounds, and for the tailings pond dykes are shown in Table 9. The typical depths of open pit mines and heights of overburden/disposal and tailing pond dykes are based on information provided by Nikiforuk (2008).

Table 9 Edge Profiles of "Area Terraffectors" for Approved and Proposed Tar Sands Projects

Feature	Change in Elevation From Baseline	Edge Profile
Approved and Proposed Mine Pits	-75m	
Approved and Proposed Overburden and Disposal	+60m	
Approved and Proposed Tailings Pond Dykes	+50m	

3.3.6. Regional Composite Maps Displayed in Google Earth Software

Using the Visual Nature Studio "Scene Express" extension (3D Nature LLC, n.d.), planimetric regional maps were exported as GeoTiffs for the existing, approved, and proposed scenarios. Shading from the elevation data[18] and the "area terraffectors" was burned into these GeoTiffs to simulate a 3D effect on a 2D map. As each GeoTiff was over 600MB, they were processed using MapTiler software (Pridal, 2008) so that the images could be served efficiently through the internet using a "keyhole markup language" (kml) network link in Google Earth software. "Placemarks" were added to identify each open pit mining project in Google Earth software. The planimetric regional maps for existing, approved, and proposed open pit mines in Google Earth software are shown in Figure 32, Figure 33, and Figure 34. To emphasize the additive cumulative physical footprint of the open pit mines, the existing, approved, and proposed scenarios are combined in each map in the sequence rather than showing each scenarios separately. The round radio buttons were used to alternately show the existing, approved, and proposed scenarios. To prompt the user, a colour-coded title bar (i.e. green for existing, orange for approved and existing, and red for proposed, approved, and existing) appears at the top of the Google Earth display window.

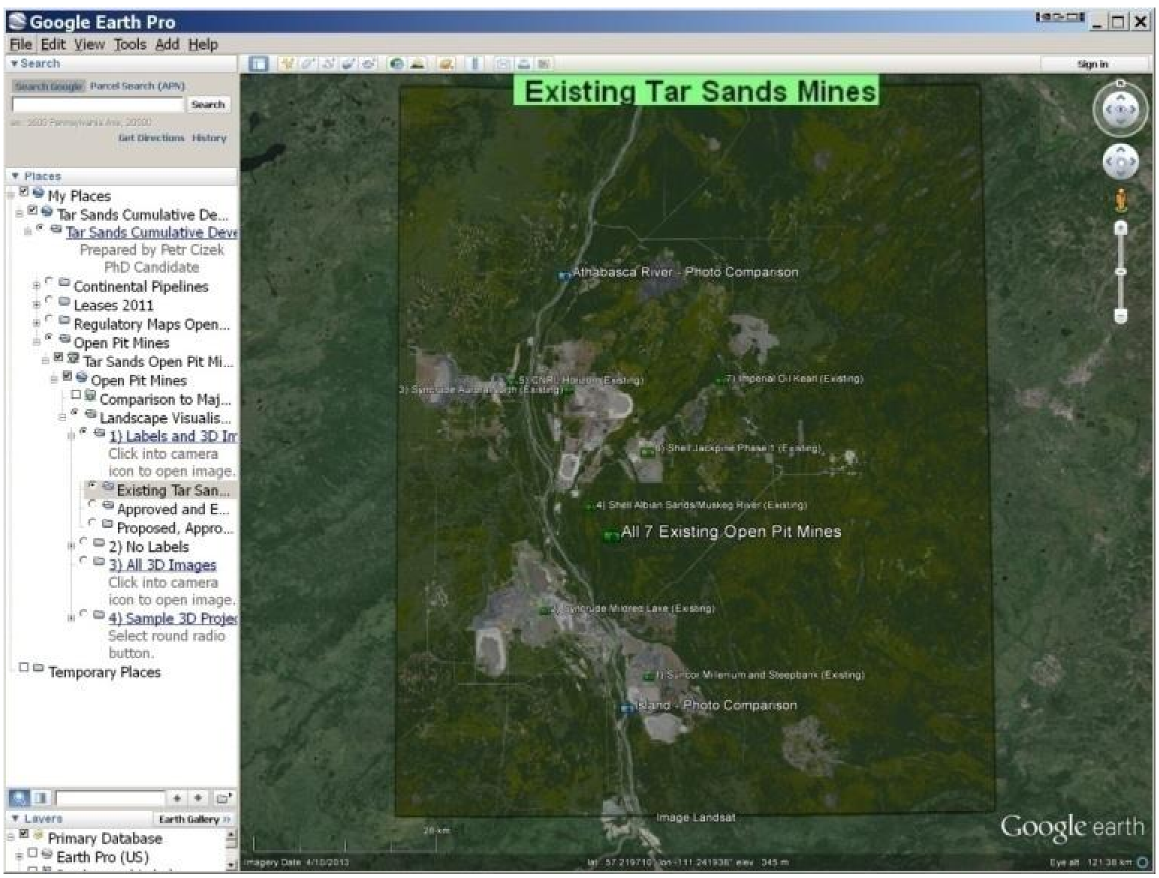


Figure 32 Regional Map of Existing Tar Sands Mines

[18] The shading for the sun angle was set for noon on August 21, which is the same date when the aerial oblique photographs were taken.

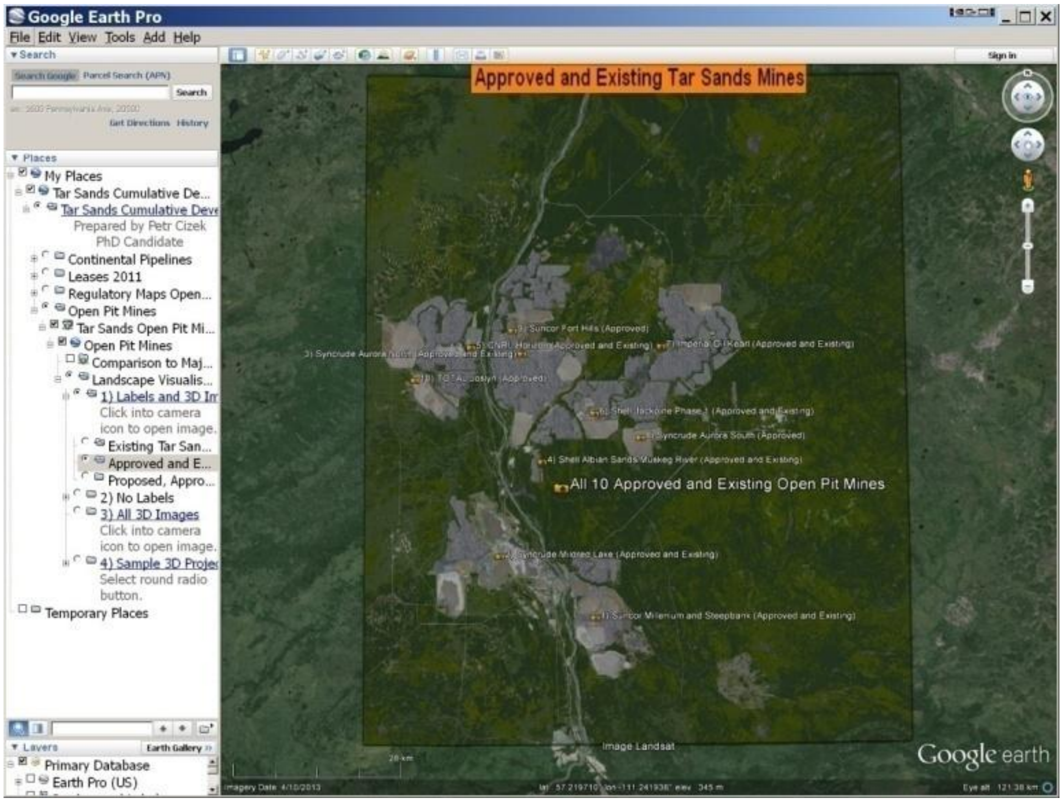


Figure 33 Regional Map of Approved and Existing Tar Sands Mines

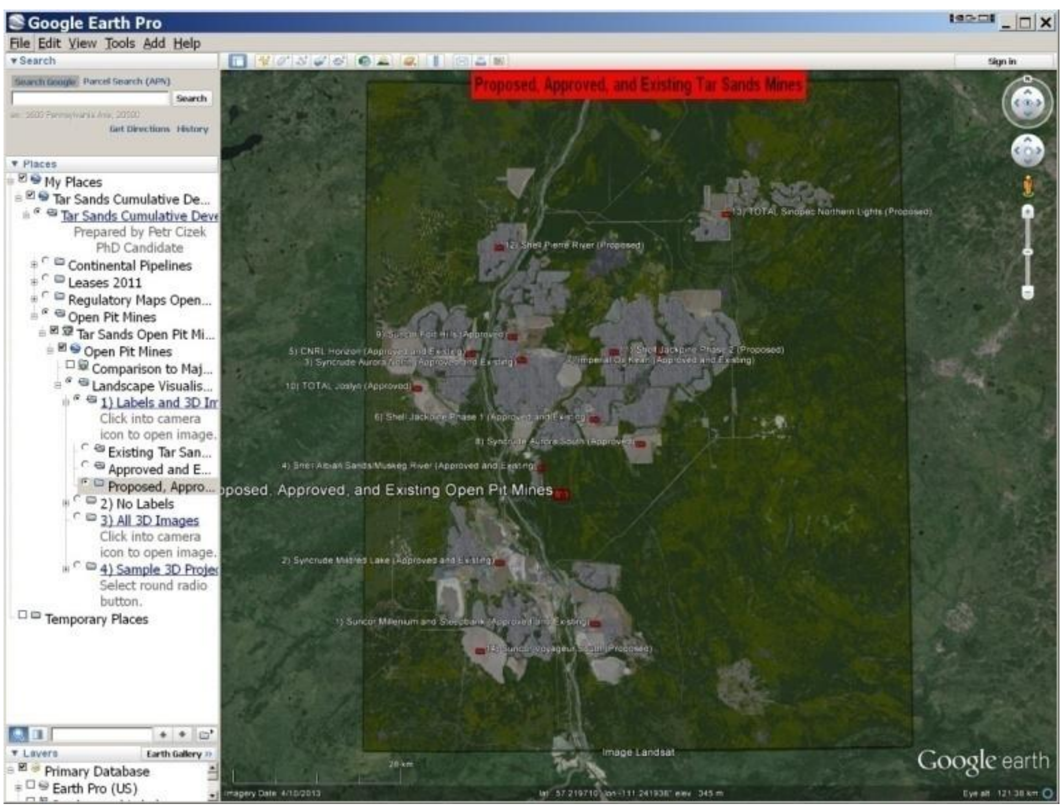


Figure 34 Regional Map of Proposed, Approved, and Existing Tar Sands Mines

3.3.7. Comparison to Major Cities

In order for viewers to better comprehend the geographic area or scale of the tar sands developments, the open pit mine scenarios were compared to outlines of major Canadian and American cities and surrounding metropolitan urban areas. Outlines of municipal boundaries of major cities and their surrounding metropolitan "urban areas" were downloaded as GIS shapefiles for Edmonton, Calgary, Toronto, Vancouver, New York City, and Los Angeles (Statistics Canada, 2014; United States Census Bureau, 2013). The metropolitan "urban area", which surrounds the major cities, is defined as having population of at least 400 persons/km^2 in Canada and 190 persons/km^2 in the United States. [19] An "urban area" is not the same as a "census metropolitan area", which is based on legally-defined municipal districsts that include rural areas. The reason for using metropolitan "urban areas" rather than "census metropolitan areas" was because participants might be more familiar with the scale of contiguous metropolitan urbanization rather than with legally-defined metropolitan boundaries.

Using ArcGIS software (Environmental Systems Research Institute, 2008), the shapefiles were converted into graphics and then moved over the tar sands open pit mines at scale. The graphics were then converted back into GIS shapefiles that were converted to "keyhole markup language" (kml) files served through the internet by a network link. The outlines of the major cities can be viewed over all three open pit mining scenarios:

1) Existing;
2) Approved and Existing; and
3) Proposed, Approved, and Existing.

Outlines of the cities were also located over the actual cities in Google Earth so that the viewer could automatically zoom back and forth between the outlines of the cities tar sands open pit mines and the outlines overlaying the cities themselves to get a better understanding of relative scales. The legally-defined municipal boundaries of the major cities are shown outlined in red, while surrounding the metropolitan "urban areas" are shown outlined in white. The Canadian metropolitan "urban areas" all have about the same geographic area. However, the legally-defined municipal boundary of the City of Vancouver is about one-third the size of the legally-defined municipal boundaries City of Edmonton and the City of Calgary. While the metropolitan "urban areas" of New York and Los Angeles both have about the same geographic area, the municipal boundary of the legally-defined City of Toronto is about the same geographic area as the legally-defined municipal boundaries of the City of New York or the City of Los Angeles. As discussed in more detail in Chapter 8 "Discussion and Conclusions" these differences may have led to some confusion among participants.

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[19] In Canada, "The Urban Area Boundary Files portray the urban area boundaries for which 2006 Census data are disseminated. An urban area has a minimum population concentration of 1,000 persons and a population density of at least 400 persons per square kilometre, based on the current census population count." (Statistics Canada, 2014). In the United States, the "Urban areas" are defined as "contiguous census block groups with a population density of at least 1,000 /sq mi (390 /km^2) with any census block groups around this core having a density of at least 500 /sq mi (190 /km^2). Urban areas are delineated without regard to political boundaries." (United States Census Bureau, 2013).

In Appendix “F”, Google Earth screenshots of the outlines of all the selected cities and metropolitan areas are shown compared to the proposed open pit mine scenario, as well as over the actual cities and metropolitan areas. As an example, the municipal and metropolitan boundaries of Edmonton are shown overlaid on the existing, approved, and proposed tar sands mines in Figure 39. In Figure 40, these boundaries are shown overlaid on the actual satellite image of Edmonton.

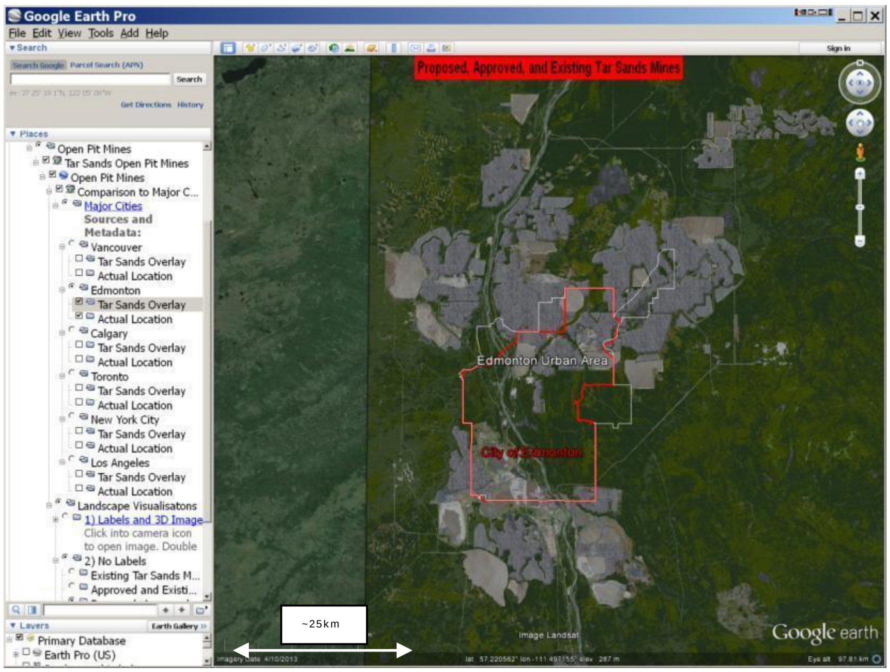


Figure 35 Edmonton Metropolitan Urban Area Outline Compared to Proposed, Approved, and Existing Tar Sands Mines

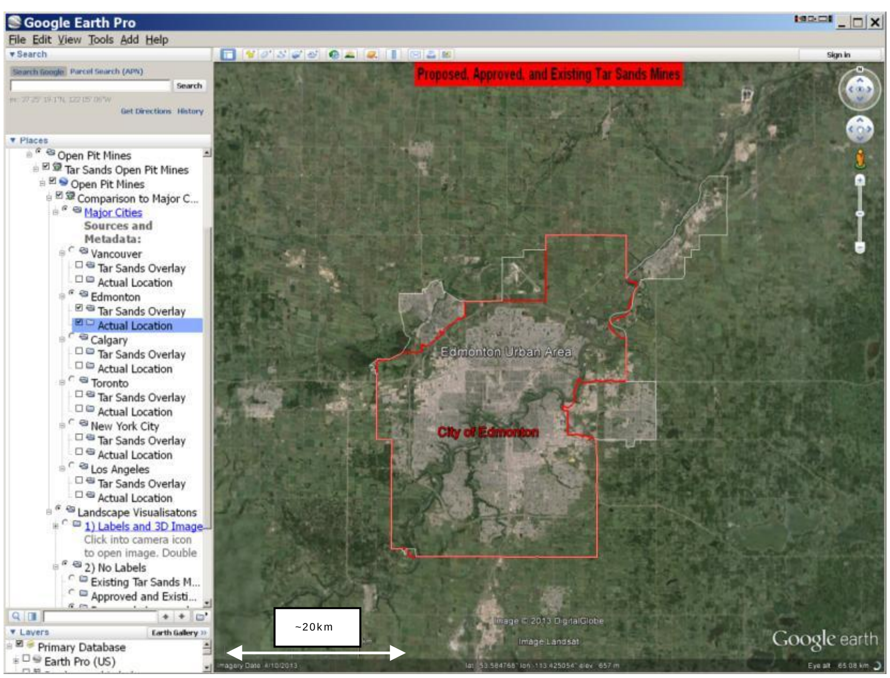


Figure 36 Edmonton Metropolitan Urban Area Outline in Actual Location

In order to generate static landscape visualisations of the open pit mines, Visual Nature Studio software (3D Nature LLC, n.d.) was used to generate 3D foliage in addition to the ground cover colours and textures. The colours and textures from these static landscape visualisations were applied to the 2D maps and interactive landscape visualisations displayed within Google Earth software. The following ethical principles (Sheppard, 2001; Sheppard & Cizek, 2009) were applied to generating the landscape visualisations:

1) **Accuracy**: Visualisations should simulate the actual or expected appearance of the landscape (at least for those landscape factors being judged), without distortion and at an appropriate level of abstraction/realism for the intended purpose;

2) **Representativeness**: Visualisations should represent typical or important views/conditions of the landscape;

3) **Visual clarity**: The details, components, and overall content of the visualisation should be clearly communicated;

4) **Interest**: Visualisations should engage and hold the interest of the audience;

5) **Legitimacy**: Visualisations should be defensible and their level of accuracy demonstrable;

6) **Access to visual information**: Visualisations should be readily accessible to the public via a variety of formats and communication channels; and

7) **Framing and presentation**: Important contextual and other relevant information (such as labeling, narration, mapping, etc.) should be presented in a clear, neutral fashion, along with the visualisation imagery.

These principles also relate to the measurable evaluation criteria controlled by the researcher, as described in Chapter 2.4. The principles of accuracy, representativeness, and legitimacy also relate to the participants' rating of "believability" as described in Section 5.4.2.

The colours and textures for the foliage were assigned based on a site visit to Fort McMurray on August 20-22, 2008, where 441 GPS-referenced ground-based and oblique aerial photographs were taken of the open pit mines and surrounding forest using GPS Photo-Link software (Geospatial Experts Inc., n.d.), as shown in Table 10.

Table 10 Summary of GPS Photography August 20-22, 2008

Date	**Number of Photos**	**Time (Mountain Daylight)**
August 20, 2008	58 ground-based photos	15:22 – 19:23
August 21, 2008	137 ground-based photos	10:32 – 19:41
August 22, 2008	180 aerial oblique photos	11:23 – 13:01
August 22, 2008	66 ground-based photos	17:44 – 19:38
TOTAL	441 photos	

The aerial survey was conducted in a Cessna 206 aircraft operated by Fort McMurray Aviation Ltd. flying at the minimum permissible altitude of approximately 305 m (1000 ft.). Conditions were overcast and moderately hazy. The flight path was from Fort McMurray Airport (YMM) north along the left bank of the Athabasca River to the northernmost end of the proposed tar sands open pit mines and returning to south to Fort McMurray along the right bank of the Athabasca River. An additional loop was flown south of Fort McMurray to the OPTI-Nexen

Long Lake "in-situ" project before returning to the Fort Mc Murray airport. The flight path is described in detail in Appendix "D".

The colour bands of the broad land cover types (i.e. coniferous forest, deciduous forest, mixed forest, wetlands) across the study area were sampled from the aerial oblique photographs using IrfanView image management software (Skiljan, 2005) to assign similar colours to the 3D foliage within Visual Nature Studio (3D Nature LLC, n.d.).

Alpac Resources Ltd. 1:20,000 forest inventory data surrounding the approved CNRL Horizon mine, which were made available by an anonymous consultant on a confidential basis, were used to assign the tree species, tree height and stems/hectare to the ecosystem variables within Visual Nature Studio as shown in Appendix "E". Generic tree models were selected in Visual Nature Studio software for white spruce (*picea glauca*), black spruce (*picea mariana*), and aspen (*populus tremuloides*).

To address the ethical principles of accuracy, representativeness, and legitimacy (Sheppard, 2001; Sheppard & Cizek, 2009), the landscape visualisations were calibrated using an iterative process by comparing them to two oblique aerial photographs. Adjustments were made within Visual Nature Studio to render landscape visualisations that would be as similar as possible to the two oblique aerial photographs. The rationale for selecting these two photographs was:

1) The photographs represented two extreme locations of the study area – one photograph was at the northern end and the second photograph was at the southern end;

2) One photograph had a developed project with a tailings pond while the second photograph was of a largely undisturbed landscape;

3) The Athabasca River was visible in photographs from two different viewpoints, one facing north along the length of the river and one facing east across the river; and

4) Horizon, clouds, and haze were visible in both photographs.

Calibration involved adjusting the following variables for all land cover and foliage features using the "Material Editor" within Visual Nature Studio software (3D Nature LLC, 2008):

1) Diffuse colour and intensity: The diffuse intensity of a material is a measure of how much of the diffuse color of a surface is returned to the camera;

2) Luminosity: Luminosity affects how the Material is shaded by the Sun Light;

3) Reflectivity: Reflection of their surroundings and other 3D Objects, as well as parts of their own geometry;

4) Specularity: Specularity is the amount of shininess for a material;

5) Transparency: How much can be seen through a 3D object; and

6) Translucency: Translucency is the amount of light transmission for a material.

The cloud model of the landscape visualisations was adjusted to correspond to the oblique aerial photographs by setting the shading, coverage, and density variables. The colour, start distance, and end distance of the haze was also adjusted in the landscape visualisations to correspond to the oblique aerial photographs. To increase the brightness of the landscape visualisations so that they would better correspond to the oblique aerial photographs, light colour intensity was increased to 130%. Other than adding some annotations, no post-production changes were made to the final landscape visualisation images using digital image manipulation software such as Photoshop (Adobe Corporation, 2013) .

In the southern end of the study area, the comparison between the oblique aerial photograph and the landscape visualisation is shown in Figure 37 and Figure 38. There were some remaining differences between the oblique aerial photograph and the landscape visualisation:

1) The tailings pond in the landscape visualisation is smaller than in the oblique aerial photograph possibly due to differences in dates between the satellite image and the photograph;

2) In the landscape visualisation, the channel in the Athabasca River behind the island does not appear flat, possibly due to errors in the digital elevation model;

3) The cloud cover in the landscape visualisation is not completely accurate and the landscape visualisation is less hazy than the oblique aerial photograph; and

4) Reflections in the water are darker in the photograph.

In the northern end of the study area, the comparison between the oblique aerial photograph and the landscape visualisation is shown in Figure 39 and Figure 40. There were some remaining differences between the oblique aerial photograph and the landscape visualisation:

1) Some islands and sandbars are missing in the landscape visualisation, possibly due to the limited accuracy of the base map;

2) In the landscape visualisation, there are some additional clearings in the forest due to different dates between the satellite image and the photograph; and

3) There is less haze in the landscape visualisation than in the oblique aerial photograph.

Figure 37 Oblique Aerial Photograph ~600m above ground level, Southern End, August 21, 2008

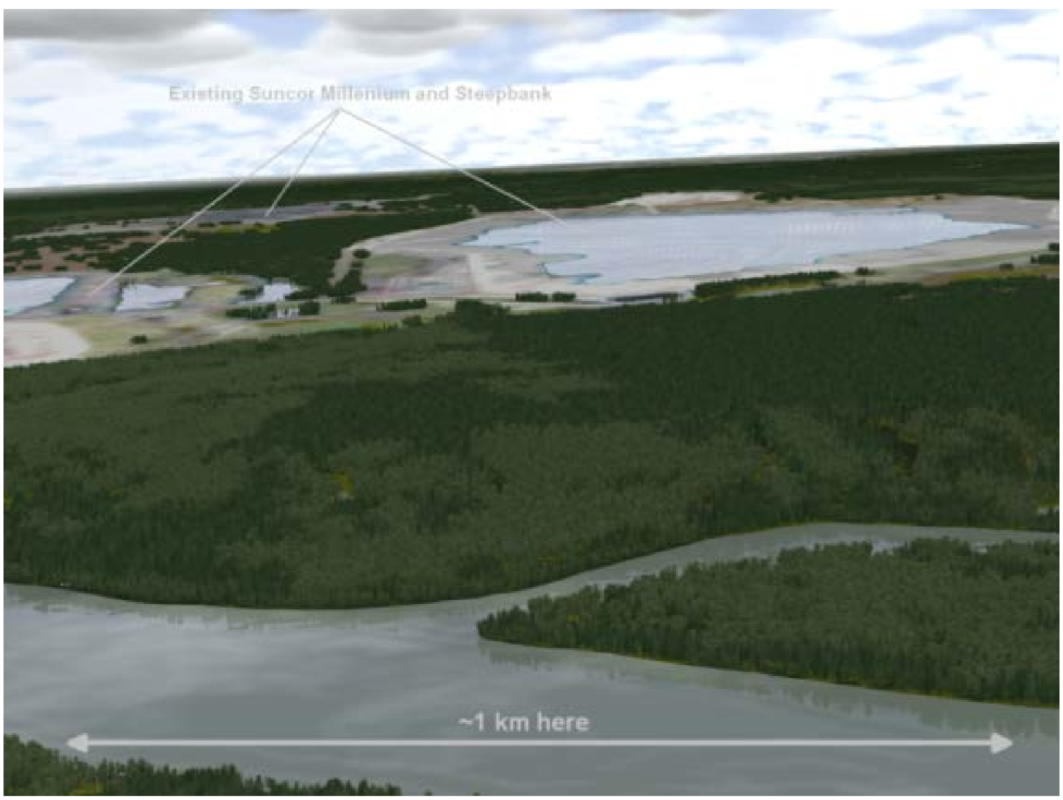


Figure 38 Landscape Visualisation, Southern End, Existing Open Pit Mines

Figure 39 Oblique Aerial Photograph, ~580m above ground level, Northern End

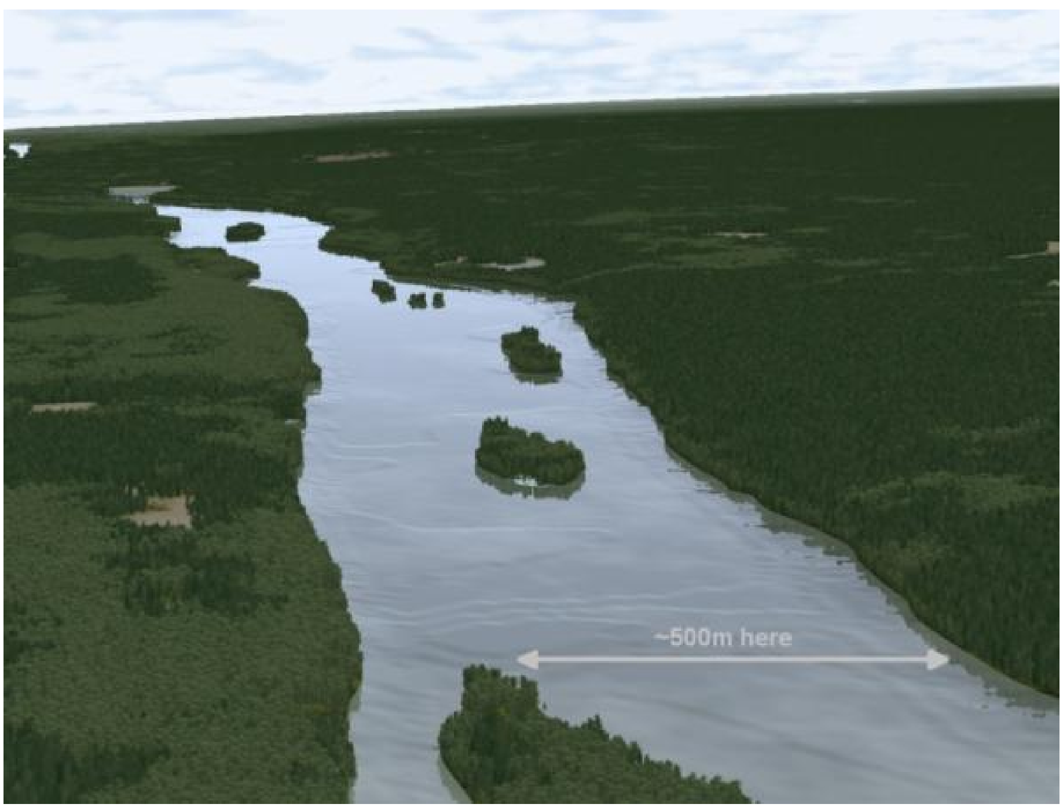


Figure 40 Landscape Visualisation, Northern End

Using the same settings for 3D foliage and ground cover that were calibrated to the two oblique aerial photographs, additional landscape visualisations were generated in Visual Nature Studio for each of the fourteen existing, approved, and proposed open pit mines. As well, one high oblique overhead landscape visualisation where all fourteen open pit mines were visible was generated. Three scenarios were generated for each open pit mine viewpoint showing the all existing, approved, and proposed open pit mines visible from that viewpoint.

The rationale for selecting the oblique aerial viewpoint showing all fourteen open pit mines was the minimum height where it was possible to see all the open pit mining projects in one image. The rationale for selecting the oblique aerial viewpoints (i.e. height, heading, tilt, and field of view) for the individual open pit mines was to be able to see the entire open pit mine project with a horizon in the background for context.

Static landscape visualisations of all existing, approved, and proposed open pit mines were loaded into Google Earth as low-resolution images in "Popup Balloons". Within each "Popup Balloon", "HTML Hyper-links" were included so that higher-resolution images that could be viewed in a web-browser where additional "HTML Hyper-links" were included to allow switching between scenarios. Static landscape visualisations from oblique aerial viewpoints showing the entirety of each open pit mine were generated for each scenario (existing, approved, and proposed). Also, static landscape visualisations from an oblique aerial viewpoint showing all the open pit mines together were generated for each scenario (existing, approved, and proposed). Finally, "Popup Balloons" and "HTML Hyper-links" showing all the scenarios side-by-side were created. Sample high-resolution images are shown in Figure 41 to Figure 46. All the images for each open pit mine within each scenario are shown in Appendix "G".

All Open Pit Mines - High Overhead Oblique (Camera position 56 km above ground level)

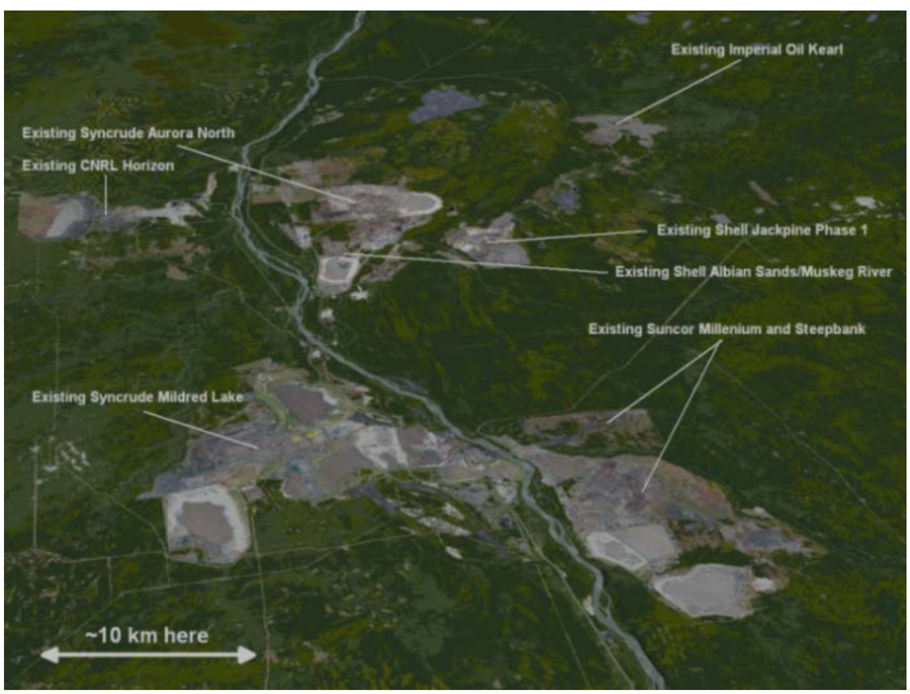


Figure 41 All Open Pit Mines – Existing

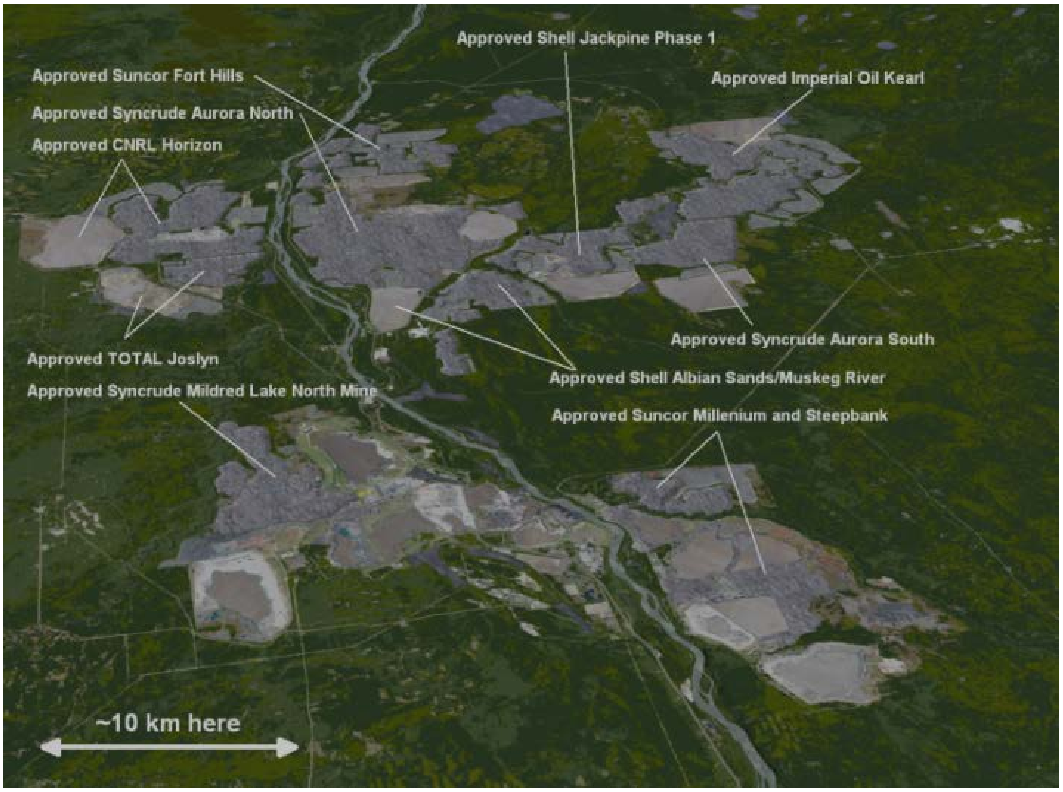


Figure 42 All Open Pit Mines - Approved and Existing

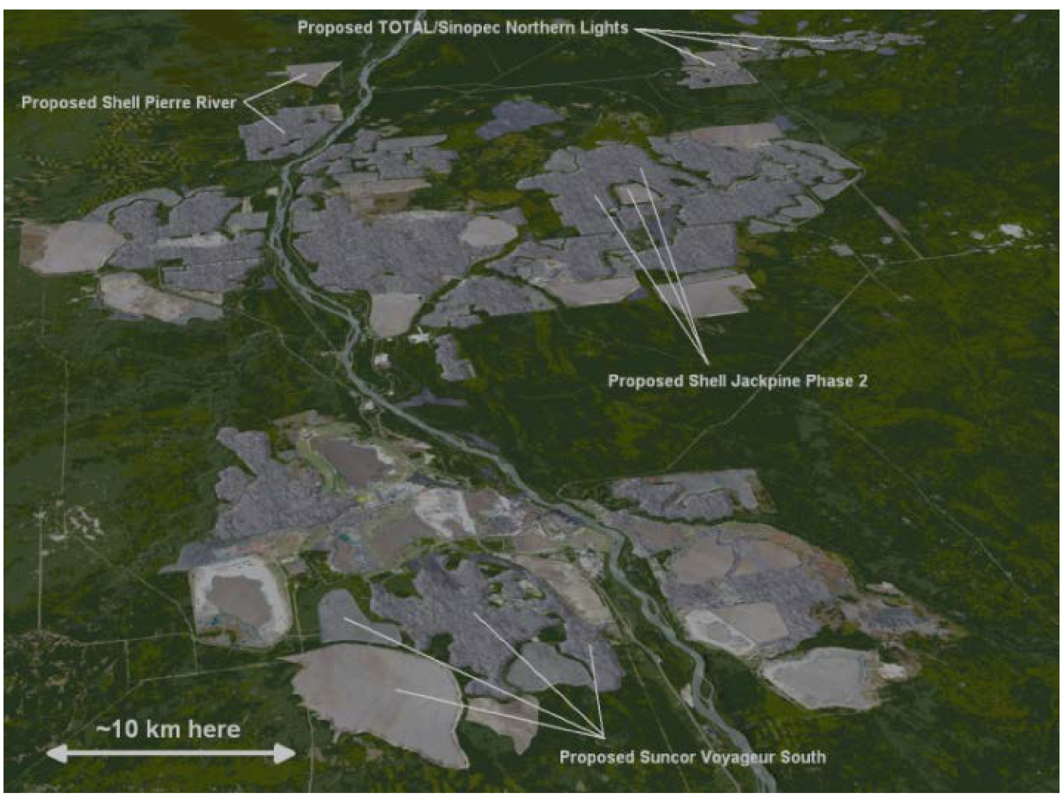


Figure 43 All Open Pit Mines - Proposed, Approved, and Existing

Mine #10 TOTAL Joslyn – Approved Project – Camera Position 2,676 m above ground level

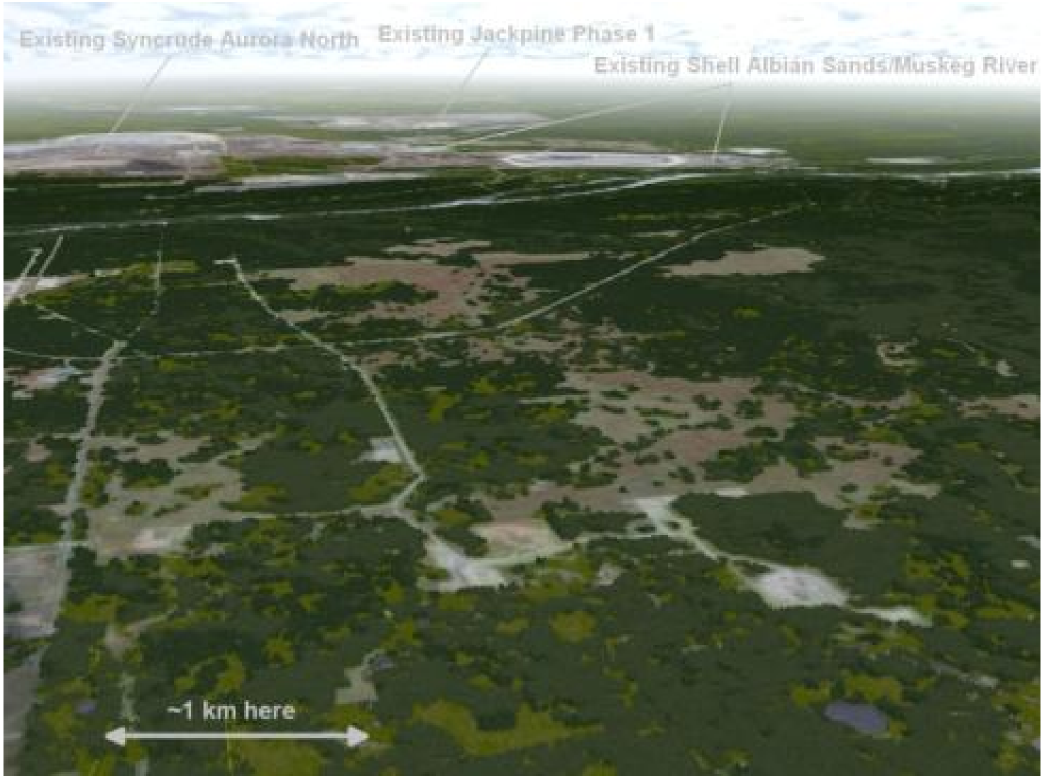


Figure 44 TOTAL Joslyn – Existing

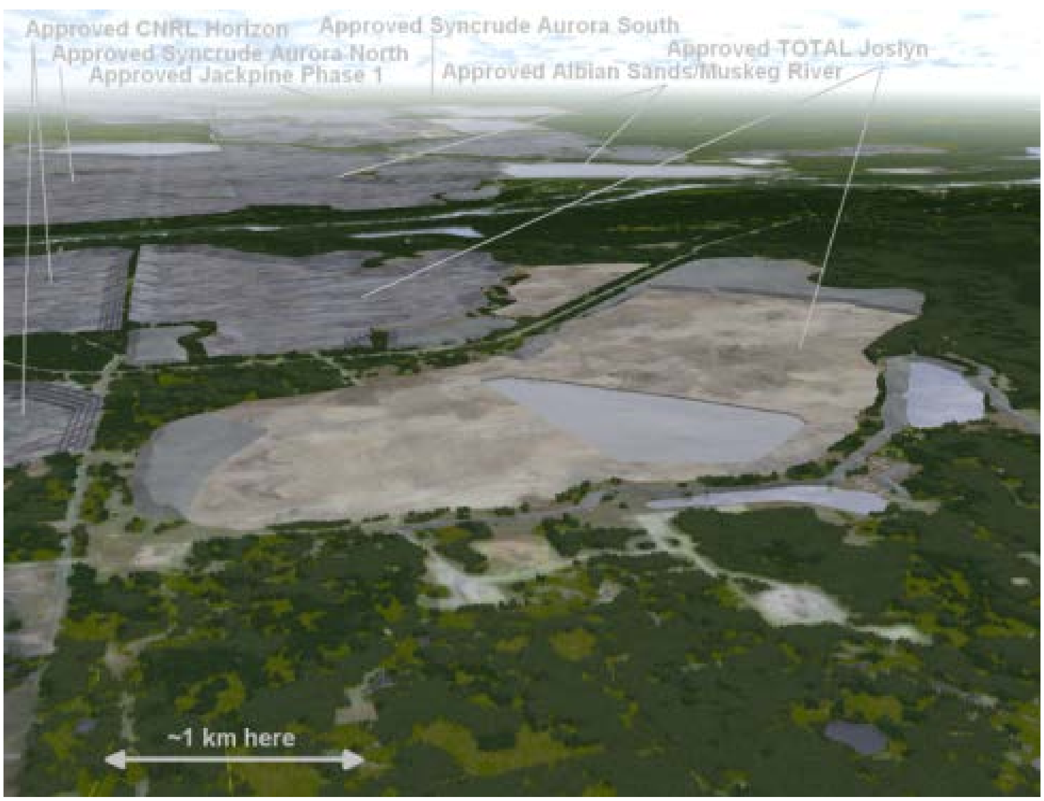


Figure 45 TOTAL Joslyn - Approved and Existing

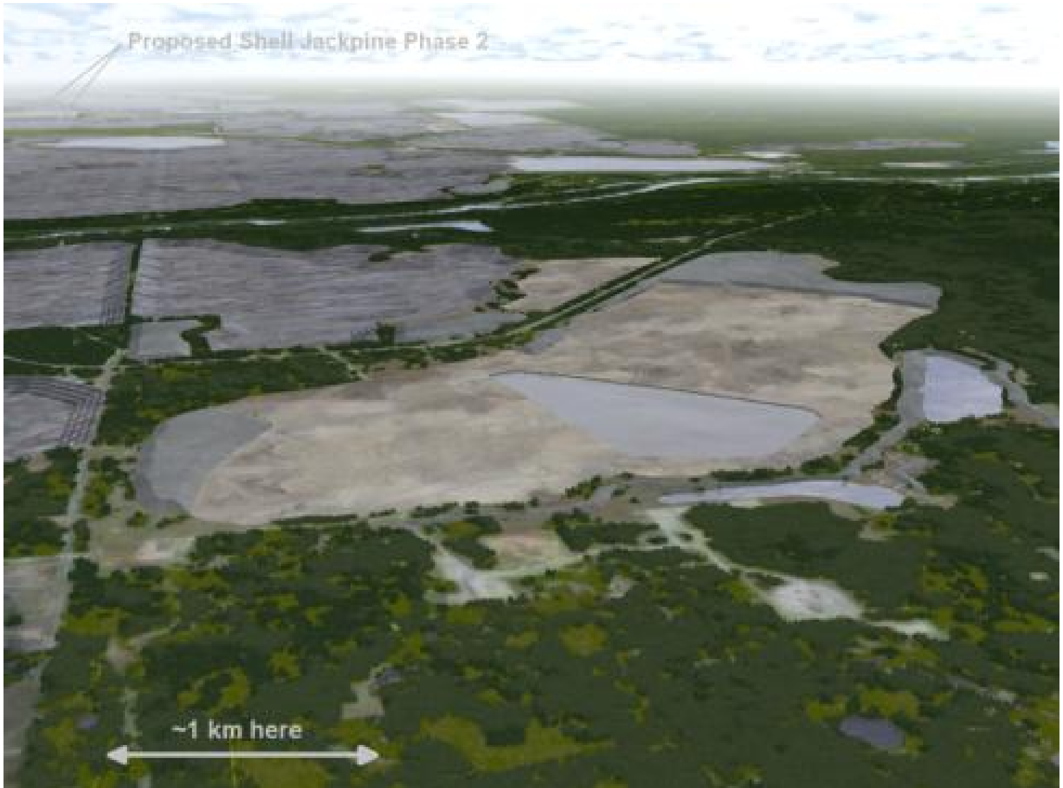


Figure 46 TOTAL Joslyn - Proposed, Approved, and Existing[20]

3.4. Interactive Landscape Visualisations of Sample Tar Sands Open Pit Mines

Unlike static landscape visualisations where the landscape is shown from a fixed viewpoint, interactive landscape visualisations allow the viewer to move at will through the modelled area. Interactive landscape visualisations were created for two sample proposed open pit mines – Shell Pierre River and TOTAL Sinopec Northern Lights. Showing the restoration that would take place once mining is completed for each project was outside the scope of this study.

These two mines were selected to simplify the process of creating the interactive landscape visualisations because they are proposed open pit mines, which are relatively isolated from other existing or approved mines. Therefore, few or no adjacent open pit mines would have to be simulated. Existing photographs of current open pits could not be used because they did not allow for interactive viewing, scale transitions, and future conditions.

There are three levels of detail for each of the two interactive landscape visualisations. Level of detail refers to both the geographic area of visible content as well as the resolution of the data (i.e. lower levels of detail show more geographic areas at lower resolution and higher levels of detail show smaller geographic areas at higher resolution). The first viewpoints at the lowest level of detail were the same as the static landscape visualisations for the Shell Pierre River and TOTAL Sinopec Northern Light open pit mines. As in the static landscape visualisations, the

[20] Note the proposed tar sands open pit mine near horizon in top left of image. When individual tar sands open pit mines are viewed from lower level oblique viewpoints, approved or proposed tar sands open pit mines are only visible on the horizon due to large geographic area of the combined tar sands open pit mines.

rationale for selecting these first aerial oblique viewpoints (i.e. height, heading, tilt, and field of view) for the interactive landscape visualisations was to be able see the entire open pit mine project with a horizon in the background. The aerial oblique viewpoints for the second level of detail were selected to be able to see 3D trees in a representative sample area at the edge of the open pit. The ground-level viewpoints at the third level of detail were selected to view mining machinery and people in the foreground and the open pit wall in the background from the same heading as the second level of detail. While Google Earth software is pre-set to automatically zoom into these viewpoints, the viewer is able to move to any other viewpoint interactively, as well as automatically returning to the original viewpoints.

The three pre-set viewpoints in Google Earth with three levels of detail and viewpoint proximities to ground level are summarized in Table 11.

Table 11 Summary of Interactive Landscape Visualisations

Level of Detail	Shell Pierre River	TOTAL Sinopec Northern Lights
#1 Entire Open Pit Oblique Aerial View	11km x 9.5km terrain and ground textures (~10m pixel resolution) only (no trees) ~1km above ground level	4.5km x 7.5km terrain and ground textures (~10m pixel resolution) only (no trees) ~925m above ground level
#2 Corner of Open Pit Oblique Aerial View	1km x 1km terrain and ground textures (~1m pixel resolution) and trees ~ 325 m above ground level	1km x 1km terrain and ground textures (~1m pixel resolution) and trees ~360m above ground level
#3 Corner of Open Pit Ground View	1km x 1km terrain and ground textures (~1m pixel resolution), trees, and mining equipment at ground level	1km x 1km terrain and ground textures (~1m pixel resolution), trees, and mining equipment at ground level

Using the Visual Nature Studio “Scene Express” export module (3D Nature LLC, n.d.), the six scenes listed in Table 11 were exported as “keyhole markup language” (kml) files that included terrain models and tree cross-boards in COLLADA 3D object modelling format (Khronos Group, 2013) so that they could be loaded into Google Earth software and viewed interactively.[21] A tree-cross board is a simple 3D digital model that places two images in a vertical perpendicular cross. A sample 3D cross-board model of white spruce (*Picea glauca*) is shown in Figure 47.

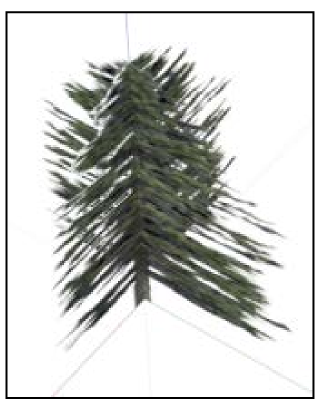


Figure 47 Sample 3D cross-board model of white spruce (*Picea glauca*)

[21] It was discovered that the Visual Nature Studio Scene Express module does not correctly export tree cross-board models. Cross-board models had to be created for each tree species (White Spruce, Black Spruce, and Aspen) in Sketchup software (Google Sketchup, 2007), which replaced the tree models exported from Visual Nature Studio.

Compressed files (kmz format) had to be kept between 3MB and 4MB to allow for efficient access through the internet and also to allow for efficient processing of the 3D images by client-side computer graphics. Therefore, only interactive landscape visualisations at the 1km x 1km level of detail could include trees. Also, only trees above 10m high could be included to reduce file sizes associated with stem density. This reduced the forest tree density and possibly the perceived "thickness" of the forest, as well as eliminating any 3D ground-cover.

Using Visual Nature Studio software, it was possible to digitally excavate into the original terrain to show open pit mines. However, it is impossible to excavate into the standard Google Earth digital elevation model. As a workaround, the "keyhole markup language" (kml) file containing the exported terrain models was edited to raise the baseline elevations of the proposed open pit mines and the surrounding terrain at the rim of the open pit by 75m, which is the depth of the mine pits, so that the open pits would appear in Google Earth.

The consequence of this workaround was that there is a mismatch between the original Google Earth terrain when viewing past the edge of the modified and elevated terrain around the open pit. However, this mismatch does not occur when viewing within the modified and elevated terrain. Due to the absence of a "bump feature", it is also possible for the viewer to pass through the modified terrain during interactive viewing. While it is possible to raise terrain features in Google Earth, the inability to excavate into the original terrain remains an important limitation for visualising open pit mines.

Three-dimensional digital models of mining equipment including the "heavy hauler" dump truck, pickup trucks, and workers were downloaded from the "Sketchup 3D Warehouse" (Trimble Navigation Ltd., 2013) in COLLADA format (Khronos Group, 2013). Since a 3D model of a the type of excavator used in the tar sands open pit mines was not freely available at the "Sketchup 3D Warehouse", a 3D model was purchased and downloaded from a commercial source (The 3D Studio, 2013). However, this 3D model was so detailed that it had a file size of 30MB (Wavefront format), which could not be efficiently served through the internet. The complexity of this 3D model was reduced using Vizup software (Vizup, 2013) and converted to a 6MB COLLADA file using MeshLab software (3D-Coform Project, n.d.). The COLLADA models of the mining equipment were all copied into a kml file, which was edited to place them at the bottom of the open pit mines.

Google Earth screenshots for the pre-set viewpoints of the three levels of detail for the proposed Shell Pierre River open pit mine are shown in Figure 48, Figure 49, and Figure 50. Google Earth screenshots for the pre-set viewpoint of the three levels of detail for the proposed TOTAL Sinopec Northern Lights open pit mine are shown in Figure 51, Figure 52, and Figure 53.

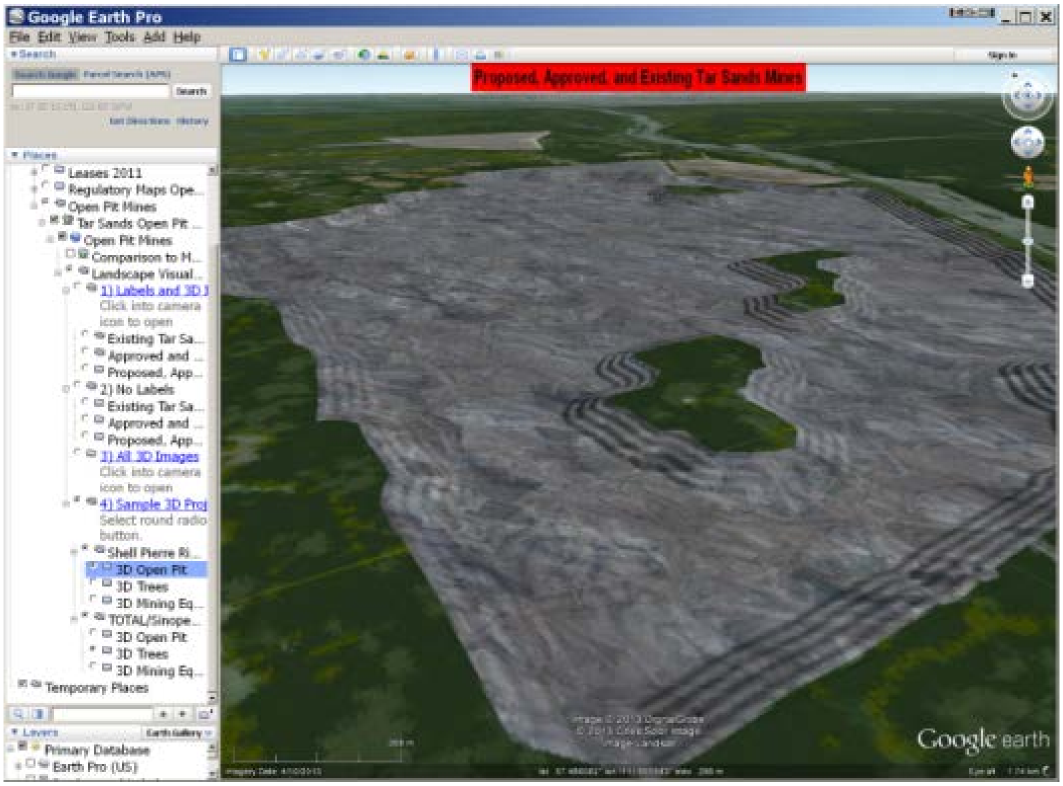


Figure 48 Shell Pierre River Interactive Landscape Visualisation LOD #1

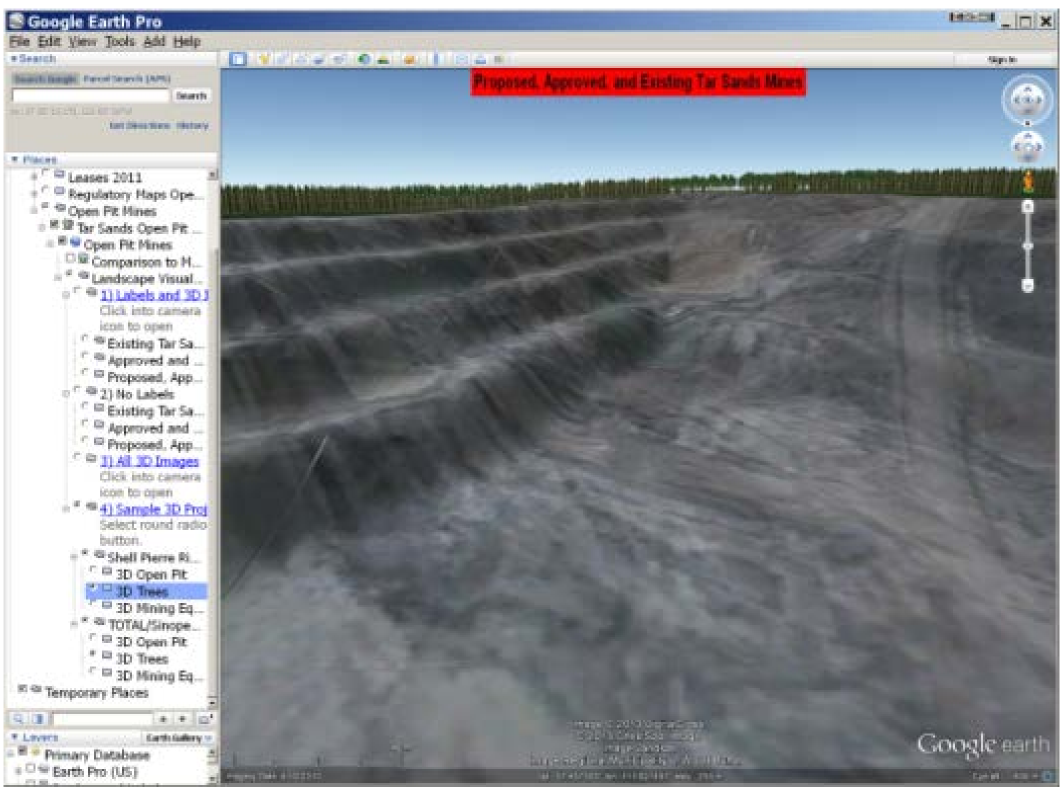


Figure 49 Shell Pierre River Interactive Landscape Visualisation LOD #2

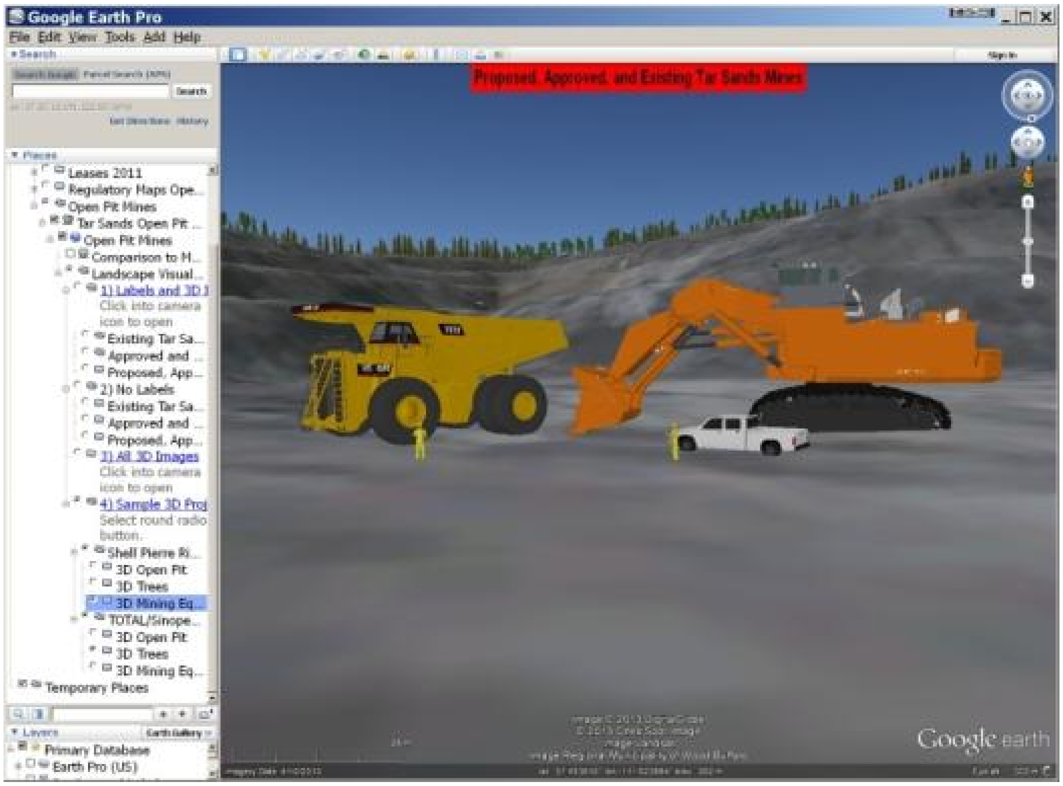


Figure 50 Shell Pierre River Interactive Landscape Visualisation LOD #3

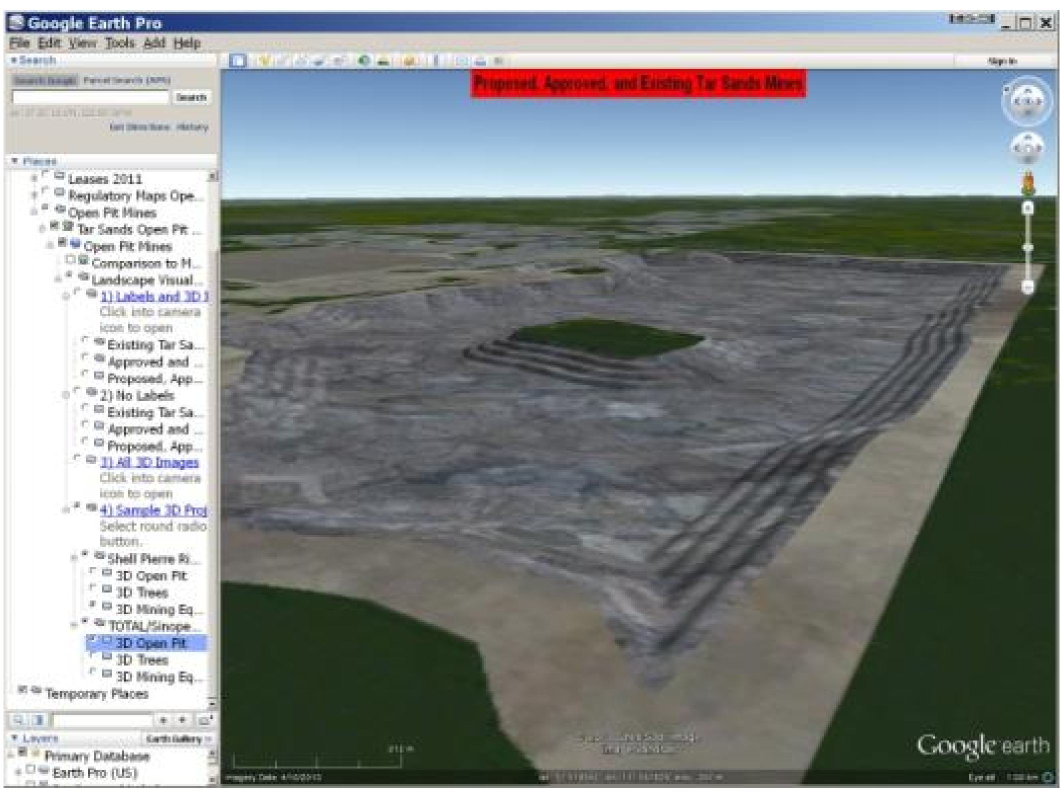


Figure 51 TOTAL Sinopec Northern Lights Interactive Landscape Visualisation LOD #1

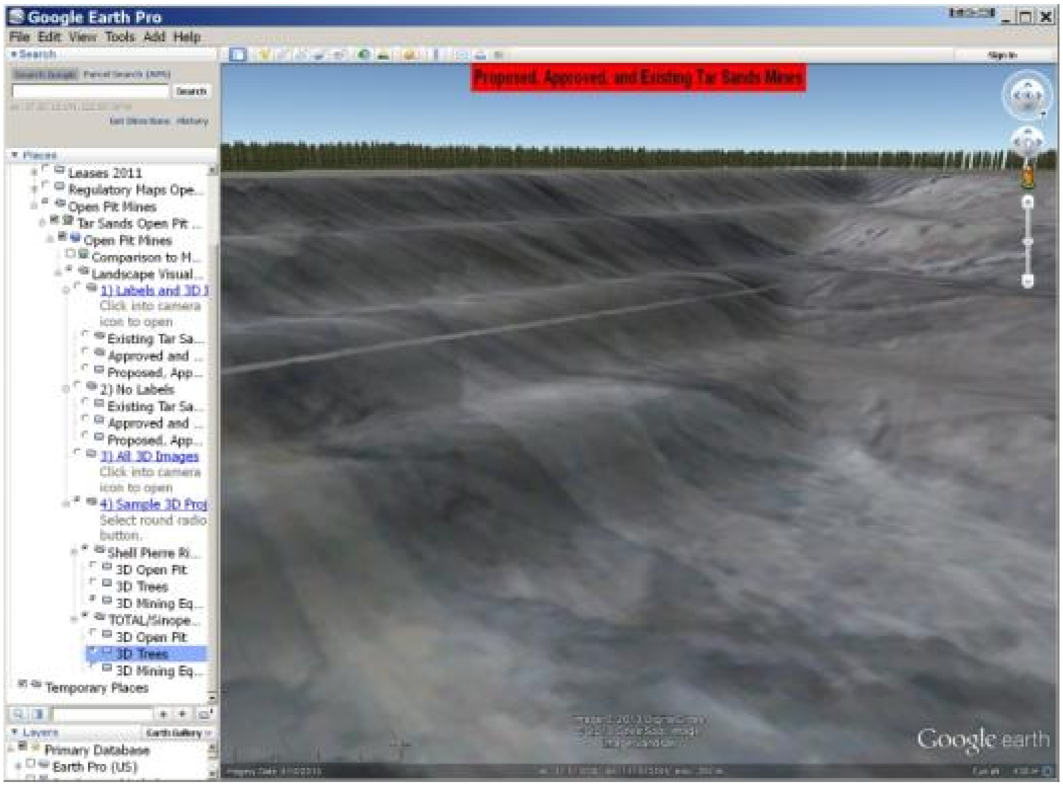


Figure 52 TOTAL Sinopec Northern Lights Interactive Landscape Visualisation LOD #2

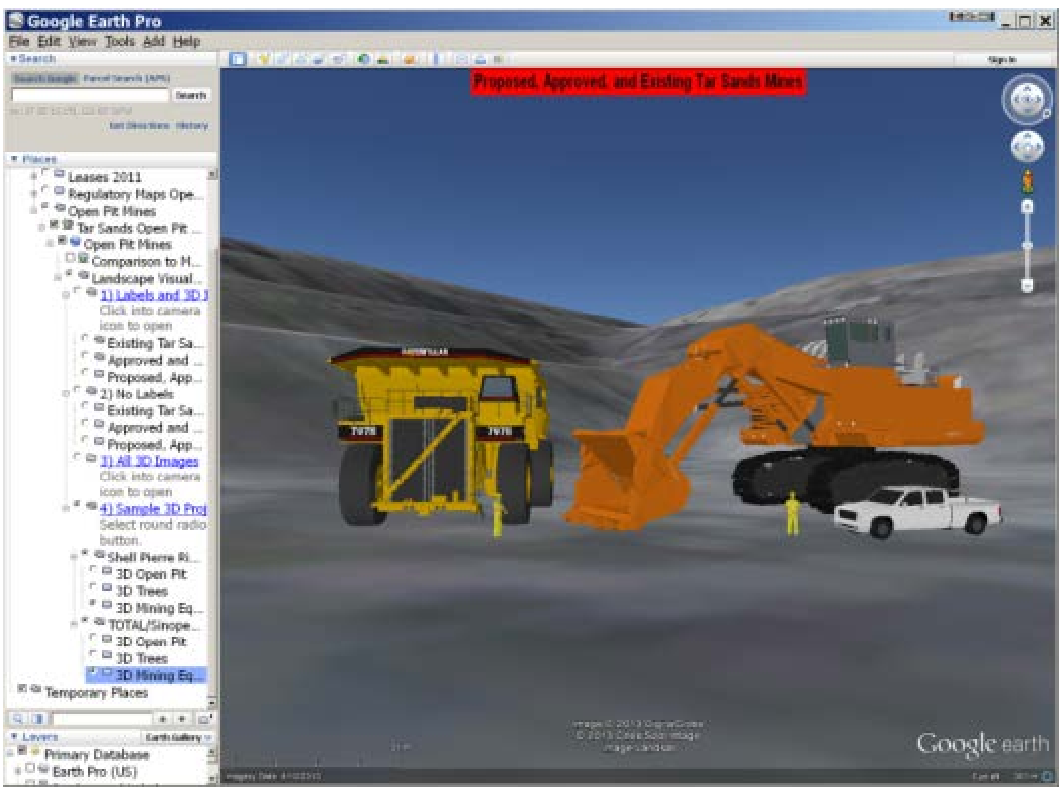


Figure 53 TOTAL Sinopec Northern Lights Interactive Landscape Visualisation LOD #3

3.5. Concluding Comments

In this chapter, the methods used to create maps and landscape visualisations were described at the following geographic scales and levels of detail:

1) Continental Pipeline Maps;
2) Provincial Tar Sands Lease Maps;
3) Regional Maps of Tar Sands Open Pit Mines;
4) Static Landscape Visualisations of Tar Sands Open Pit Mines; and
5) Interactive Landscape Visualisations of Sample Tar Sands Open Pit Mines.

These visual materials were all organized in a Google Earth "Places" menu interface. The detailed instructions to the focus group participants describing the use and operation of the Google Earth interface and contained in the research protocol, which is described in the following "Chapter 4: Social Research Methods"

CHAPTER 4: SOCIAL RESEARCH METHODS

The social data collection procedures are described in this chapter. Details of the data analysis are provided with the data in Chapters 5-7.

4.1. Summary of Procedures

This study examined the responses of members of the general public to visualizations of the tar sand open pit mines, and the effect of viewing those visualizations on their opinions and perceptions. Three focus groups with up to twelve participants each were held. The sessions, lasting two to three hours per session, were facilitated by the researcher in university computer laboratories where each participant accessed a personal desktop computer. The total number of participants was a compromise between practicality of accessing local participants on the available budget and seeking a range of responses at the sample locations in Vancouver and Edmonton. This is consistent with precedents (Lewis & Sheppard, 2005) where in-depth results are desired in exploratory studies to help establish the nature of interactions with the visual material, rather than seeking to generalise to a large population.

During each session, the group discussed their responses to the material and showed each other and the researcher what they were doing, using a screenshot image projected from a computer on a screen. The participants were also asked to fill out one initial questionnaire before the session and one follow up questionnaire after the session to determine if there are any differences in their perceptions or opinions before and after viewing the maps and landscape visualisations. Participants were asked to save screenshots of views they considered most interesting or informative. The screenshots were saved in individual folders on a shared network drive. No names were attached to the screenshots, but the time and date stamp of the digital image was retained. Each computer was also set up to video-record each participant's use of the software. This was a video-recording of the computer screen only – no video of the actual users was captured. Each session was audio-recorded and transcribed.

The research instruments (i.e. initial and follow-up questionnaires, screenshots taken by participants, computer screen video recordings, focus group discussion audio-recordings, and notes taken by observers) were designed to allow for data analysis using a combination of quantitative and qualitative methods, as described in Chapter 6 "Quantitative Methods" and Chapter 7 "Qualitative Methods". The quantitative methods used were:

1) descriptive statistics of questionnaire results and the screenshots taken by participants;
2) statistical tests to identify any significant differences in participant response before and after viewing the maps and landscape visualisations; and
3) statistical tests to identify any significant correlations between cross-tabulated questionnaire variables.

Qualitative methods involved organizing the following data into thematic categories:

1) written responses to open-ended questions in the questionnaires; and
2) transcribed audio-recording of focus group discussions.

The notes taken by the observers and the computer screen video recordings were used to refresh the researcher's memory and to triangulate with the analysis of the transcribed audio recordings of focus group discussions.

4.2. Participant Samples and Locations

Combined with initial and follow up questionnaires, the focus group technique (Morgan, 1997) was selected to allow a fuller exploration of the reasons why users react or interact with the visual material in a particular way in a computer laboratory setting. The goal was to recruit samples from the general public, without particular training or experience in the use of virtual globes such as Google Earth or knowledge about energy projects, but including a range of demographics. It was expected that there might be differences between participants from British Columbia and Alberta, because of the location of the tar sands in Alberta and the existing and proposed tar sands pipelines across British Columbia. Therefore, focus groups of up to twelve participants each were conducted with members of the general public residing in Vancouver and Edmonton. Focus groups were not conducted in Fort McMurray, Alberta the major centre of tar sands open pit mining, due to the anticipated difficulty of recruiting members of the general public who are not economically dependent on tar sands production and development. In order to test and trouble-shoot the research protocol, the questionnaires, and the usability of the Google Earth project, a pre-test was conducted with senior (third and fourth year) undergraduate students from the Faculty of Forestry at the University of British Columbia.

4.2.1. <u>Inclusion and Exclusion Criteria</u>

Potential participants in the focus groups were limited through the following inclusion and exclusion criteria.

4.2.1.1. Inclusion Criteria

The focus group inclusion criteria were defined as:

1) Persons over the age of eighteen; and
2) Residents of Vancouver, British Columbia and Edmonton, Alberta (including surrounding metropolitan and rural areas).

4.2.1.2. *Exclusion Criteria*

In order to recruit participants who did not have any pre-defined biases regarding tar sands production and development, the primary focus group exclusion criteria were:

1) Technical experts in environmental or resource fields;
2) Direct employees of oil and gas projects; and
3) Environmental agency or organization staff.

Additional exclusion criteria were:

1) Persons who are under the age of 18, who cannot provide consent directly;
2) Persons who are visually impaired who cannot operate a standard computer;
3) Persons who do not have at least moderate computer operating skills;
4) A maximum of one employee per company to avoid pre-existing group biases; and
5) A maximum of one member per household to avoid pre-existing group biases

The amount of computer mapping or visualisation experience was not used as an exclusion criterion of potential participants.

4.3. Focus Group Recruitment and Participation

Focus groups with up to twelve participants each were scheduled in university computer laboratories at the following locations:

1) Pre-Test, University of British Columbia Faculty of Forestry (Main Campus, Point Grey) – August 10, 2012, 1pm to 3:30 pm;

2) Vancouver, University of British Columbia (Robson Square Campus, Downtown) – August 13 and 14, 2012, 7pm to 9:30pm; and

3) Edmonton, University of Alberta (Main Campus, Technology Training Centre) – August 16, 2012, 7pm to 9:30pm.

Recruitment was carried out through newspaper advertisements and internet postings, which briefly described the study, the proposed date and location, and which contained the researcher's contact phone number and email. A $25 honorarium and a free "USB flash" drive were offered as a token of appreciation to potential participants. In mid-July 2012, ads were placed in:

1) Georgia Straight (Vancouver weekly);
2) Vue Weekly (Edmonton weekly);
3) Edmonton Journal (Edmonton daily);
4) Craigslist (free Internet ads Vancouver and Edmonton);

5) Kijiji (free internet ads Vancouver and Edmonton); and
6) Undergraduate e-mail list, Faculty of Forestry, University of British Columbia (Pre-test only).

Within forty-eight hours of being contacted by a potential subject by telephone or email, the researcher asked the potential participant screening questions on above criteria by telephone or email, as shown in Appendix “H”.

If the potential participant met the screening criteria, the researcher provided the potential participant with detailed information about the study, including the consent form, as shown in Appendix “I”. Potential participants had at least two weeks from the time they made initial contact with the project investigators to decide whether or not to participate by signing the consent form. Consent forms for the actual focus groups were received within two weeks of contact.

4.4. Focus Group Recruitment and Participation

The ads in the Vancouver weekly newspaper and on the internet sought members of the general public for the focus group session as well as students from the University of British Columbia for the pre-test. However, no responses were received from students, possibly due to the summer break. Therefore, ads for students were also placed on Faculty of Forestry undergraduate mailing list on August 6, 2012. A pre-test with eight confirmed student participants was scheduled for August 10, 2012. The pre-test focus group was used only to refine the research protocol and logistics – the results from it were not used in this study.

The response for the Vancouver focus groups with the general public was large enough that a second focus group session was scheduled for August 13, 2012 in addition to original session scheduled for August 14, 2012. Even with the addition of a second session, nine potential participants were placed on a waiting list and could not be included. In Vancouver, no potential participants had to be screened out.

In Edmonton, the initial ads in the weekly newspaper and internet ads yielded only six potential participants. Therefore, an additional ad was placed in the daily newspaper for one day, which brought the number of confirmed participants to twelve. In Edmonton, five potential participants who worked for the oil and gas industry or a government environmental agency were screened out, while two potential participants were placed on a waiting list and could not be included.

Each confirmed participant was reminded about the time and place of each focus group at least 24 hours ahead of time by email or phone. The actual number of participants who attended the pre-test focus group is shown in Table 12.

Table 12 Participants Attending Pre-Test

Location and Date	Number of Participants Attended Entire Session	Missing Participants
UBC Pre-Test Aug. 10, 2012	7	1 participant left following the introduction

The actual number of participants who attended the three focus groups is shown in Table 13.

Table 13 Participants Attending Focus Groups

Location and Date	**Number of Participants Attended Entire Session**	**Missing Participants**
Vancouver, Aug. 12, 2012	11	1 participant left during the break
Vancouver, Aug. 13, 2012	10	2 participants forgot to attend and sent regrets
Edmonton, Aug. 15, 2012	11	1 participant showed up late and missed initial questionnaire and therefore he was asked not to complete the follow-up questionnaire
TOTAL	**32**	**4 total missing participants**

Therefore, the total number of participants who attended an entire focus group and who completed both initial and follow up questionnaires was 32.

4.5. Research Facilities

The sessions were held in standard university instructional computer labs where personal computers running Microsoft Windows operating systems (Microsoft Corporation, 2013) were connected through a local area network with high-speed internet access of at least 20Mbps. Schematic drawings of the two floor layouts for the computer labs at the University of British Columbia (Robson Square Campus) and at the University of Alberta, Technology Training Centre are shown in Figure 204 and Figure 205 in Appendix "J". Each participant sat at one of twelve personal computer workstations and faced the researcher, who in turn faced all the participants from the front of the room at his own computer workstation. The contents of the researcher's personal computer were also projected onto a five foot wide screen, which could be seen by all the participants. It was important to maintain a similar range of distances (approximately 6 to 20 feet) and viewing angle to the big screen between the Vancouver and Edmonton focus groups. Overall there was no major difference.

Overall the floor layouts of the two computer laboratories were somewhat similar, with two major differences:

1) The University of Alberta lab was a bigger room that had larger and more comfortable workstations for the participants than the University of British Columbia lab, which was quite cramped; and

2) Due to space limitations, the observers in the University of British Columbia lab were only able to sit at the back of the room behind the focus group participants. Although they could see the researcher's computer projected on the large screen and could also see what the participants were viewing on their individual screens, the observers could not see the facial expressions of the participants. At the University of Alberta lab, the observer remained sitting at the front of the room so he could see the facial expressions of the participants as well as the researcher's computer projected on the large screen, but he could not see what the participants were doing on their individual computer screens. These differences did not affect the interpretation of the results, since the notes taken by the observers were only used to refresh the researcher's memory about participants'

verbal comments. The researcher did not attempt to document or interpret participants' facial expressions.

As summarized in Table 14, the greatest difference between the two computer labs was the quality of the computer hardware, which was likely to influence research results. Overall, the hardware at the University of Alberta was considerably more advanced than the University of British Columbia (Robson Square Campus). The most significant limitation of the computer hardware at the University of British Columbia was the lack of a graphics card with dedicated video memory, which made viewing the interactive landscape visualisations cumbersome. This is discussed in more detail in Chapter 6 "Quantitative Analysis" and Chapter 7 "Qualitative Analysis".

Table 14 Computer Lab Hardware Specifications

Computer Lab	**Processor**	**Random Access Memory**	**Hard Drive**	**Video Card**	**Monitor**
University of British Columbia, Robson Square Campus	Intel Core 2 Duo 2.13 GHz Processor	2 GB	80 GB Hard Drive	Built in Intel Graphics Media Accelerator	DELL 19" LCD monitor
University of Alberta, Technology Training Centre	Intel i7 870 2.93 GHz	8 GB	1TB hard drive (2 partitions)	nVidia GeForce GT 430 1GB memory	21" wide screen monitor

4.6. Research Protocol

Google Earth software (Google Corporation, 2007) and Debut Video Capture software (NCH Software, 2013) were installed on all the computers and the keyhole markup language (kml) network link file to the tar sands maps and landscape visualisations was loaded into Google Earth. Right at the beginning of each focus group session, the researcher started up the screen video capture in Debut Video Capture software. At the same time, the technical assistant started the audio recording of the focus group session using an omni-directional microphone placed in the middle of the computer lab.

The focus groups included up to two assistants and up to two observers, who took notes. In all sessions, an assistant who was skilled in the use of Google Earth software was available for technical support to focus group participants.

Based on the pre-test with undergraduate students at the University of British Columbia, Faculty of Forestry, the following minor changes were made to the research protocol and questionnaire:

1) A handout with the brief factual context about the tar sands, as shown in Appendix "N", was handed out only after the initial questionnaire had been completed to avoid biasing the response;

2) Note paper stating “Please do not use computer until instructed” was taped across each of the participant’s computer screens to prevent participants from becoming distracted by using the computers during the introductory parts of the focus group session; and

3) The follow up questionnaire was modified by adding “Trees” as one of the multiple option check marks for the question “What images or features were most helpful in expressing the ***scale*** of the open pit tar sands projects? Please check all that apply.”

Upon arriving at each location, focus group participants were greeted at the entrance of the computer laboratories by the assistants sitting at a table. Each participant was provided a name tag with their first names only and given the $25 honorarium in cash, for which they were asked to sign a receipt. The honorarium was provided during registration, thereby giving subjects the opportunity to withdraw without disrupting the session or waiting until the session was complete to receive their honorarium had they decided not to complete the focus group. At the conclusion of the session, participants who had completed the entire focus group session were also provided with a “USB flash” drive containing all the screenshots that they had individually selected.

A summary of the research protocol is shown in Table 15 and the full research protocol is shown in Appendix “K”.

Table 15 Summary of Research Protocol

Activity	**Activity Time (min)**	**Cumulative Time (hrs: min)**
1. Introduction	3	0:03
2. Initial Questionnaires	10	0:13
3. Brief Factual Context	2	0:15
4. Practice Navigation and Screenshots	10	0:25
5. Context of Tar Sands Development	10	0:35
6. Existing Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	30	1:05
7. Break	10	1:15
8. Adding Approved Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	25	1:40
9. Adding Planned Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	35	2:15
10. Follow Up Questionnaires	10	2:25
11. Collect Questionnaires and Copy Individual Screenshots to Jump Drives	10	2:35

During each major component in the research protocol, participants were asked if they had any questions. The research protocol is described in more detail as follows:

1) Introduction – The focus groups began with a brief introduction where the researcher reviewed the agenda and read out the confidentiality statement contained in the consent form.;

2) Initial Questionnaires – Participants were asked to complete the initial questionnaires , as shown in Appendix “L”. Participants were notified when there were five minutes left and

when there was one minute left before the assistants collected the completed questionnaires;

3) Brief Factual Context – The assistants distributed a printed handout with a brief factual context about tar sands development on seven slides to the participants. These slides were presented by the researcher using his computer projected on the screen;

4) Practice Navigation and Screenshots – The researcher led the focus group participants through a brief demonstration of keyboard and mouse navigation controls for Google Earth, which were also summarized in the handout provided to participants for future reference (Google Corporation, 2013a). The researcher also showed the participants how to take screenshots using Debut Video Capture software (NCH Software, 2013) by pressing the "F10" key;

5) Context of Tar Sands Development – Using the Google Earth interface with the tar sands project database described in Chapter 3, the researcher presented the context of tar sands development at the continental scale showing pipelines, at the provincial scale showing tar sands leases, and at the individual project scale showing the regulatory maps.[22] The researcher showed the participants how to select different scenarios and levels of detail and how to navigate through the material;

6) Existing Tar Sands Open Pit Mines – The researcher showed the participants how to select the existing tar sands open pit mine scenario and how to navigate through the material. He also showed the participants how to click on the "placemarks", which displayed the static landscape visualisations in "popup balloons". The researcher pointed out the comparisons of the two sample oblique aerial photographs taken in 2008 to the corresponding static landscape visualisations in the "popup balloons" as a way of assessing the accuracy of the landscape visualisations. The researcher then showed how the hyper-links in the "balloons" could be clicked to display the larger high resolution images of the static landscape visualisations covering most of the computer screen. The researcher showed how the outlines of the major cities could be compared to the existing tar sands open pit mines in plan view. Participants were given three minutes of free time to conduct their own exploration and reminded to take screenshots throughout the presentation. At the end of the demonstration, the researcher asked up to two participants to present the most informative and compelling screenshots to the focus group, which the researcher accessed through the local area network and projected onto the computer screen. During these screenshot presentations, the researcher encouraged discussion among the participants;

7) Break – Refreshments were provided for the participants in the hall outside the computer labs;

8) Adding Approved Tar Sands Open Pit Mines – The researcher showed the participants how to select and view the approved tar sands open pit mine scenario. He asked

[22] The "regulatory maps" are the approved and planned projects from government and industry data described in Section 3.3.2.

participants to click on the “placemarks”, which would display the static landscape visualisations in “balloons”. The researcher then asked the participants to click the hyper-links in the “balloons” to display the high resolution images of the static landscape visualisations. He also asked the participants to click on additional hyper-links within the web-pages displaying the static landscape visualisations to access the “existing” and “proposed” scenarios. The researcher asked the participants to compare the outlines of the major cities to the approved tar sands open pit mines. Participants were given three minutes of free time to conduct their own exploration and reminded to take screenshots throughout the presentation. At the end of the demonstration, the researcher asked up to two participants to present the most informative and compelling screenshots to the focus group, which the researcher accessed through the local area network and projected onto the computer screen. During these screenshot presentations, the researcher encouraged discussion among the participants;

9) Adding Proposed Tar Sands Open Pit Mines – The researcher showed the participants how to select the proposed tar sands open pit mine scenario. He asked participants to navigate through all the features that had already been presented in the previous scenarios. In addition, the researcher showed the participants how to select the sample interactive landscape visualisations for the proposed Shell Pierre River and TOTAL Sinopec open pit mines. The researcher showed the participants how to view the interactive landscape visualisations at three levels of detail and how to navigate through the interactive landscape visualisations. Participants were given three minutes of free time to conduct their own exploration and reminded to take screenshots throughout the presentation. At the end of the demonstration, the researcher asked up to two participants to present the most informative and compelling screenshots to the focus group, which the researcher accessed through the local area network and projected onto the computer screen. During these screenshot presentations, the researcher encouraged discussion among the participants;

10) Follow Up Questionnaires – Participants were asked to complete the follow up questionnaires , as shown in Appendix “M”. Participants were notified when there were five minutes left and when there was one minute left before the assistants collected the completed questionnaires; and

11) Collect Questionnaires and Copy Individual Screenshots to Jump Drives – As the participants handed in their questionnaires, the researcher copied their individual screenshots to individual “USB Flash” drives, which were given to each participant as a token of appreciation and souvenir of the focus group session.

The above protocol (via demonstrations and participants' own explorations) thus allowed focus group participants to view the following content and viewpoints on the tar sands open pit mines via the Google Earth interface tool as:

1) Regional mapping of existing/approved/planned scenarios, seen interactively at scales from global down to individual pits, in plan view or oblique aerial views at varying elevations, with 3D terrain but without 3D vegetation or excavated pits;

2) Static landscape visualisations as medium-resolution images in “pop up balloons” or high-resolution images in full-screen of the existing/approved/planned scenarios, seen in static pre-selected views at the regional overview scale and at individual pit scale, in oblique aerial views (mostly at lower elevations), with 3D terrain, 3D vegetation, and 3D excavated pits; and

3) Interactive full-3D landscape visualizations of two future planned open pit mines, seen interactively at scales from low elevation views of an individual pit to ground-level views showing mining machinery and people at the bottom of a pit with 3D terrain, 3D vegetation, and 3D excavated pits.

At the end of each focus group session, the researcher stopped the video recording on each computer and then used the local area network to copy all the screenshots and video recordings to a portable hard-drive. The technical assistant also stopped the audio recording. At the conclusion of each session the computer lab technicians were asked to delete all the material from the network and workstations.

4.7. Questionnaires

This section summarizes the initial and follow-up questionnaires, which are shown in Appendix “L” and “M” respectively. Both questionnaires were printed on 8.5”x11” black and white paper and stapled in the top left hand corner. The initial questionnaire was six pages long and the follow up questionnaire was eight pages long. Each copy of the initial and follow up questionnaires was coded with each participant’s unique personal identification number, which was also the same unique personal identification number used for each participant’s screenshots and the video. The questionnaires were distributed to the participants along with 8.5”x11” manila envelopes that were only marked with “Q1” or “Q2” to identify them as the initial and follow up questionnaires respectively. Upon completing the questionnaires, participants were asked to insert them into the envelopes, seal them, and return them to the assistants.

4.7.1. Initial Questionnaire

The initial questionnaire consisted of three sections:

1) Section I: General Questions;
2) Section II: Scale Questions; and
3) Section III: Other Questions.

4.7.1.1. Section I: General Questions

Using a five point ordinal rating scale ranging from 1 to 5, participants were asked to rank their previous experience:

1) Reading or using maps;
2) Using computers; and
3) Using Google Earth or other computer mapping programs.

Also using a five-point ordinal rating scale ranging from 1 to 5, participants were also asked to rank how frequently had seen or read about the open pit tar sands project near Fort McMurray, Alberta in the following media:

1) Photographs;
2) TV broadcasts, films, or videos;
3) Articles or books; and
4) Maps.

Using a multi-option variable checkmark, participants were asked if they had ever:

1) Seen or been to the open pit tar sands projects near Fort McMurray
2) Seen the projects form a plane or helicopter
3) Seen the projects from the ground; and
4) Lived nearby for a period of time.

4.7.1.2. Section II: Scale Questions

Using a five-point ordinal rating scale ranging from 1 to 5, participants were asked about their knowledge of the size or geographic area of the open pit tar sands projects near Fort McMurray, Alberta. Using a circle-the-answer format including the option to answer “Don’t Know”, participants were asked how large they thought the total size or geographic areas was of the combined ***existing*** open pit mines. Using a five-point ordinal rating scale ranging from +2 (Very Supportive) to -2 (Very Opposed), participants were asked their opinion about the ***existing*** open pit tar sands projects that have already been built. Participants were asked an open-ended question to explain why they were opposed or supportive.

Using a circle-the-answer format including the option to answer “Don’t Know”, participants were asked how large they thought the total size or geographic areas was of the combined ***approved*** open pit mines. Also using a circle-the-answer format including the option to answer “Don’t Know”, participants were asked how many times they thought that the total size or geographic area of the combined open pit tar sands would increase if all the ***approved*** projects were built in addition to the ***existing*** open pit tar sands projects.

Using a circle-the-answer format including the option to answer “Don’t Know”, participants were asked how large they thought the total size or geographic areas was of the combined ***planned*** open pit mines. Also, using a circle-the-answer format, including the option to answer

“Don’t Know”, participants were asked how many times they thought that the total size or geographic area of the combined open pit tar sands would increase if all the ***planned*** and ***approved*** projects were built in addition to the ***existing*** open pit tar sands projects.

Using a five-point ordinal rating scale ranging from +2 (Very Supportive) to -2 (Very Opposed), participants were asked their opinion about the expansion of the future ***approved and planned*** open pit tar sands projects that have already been built. Participants were asked an open-ended question to explain why they were opposed or supportive.

4.7.1.3. Section III: Other Questions

Using a fill-in-the-blank format, the participants were asked about their residence. Using single-option checklists, participants were asked about their:

1) Gender;
2) Age group;
3) Highest level of formal education; and
4) Occupation (For the occupation variable, an additional fill in the blank format was provided for “Other”).

Using a five point ordinal rating scale ranging from 1 to 5, participants were asked how involved they are right now in promoting their opinions about tar sand development in the Fort McMurray region of Alberta to government, industry or the public. Finally, participants were asked to provide open-ended comments or concerns about tar sands development or this questionnaire.

4.7.2. Follow Up Questionnaire

The follow up questionnaire was presented all in one section. Using a five-point ordinal rating scale ranging from 1 to 5, participants were asked about how much new knowledge they gained about the size or geographic area of open pit tar sands projects near Fort McMurray, Alberta.

As in the initial questionnaire the same questions were asked about the size or geographic area of ***existing*** open pit mines and the participant’s opinion about these existing open pit mines were repeated. The participants were asked an open-ended question to explain if they felt more or less concerned or supportive.

As in the initial questionnaire, the same questions were asked about the size or geographic area of ***approved*** open pit mines and the increase in size of the ***approved*** open pit mines in addition to the ***existing*** open pit mines.

As in the initial questionnaire, the same questions were asked about the size or geographic area of ***planned*** open pit mines and the increase in size of the ***planned and approved*** open pit mines in addition to the ***existing*** open pit mines. Using a five-point ordinal rating scale ranging from +2 (Very Supportive) to -2 (Very Opposed), the participants were asked about their opinion of the expansion of future ***approved*** and ***planned*** open pit mines near Fort McMurray, Alberta.

Participants were then asked an open-ended question to explain why they were opposed or supportive.

Using a five-point ordinal rating scale ranging from 1 to 5, participants were asked if their opinion about the open pit tar sands projects had changed as a result of this focus group. This was followed by an open-ended question asking the participants to explain why.

Using five-point ordinal rating scale ranging from 1 to 5, participants were asked how useful they found the Google Earth tool in learning about the open pit tar sands projects in the Fort McMurray region of Alberta. Using a multi-option checklist, participants were asked what images or features they thought were most helpful in expressing the scale of the open pit tar sands projects. This checklist included:

1) People;
2) Mining Machinery;
3) Trees;
4) Cities;
5) Alberta Provincial Boundary;
6) Zoom tool;
7) Scale tool; and
8) Images in Popup Balloons.

An open-ended question also asked the participants to list any other images or features.

Using an open-ended question format, participants were asked two open-ended questions to provide any additional comments about the Google Earth tool's ***weaknesses*** and ***strengths*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features.

Using a five-point ordinal rating scale ranging from 1 to 5, participants were asked how believable they found the ***maps*** shown in the Google Earth tool. Using an open-ended question format, participants were asked which maps they found most compelling or informative and to explain briefly why. Using an open-ended question format, participants were asked how the maps might have been improved and to explain briefly how.

Using a five-point ordinal rating scale ranging from 1 to 5, participants were asked how believable they found the static ***3D computer simulations*** shown in the "balloons" in the Google Earth tool. Using an open-ended question format, participants were asked which ***3D computer simulations*** shown in the "balloons" in the Google Earth tool they found most compelling or informative and to explain briefly why. Using an open-ended question format, participants were asked how the ***3D computer simulations*** shown in the "balloons" in the Google Earth tool might have been improved and to explain briefly how.

Using an open-ended question format, participants were asked if they had any problems understanding the research process or filling out the questionnaire and to explain briefly. Finally, using an open-ended question format, participants were asked to provide any additional comments on the tar sands, the Google Earth tool, or the overall research session.

4.8. Concluding Comments

In this chapter, the components of the social research methods, which were participant samples and locations, focus group recruitment and participation, research facilities, research protocol, and questionnaires have been described. In the following "Chapter 5: Results", the data obtained in the focus groups is described.

CHAPTER 5: RESEARCH DATA

The purpose of this chapter is to describe the data collected from the focus groups, which were:

1) Transcripts of focus group discussions and notes from observers;
2) Participants' screenshots;
3) Screen video capture of participants' use of computers; and
4) Completed questionnaires (i.e. descriptive statistics and written responses to open-ended questions).

The quantitative analysis of the questionnaire data and the participants' screenshots is presented in Chapter 6 "Quantitative Analysis". Qualitative analysis of the transcripts from the focus group discussions and the written responses to the open-ended questionnaires is presented in the Chapter 7 "Qualitative Analysis".

5.1. Transcripts of Focus Group Discussions

The researcher transcribed the focus group discussions. Given that the pre-test was performed to fine-tune the research protocol, the recorded audio of the pre-test session was not transcribed. The transcribed material from the focus groups is presented thematically rather than chronologically in Chapter 7 "Qualitative Analysis". To further reduce the time and effort required, those portions of the focus groups where the researcher was presenting while following the text in the research protocol were not transcribed. Only those portions of the focus groups where participants asked questions and engaged in discussion were transcribed.

The researcher used the notes provided by the observers to refresh his memory and to gain additional perspective about the emotional reactions of participants to the material. Thereby, the researcher identified "Key moments" where the tone of participants' voices became emotional or where several participants became excited and started talking all at once.

Each focus group session started at 7pm and concluded by 9:30pm. The time shown in the focus group transcripts is the time in the audio file where the recording started at "0:00:00" at about 7p.m. Where an unknown participant asked a question or engaged in discussion, he or she is listed as "Unknown participant". Where a known participant asked a question or engaged in discussion, he or she is listed according to his or her unique personal identification number. Other codes used in the transcripts are:

1) PC = Petr Cizek;
2) KW = Kyle Whiting; and
3) SS = Stephen Sheppard

The researcher's comments and descriptions of participant reactions are written in block letters (i.e. CAPS) in the transcript. When a participant's voice was unclear, the term "INDISTINCT" is used in the transcript.

5.2. Participants' Screenshots

According to the research protocol, participants were asked to press "F10" on their keyboards to capture screenshot images of viewpoints in Google Earth that they found interesting. To motivate participants to take these screenshot images, they were told that they would receive copies of all their screenshot images on a complimentary USB flash-drive following the completion of the session. Using Debut Video Capture software (NCH Software, 2013), screenshot images were recorded as medium resolution (≤ 500 KB) ".jpgs" on each participant's individual computer.

All screenshot images, including duplicates, were counted in the analysis and this may affect results. Some duplicate screenshot images may have been captured because participants did not have a visual cue that a screenshot image had been taken or they were just getting used to the computer interface.[23] On the other hand, these duplicate screenshot image images may have been captured because participants were so interested in the image displayed on the monitor that they pressed "F10" several times. It is impossible to know why duplicate screenshots were taken because they appear throughout the course of the focus group sessions.

Following completion of the session, screenshot images from each individual computer were copied to each participant's complimentary USB flash-drive. The screenshots were also copied to the researcher's portable hard-drive into unique folders designated for each participant.

It was later discovered that screenshot images from participant E03 were mistakenly copied into the folder of participant E02. Coincidentally, following the session, participant E02 had emailed the facilitator 17 out of 42 screenshot images that he had selected, requesting permission to send them to his colleagues. Unfortunately, participant E02 had erased the "redundant" 25 screenshot images from his USB flash-drive. Therefore, there are 25 missing screenshot images from the total dataset of 1,299 screenshot images or 1.9% of the total.

5.3. Video Capture of Participants' Use of Computers

Using Debut Video Capture software (NCH Software, 2013), videos of computer screen activity were successfully recorded of the entire focus groups from 26 out of 32 participants (i.e. 81.3% success rate). It is not known why all the video recordings did not succeed. In one case, a computer froze up and had to be powered down and restarted. Although the video capture software was shrunk to the notification area of the Windows operating system taskbar, some participants may have also mistakenly shut off the video recordings. It was found that running the video capture of screen activity consumed considerable computing resources rendering the

[23] "Debut version 1.64" shareware was used in the focus groups to capture both screenshots and video from each participant's computer screen. This software was minimized to the toolbar and was run in the background so that the participants' video screens were filled with a window of the Google Earth software only. Although "Debut 1.64" does provide a "flash" option when a screenshot is taken, this does not work when the software runs in the background. "Debut 1.64" does provide a "camera shutter" audio sound option when screenshots are taken, but the lab computers all had their audio turned off to avoid distracting the participants. A newer version of the software Debut version 1.7 was released after the focus groups had already taken place. This version provides a visual cue that a screenshot has been taken by using a "popup" balloon from the icon in the toolbar, regardless of whether the software is running in the background or not.

software somewhat unstable so in some cases the video capture may have stopped due to a computer failure.

Video recordings were purposely set in low resolution compressed format (1024 kbps in Windows Media Video format) to maintain file size within an acceptable level during the two and half (2.5) hour workshops. Nevertheless, all the successful video recordings have file sizes exceeding 1GB.

While these video recordings were used selectively to confirm some participants' use of the Google Earth interface, they have not yet been analysed systematically. As there are 26 video recordings lasting two and half (2.5) hours each, this would require reviewing 65 total hours of video.

5.4. Completed Questionnaires

A total of 32 participants attended each entire focus group and completed both the initial and follow up questionnaires. Questionnaire data were coded in SPSS software (International Business Machines Corp., n.d.-b), which was used to generate descriptive statistics for the combined three focus groups.

5.4.1. Initial Questionnaire

The initial questionnaire consisted of three sections:

1) Section I: General Questions;
2) Section II: Scale Questions; and
3) Section III: Other Questions.

5.4.1.1. *Section I: Initial Questions*

As shown in Table 16, the largest number of participants (59.4%) had "Some Experience" reading or using maps, which was also the median rank. None of the participants had "No Experience" or self-identified as a "Mapping Expert".

Table 16 Experience Reading or Using Maps

1) What level of experience do you have in ***reading or using maps***?					
1 No Experience		2 Little Experience	3 Some Experience	4 Much Experience	5 Mapping Expert
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No Experience	0	0.0	0.0	0.0
	Little Experience	6	18.8	18.8	18.8
	Some Experience	19	59.4	59.4	78.1
	Much Experience	7	21.9	21.9	100.0
	Mapping Expert	0	0.0	0.0	100.0
	Total	32	100.0	100.0	

As shown in Table 17, the largest number of (56.3%) of participants had “Much Experience” using computer, which was also the median rank. None of the participants thought he or she had “No experience” and only one participant self-identified as a “Computer Expert”.

Table 17 Experience Using Computers

2) What level of experience do you have in ***using computers***?					
1 No Experience		2 Little Experience	3 Some Experience	4 Much Experience	4 Computer Expert
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No Experience	0	0.0	0.0	0.0
	Little Experience	2	6.3	6.3	6.3
	Some Experience	11	34.4	34.4	40.6
	Much Experience	18	56.3	56.3	96.9
	Computer Expert	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

As shown in Table 18, the largest number of participants (37.5%) had “Some Experience” using “Google Earth or Other Computer Mapping Programs.” However, the median rank was “Little Experience”. No participant self-identified as a “Professional Expert”.

Table 18 Experience Using Google Earth or Other Computer Mapping Programs

3) What level of experience do you have in ***using Google Earth or other computer mapping programs*** in your work or leisure time?					
1 No Experience		2 Little Experience	3 Some Experience	4 Much Experience	5 Professional Expert
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No Experience	8	25.0	25.0	25.0
	Little Experience	11	34.4	34.4	59.4
	Some Experience	12	37.5	37.5	96.9
	Much Experience	1	3.1	3.1	100.0
	Professional Expert	0	0.0	0.0	100.0
	Total	32	100.0	100.0	

As shown in Table 19, the largest number of participants (40.6%) had seen no photographs of the open pit tar sands projects near Fort McMurray. Over two-thirds of the participants had seen few to no photographs of the open pit tar sands projects. None of the participants had seen “Many” or “Very Many” photographs.

Table 19 Amount of Photographs Seen

4) How many ***photographs*** have you seen that show the ***open pit*** tar sands projects around Fort McMurray, Alberta?					
1 None		2 Few	3 Some	4 Many	5 Very Many
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	None	13	40.6	40.6	40.6
	Few	10	31.3	31.3	71.9
	Some	9	28.1	28.1	100.0
	Many	0	0.0	0.0	100.0
	Very Many	0	0.0	0.0	100.0
	Total	32	100.0	100.0	

As shown in Table 20, the largest number of participants had seen no “TV broadcasts, films, or videos” showing the open pit tar sands projects near Fort McMurray, Alberta. Almost two-thirds (65.5%) of participants had seen few to no TV broadcasts, films, or videos of the open pit tar sands projects. One participant had seen “Many”, but no participant had seen “Very Many”.

Table 20 Amount of TV Broadcasts, Films, or Videos Seen

5) How many ***TV broadcasts***, ***films, or videos*** have you seen that show the ***open pit*** tar sands project near Fort McMurray, Alberta?					
1 None		2 Few	3 Some	4 Many	5 Very Many
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	None	13	40.6	40.6	40.6
	Few	8	25.0	25.0	65.6
	Some	10	31.3	31.3	96.9
	Many	1	3.1	3.1	100.0
	Very Many	0	0.0	0.0	100.0
	Total	32	100.0	100.0	

As shown in Table 21, the largest number of participants (46.9%) had not read any articles or books about the open pit tar sands projects. Over two-thirds of participants had read few to no articles or books about the tar sands open pit projects. One participant had read “Many” and one other participant had read “Very Many”.

Table 21 Amount of Articles or Books Read

6) How many ***articles or books*** have your read about the ***open pit*** tar sands projects near Fort McMurray, Alberta?					
1 None		2 Few	3 Some	4 Many	5 Very Many
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	None	15	46.9	46.9	46.9
	Few	8	25.0	25.0	71.9
	Some	7	21.9	21.9	93.8
	Many	1	3.1	3.1	96.9
	Very Many	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

As shown in Table 22, almost two-thirds (59.4%) of the participants had not seen any maps showing the open pit tar sands projects. Almost all the participants had seen few or no maps of the tar sands open pit mines. One participant had seen "Some" and no participant had seen "Many" or "Very Many".

Table 22 Amount of Maps Seen

7) How many ***maps*** have you seen that show the ***open pit*** tar sands projects near Fort McMurray, Alberta?

1 None	2 Few	3 Some	4 Many	5 Very Many

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	19	59.4	59.4	59.4
	Few	12	37.5	37.5	96.9
	Some	1	3.1	3.1	100.0
	Many	0	0.0	0.0	100.0
	Very Many	0	0.0	0.0	100.0
	Total	32	100.0	100.0	

As shown in Table 23, almost nine-tenths (87.5%) of participants had not seen the actual open pit tar sands projects near Fort McMurray. Four participants had seen the projects from the ground, two participants had also seen the projects from the air, and one participant had also lived nearby.

Table 23 Seen the Actual Open Pit Tar Sands Projects

8) Have you ever seen or been to the ***open pit*** tar sands projects near Fort McMurray? (Please check all that apply)

☐ Not seen

☐ Seen from a plane or helicopter

☐ Seen from the ground

☐ Lived nearby for a period of time

Seen or been to open pits			
	N	**Sum**	**Percent**
Not seen pits	32	28	87.5
Seen from air	32	2	6.3
Seen from ground	32	4	12.5
Lived nearby	32	1	3.1

5.4.1.2. *Section II: Scale Questions*

As shown in Table 24, the largest number of participants (43.6%) stated that they had "Little Knowledge" about the geographic area of the open pit tar sands projects. Three-quarters of participants stated that they had little or no knowledge. Eight participants stated that they had "Some knowledge" but no participant stated that he or she had "Much Knowledge" or "In-depth Knowledge".

Table 24 Knowledge About Geographic Area

1) How much knowledge do you have about the ***size or geographic area*** of the ***open pit*** tar sands projects near Fort McMurray, Alberta?					
1 No Knowledge		2 Little Knowledge	3 Some Knowledge	4 Much Knowledge	5 In-depth Knowledge
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No Knowledge	10	31.3	31.3	31.3
	Little Knowledge	14	43.8	43.8	75.0
	Some Knowledge	8	25.0	25.0	100.0
	Much Knowledge	0	0.0	0.0	100.0
	In-depth Knowledge	0	0.0	0.0	100.0
	Total	32	100.0	100.0	

As shown in Table 25 and Figure 58, the largest number of participants (34.4%) thought that the geographic area of all the combined ***existing*** open pit tar sands projects was as large as a "Canadian metropolitan city", which was also the median rank among those participants who did not answer "Don't Know". Based on calculations using ArcGIS software (Environmental Systems Research Institute, 2008) this is also the spatially correct answer.[24] Over one-fifth (21.9%) of participants did not know the geographic area. Some participants may have been confused about the terminology since outlines of municipal city boundaries and census tract urban areas were shown and labelled in the Google Earth project rather than "metropolitan cities".

[24] The approximate width of the "Canadian metropolitan cities" (25km x 25km = 525 km^2) and the "World metropolitan cities" (100 km x 100 km = 10,000 km^2) were used as guidelines in the questionnaire. Based on the census "urban area" definitions, the actual geographic area of the "Canadian metropolitan cities" ranges from Calgary (722 km^2), Edmonton (871 km^2), Vancouver (1,199 km^2) to Toronto 1,779 km^2) while the actual geographic area of the "World metropolitan cities" ranges from Los Angeles (4,345 km^2) to New York (8,936 km^2).

Table 25 Perceived Geographic Area of Existing Tar Sands Open Pit Mines, Before Viewing

2) How ***large*** do you think is the ***total*** size or geographic area of all the combined ***existing*** open pit tar sands projects that have already been developed in the Fort McMurray region of Alberta?						
0 Don't know	1 As large as a football field (about 100 metres across or 0.1km across)	2 As large as a neighbourhood (about 1 km across)	3 As large as a town (about 5 km across)	4 As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	5 As large as one of the world's largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	6 As large as a western province or state (about 500 km across)

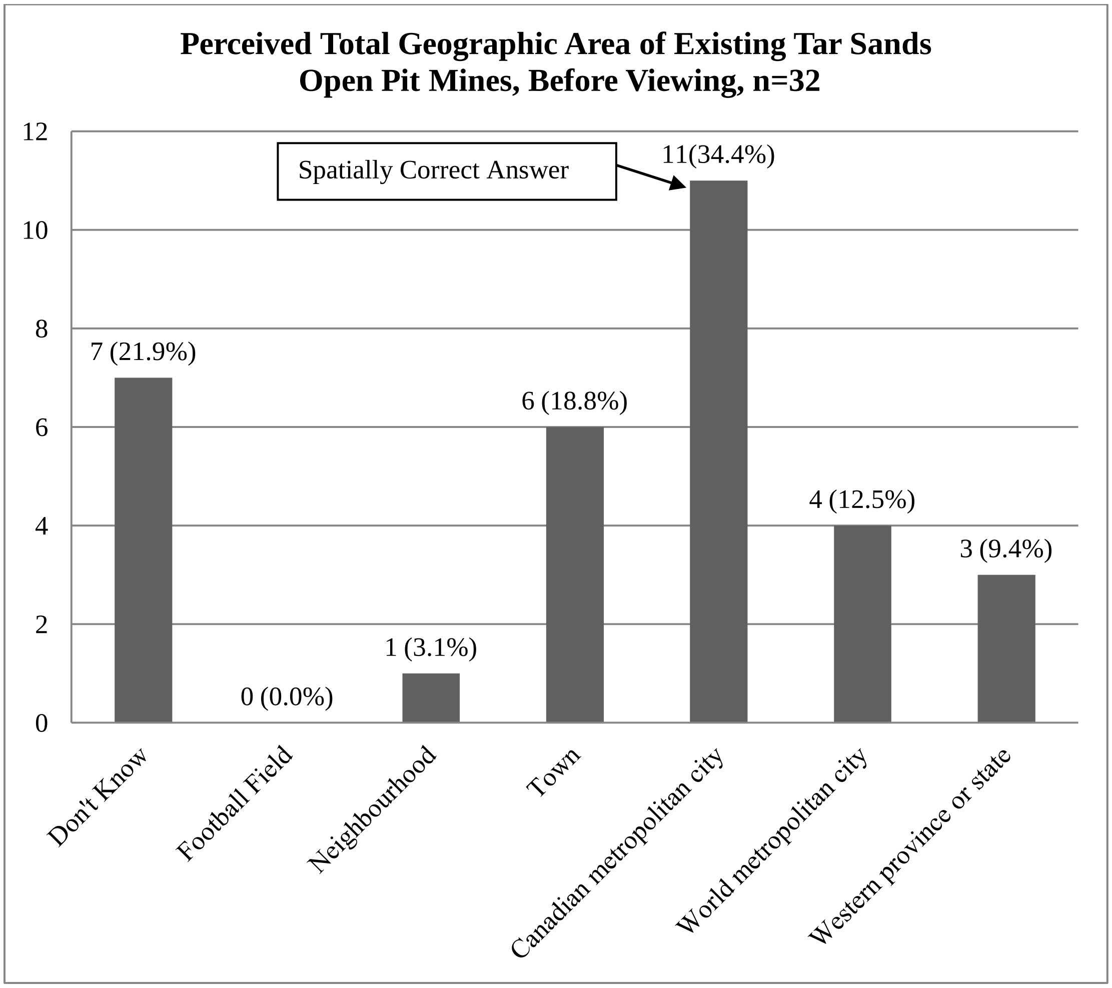


Figure 54 Perceived Total Geographic Area of Existing Tar Sands Open Pit Mines, Before Viewing

As shown in Table 26 and Figure 59, the largest number of participants (34.4%) had a "Neutral" opinion about the ***existing*** open pit tar sands projects. Over nine-tenths of participants were neutral or opposed. Only three participants were "Supportive" and no participant was "Very Supportive".

Table 26 Opinion About Existing Tar Sands Open Pit Mines, Before Viewing

3) What is your ***opinion*** about the ***existing*** open pit tar sands projects that have already been built near Fort McMurray, Alberta?				
+2 Very Supportive	+1 Somewhat Supportive	0 Neutral	-1 Somewhat Opposed	-2 Very Opposed

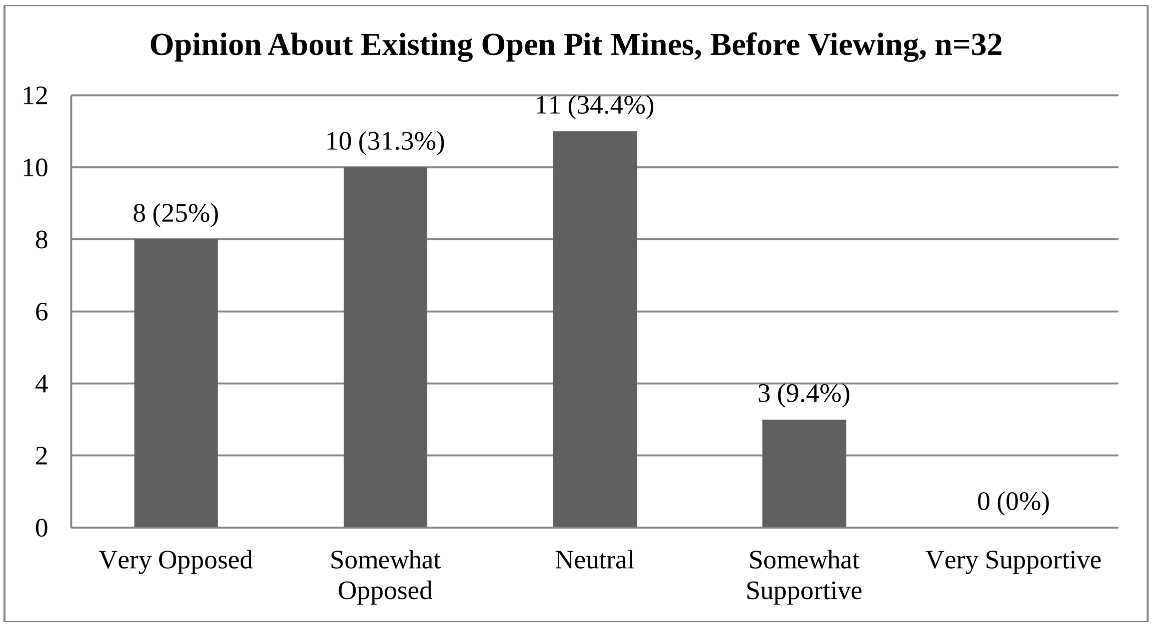


Figure 55 Opinion About Existing Tar Sands Open Pit Mines, Before Viewing

As shown in Table 74 within Appendix "O", three-quarters of the participants (24 out of 32) responded to the open-ended question asking them to explain their opinion about the ***existing*** open pit tar sands mines: "If you are supportive or opposed, please explain why (briefly). Please write in block letters.". Only two of these twenty-four participants (8.3%) expressed positive opinions about the ***existing*** tar sands open pit mines.

As shown in Table 27 and Figure 60, the largest number of participants (31.3%) thought that the total geographic area of all the ***approved*** open pit tar sands projects was “As large as one of the world’ largest metropolitan cities”, which is not the spatially correct answer. Among participants who did not answer “Don’t Know”, “As large as one of the world’ largest metropolitan cities” was also the median rank. As calculated using ArcGIS software, the actual size of the combined ***approved*** tar sands projects is actually about as large as a Canadian metropolitan city. No participant thought that the ***approved*** open pit tar sands projects were as large as a “Football field”.

Table 27 Perceived Geographic Area of Approved Tar Sands Open Pit Mines, Before Viewing

5) How ***large*** do you think is the ***total*** size or geographic area of all the combined ***approved*** open pit tar sands projects that governments have already permitted but that have not yet been developed near Fort McMurray, Alberta?						
0 Don’t know	1 As large as a football field (about 100 metres or 0.1 km across)	2 As large as a neighbourhood (about 1 km across)	3 As large as a town (about 5 km across)	4 As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	5 As large as one of the world’s largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	6 As large as a western province or state (about 500 km across)

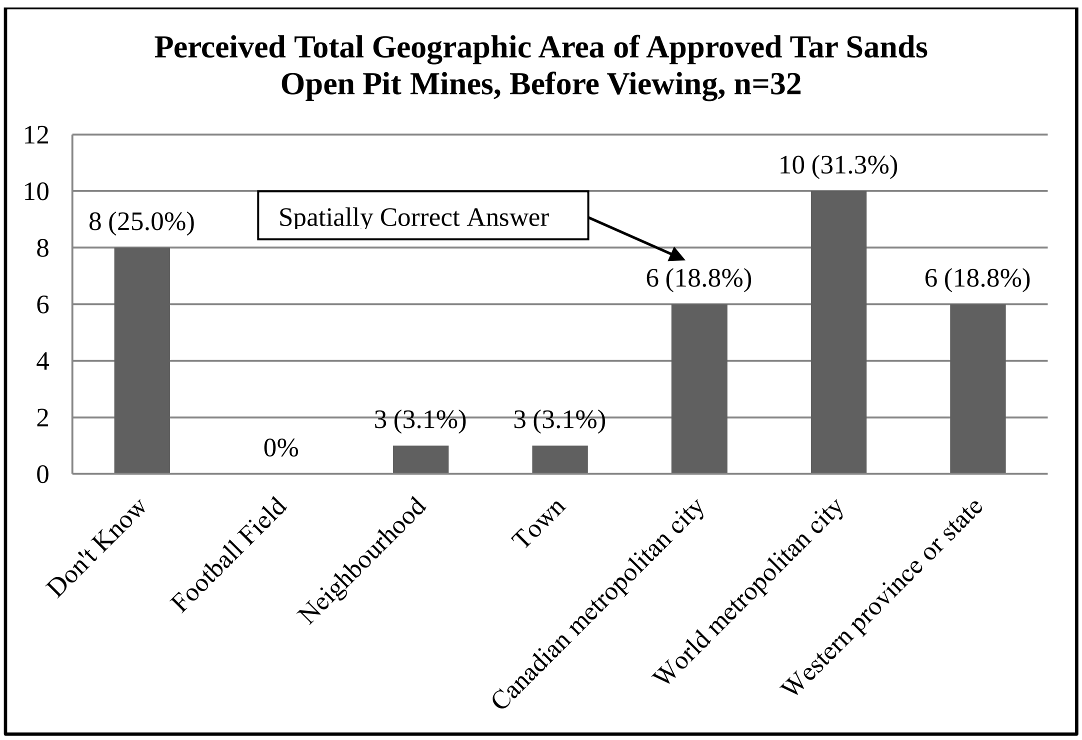


Figure 56 Perceived Geographic Area of Approved Tar Sands Open Pit Mines, Before Viewing

As shown in Table 28 and Figure 61, the largest number of participants (43.8%) did not know how many times the geographic area would increase if all the ***approved*** open pit tar sands projects were built. Among those participants who did not state "Don't Know", the median rank was "About 3 times the existing size", which is not the spatially correct answer. Using ArcGIS software, it was calculated that the total geographic area of the open pit tar sands projects would increase about two times the existing size (100%). There was no participant who thought the geographic area would grow by a factor of 1.5 (50% increase).

Table 28 Perceived Growth of Tar Sands Open Pit Mines if All Approved Projects Built, Before Viewing

6) If all the ***approved*** open pit tar sands projects were built in addition to ***existing*** open pit tar sands projects, how many times would the ***total*** size or geographic area of the combined open pit tar sands projects increase?					
0 Don't know	1 About 1.5 times the existing size (50% increase)	2 About 2 times the existing size (100% increase)	***3*** About 3 times the existing size (200% increase)	4 About 5 times the existing size (400% increase)	5 More than 10 times the existing size (>1,000% increase)

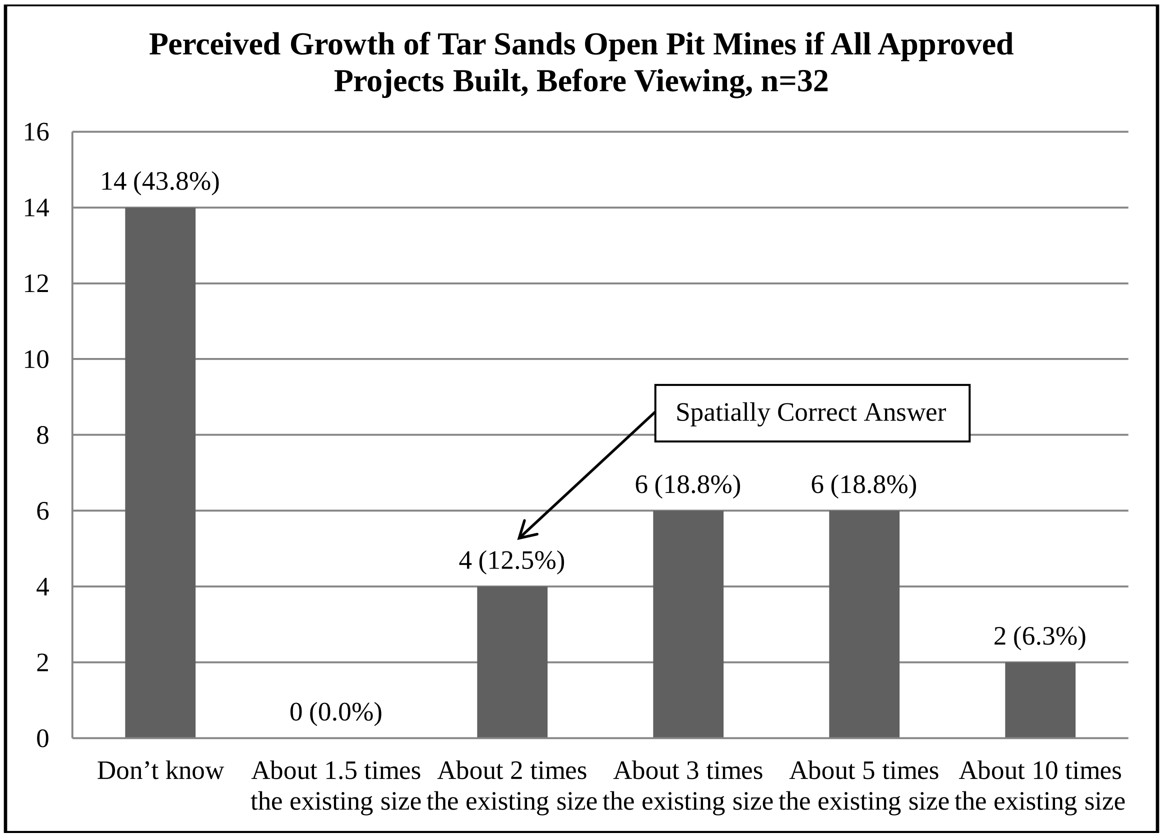


Figure 57 Perceived Growth of Tar Sands Open Pit Mines if All Approved Projects Built, Before Viewing

As shown in Table 29 and Figure 58, the largest number of participants (40.6%) did not know the total geographic area of the ***planned*** open pit tar sands mines. Among those participants who did not state "Don't Know", the median rank was "As large as one of the world's metropolitan cities", which is not the spatially correct correct answer. As calculated using ArcGIS, the total geographic area of the planned open pit tar sands mines is actually about as large as a Canadian metropolitan city. No participant thought that the geographic area of the ***planned*** open pit tar sands mines was as large as "Football field" or as large as "Neighbourhood".

Table 29 Perceived Total Geographic Area of Planned Tar Sands Open Pit Mines, Before Viewing

7) How ***large*** do you think is the ***total*** size or geographic area of combined ***planned*** open pit tar sands projects that industry has disclosed or proposed, but that governments have not yet approved and that have not yet been developed near Fort McMurray, Alberta?						
0 Don't know	1 As large as a football field (about 100 metres across or 0.1km across)	2 As large as a neighbourhood (about 1 km across)	3 As large as a town (about 5 km across)	4 As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	5 As large as one of the world's largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	6 As large as a western province or state (about 500 km across)

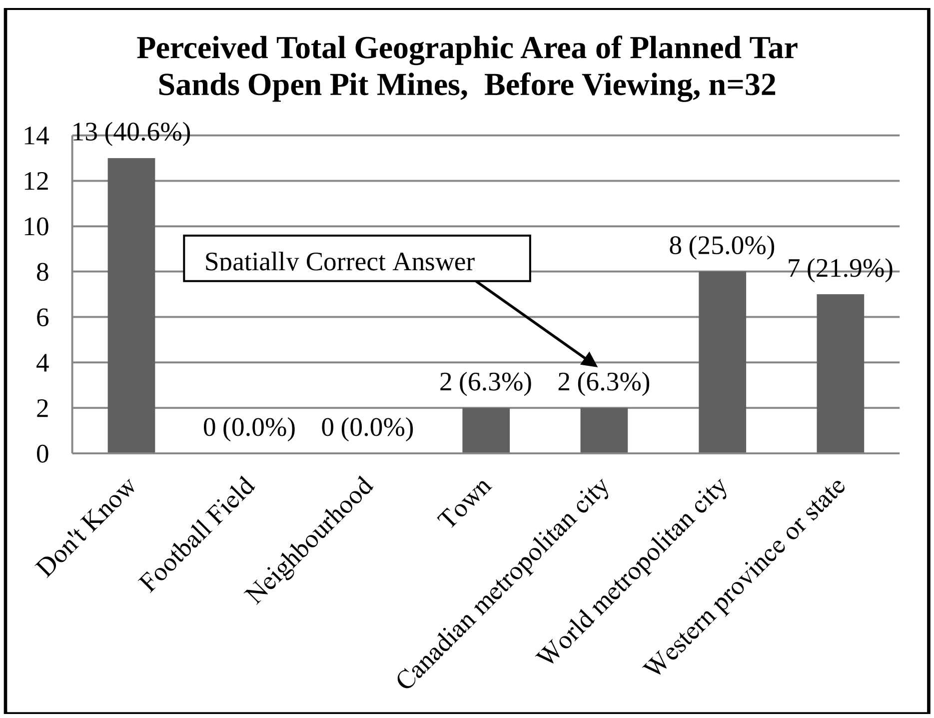


Figure 58 Perceived Total Geographic Area of Planned Tar Sands Open Pit Mines, Before Viewing

As shown in Table 30 and Figure 59, the largest number of participants (46.9%) did not know how many times the geographic area of the ***existing*** tar sands open pit mines would increase if the ***planned and approved*** projects were built. Among those participants who did not state "Don't Know", the median rank was "About 5 time the existing size", which is not the spatially correct answer. Using ArcGIS software, it was calculated that the geographic area would increase about three times the existing size (200% increase).

Table 30 Perceived Growth of Tar Sands Open Pit Mines if All Planned and Approved Projects Built, Before Viewing

8) If all the ***planned and approved*** open pit tar sands projects were built in addition to ***existing*** open pit tar sands projects, how many times would the ***total*** size or geographic area of the combined open pit tar sands projects increase?					
a) Don't know	b) About 1.5 times the existing size (50% increase)	c) About 2 times the existing size (100% increase)	d) About 3 times the existing size (200% increase)	e) About 5 times the existing size (400% increase)	f) More than 10 times the existing size (>1,000% increase)

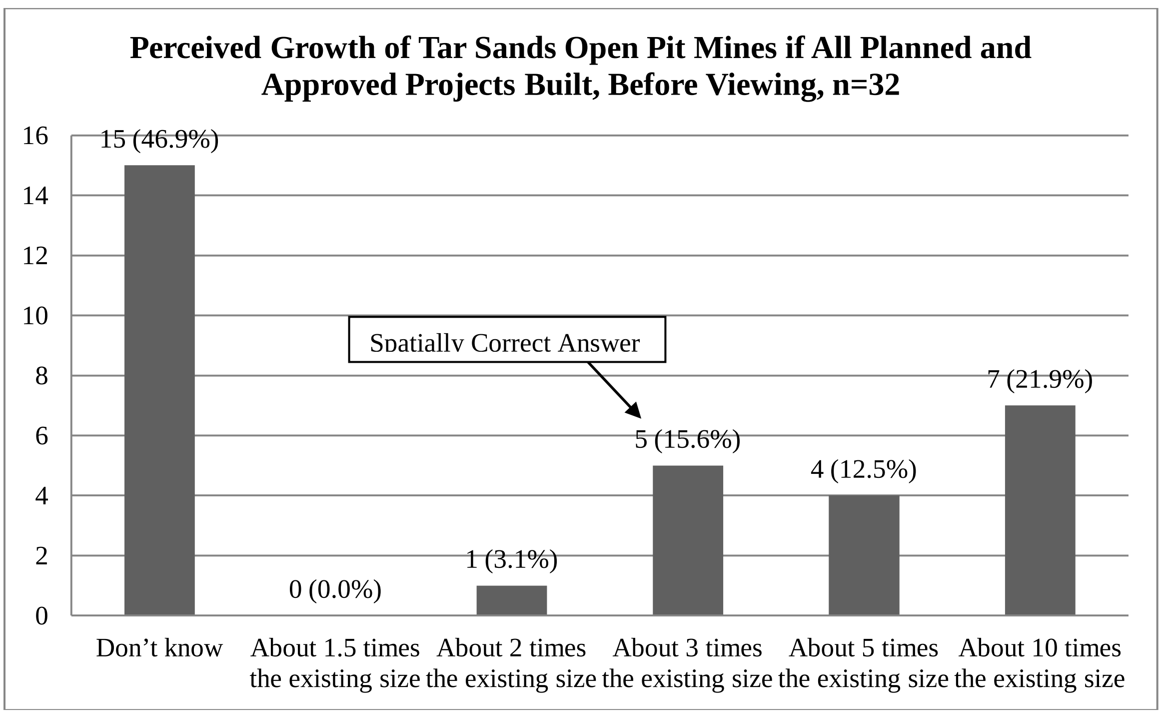


Figure 59 Perceived Growth of Tar Sands Open Pit Mines if All Planned and Approved Projects Built, Before Viewing

As shown in Table 31 and Figure 60, the largest number of participants were tied as “Somewhat Opposed” (31.3%) and “Very Opposed” (31.3%) to the expansion of ***future approved and planned*** open pit tar sands projects. Before viewing, almost two-thirds (62.6%) of participants were opposed to the expansion of ***future approved and planned*** open pit tar sands projects.

Table 31 Opinion About Expansion of Future Approved and Planned Open Pit Tar Sands Project, Before Viewing

9) What is your ***opinion*** about the expansion of ***future approved and planned*** open pit tar sands projects near Fort McMurray, Alberta?				
+2 Very Supportive	+1 Somewhat Supportive	0 Neutral	-1 Somewhat Opposed	-2 Very Opposed
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**

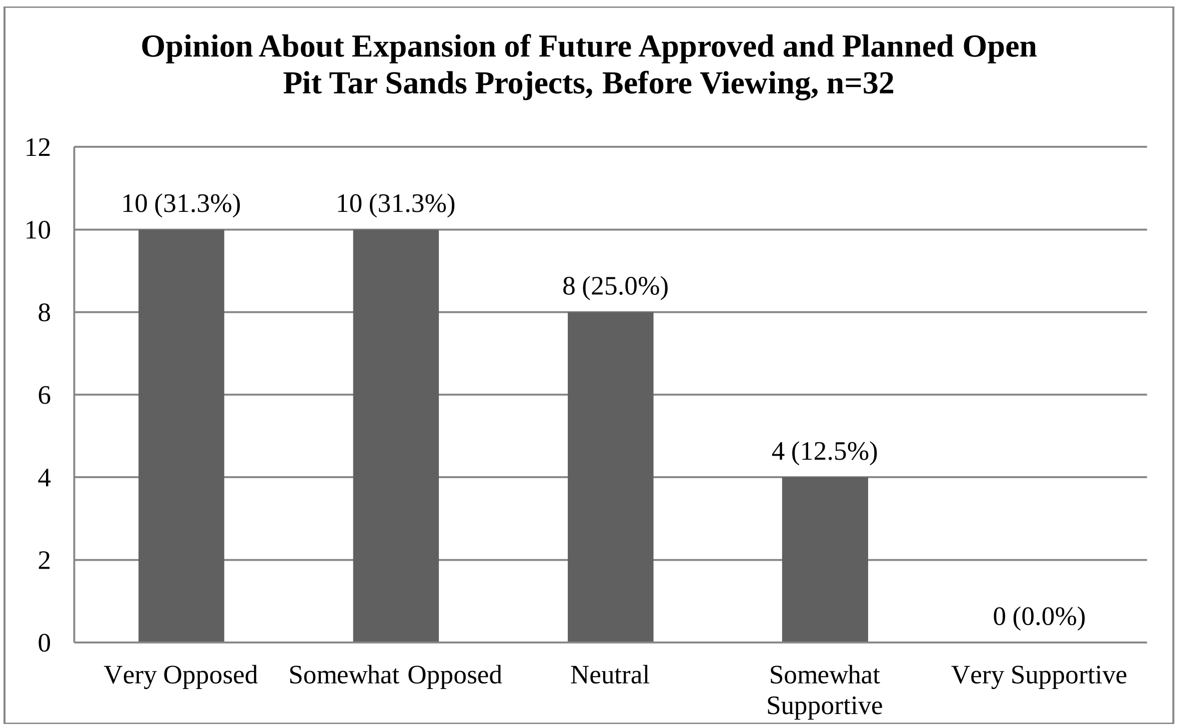


Figure 60 Opinion About Expansion of Future Approved and Planned Open Pit Tar Sands Projects, Before Viewing

As shown in Table 75 within Appendix “O”, almost four-fifths of the participants (78.1% or 25 out of 32) responded to the open-ended question asking them to explain their opinion about the expansion of ***future planned and approved*** open pit tar sands mines. Three out of twenty-five (12%) participants stated that they supported expansion of the future approved and planned tar sands open pit mines.

5.4.1.3. *Section III: Other Questions*

As shown in Table 32, there were almost twice as many participants residing in British Columbia (21) as in Alberta (11) because there were two focus groups held in Vancouver and only one held in Edmonton.

Table 32 Province of Residence of Focus Group Participants

Province:__________					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Alberta	11	34.4	34.4	34.4
	British Columbia	21	65.6	65.6	100.0
	Total	32	100.0	100.0	

As shown in Table 33, almost two-thirds (61.3%) of the participants resided in the City of Vancouver and one-quarter (25.8%) resided in the City of Edmonton. Four participants lived in suburban or nearby small towns.

Table 33 Municipal Residence of Focus Group Participants

1) Residence (City, Town, or Village):______________________				
		Frequency	**Percent**	**Valid Percent**
Valid	**Alberta**			
	Edmonton	8	25.0	25.8
	Onoway	1	3.1	3.2
	Sherwood Park	1	3.1	3.2
	British Columbia			
	Vancouver	19	59.4	61.3
	Burnaby	2	6.3	6.5
	Total	31	96.9	100.0
Missing	Unknown	1	3.1	
Total		32	100.0	

As shown in Table 34, slightly over half (53%) the participants were male and slightly less than half (47%) of the participants were female. The gender distribution of the participants is approximately the reverse of the overall Canadian gender distribution, where less than half of Canadians over the age of 18 are male (48.5%) and slightly more than half are female (51.5%) (Statistics Canada, 2013a).

Table 34 Gender Distribution of Focus Group Participants

2) Gender: ☐ Male ☐ Female					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Female	15	46.9	46.9	46.9
	Male	17	53.1	53.1	100.0
	Total	32	100.0	100.0	

As shown in Table 35 and Figure 61, the greatest number of participants (25%) was in the 30-39 decadal age group. However, the median age of participants was in the 40-49 decadal age group. This is somewhat older than the Canadian median age of 40.0 in 2012, which also includes persons under the age of eighteen (Statistics Canada, 2013a). None of the participants in the focus groups were younger than twenty years old.

Table 35 Age Groups of Focus Group Participants

3) Age Group: 1☐ 0-19 years old 2☐ 20-29 years old 3☐ 30-39 years old 4☐ 40-49 years old 5☐ 50-59 years old 6☐ 60-69 years old 7☐ 70+ years old

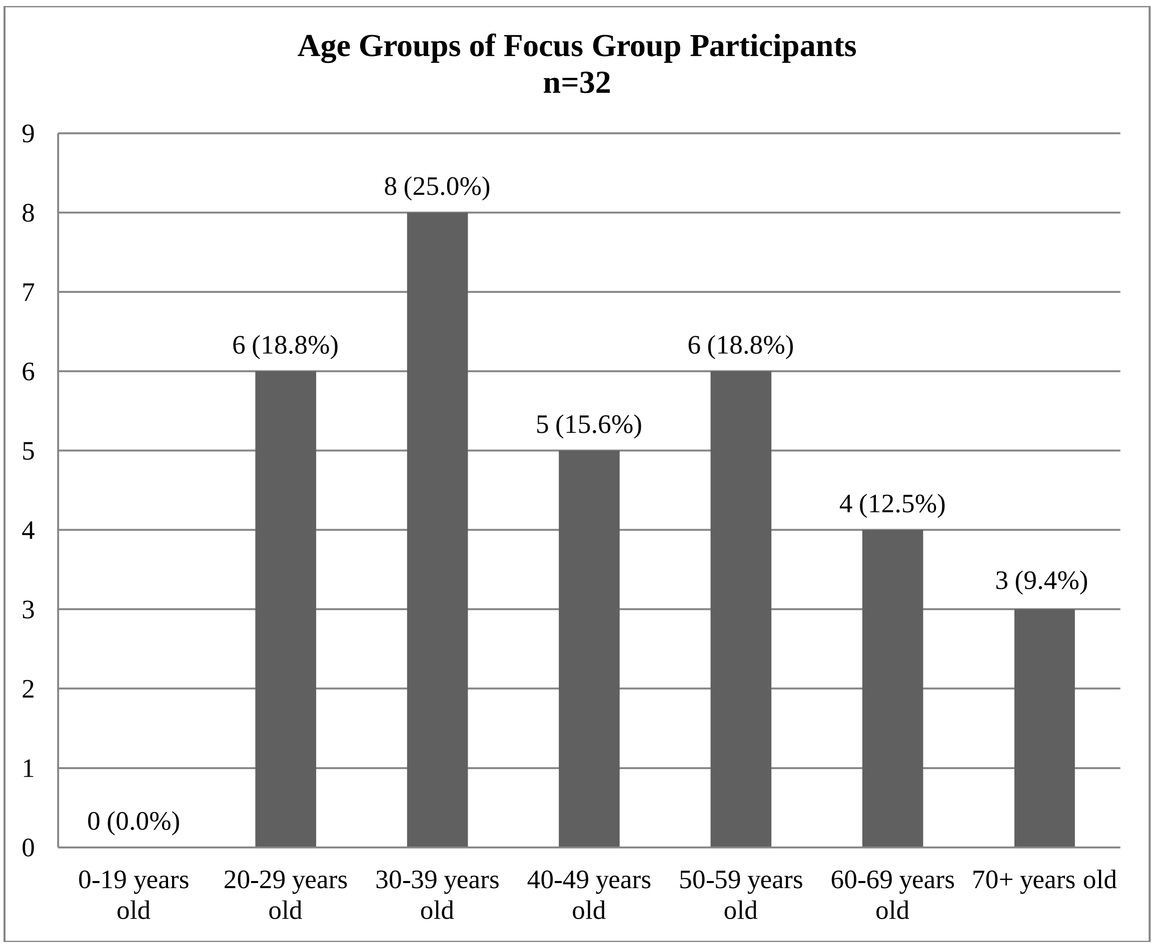


Figure 61 Age Groups of Focus Group Participants

As shown in Figure 62, the largest number of participants (34.4%) had a “Bachelor’s University Degree”, which was also the median rank. Over half (59.6%) of participants had university degree, yet only 20.0% of Canadians age 15 and over have a university degree (Statistics Canada, 2013b). All participants had at least “Some College or Technical School Studies”. Participants were asked to select only one of the education levels shown in Figure 62.

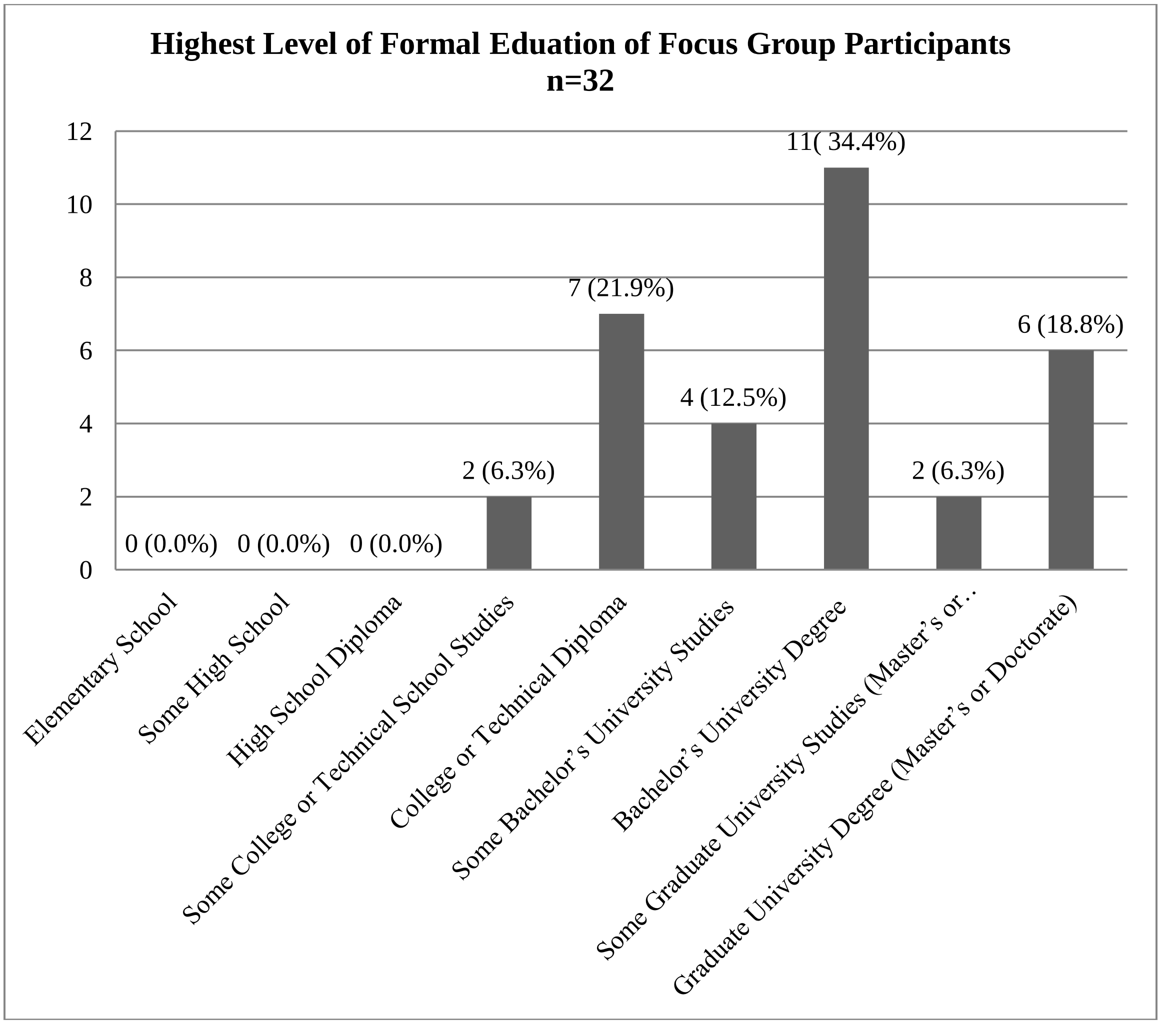


Figure 62 Highest Level of Formal Education of Focus Group Participants

As shown in Figure 63, the largest number of participants (21.9%) were “Retired”. There are no census statistics available for the percent of retirees, but only 14.9% of the Canadian population was over the age of 65 (Statistics Canada, 2012). The second largest number of participants (18.8%) were in “Management, Finance, and Administrative” occupations, but only 11.5% of the Canadian labour force was in this occupation (Statistics Canada, 2013c). Only one participant (3.1%) was in the “Trades, Transport and Equipment Operators, Primary Industry, Processing, Manufacturing and Utilities” occupations, yet 20.6% of the Canadian labour force was in these occupations (Statistics Canada, 2013c). Participants were asked to select only one of the occupation groups shown in Figure 63.

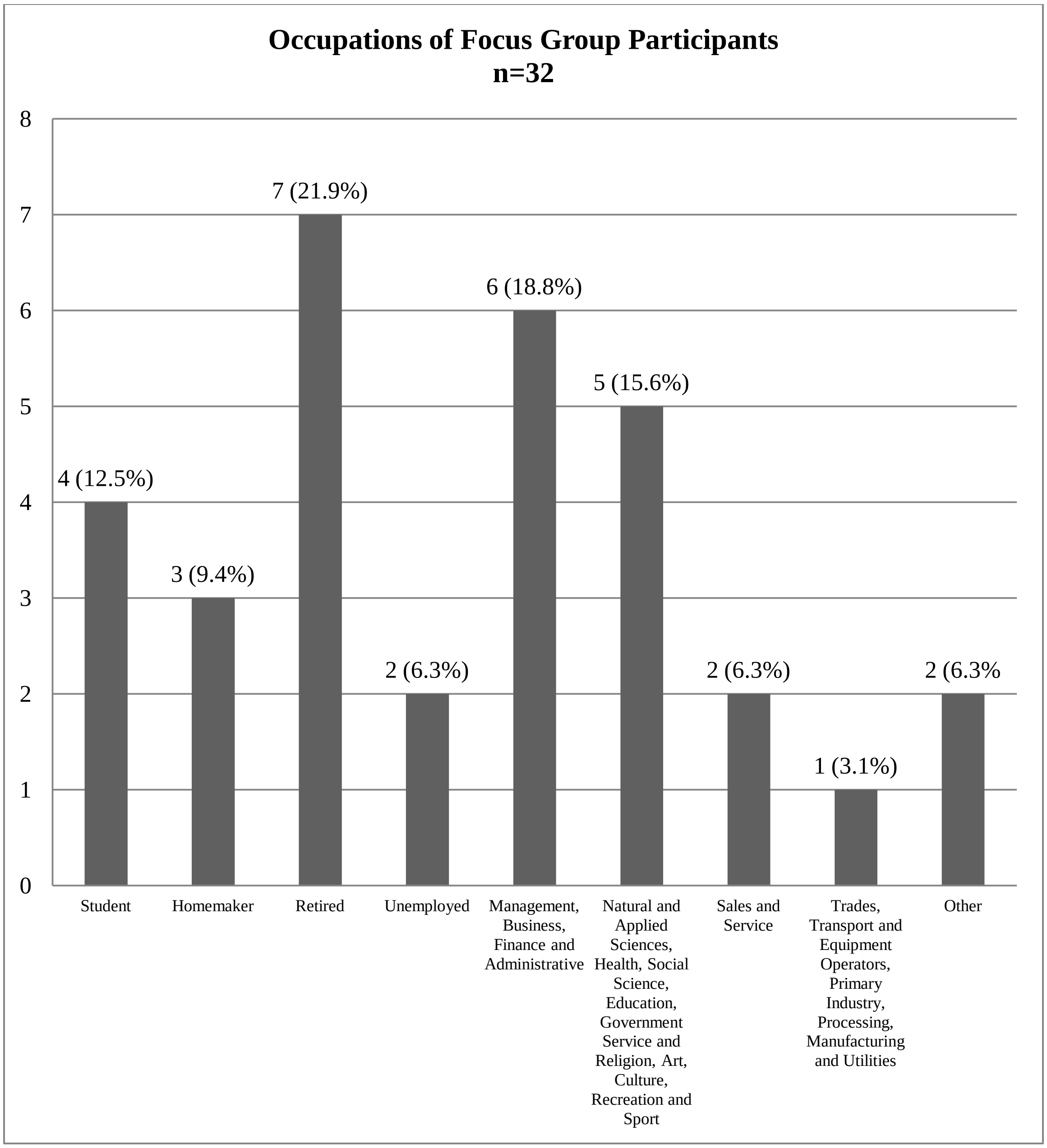


Figure 63 Occupations of Focus Group Participants

5.4.1.3.1. Advocacy and Involvement

As shown in Table 36, the largest number of participants (71.9%) were "Not involved" in promoting their opinions about tar sands development, which is also the median rank. No participant was "Highly Involved" or "Extremely Involved".

Table 36 Involvement in Promoting Opinions

6) How involved are you right now in promoting your opinions about tar sands development in the Fort McMurray region of Alberta to government, industry, or the public?

1 Not involved	2 Slightly involved	3 Moderately involved	4 Highly involved	5 Extremely involved

		Frequency	Percent
Valid	Not involved	23	71.9
	Slightly involved	5	15.6
	Moderately involved	4	12.5
	Highly involved	0	0.0
	Extremely involved	0	0.0
	Total	32	100.0

Over two-fifths (43.8%) of participants (14 out of 32) provided additional comments or concerns about the tar sand projects or this questionnaire. Thirteen participants expressed enthusiasm for the focus group or concerns about the tar sands, but one participant stated "I can't see where this is going."

5.4.2. <u>Follow Up Questionnaire</u>

Participants were asked "How much new knowledge did you gain about the size or geographic area of open pit tar sands projects near Fort McMurray, Alberta?" As shown in Figure 64, the largest number of participants thought they gained "Much New Knowledge" about the geographic area of open pit tar sands projects. Almost all participants (84.4%) thought they gained "Much New Knowledge" or "In-depth" new knowledge. No participant thought he or she gained "No new knowledge."

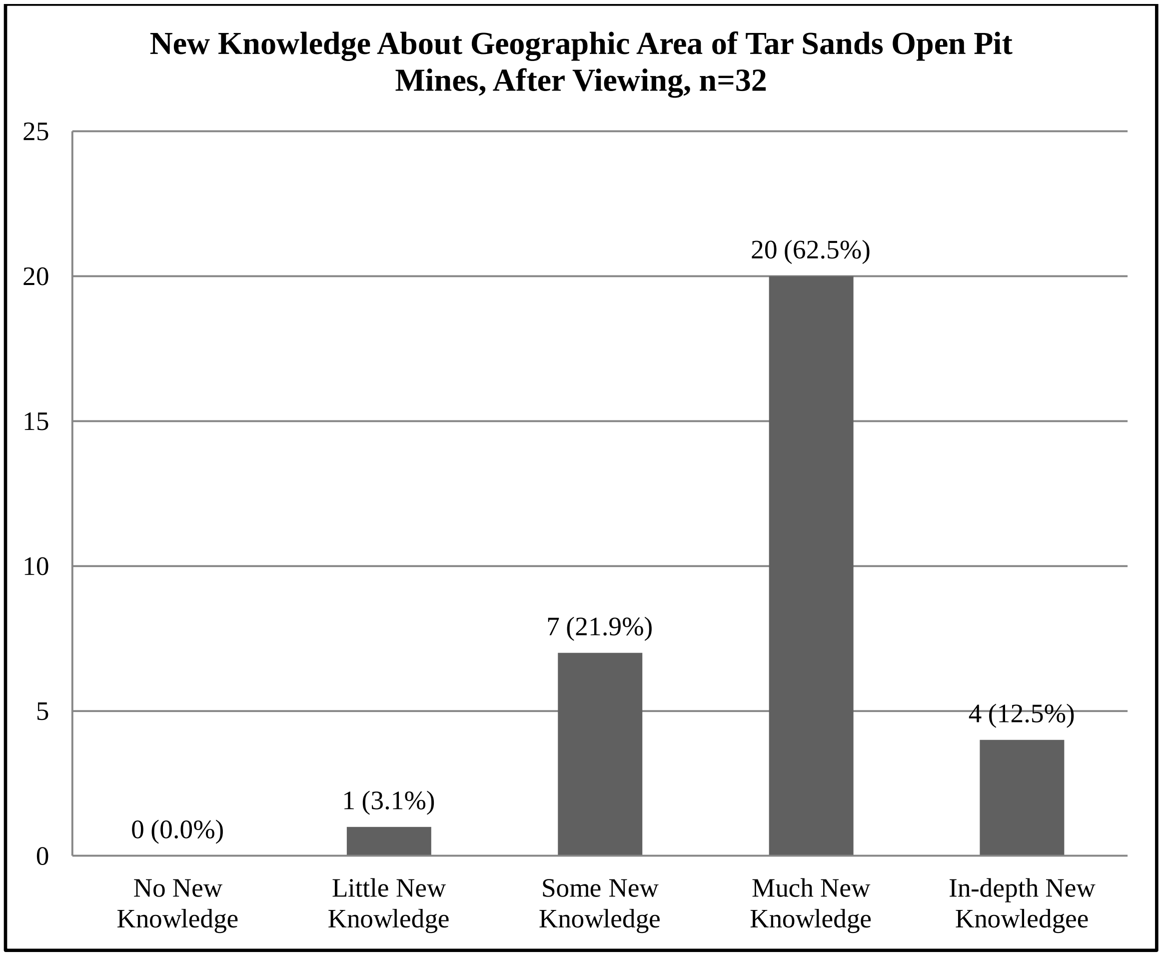


Figure 64 New Knowledge About Geographic Area of Tar Sands Open Pit Tar Sands, After Viewing

As shown in Table 37 and Figure 65, the largest number of participants (43.8%) thought the ***existing*** open pit tar sands were “As large as one of the world’s largest metropolitan cities”, which was also the median rank. As calculated using ArcGIS, the ***existing*** open pit tar sands are actually as large as a Canadian metropolitan city. No participant stated “Don’t know” or “As large as a football field”.

Table 37 Perceived Total Geographic Area of Existing Tar Sands Open Pit Mines, After Viewing

2) How ***large*** do you think is the size or geographic area of ***existing*** open pit tar sands projects that have already been built near Fort McMurray, Alberta?						
0 Don’t know	1 As large as a football field (about 100 metres across or 0.1km across)	2 As large as a neighbourhood (about 1 km across)	3 As large as a town (about 5 km across)	4 As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	5 As large as one of the world’s largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	6 As large as a western province or state (about 500 km across)

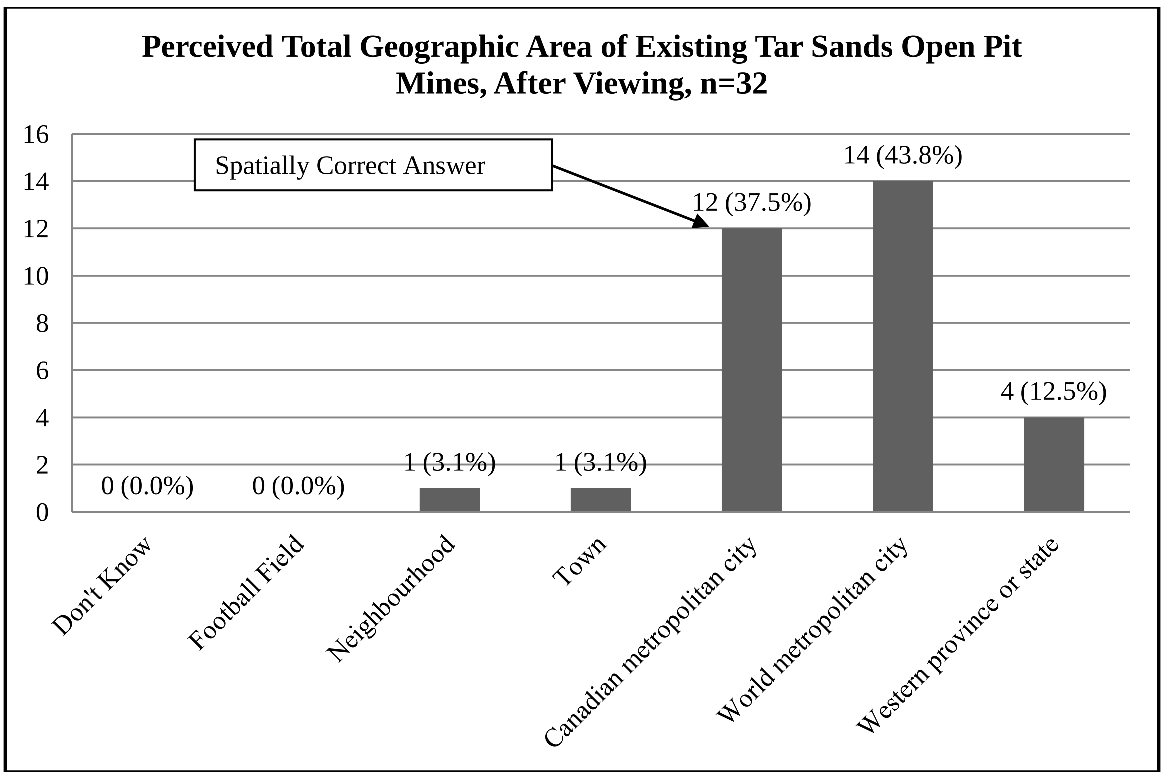


Figure 65 Perceived Total Geographic Area of Existing Tar Sands Open Pit Mines, After Viewing

Participants were asked “What is your opinion about the existing open pit tar sands projects that have already been built near Fort McMurray, Alberta?”. As shown in Figure 66, the largest number of participants was “Extremely Opposed” to the ***existing*** tar sands open pit tar mines. After viewing, almost two-thirds of participants (62.5%) were opposed to the existing tar sands open pit mines. One participant did not answer this question.

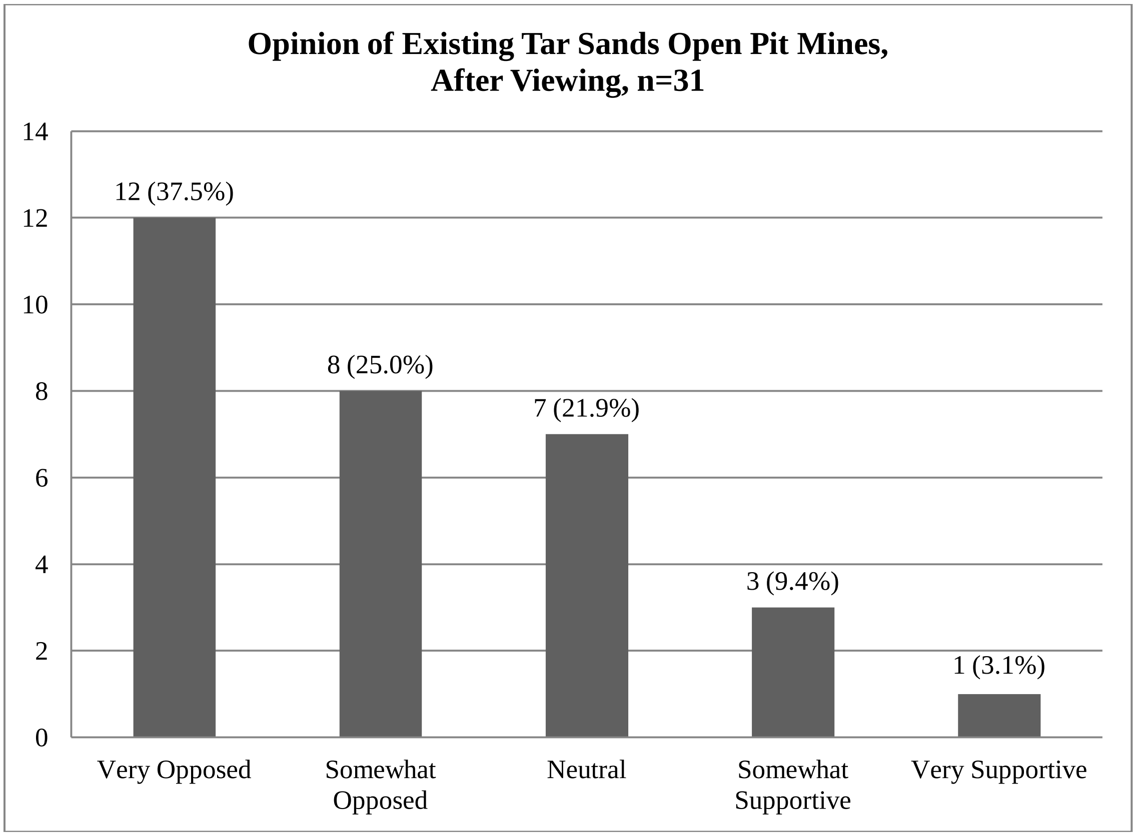


Figure 66 Opinion of Existing Tar Sands Open Pit Mines, After Viewing

As shown in Table 76 within Appendix “O”, almost four-fifths of participants (78.1% or 25 out of 32) answered the open-ended question explaining whether they felt more or less concerned or supportive about ***existing*** tar sands open pit mines. Three out of twenty-five participants (12%) stated that they were supportive of the existing tar sands open pit mines, while the rest of the participants expressed concerns or opposition.

As shown in Table 38 and Figure 67, the largest number of participants (56.3%) thought that the geographic area of the ***approved*** open pit tar sands projects was “As large as one of the world’s largest metropolitan cities”, which is also the median rank. As calculated using ArcGIS, the actual geographic area of the ***approved*** open pit tar sands projects is as large as a Canadian metropolitan city.

Table 38 Perceived Total Geographic Area of Approved Tar Sands Open Pit Mines, After Viewing

5) How ***large*** do you think is the size or geographic area of ***approved*** open pit tar sands projects that governments have already permitted but that have not yet been built near Fort McMurray, Alberta?						
0 Don’t know	1 As large as a football field (about 100 metres across or 0.1km across)	2 As large as a neighbourhood (about 1 km across)	3 As large as a town (about 5 km across)	4 As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	5 As large as one of the world’s largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	6 As large as a western province or state (about 500 km across)

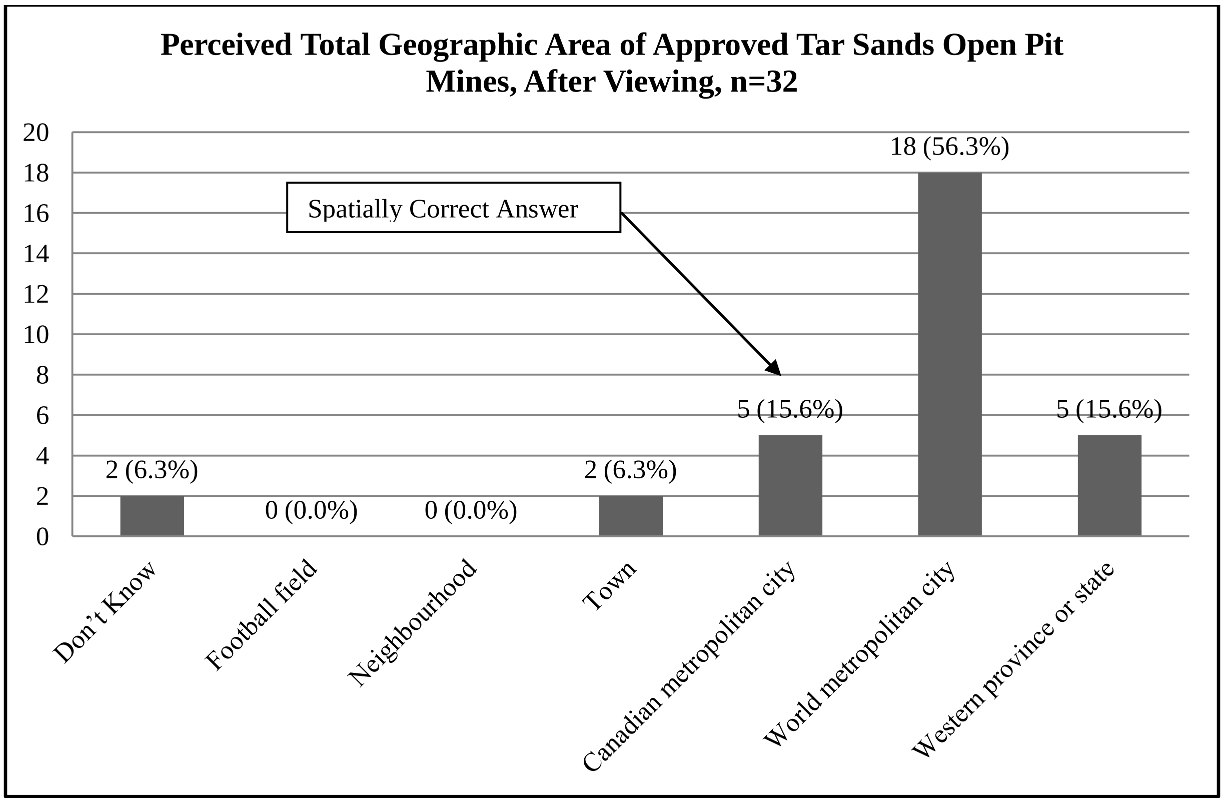


Figure 67 Perceived Total Geographic Area of Approved Tar Sands Open Pit Mines, After Viewing

As shown in Table 39 and Figure 68, the largest number of participants stated that if all ***approved*** open pit tar sands projects were built, the geographic area of the ***existing*** tar sand open pit mines would increase “About 3 times the existing size”, which is also the median rank. As calculated using ArcGIS, the geographic area would actually increase “About 2 times the existing size”. One (1) participant stated “Don’t Know”.

Table 39 Perceived Growth of Geographic Area if All Approved Open Pit Tar Sand Projects Built, Before Viewing

6) If all the ***approved*** open pit tar sands projects were built in addition to ***existing*** open pit tar sands projects, how many times would the ***total*** size or geographic area of open pit tar sands projects increase?				
a) Don’t know	b) About 1.5 times the existing size (50% increase)	c) About 2 times the existing size (100% increase)	d) About 3 times the existing size (200% increase)	e) More than 10 times the existing size (>1,000% increase)

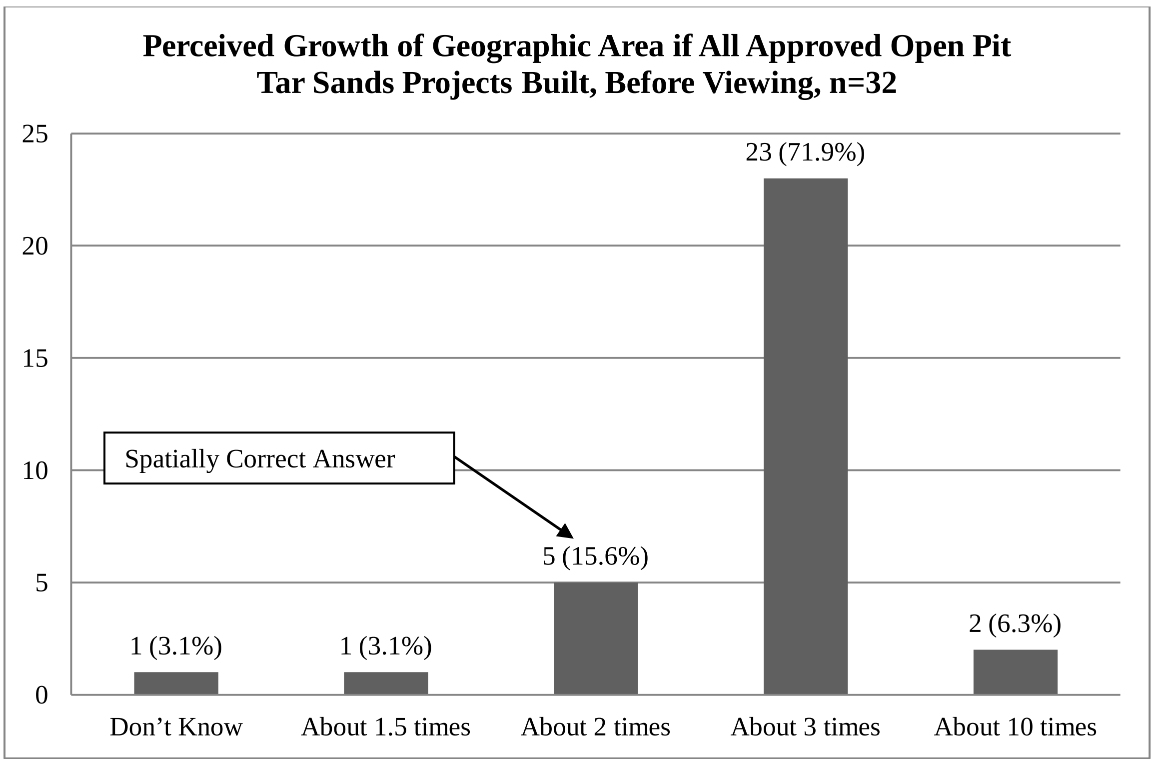


Figure 68 Perceived Growth of Geographic Area if All Approved Open Pit Tar Sand Projects Built, Before Viewing

As shown in Table 40 and Figure 73, the largest number of participants thought that the geographic area of the ***planned*** open pit tar sands projects was “As large as one of the world’s largest metropolitan cities”, which is also the median rank. As calculated using ArcGIS, the geographic area of the ***planned*** tar sand open pit mines is actually as large as a Canadian metropolitan city. One participant stated “Don’t Know” and no participant stated “As large as a football field” or “As large as a western province or state”.

Table 40 Perceived Geographic Area of Planned Tar Sands Open Pit Mines, After Viewing

7) How ***large*** do you think is the size or geographic area of ***planned*** open pit tar sands projects that industry has disclosed or proposed, but that governments have not yet approved and that have not yet been built near Fort McMurray, Alberta?						
0 Don’t know	1 As large as a football field (about 100 metres across or 0.1km across)	2 As large as a neighbourhood (about 1 km across)	3 As large as a town (about 5 km across)	4 As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	5 As large as one of the world’s largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	6 As large as a western province or state (about 500 km across)

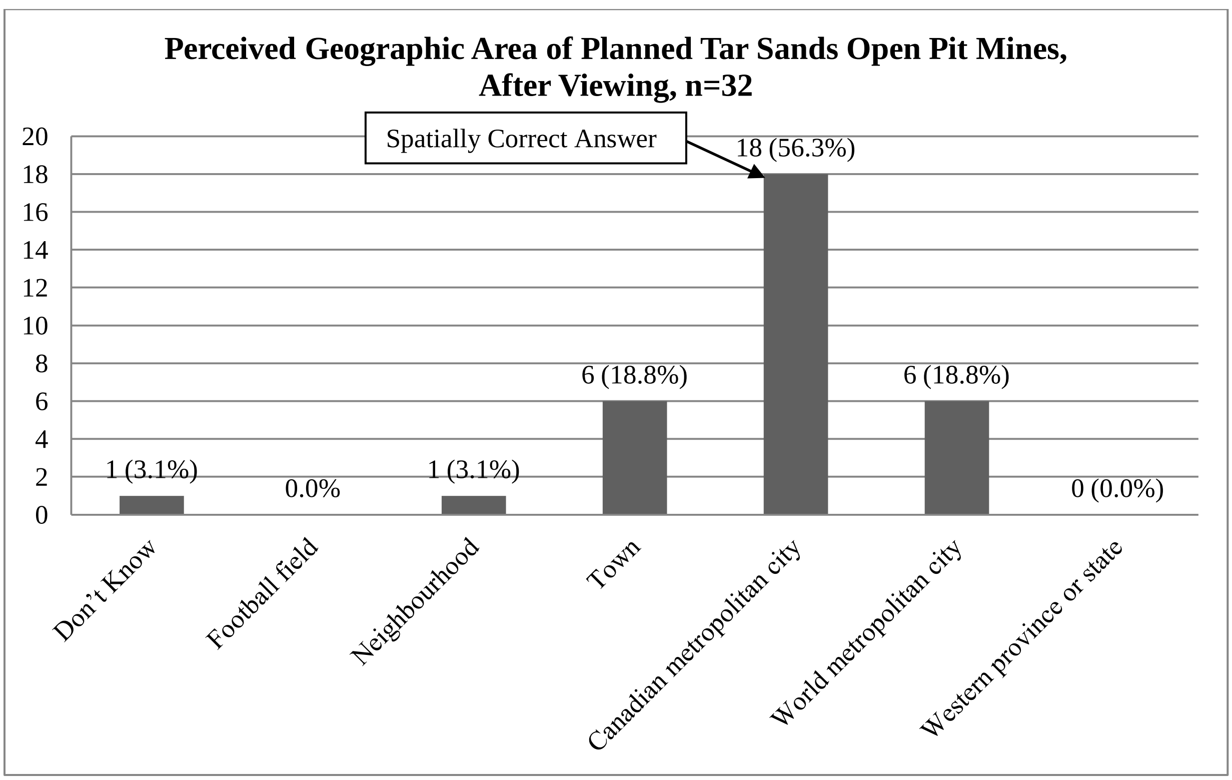


Figure 69 Perceived Geographic Area of Planned Tar Sands Open Pit Mines, After Viewing

As shown in Table 41 and Figure 70, the largest number of participants (53.1%) stated that geographic area of the ***existing*** tar sands open pit mines would increase “About 3 times the existing size” if all the ***approved*** and ***planned*** open pit tar sands projects were built, which is also the median rank and the spatially correct answer as calculated using ArcGIS software. Two participants answered “Don’t Know” and no participant answered “About 1.5 times the existing size”.

Table 41 Perceived Growth of Existing Tar Sands Open Pit Mines if All Approved and Proposed Open Pit Tar Sands Projects Built, After Viewing

8) If all the ***approved*** and ***planned*** open pit tar sands projects were built in addition to ***existing*** open pit tar sands projects, how many times would the ***total*** size or geographic area of open pit tar sands projects increase?				
a) Don’t know	b) About 1.5 times the existing size (50% increase)	c) About 2 times the existing size (100% increase)	d) About 3 times the existing size (200% increase)	e) More than 10 times the existing size (>1,000% increase)

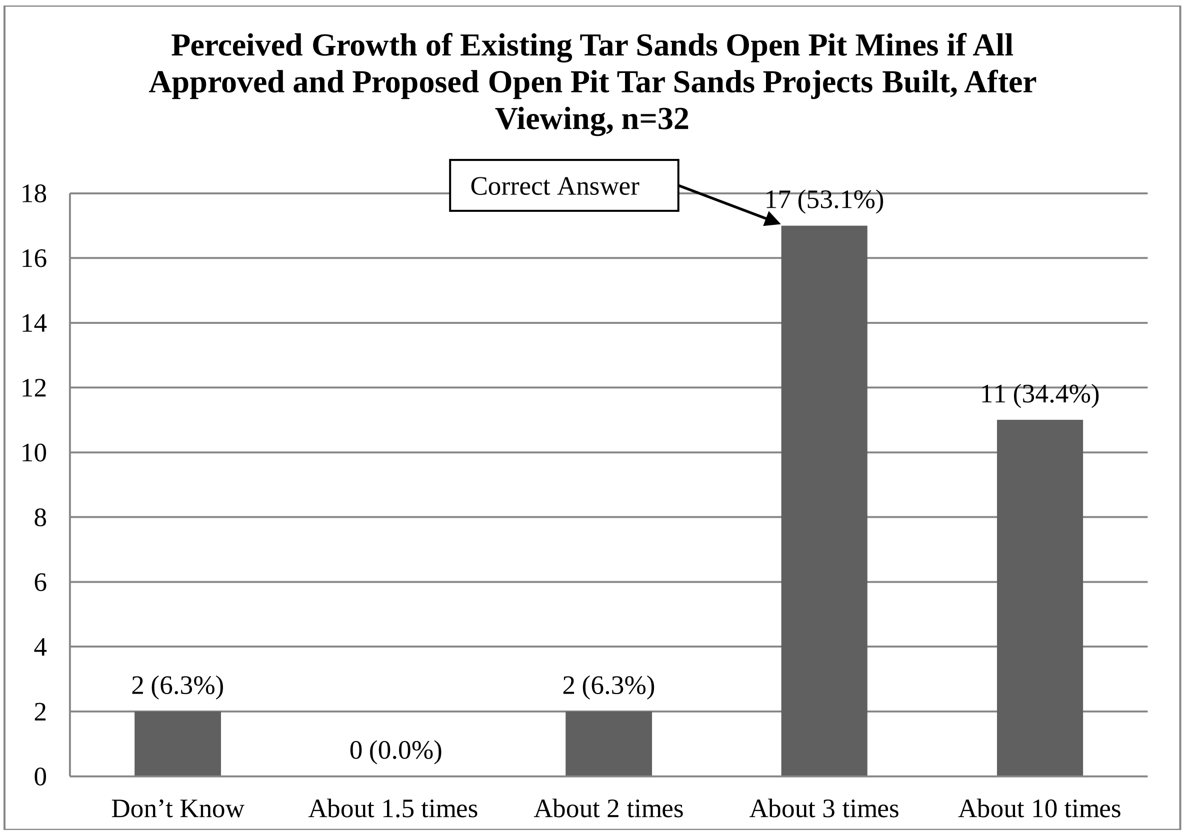


Figure 70 Perceived Growth of Existing Tar Sands Open Pit Mines if All Approved and Proposed Open Pit Tar Sands Projects Built, After Viewing

Participants were asked "What is your opinion about the ***expansion*** of future approved and planned open pit tar sands projects near Fort McMurray, Alberta?". As shown in Figure 71, the largest number of participants (46.9%) were "Extremely Opposed" to the expansion of future ***approved and planned*** open pit tar sand projects. Over four-fifths (81.3%) of participants were opposed to expansion of future ***approved and planned*** open pit tar sands projects.

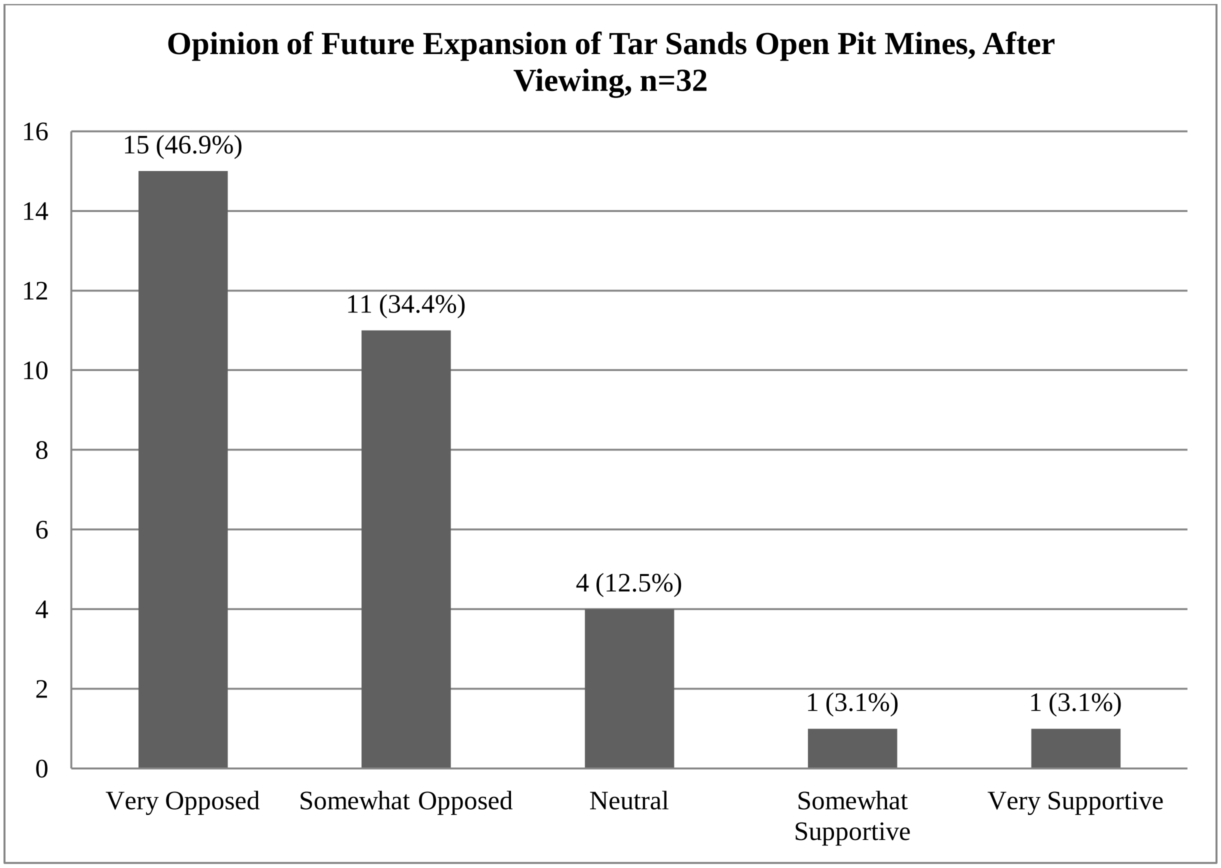


Figure 71 Opinion of Future Expansion of Tar Sands Open Pit Mines, After Viewing

As shown in Table 77 within Appendix “O”, 87.5% answered the open-ended question “If you feel opposed or supportive, please explain why.” Two out of twenty-eight participants (7.1%) stated that they were supportive of the expansion of tar sands open pit mines while the remainder were concerned or opposed (See Chapter 7 for full details on results).

Participants were asked “Has your opinion about open pit tar sands projects changed as a result of this focus group?”. As shown in Figure 72, the largest number of participants (31.3%) stated that their opinion about open pit tar sands project was “Somewhat changed” as a result of this focus group, which is also the median rank.

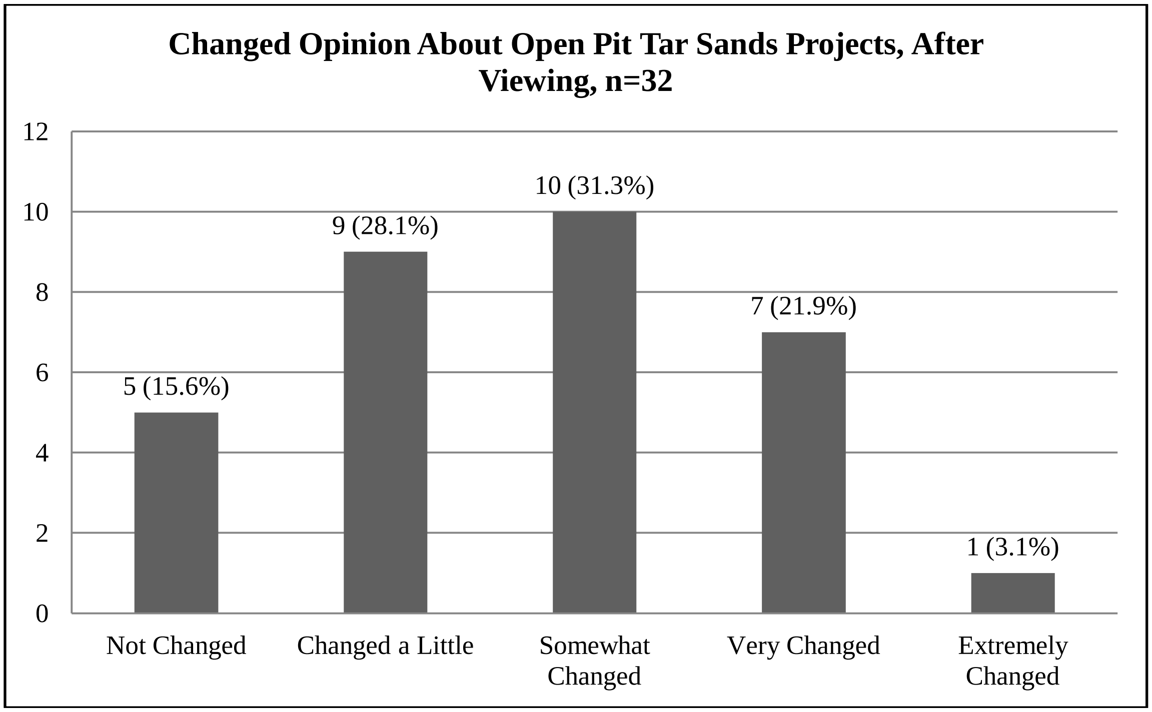


Figure 72 Changed Opinion About Open Pit Tar Sands Projects, After Viewing

As shown in Table 78 within Appendix “O”, almost all (96.9%) participants answered the open-ended question, “Please explain why” their opinion about open pit tar sands projects changed. Two participants stated that they did not learn anything new and one participant stated that she learned how the scale of the projects would “support the BC economy and provide jobs”. The remainder of the participants stated what they had learned or their concern and opposition to the open pit tar sands projects.

Participants were asked "Overall, how useful did you find the Google Earth tool in learning about the open pit tar sands projects in the Fort McMurray Region of Alberta?". As shown in Figure 73, the largest number of participants (56.3%) found the Google Earth tool "Mostly useful", which is also the median rank. About 78% of participants found the Google Earth tool to be "Mostly useful" or "Very useful". No participant found the Google Earth tool to be "Not at all useful."

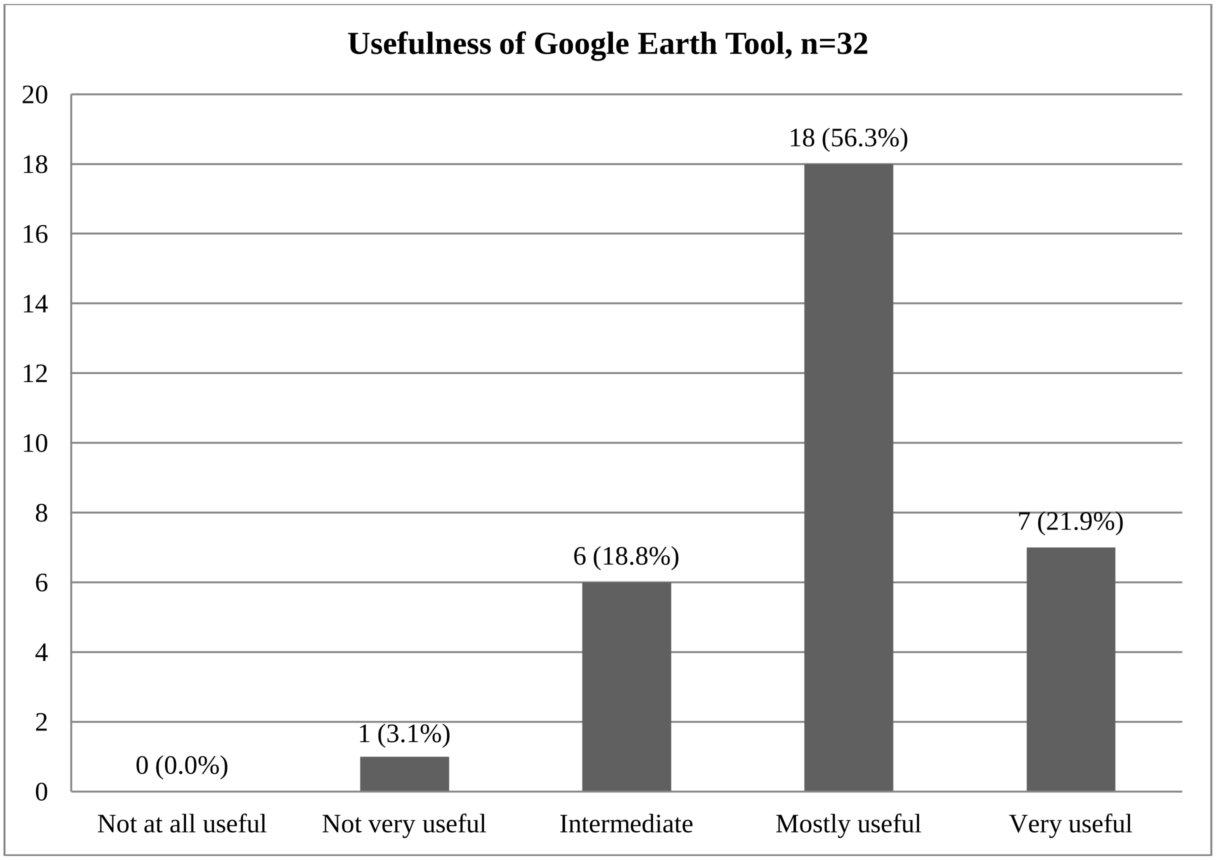


Figure 73 Usefulness of Google Earth Tool

As shown in Figure 74 and
Table 42, the city outline overlays were selected the greatest number of times (22 times out of 98) as being most helpful in expressing the scale of the tar sands open pit mines. Mining machinery (6 times out of 98) and trees (5 times out of 98) were selected least often. Participants were asked to select all of the options that applied shown in

Table 42.

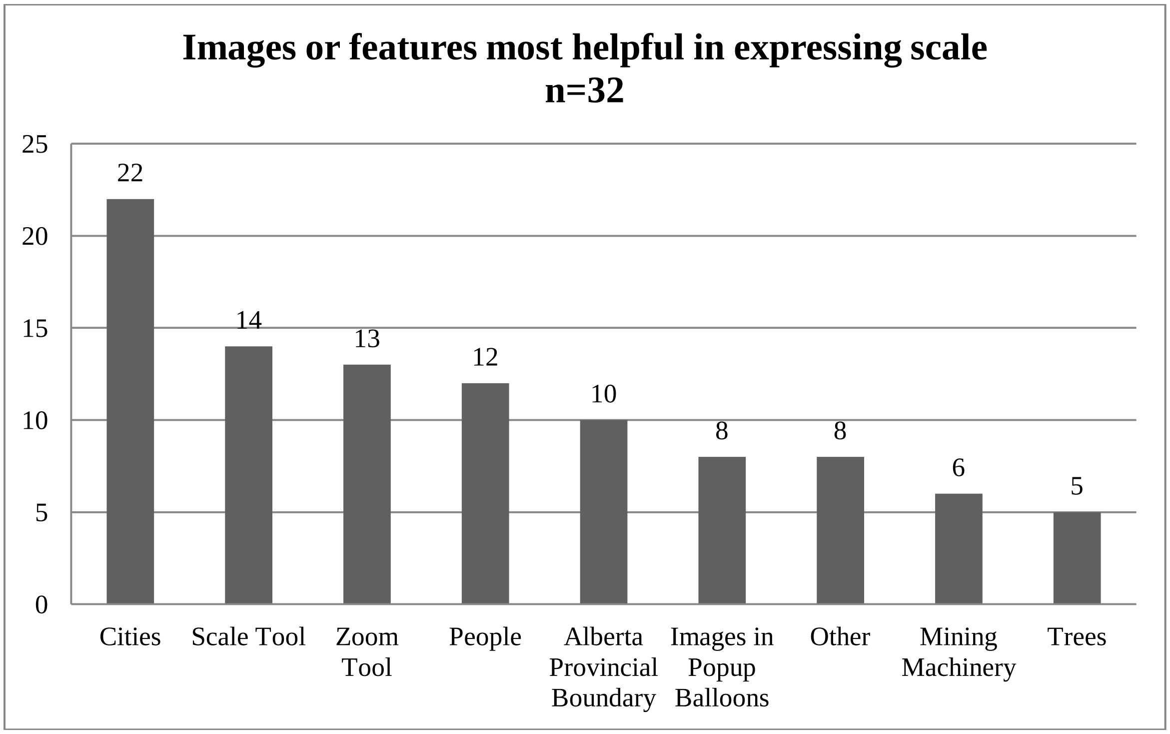


Figure 74 Images and Features Most Helpful in Expressing Scale

Table 42 Other Images or Features Most Helpful in Expressing Scale (Each Mentioned Once Only)

Other
1. Alberta lakes, rivers; Canada as a whole
2. City of Fort McMurray, buildings, global scale (map of the world)
3. Comparison to cities
4. Global scale
5. Pipeline projects
6. River
7. The government maps
8. The maps provide the scale of the project.

As shown in Table 79 within Appendix “O”, almost two-thirds (65.6%) of participants answered the open-ended question about the Google Earth tool’s ***weaknesses***. As shown in Table 80 with Appendix “O”, almost two-thirds (62.5%) of participants responded to the open-ended question about the Google Earth tool’s ***strengths***. One participant stated that the Google Earth tool “takes some getting used to.” These results are discussed in more detail in “Chapter 7: Qualitative Analysis”.

Participants were asked "How believable did you find the maps shown in the Google Earth tool?". As shown in Figure 75, the largest number of participants thought the believability of the maps was "Intermediate" (31.3%) and "Mostly Believable" (31.3%). Almost two-thirds of the participants (59.4%) thought the maps were "Mostly believable" or "Highly believable".

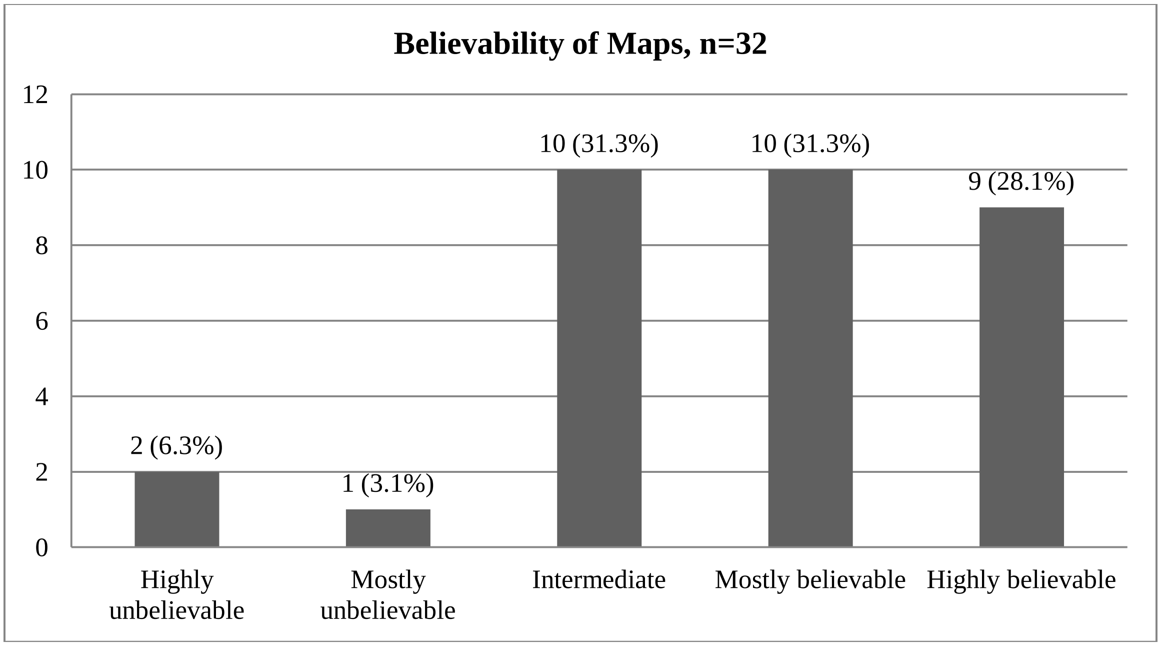


Figure 75 Believability of Maps

Answers to the open-ended question about explaining which maps participants found most compelling or informative are shown in Table 81 within Appendix "O". Answers to the open-ended question about how the maps might have been improved are Table 82 within Appendix "O". These results are discussed in greater detail in "Chapter 7: Qualitative Analysis".

Participants were asked “How believable did you find the static 3D computer simulations shown in the “balloons” in the Google Earth tool?”. As shown in Figure 76, the largest number of participants (53.6%) thought the believability of static 3D computer simulations was “Intermediate”, which was also the median rank. However, more participants thought the static 3D visualisations were “Mostly believable” or “Highly believable” (28.2%) than participants who thought they were “Mostly unbelievable” (18.8%). No participant thought the 3D computer simulations were “Highly unbelievable”.

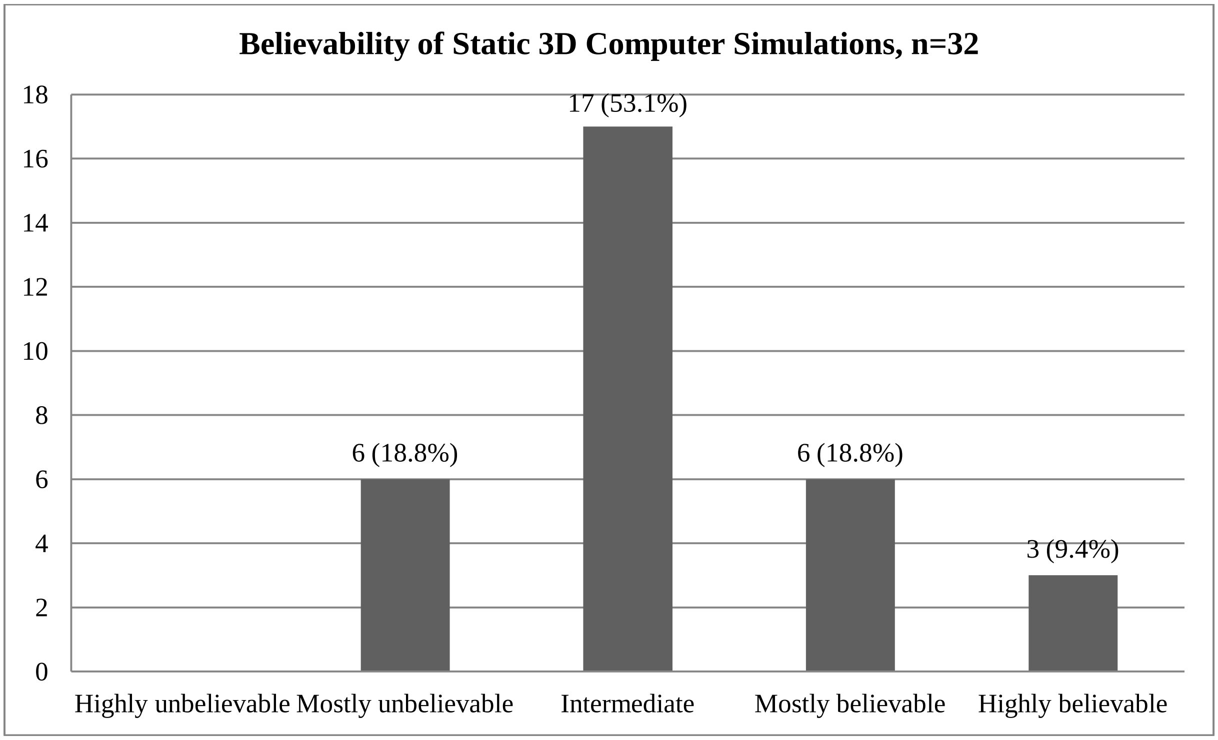


Figure 76 Believability of Static 3D Computer Simulations

Almost two-thirds of participants answered the open-ended question about the most compelling or informative 3D computer simulations, as shown in Table 83 within Appendix “O”. There were 11 complimentary comments (52.3%) and 10 critical comments (47.6%.).

The following answers to open-ended questions are shown in Appendix “O”:

1) Over two-thirds of participants replied to the open-ended question about how the maps might have been improved, as shown in Table 82;

2) Half the participants replied to the open-ended question about how the 3D computer simulations might have been improved, as shown in Table 84;

3) About two-fifths of participants replied to the question about whether they had any problems understanding the research process or filling out the questionnaire, as shown in Table 85; and

4) Almost two-thirds of participants replied to the question about whether they had any additional comments, as shown in
5) Table 86.

5.5. Concluding Comments

In this chapter, the data collected from the focus groups have been described, including:

1) Transcripts of focus group discussions and notes from observers;
2) Participants’ screenshots;
3) Screen video capture of participants’ use of computers; and
4) Completed questionnaires (i.e. descriptive statistics and written responses to open-ended questions).

Overall, focus group participants were older, more educated, and were more “white-collar” than the Canadian average. Before viewing the Google Earth project, participants were mostly opposed to the tar sands open pit mines. In the following Chapter 6 “Quantitative Analysis”, further analysis of the questionnaire data and the participants’ screenshots is presented and discussed. In Chapter 7 “Qualitative Analysis”, the transcripts from the focus group discussions and the written responses to the open-ended questionnaires are presented thematically and analysed.

CHAPTER 6: QUANTITATIVE ANALYSIS

6.1 Introduction to Quantitative Analysis

The purpose of this chapter is to analyse the quantitative data from the initial and follow up questionnaires by comparing responses to the two questionnaires as well as by identifying correlations between variables. A quantitative analysis of the screenshots that were selected by the participants is also undertaken.

The initial and follow up questionnaires contained the same questions concerning:

1) Opinion about existing tar sands open pit mines;
2) Perceived geographic area of existing, approved, and planned tar sands open pit mines;
3) Perceived growth of approved and planned tar sands open pit mines; and
4) Opinion about future growth of future approved and planned tar sands open pit mines.

By determining whether or not there is a statistically significant difference in participant responses to the same questions in the initial and follow up questionnaires, this may indicate whether the process of viewing the Google Earth project affected participants' perceptions and opinions. In turn, this may indicate whether or not it is useful to use virtual globes such as Google Earth to communicate the cumulative development of very large projects such as the tar sands open pit mines to the general public. In addition to being used by technical specialists, virtual globes such as Google Earth are currently being used in efforts to communicate environmental and landscape change to the general public (Schroth et al., 2011; Sheppard & Cizek, 2009). Therefore, this study specifically focused on examining whether viewing the tar sands open pit mines within a Google Earth project had an effect on the perceptions and opinions of members of the general public. Correlations between survey variables were also examined to determine if there were any statistically significant relationships between socio-demographic characteristics, perceptions, and opinions.

The follow up questionnaire also included questions about the believability of the maps compared to the static landscape visualisation images. By determining whether or not there is a difference in participant opinions about the believability of maps compared to static landscape visualisation images, this may assist practitioners in focusing their efforts to prepare the most useful visual material for communicating the cumulative development of large industrial projects such as the tar sands open pit mines to the general public. [25]

As discussed in more detail in Chapter 4 "Social Research Methods", participants were encouraged to take screenshots of viewpoints of the tar sands open pit mines that they found most interesting or compelling. By comparing the frequency of different viewpoints and topics

[25] "Maps" are defined as 2D images displayed in Google Earth as draped overlays. "Static landscape visualisations" are defined as 3D images displayed in Google Earth within pop-up balloons or hyper-linked to standard web-pages. "Interactive landscape visualisations" are defined as 3D terrain, trees, mining machinery, and people displayed within Google Earth. No specific questions were asked comparing "Interactive landscape visualisations" to "Maps" or "Static landscape visualisations".

this may also assist practitioners in focusing their efforts to prepare visual materials that are most interesting and compelling to the general public.

Therefore, there are four types of analysis used in this chapter:

1) Comparison of initial and follow up questionnaire results;
2) Comparison of believability of maps and landscape visualisation images;
3) Correlation among questionnaire variables; and
4) Screenshot Analysis.

Using SPSS software (International Business Machines Corp., n.d.-b), all quantitative data were analysed using Kolmogorov-Smirnov and Shapiro-Wilk tests to determine whether the individual variables were normally distributed.[26] It was found that none of the individual variables have a normal distribution. Therefore, only non-parametric tests are used for further quantitative data analysis. With the exception of the correlation tests that use an adjusted Bonferroni significance level to account for the number of tests using the same variable, all other tests are considered significant at 95% confidence interval and 5% significance level (<.05). As described in Section 6.3.2., there were no significant correlations between the residence of focus group participants (i.e. British Columbia or Alberta), so the results from all three focus groups could be aggregated for analysis.

6.2. Comparison of Initial and Follow Up Questionnaire Results

In this section, initial and follow up questionnaire results about geographic area, growth, and opinion about the tar sands open pit mines are compared to determine whether the differences are statistically significant. Where there are significant differences this may indicate that viewing the Google Earth project had affected the participants' perceptions and opinions of the tar sands open pit mines.

Since there are two related samples of ordinal data about geographic area, growth, and opinion about the tar sands open pit mines, the nonparametric Wilcoxon Signed-Ranks test (International Business Machines Corp., n.d.a) was used to determine whether there were significant differences before and after viewing the Google Earth project. For the questions about geographic area and growth, participants also had the option of stating "Don't know", which is a nominal variable. Therefore, only those participants who thought they knew the geographic area or growth both before and after viewing could be used in the Wilcoxon Signed-Ranks test, which requires at least ordinal data.

Participants' responses were therefore re-classified into two categories – those who stated "Don't know" and those who thought they knew the geographic area or growth of the tar sands open pit mines. The nonparametric McNemar test, which measures differences between related samples of binary data (International Business Machines Corp., n.d.a), was used to determine whether or not there was a statistically significant difference in the number of participants who stated "Don't know" before and after viewing the Google Earth project. If there were significantly fewer

[26] The Kolmogorov-Smirnov and Shapiro-Wilk tests are the only two tests available in SPSS software for to test whether a single variable has a normal distribution (International Business Machines Corp., n.d.a).

participants who stated "Don't know" ***after*** viewing the Google Earth project, this indicates that some learning about the geographic area and growth of the tar sands open pit mines took place.

The significance of the differences in the perception of geographic area and growth is summarized in Table 43. Among those participants who thought they knew the geographic area and growth of the tar sands open pit mines both before and after viewing, there was a significant change in perception after viewing the Google Earth project only for the geographic area of the ***existing*** tar sands open pit mines where the perceived geographic area increased. This may be due to the smaller sample sizes in the other cases or it may indicate that the perception of participants who thought they knew the geographic area or growth of the ***approved*** and ***planned*** tar sands open pit mines beforehand was not changed significantly by viewing the Google Earth project. Nevertheless, in all cases there were significantly fewer participants who stated "Don't know" after viewing the Google Earth project, which suggests that some learning took place as a result of viewing the Google Earth project.

Table 43 Summary of Significance of Differences in Perception of Geographic Area and Growth of Tar Sands Open Pit Mines, Before and After Viewing

Related paired sample before and after viewing the Google Earth project	Number of participants who thought they knew the geographic area or growth both before and after viewing.	Significance of difference in perception, before and after viewing (Wilcoxon Signed Ranks Test) – Significant differences marked with asterisk (*)	Reduced number of participants who stated "Don't know"	Significance of difference in number participants stating "Don't know" after viewing (McNemar Test) – Significant differences marked with asterisk (*)
Perceived geographic area of ***existing*** tar sands open pit mines, before and after viewing	25	.008*	-7	.016*
Perceived geographic area of ***approved*** tar sands open pit mines, before and after viewing	24	.378	-6	.031*
Perceived geographic area of ***planned*** tar sands open pit mines, before and after viewing	19	.405	-12	.000*
Perceived growth in geographic area of ***approved*** tar sands open pit mines, before and after viewing	18	.113	-13	.000*
Perceived growth in geographic area of ***planned and approved*** tar sands open pit mines, before and after viewing	17	.174	-13	.000*

The significance of changes in opinion about the tar sand open pit mines is summarized in Table 44. After viewing the Google Earth project, participants became more opposed to both existing and future tar sands open pit mines. Also, more participants became more opposed to future tar sands open pit mines than existing open pit mines after viewing the Google Earth project. However, the differences between the related paired samples were not significant in two cases. There was not a significant difference in the opinion of participants about existing tar sands open pit mines before and after viewing the Google Earth project. Also, there was not a significant difference in the opinion of participants about existing and future tar sands open pit mines before viewing the Google Earth project. This indicates that viewing the Google Earth project may have significantly changed the opinion of participants mostly about the future tar sands open pit mines. Overall, it is possible that the future tar sands open pit mines may represent a threshold of limits of acceptable landscape change. However, there is no evidence of a particular threshold – only that the existing tar sands open pit mines are generally acceptable but that the future are not.

Table 44 Summary of Significance of Differences in Opinion of Existing and Future Tar Sands Open Pit Mines, Before and After Viewing

Related paired sample before and after viewing the Google Earth project	**Significance of difference in opinion (Wilcoxon Signed Rank Test) – Significant differences marked with asterisk (*)**
Change in opinion of ***existing*** tar sands open pit mines, ***before*** and ***after*** viewing	.331
Change in opinion of ***future*** tar sands open pit mines, ***before*** and ***after*** viewing	.013*
Comparison of opinion of ***existing*** and ***future*** tar sands open pit mines ***before*** viewing	.317
Comparison of opinion of ***existing*** and ***future*** tar sands open pit mines, ***after*** viewing	.021*
Comparison opinion of ***existing*** tar sand open pit mines ***before*** viewing and future mines ***after*** viewing	.008*

The analysis of the changes in perception and opinion about the tar sands open pit mines before and after viewing the Google Earth project is described in detail in the following sections.

6.2.1. Perception of Geographic Area and Growth of Geographic Area of Tar Sands Open Pit Mines, Before and After Viewing

The initial and follow up questionnaires asked the same question to examine the effect of viewing the tar sands maps and landscape visualisations. The data contain a set of matched samples from each participant. The Wilcoxon Signed-Rank Test, a non-parametric test, was used to assess whether or not there is a statistically significant change in opinions about the mines before and after viewing. All calculations were carried out using SPSS software (International Business Machines Corp., n.d.-b).

Five before and after comparisons were carried out:

1) Perceived geographic area of ***existing*** tar sands open pit mines, before and after viewing;
2) Perceived geographic area of ***approved*** tar sands open pit mines, before and after viewing;
3) Perceived geographic area of ***planned*** tar sands open pit mines, before and after viewing;
4) Perceived growth in geographic area of ***approved*** tar sands open pit mines, before and after viewing; and
5) Perceived growth in geographic area of ***planned and approved*** tar sands open pit mines, before and after viewing.

In most cases, the largest number of participants over-estimated the spatially measured geographic area and growth of the tar sands open pit mines after viewing the Google Earth project, as shown in Table 45. The largest number of participants correctly estimated geographic area and growth in two cases. Before viewing the Google Earth project, the largest number of participants (34%) correctly estimated that the geographic area of the tar sands open pit mines is about as large as a “Canadian metropolitan city”. After viewing the Google Earth project, the largest number of participants (53%) correctly estimated that the combined tar sands open pit mines would grow about three times if the approved and planned projects were constructed.

The largest number of participants over-estimated geographic area and growth in five cases. Before viewing the Google Earth project, the largest number of participants (31%) spatially over-estimated that the geographic area of the approved tar sands open pit mines would be as large as a “World metropolitan city”. After viewing the Google Earth project, the largest number of participants spatially over-estimated that the existing (43%), approved (56%), and planned (56%) tar sands open pit mines would each be as large as a “World metropolitan city”. After viewing the Google Earth project, the largest number of participants (71%) also spatially over-estimated that the combined geographic area of the tar sands open pit mines would grow about three times if the approved tar sands open pit mines were constructed.

Table 45 Comparison of Modal Responses (Percent of Participants) in Relation to Actual Geographic Area and Grown of Tar Sands Open Pit Mines, Before and After Viewing

	Existing Tar Sands Open Pit Mines	Approved Tar Sands Open Pit Mines			Planned Tar Sands Open Pit Mines		
	Geographic Area	**Geographic Area**	**Cumulative Geographic Area**	**Growth**	**Geographic Area**	**Cumulative Geographic Area**	**Growth**
Actual Geographic Area/Growth	715 km^2 (Canadian metropolitan city)[27]	544 km^2 (Canadian metropolitan city)	1,259 km^2	About 2 times (100% increase)	479 km^2 (Canadian metropolitan city)	1,738 km^2	About 3 times (200% increase)
Estimate Before Viewing	Canadian metropolitan city (34%)	World metropolitan city (31%)		Don't know (44%)	Don't know (41%)		Don't know (47%)
Estimate After Viewing	World metropolitan city (43%)	World metropolitan city (56%)		About 3 times (72%)	World metropolitan city (56%)		About 3 times (53%)

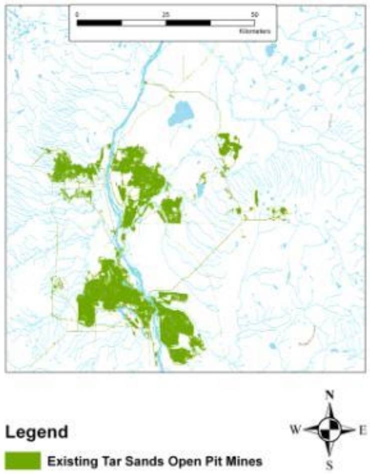
Key

	Modal Estimated Geographic Area or Growth
(green)	= Spatially Correct Answer
(pink)	= Spatially Over-estimated

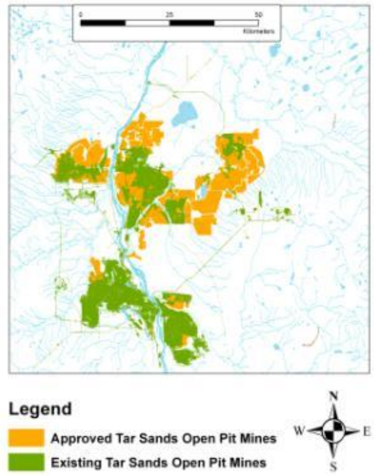
After viewing the Google Earth project, the largest number of participants may have spatially over-estimated the geographic area of the tar sands open pit mines in all scenarios (existing, approved, and planned) because of the "convex hull effect"[28] or because of different understandings about the boundaries of metropolitan areas, as discussed in more detail in Section 8.1.1. Some participants may have also spatially over-estimated the geographic area of the future scenarios due to confusion between the geographic area of ***each*** of the approved and planned scenarios (as identified in the questions) and the ***cumulative*** geographic area in each of the scenarios, as shown in Figure 77, although no evidence was found in participant evaluation comments to suggest confusion over this issue.

[27] The physical footprint of existing tar sands open pit mines was approximately 562 km^2 when it was originally calculated in 2008 using Landsat satellite imagery from 2006. By the time the focus groups were carried out in 2012, the existing physical footprint had grown to 715 km^2 (Alberta Department of Energy, 2013a). The 2012 physical footprint was used in the focus groups. The increase in the existing physical footprint means that the physical footprint of the tar sands open pit mines would grow by a factor of 1.76 if the approved mines are constructed and would grow by a factor of 2.43 if both the approved and planned tar sands open pit mines are constructed.

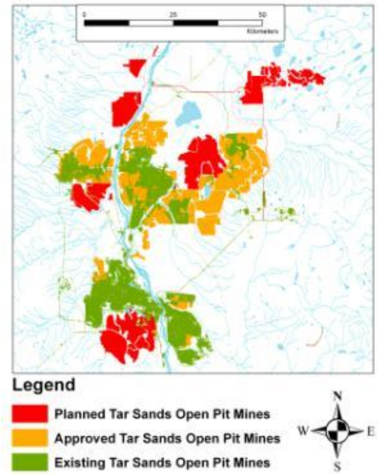
[28] "In mathematics, the convex hull or convex envelope of a set X of points in the Euclidean plane or Euclidean space is the smallest convex set that contains X." (de Berg, van Kreveld, Overmars, & Schwarzkopf, 2000, p. 3).



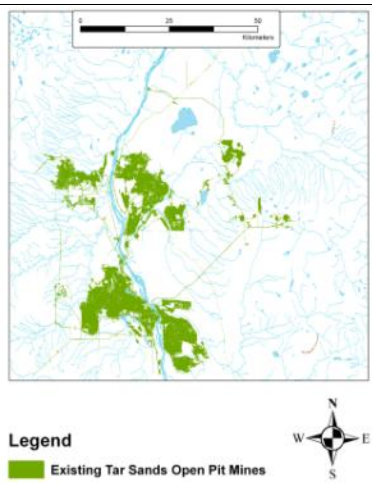
Physical Footprint of Existing Tar Sands Open Pit Mines = 715 km^2



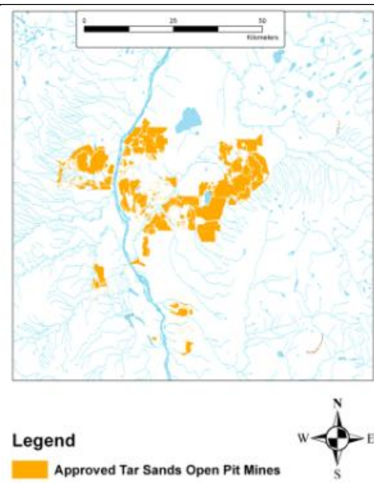
Cumulative Physical Footprint of Existing and Approved Tar Sands Open Pit Mines = 1,259 km^2



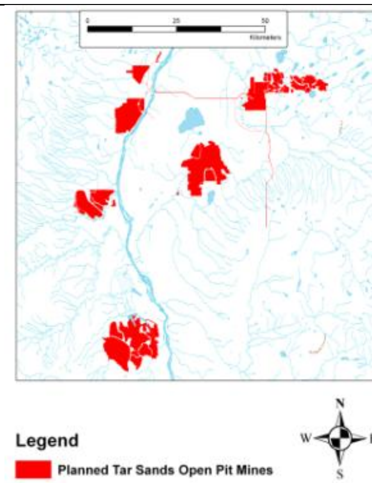
Cumulative Physical Footpint of Existing, Approved, and Planned Tar Sands Open Pit Mines = 1,738 km^2



Physical Footprint of Existing Tar Sands Open Pit Mines = 715 km^2



Physical Footprint of Only Approved Tar Sands Open Pit Mines = 544 km^2



Physical Footprint of Only Planned Tar Sands Open Pit Mines = 479 km^2

Figure 77 Comparison of Cumulative and Individual Physical Footprints of Existing, Approved, and Planned Tar Sands Open Pit Mines

6.2.1.1. Perceived Geographic Area of Existing Tar Sands Open Pit Mines, Before and After Viewing

After viewing, there were seven fewer participants who stated “Don’t Know” and no remaining participants who still stated “Don’t Know, as shown in Figure 78. Using the McNemar test, this difference is significant (0.016). After viewing, most participants (44%) perceived the geographic area of existing mines as about as large as the “World’s largest metropolitan cities”. However, the geographic area of existing mines is actually about as large as a “Canadian metropolitan city”.

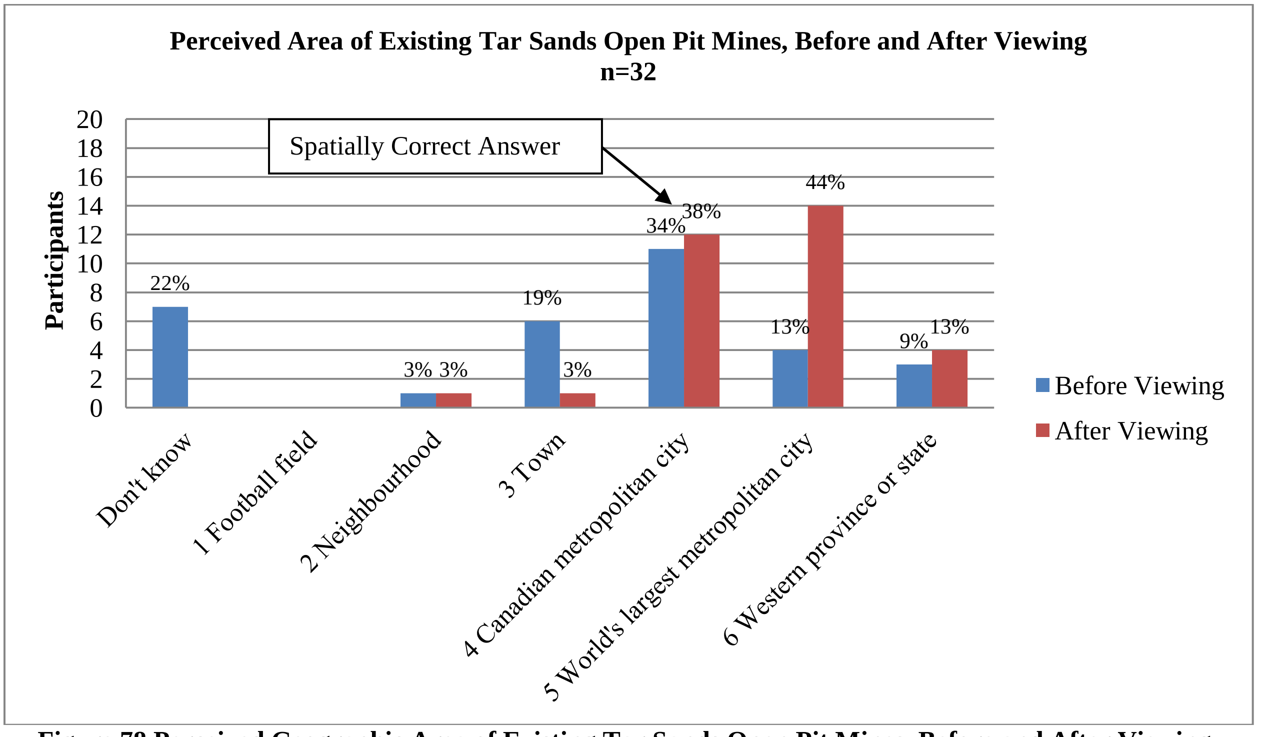


Figure 78 Perceived Geographic Area of Existing Tar Sands Open Pit Mines, Before and After Viewing

The seven participants who did not know the geographic area before viewing were not included in the Wilcoxon-Signed Rank test because this test requires at least ordinal data.[29] After viewing, 40% of these participants (10 of 25) perceived the existing tar sands open pit mines as larger while only one participant perceived the existing open pit mines as smaller after viewing than before viewing. Using the Wilcoxon-Signed Rank test, this change is significant (.008).

[29] The Wilcoxon-Signed Rank test counts positive, negative, and neutral changes among individual participants. It does not count the sum of changes between the different categories (International Business Machines Corp., n.d.a).

As shown in Figure 79, the largest number of participants, who thought they knew the existing area of the tar sands open pit mines before viewing, perceived the geographic area of the existing tar sands open pit mines to be about as large as a “Canadian metropolitan city”, both before and after viewing, which is the spatially correct answer. After viewing, five fewer participants thought that the geographic area of the existing tar sands open pit mines was as large as a “Town”. At the same time, five more participants thought that the existing tar sands were as large as one of the “World’s largest metropolitan cities” or a “Western province or state”. Therefore, the effect of viewing the existing tar sands open pit mines did not affect the modal number of participants with the correct answer, but the majority of those with inaccurate estimates shifted to the larger scales.

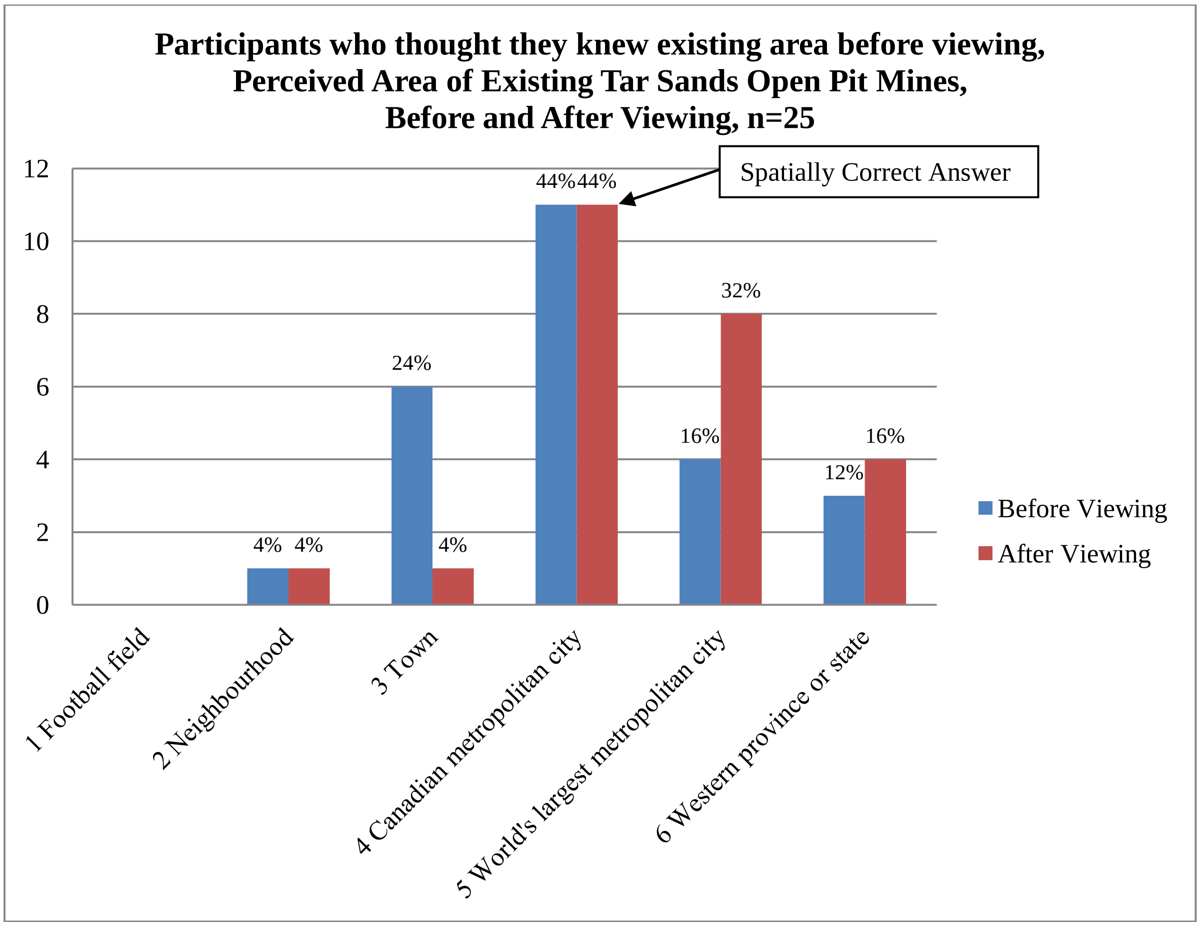


Figure 79 Participants who thought they knew existing area before viewing, Perceived Area of Existing Tar Sands Open Pit Mines, Before and After Viewing

As shown in Figure 80, the largest number of participants, who did not know the existing area of tar sands open pit mines before viewing, perceived the geographic area of existing tar sands open pit mines about as large as a “World metropolitan city” after viewing, which is not the spatially correct answer. This suggests that participants with less knowledge of the tar sands were more prone to over-estimating the scale after viewing than were those with more knowledge.

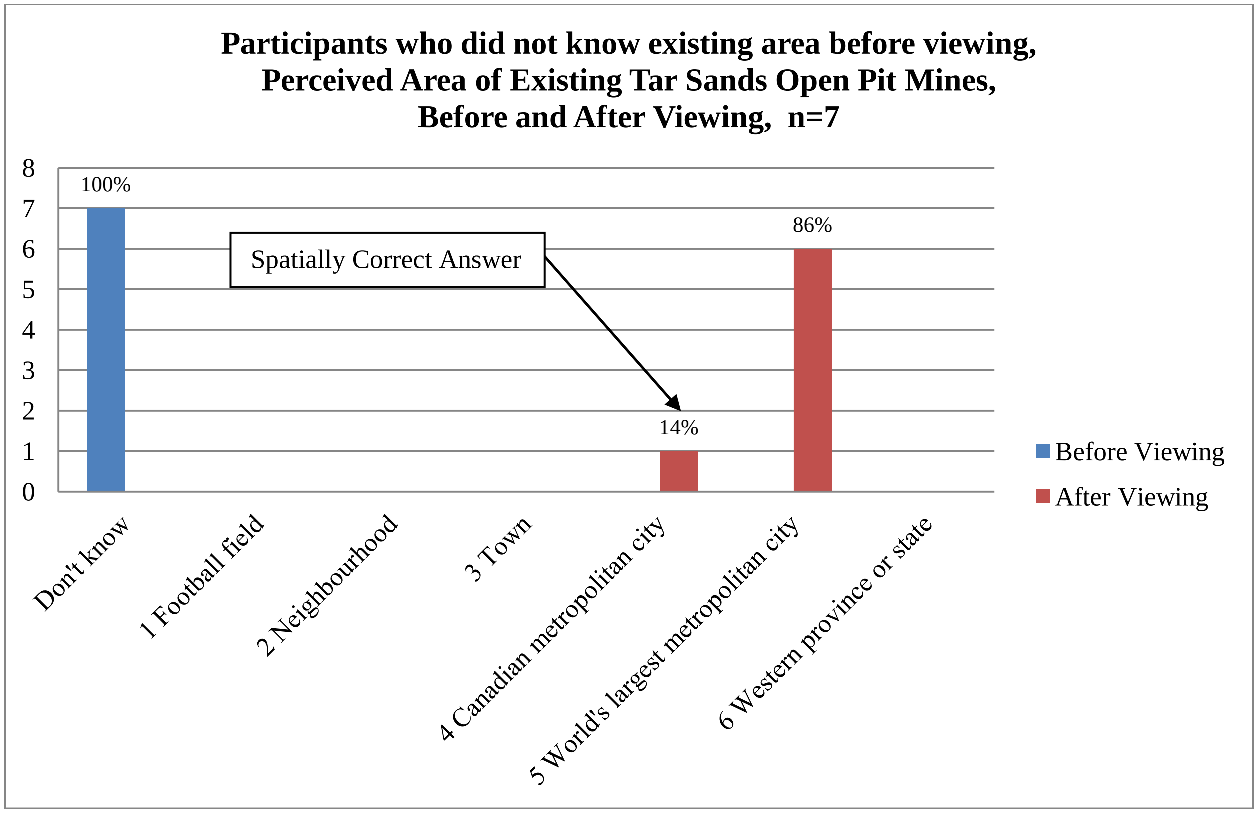


Figure 80 Participants who did not know existing area before viewing, Perceived Area of Existing Tar Sands Open Pit Mines, Before and After Viewing

6.2.1.2. Perceived Geographic Area of Approved Tar Sand Open Pit Mines, Before and After Viewing

After viewing, there were six fewer participants who stated "Don't Know" and two remaining participants who still stated "Don't Know", as shown in Figure 81. Using the McNemar test, this difference is significant (.031). The majority of participants (56%) perceived the geographic area of approved mines about as large as one of the world's largest metropolitan cities. However, the geographic area of approved mines is actually about as large as a Canadian metropolitan city. Some participants may have remembered that they perceived the geographic area of the existing tar sands open pit mines about as large as a "Canadian metropolitan city" so they ranked the approved tar sands mines about as large as one of the "World's largest metropolitan cities".

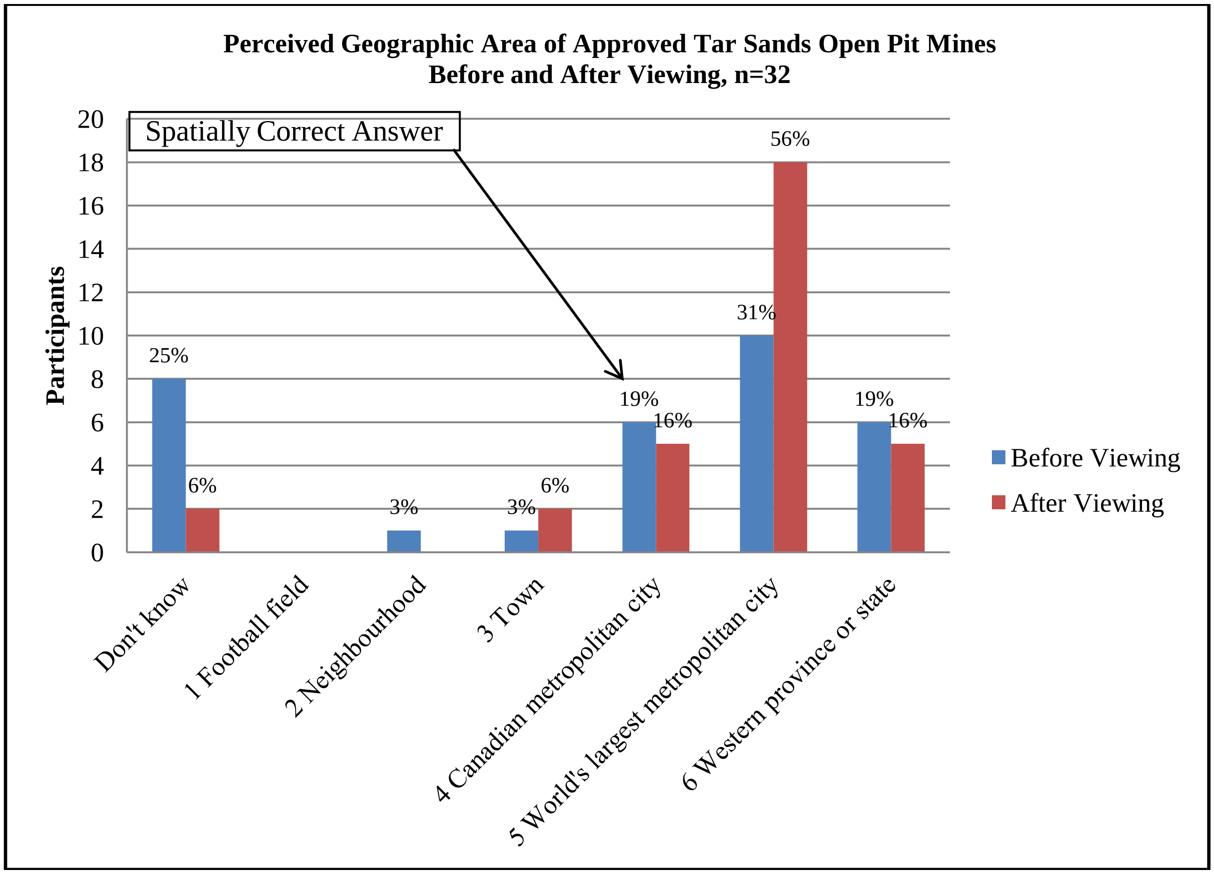


Figure 81 Perceived Geographic Area of Approved Tar Sands Open Pit Mines, Before and After Viewing

Only those 24 participants who thought they knew the geographic area before viewing are included in the Wilcoxon-Signed Ranks test. After viewing, half these participants perceived the geographic area of the approved mines as the same before viewing and one-third perceived the geographic area of the approved mines as larger. This change is not significant (.378).

As shown in Figure 82, the largest number of participants, who thought they knew the area of approved tar sands open pit mines before viewing, perceived the geographic area of the approved tar sand sands open pit mines about as large as a “World metropolitan city” both before and after viewing, which is not the spatially correct answer. After viewing, the number of participants who perceived the geographic area of the approved tar sand open pit mines as large as a “World metropolitan city” increased by four while the number of participants who perceived the geographic area as large as a “Canadian metropolitan city”, the spatially correct answer, decreased by three, representing a small increase in the tendency to over-estimate actual scale. At the same time, the number of participants who perceived the geographic area of the approved tar sands open pit mines at either end of the scale decreased, showing some slight increase in accuracy.

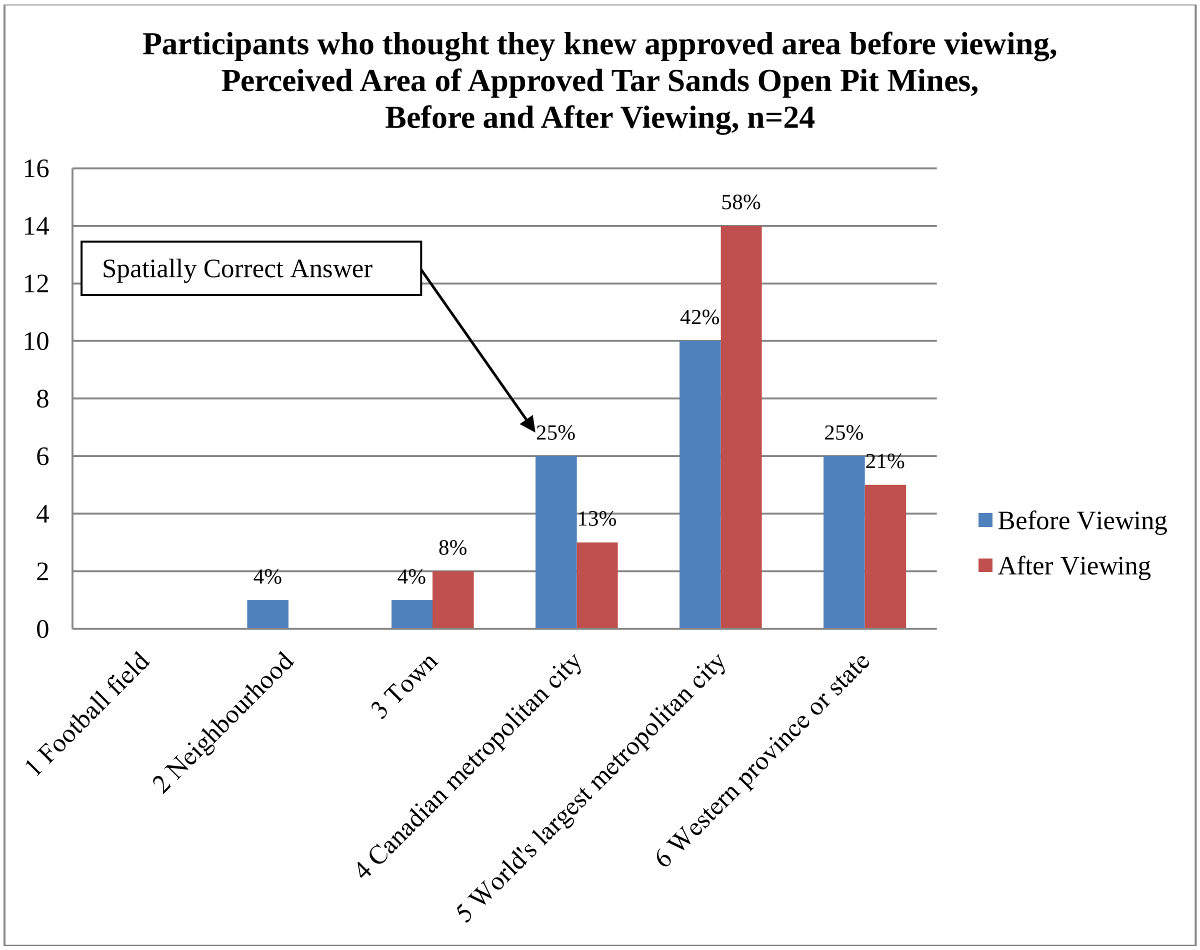


Figure 82 Participants who thought they knew approved area before viewing, Perceived Area of Approved Tar Sands Open Pit Mines, Before and After Viewing

As shown in Figure 83, the largest number of participants, who did not know the area of the approved tar sands open pit mines before viewing, perceived the geographic area of the approved tar sand sands open pit mines about as large as a “World metropolitan city” after viewing, which is not the spatially correct answer.

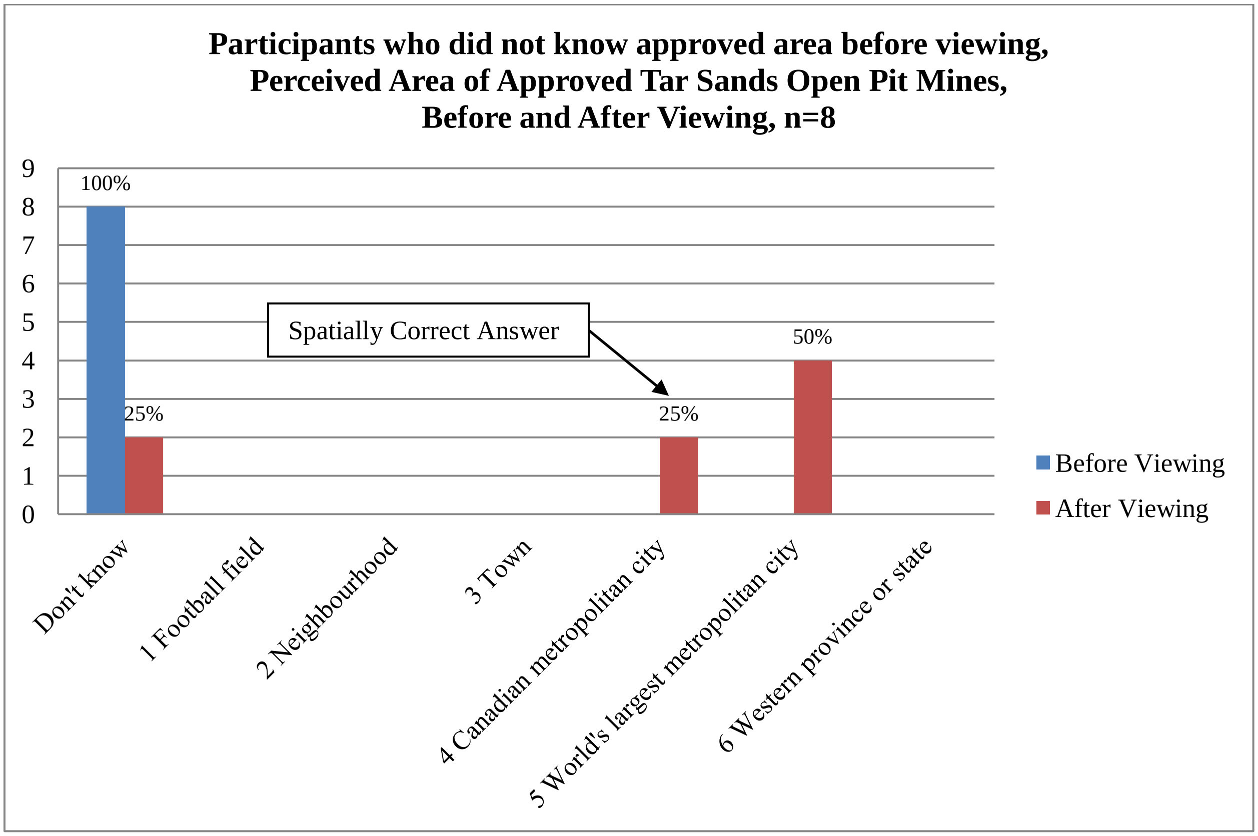


Figure 83 Participants who did not know approved area before viewing, Perceived Area of Approved Tar Sands Open Pit Mines, Before and After Viewing

6.2.1.3. Perceived Geographic Area of Planned Tar Sands Open Pit Mines, Before and After Viewing

After viewing, twelve fewer participants stated “Don’t Know” and there was only one remaining participant who stated “Don’t Know”. Using the McNemar test, this difference is significant (.000). Eighteen participants (56%) perceived the area of planned mines about as large as one of the world’s largest metropolitan cities, as shown in Figure 84. However, the area of planned mines is actually about as large as a Canadian metropolitan city.

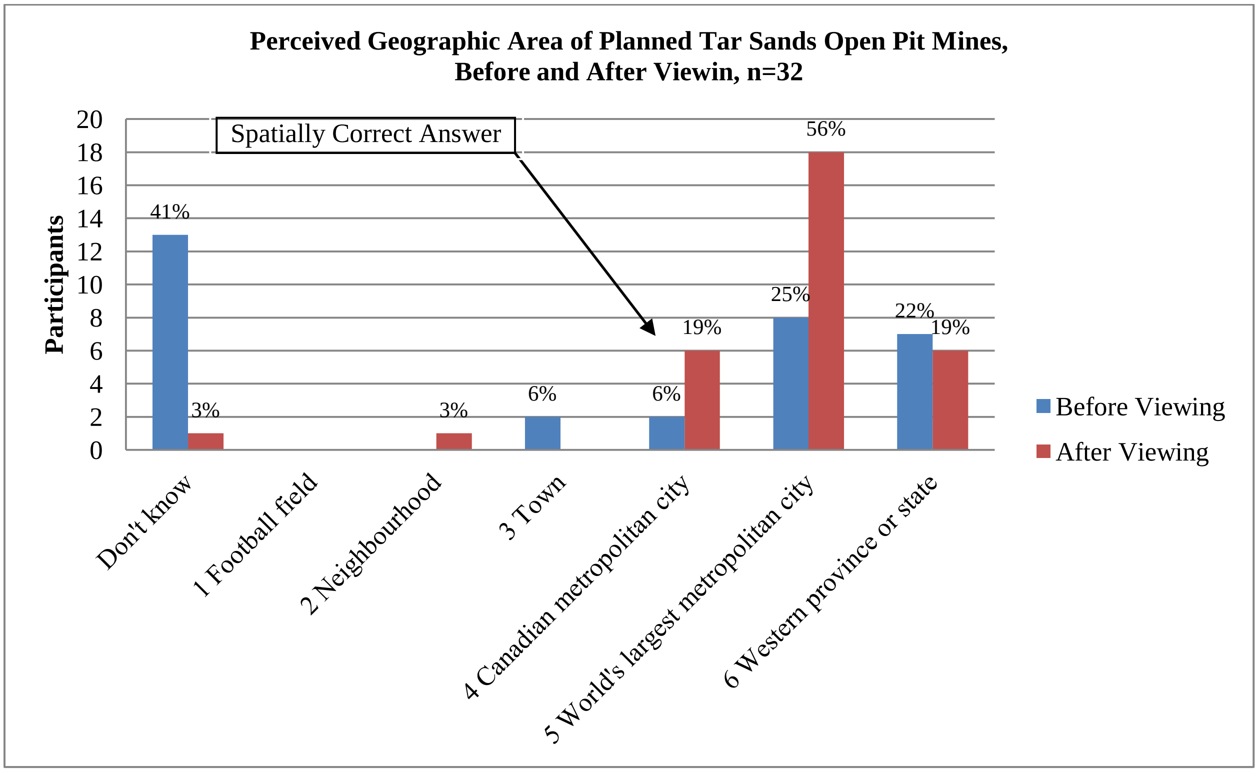


Figure 84 Perceived Geographic Area of Planned Tar Sands Open Mines, Before and After Viewing

As shown in Figure 85, the largest number of participants, who thought they knew the area of planned tar sands open pit mines before viewing, perceived the geographic area of the planned tar sand sands open pit mines about as large as a “World metropolitan city” both before and after viewing, which is not the spatially correct answer. After viewing, the number of participants who perceived the geographic area of the planned tar sand open pit mines as large as a “World metropolitan city” or as large as “Canadian metropolitan city” both increased. The number of participants who perceived the geographic area of the planned tar sands open pit mines about as large as a “Western province or state” decreased by three, indicating some increase in accuracy at the upper end of the scale.

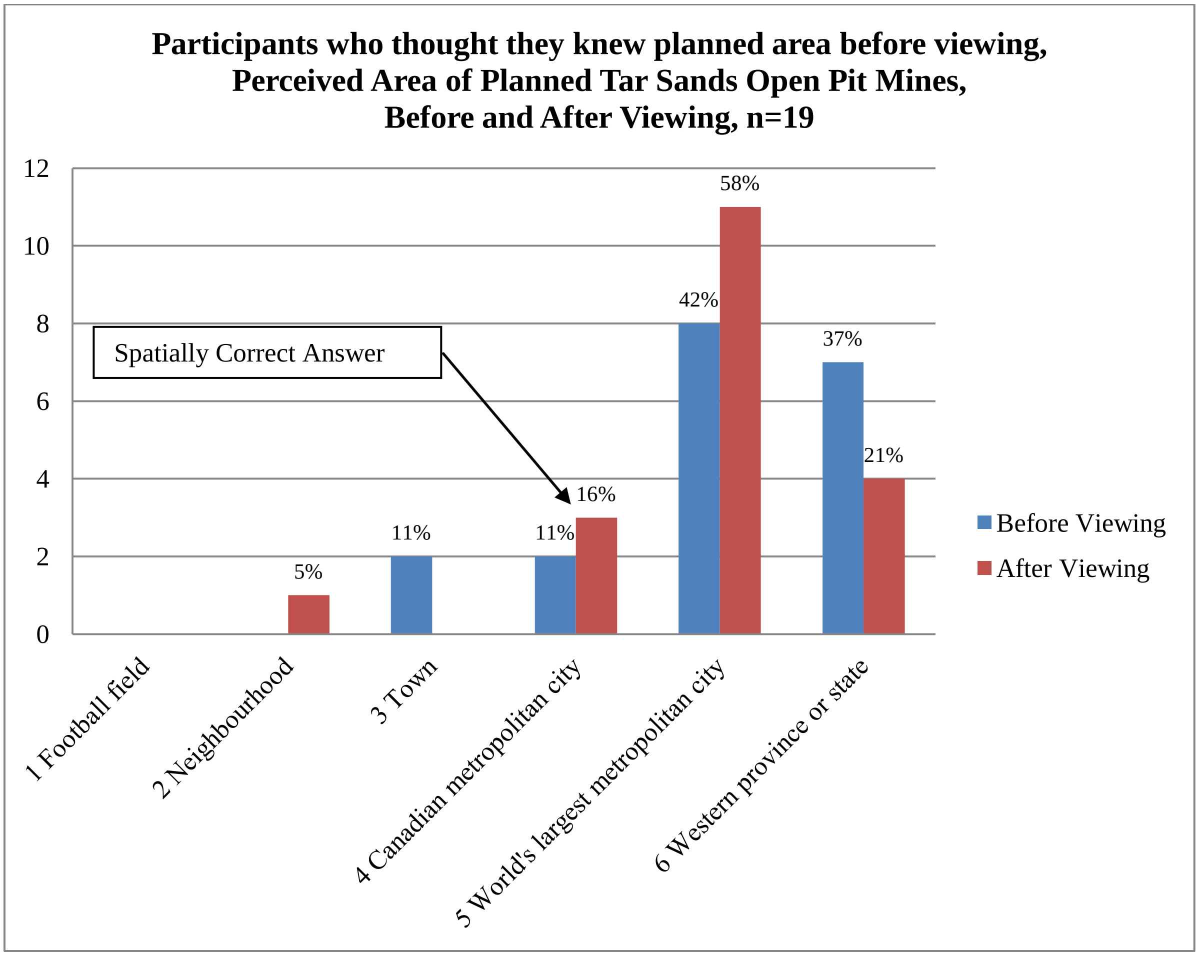


Figure 85 Participants who thought they knew planned area before viewing, Perceived Area of Planned Tar Sands Open Pit Mines, Before and After Viewing

Only those nineteen participants who thought they knew the geographic area before viewing are included in the Wilcoxon-Signed Ranks test. After viewing, the majority of these participants (14 out of 19) perceived the planned open pit mines as larger or the same while 42% (8 out of 19) perceived the planned open pit mines as smaller. The change in perception is not significant (.405).

As shown in Figure 86, the largest number of participants, who did not know the area of the planned tar sands open pit mines before viewing, perceived the geographic area of the approved tar sand sands open pit mines about as large as a "World metropolitan city" after viewing, which is not the spatially correct answer.

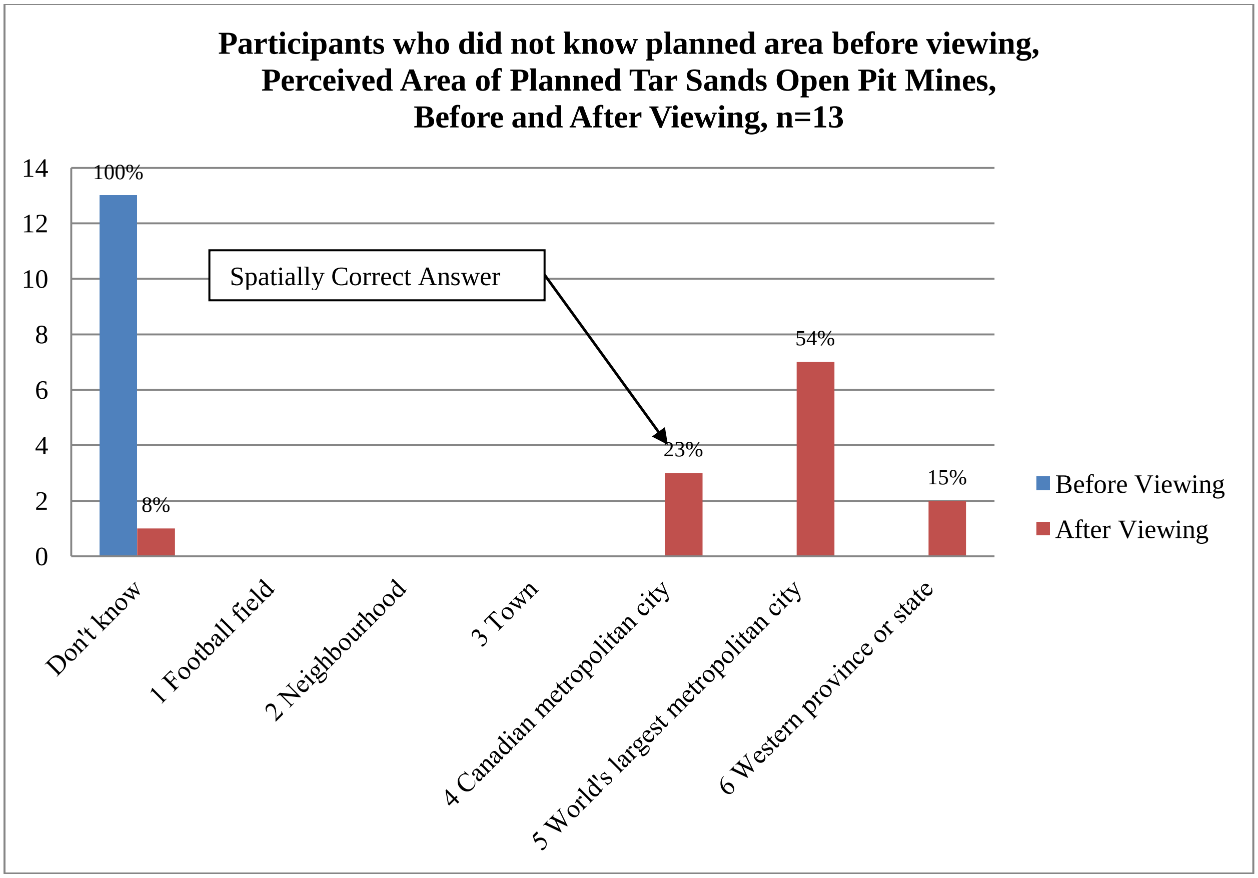


Figure 86 Participants who did not know planned area before viewing, Perceived Area of Planned Tar Sands Open Pit Mines, Before and After Viewing

6.2.1.4. Perceived Growth in Geographic Area of Approved Tar Sands Open Pit Mines, Before and After Viewing

After viewing, there were thirteen fewer participants who stated “Don’t Know” and only one remaining participant who stated “Don’t Know”. Using the McNemar test, this difference is significant (.000). After viewing, 72% of participants perceived the growth of the approved area as “About 3 times”, as shown in Figure 87. However, the growth of the approved area is actually “About 2 times” the existing area.

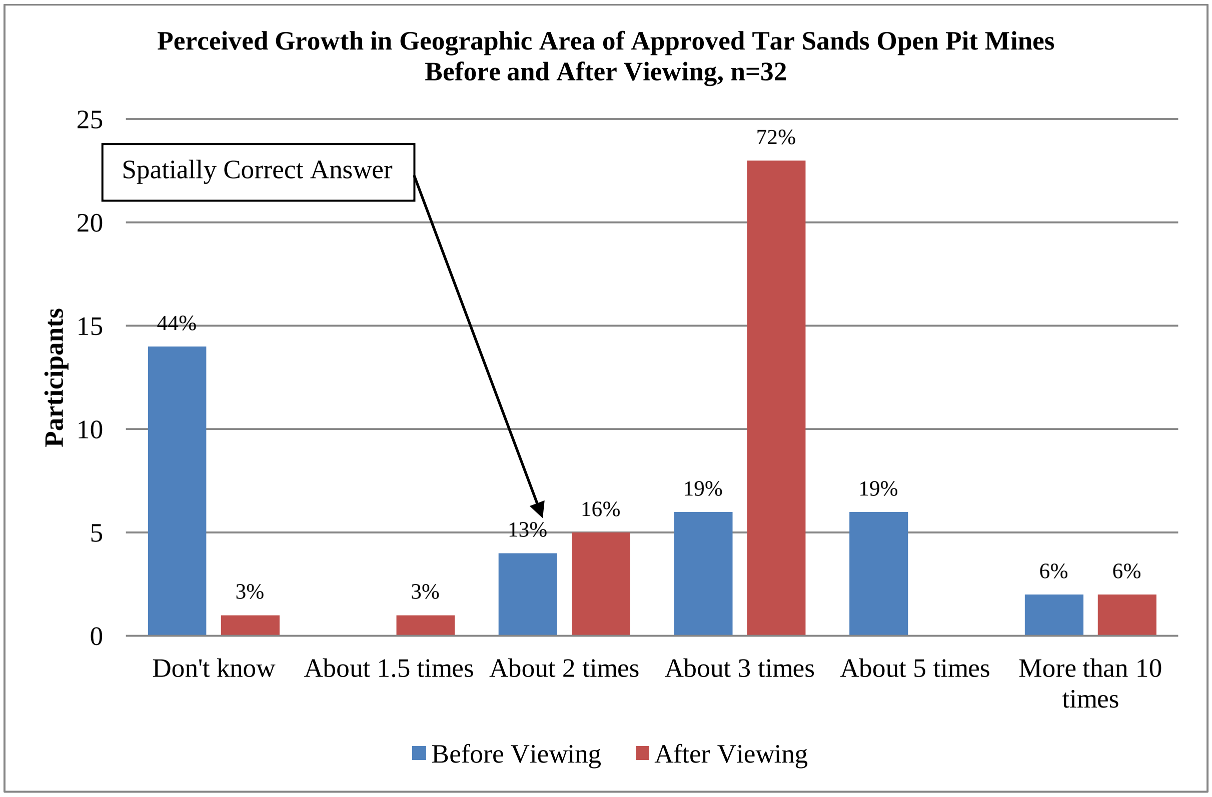


Figure 87 Perceived Growth in Geographic Area of Approved Tar Sands Open Pit Mines, Before and After Viewing

Only those eighteen participants who thought they knew the increase of the geographic area before viewing are included in the Wilcoxon-Signed Ranks test. After viewing, the majority of these participants perceived the growth as larger or the same (10 out of 18) while 44% (8 out of 18) perceived the growth as smaller. The changed perception of the growth of the approved area is not significant (.113).

As shown in Figure 88, the largest number of participants, who thought they knew the growth of the approved tar sands open pit mines before viewing, thought that the growth of the approved tar sands open pit mines would increase the total geographic area by “About 3 times”, which is not the spatially correct answer. The number of participants who thought that the growth would be “About 2 times” which is the spatially correct answer decreased by one. However, the number of participants who thought that the growth would be “About 5 times” and “More than 10 times” decreased by eight, indicating some increase in accuracy at the upper end of the scale.

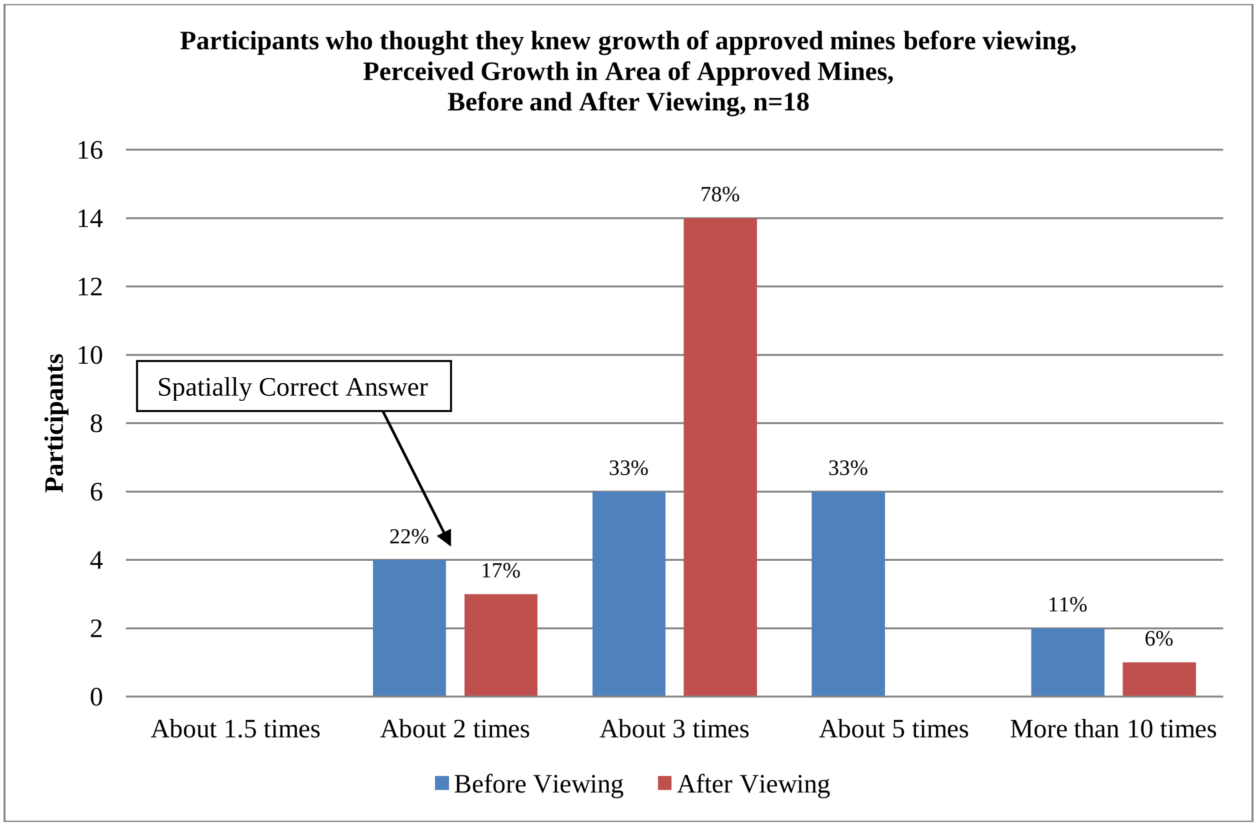


Figure 88 Participants who thought they knew growth of approved mines before viewing, Perceived Growth in Area of Approved Mines, Before and After Viewing

As shown in Figure 89, the largest number of participants, who did not know the growth of the approved tar sands open pit mines before viewing, perceived that the growth of the approved tar sands open pit mines would increase the total geographic area by “About 3 times”, which is not the spatially correct answer. There were two participants who thought that the growth would be “About 2 times”, which is the spatially correct answer. These results suggest that both the more and less knowledgeable participants tended to perceive growth of approved mines as larger than the spatially correct amount.

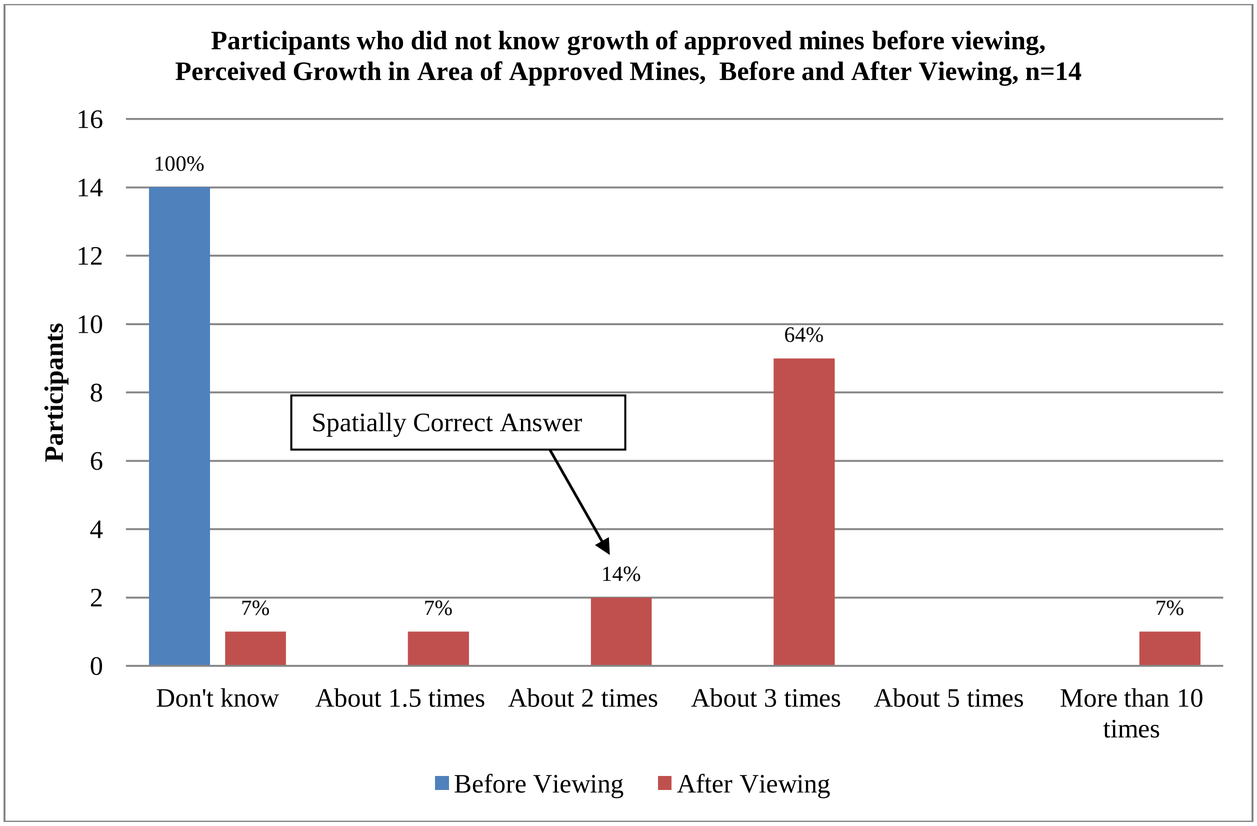


Figure 89 Participants who did not know growth of approved mines before viewing, Perceived Growth in Area of Approved Mines, Before and After Viewing

6.2.1.5. Perceived Growth in Geographic Area of Approved and Planned Tar Sands Open Pit Mines, Before and After Viewing

After viewing, there were thirteen fewer participants who stated "Don't Know" and only two remaining participants who stated "Don't Know". Using the McNemar test, this difference is significant (.000). The majority of participants (17 out of 32) perceived the growth of the approved and planned areas as "About 3 times" the area of the existing mines, which is the actual expected growth of approved and planned the mines, as shown in Figure 90. There were also four more participants who perceived the growth of the approved and planned area as "More than 10 times" the existing mines. Even though it was stressed by the researcher at the beginning of each focus session that the study dealt only with tar sands open pit mines, these participants may have confused the growth of the open pit mines with the growth of "in-situ" projects in all the leased areas in northern Alberta.

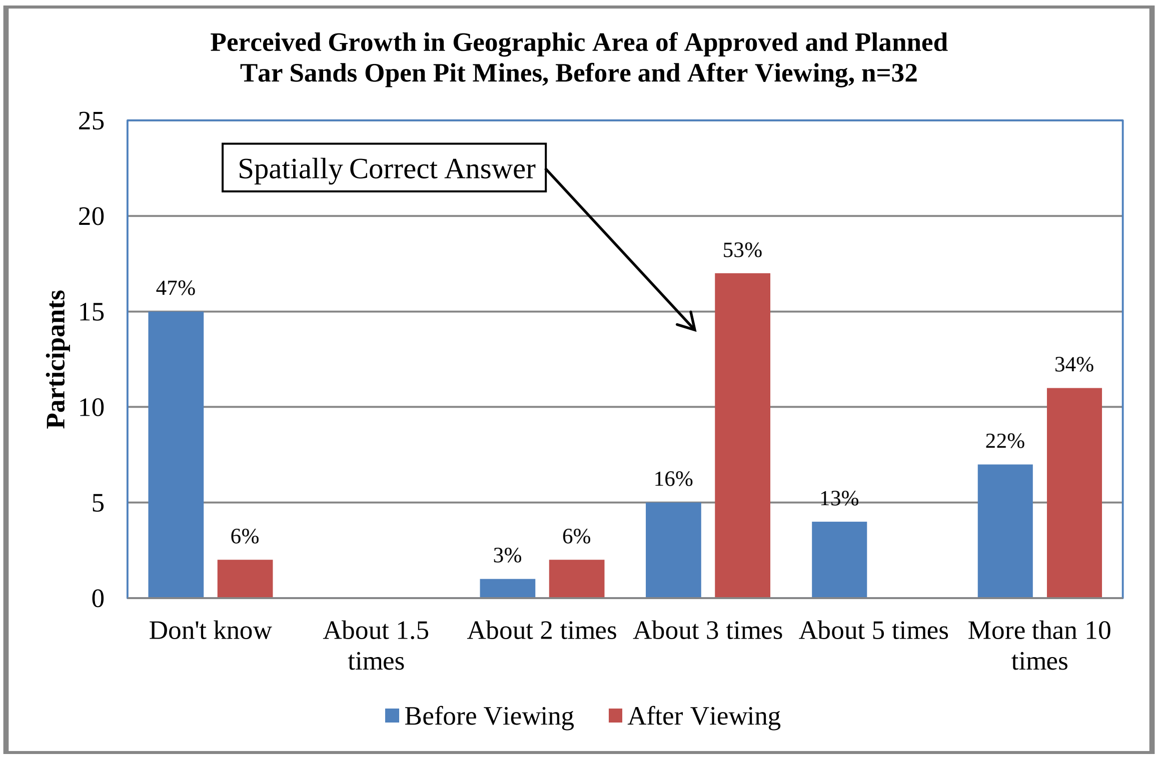


Figure 90 Perceived Growth in Geographic Area of Approved and Planned Tar Sands Open Pit Mines, Before and After Viewing

Only those seventeen participants who thought they knew the increase of the geographic area before viewing were included in the Wilcoxon-Signed Ranks test. After viewing, 53% of participants (9 out of 17) perceived the increase as greater or the same while 47% of participants (8 out of 17) perceived the increase as smaller. The changed perception of the growth of the approved and planned area is not significant (.174).

As shown in Figure 91, the largest number of participants who thought they knew the growth of the approved and planned tar sands open pit mines before viewing, perceived that the growth of the approved and planned tar sands open pit mines would increase the total geographic area by “About 3 times”, which is the spatially correct answer. The number of participants who thought the growth would be “About 5 times” and “More than 10 times” decreased by six, showing some increase in accuracy. The number of participants who under-estimated the growth as “About 2 times” stayed the same.

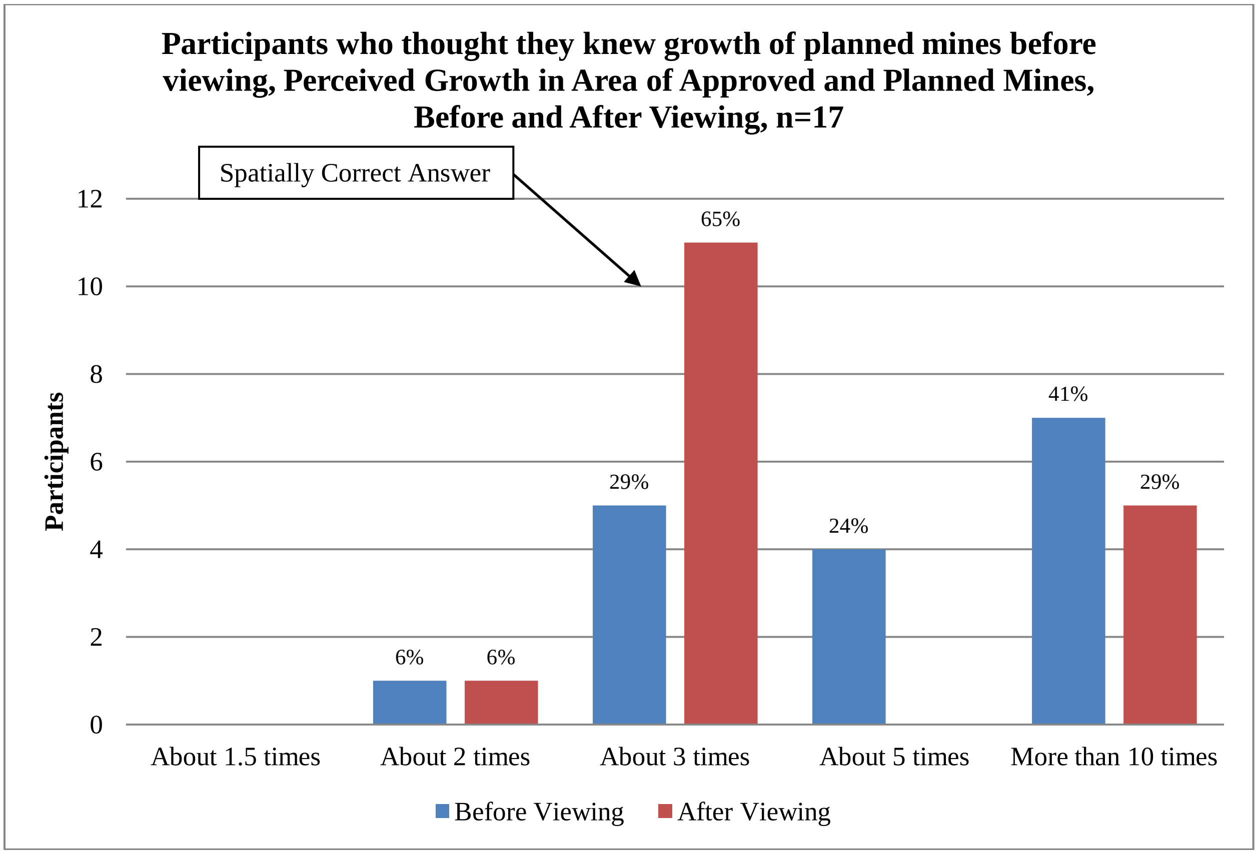


Figure 91 Participants who thought they knew growth of planned mines before viewing, Perceived Growth in Area of Approved and Planned Mines, Before and After Viewing

As shown in Figure 92, the largest number of participants who did not know the growth of the approved and planned tar sands open pit mines before viewing were equally split between those who thought the growth of the approved and planned tar sands open pit mines would increase the total geographic area by “About 3 times”, which is the spatially correct answer and also by “More than ten times”, which is not spatially correct.

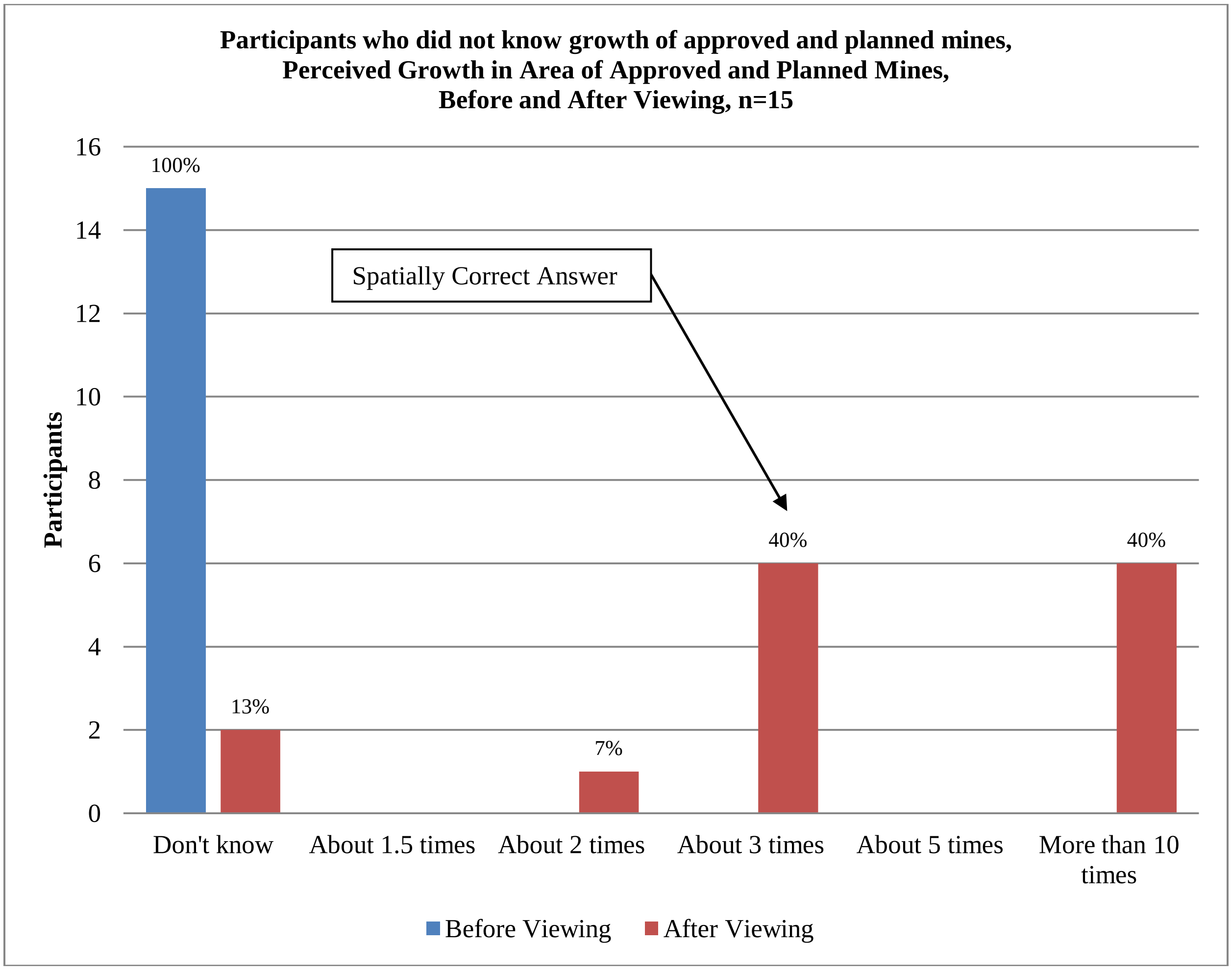


Figure 92 Participants who did not know growth of planned mines, Perceived Growth in Area of Planned Mines, Before and After Viewing

6.2.1.6. Comparison of Participants Stating "Don't Know", Before and After Viewing

As shown in Figure 93, before viewing the Google Earth project more participants stated "Don't Know" about the area of the approved and planned open pit mines compared to the existing open pit mines. Also, more participants before viewing the Google Earth project stated "Don't Know" about the growth of the open pit mines compared to the area of the open pit mines, suggesting they found it harder to mentally visualise future cumulative expansion than discrete fixed areas. However, it is also possible there is an order effect of increasing uncertainty here, since the growth questions always followed the corresponding area question.

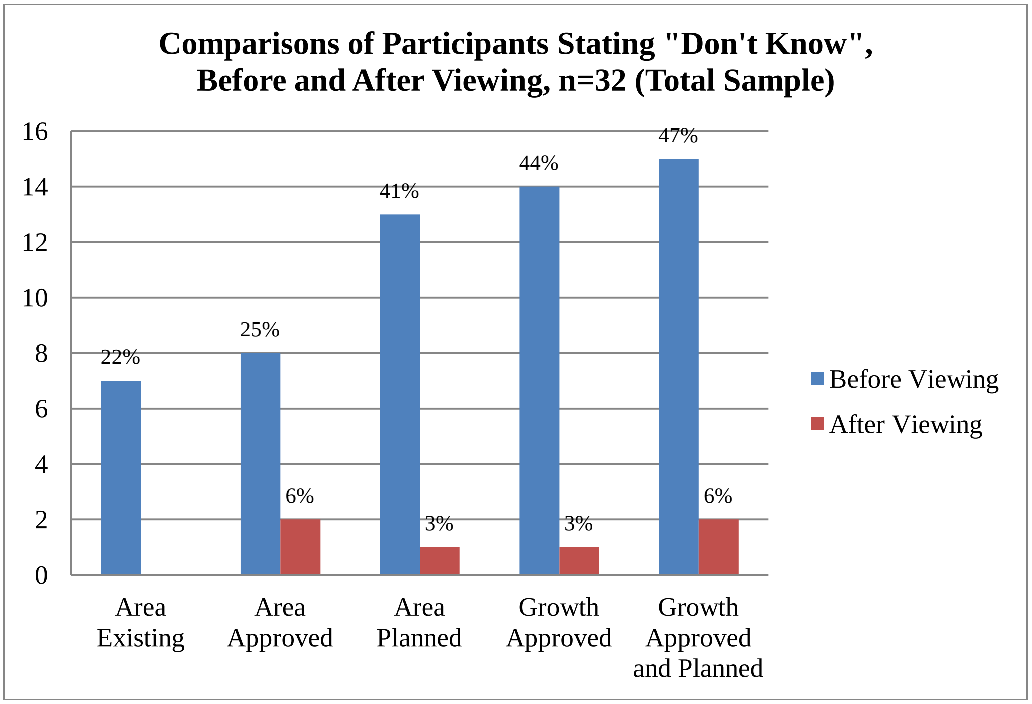


Figure 93 Comparisons of Participants Stating "Don't Know", Before and After Viewing

6.2.2. Opinion of Tar Sands Open Pit Mines, Before and After Viewing

The initial and follow up questionnaires asked the same question on opinion to examine the effect of viewing the tar sands maps and landscape visualisations. Therefore, the data contain a set of matched samples from each participant. The Wilcoxon Signed-Ranks Test, a non-parametric test, was used to assess whether or not there is a statistically significant change in opinions about the tar sands open pit mines mines before and after viewing or between existing and future tar sands open pit mines. The four samples were paired in five ways:

1) Change in Opinion: Existing Before - Opinion Existing After
2) Change in Opinion: Future Before - Opinion Future After
3) Comparison of Opinion: Existing Before - Opinion Future Before
4) Comparison of Opinion: Opinion Existing After - Opinion Future After
5) Comparison of Opinion: Opinion Existing Before - Opinion Future After

6.2.2.1. Changes in Opinion of Existing Tar Sands Open Pit Mines, Before and After Viewing

After viewing, four more participants became "Very Opposed", while two fewer participants remained "Somewhat Opposed" and four fewer participants remained "Neutral", as shown in Figure 94. After viewing, the same number of participants remained "Somewhat Supportive" while one participant became "Very Supportive". The modal opinion shifted from "Neutral" to "Very Opposed" although the majority were already opposed before viewing. However, these changes are not significant (.311) using the Wilcoxon Signed-Ranks test.

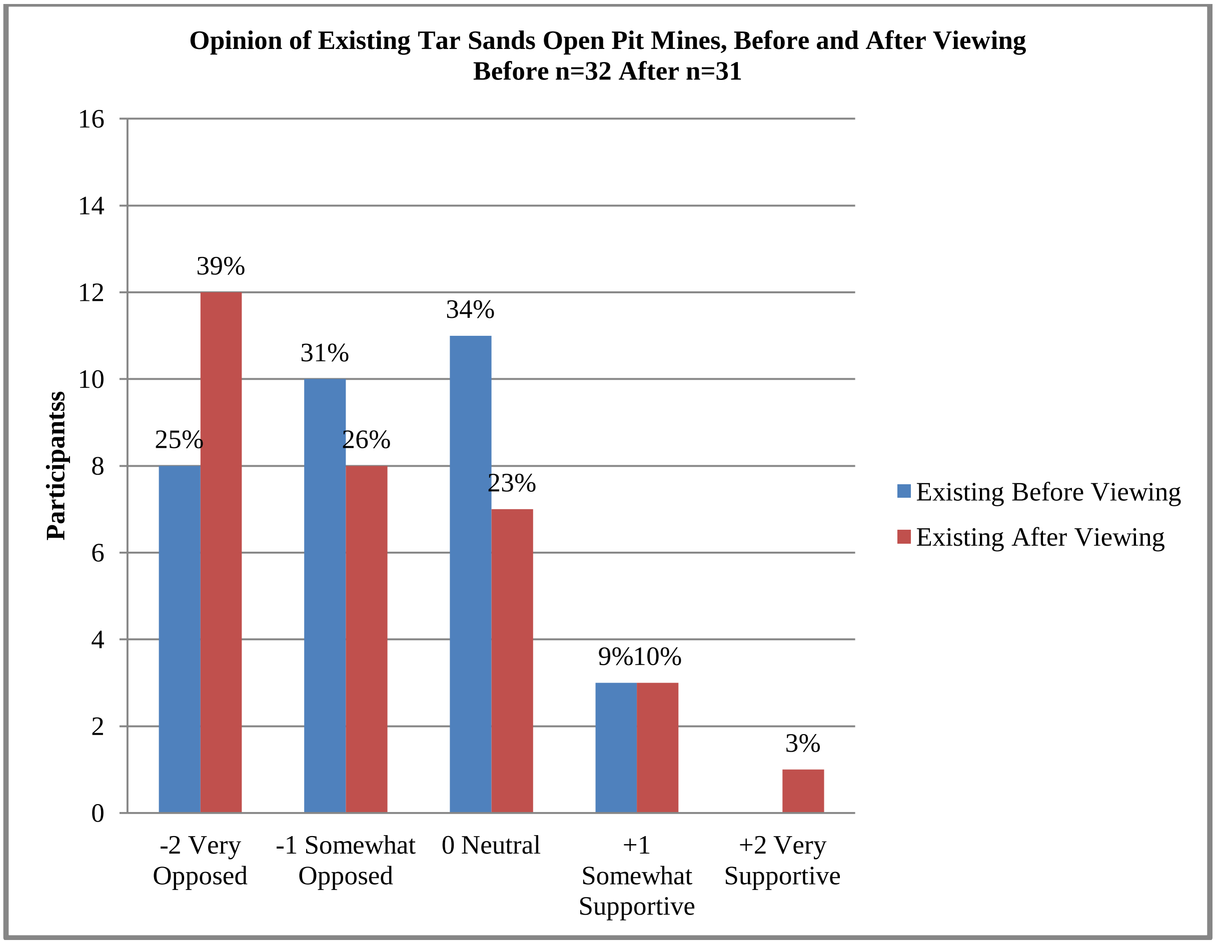


Figure 94 Opinion of Existing Tar Sands Open Pit Mines, Before and After Viewing

6.2.2.2. *Changes in Opinion of Future Tar Sands Open Pit Mines, Before and After Viewing*

After viewing, five more participants became “Very Opposed” and “Somewhat Opposed”, while four fewer participants remained “Neutral” and three fewer remained “Somewhat Supportive”, as shown in Figure 95. After viewing, one participant became “Very Supportive”. These changes are significant (.013) using the Wilcoxon Signed-Ranks Test.

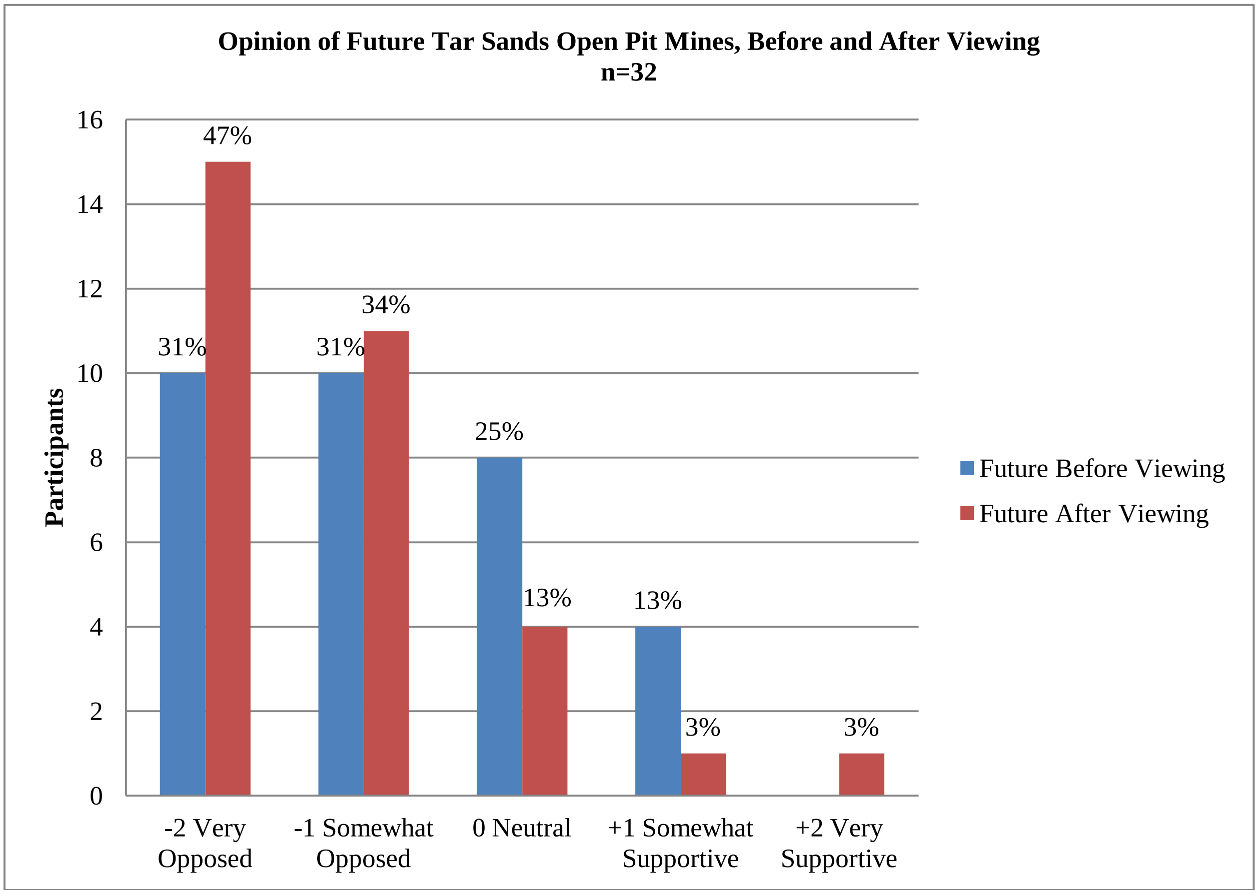


Figure 95 Opinion of Future Tar Sands Open Pit Mines, Before and After Viewing

6.2.2.3. Comparison of Opinion of Existing and Future Tar Sands Open Pit Mines, Before Viewing

Before viewing, two more participants were “Very Opposed” to future mines compared to existing mines, as shown in Figure 96. One more participant was “Somewhat Supportive” of future mines compared to existing mines. Three fewer participants were “Neutral” about future mines compared to existing mines. The modal opinion ranged from neutral for existing mines to somewhat or very opposed for future mines. These differences are not significant using the Wilcoxon Signed-Ranks Test.

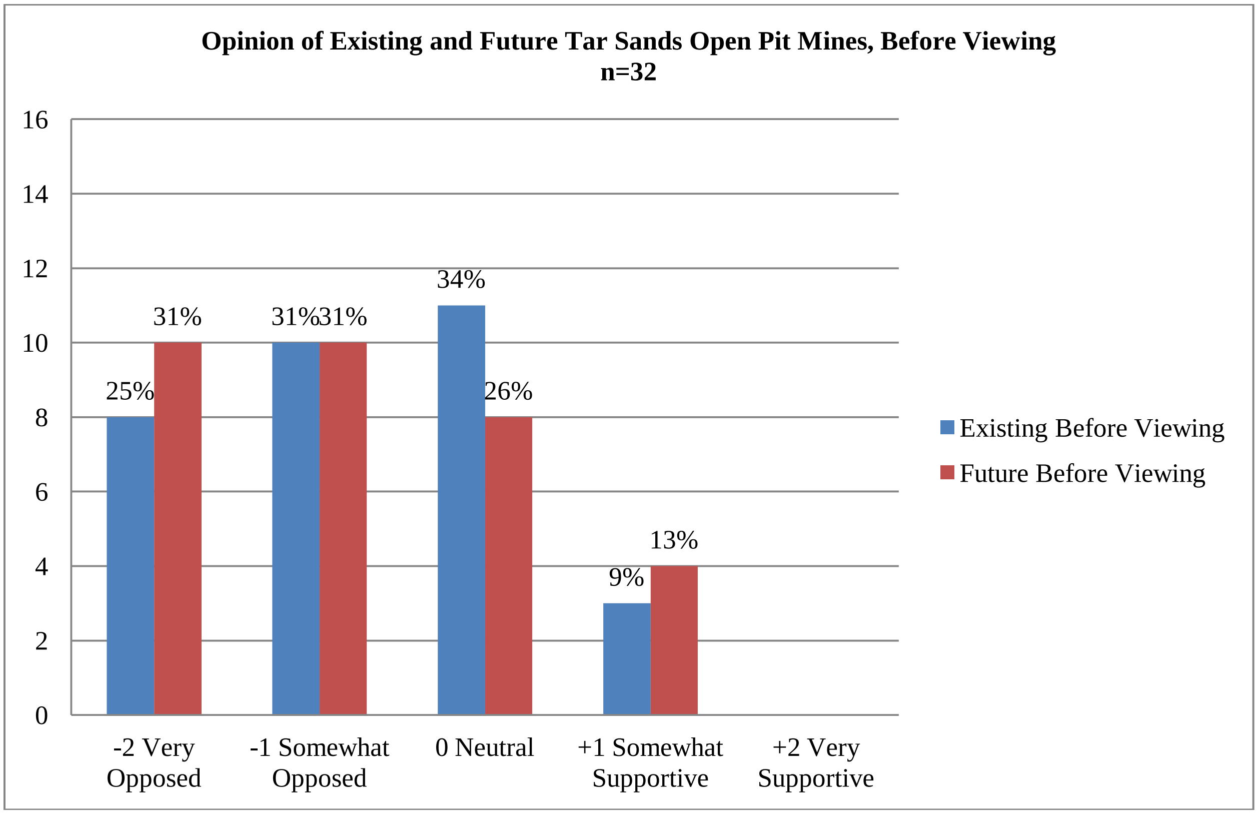


Figure 96 Opinion of Existing and Future Tar Sands Open Pit Mines, Before Viewing

6.2.2.4. Comparison of Opinion of Existing and Future Tar Sands Open Pit Mines, After Viewing

After viewing, there were six more participants who were "Very Opposed" or "Somewhat Opposed" to future mines compared with those opposed to existing mines, as shown in Figure 97. These differences are significant (.021) using the Wilcoxon Signed-Ranks Test.

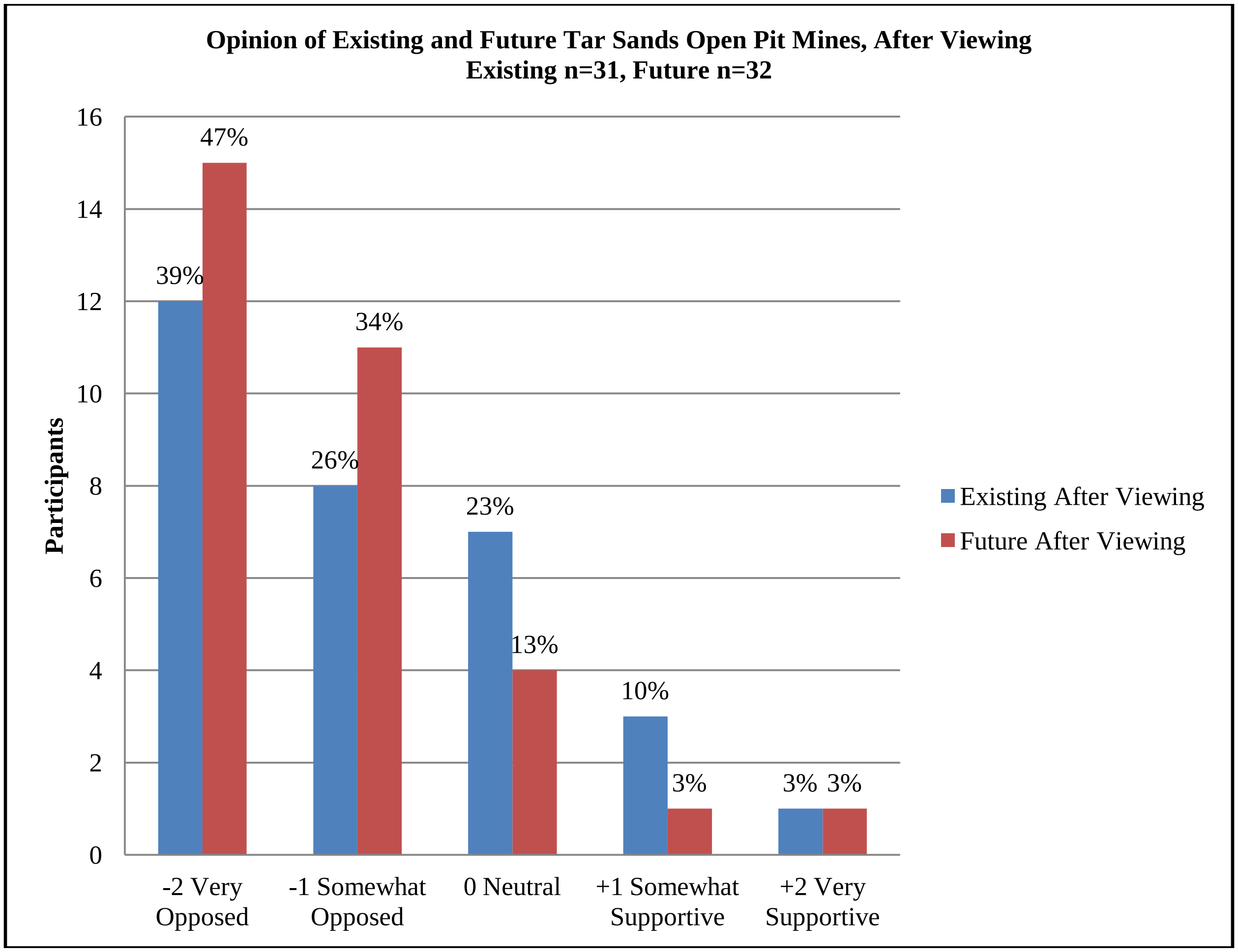


Figure 97 Opinion of Existing and Future Tar Sands Open Pit Mines, After Viewing

6.2.2.5. Comparison of Opinion of Existing Tar Sands Open Pit Mines Before Viewing versus Future Mines After Viewing

After viewing, there were seven more participants who were "Very Opposed" to future mines compared to existing mines before viewing, as shown in Figure 98. There were also seven fewer participants who were "Neutral" and "Somewhat Supportive", compared to existing mines before viewing. These changes are significant (.008).

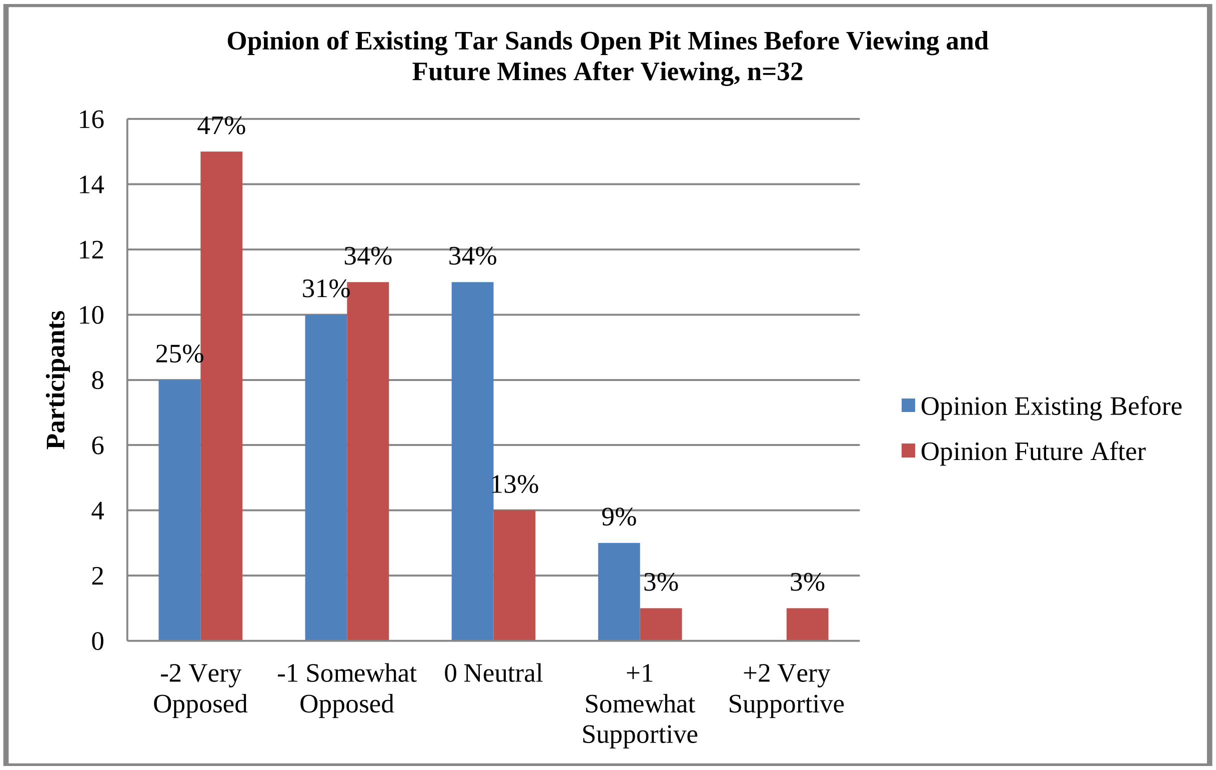


Figure 98 Opinion Existing Tar Sands Open Pit Mines Before Viewing and Future Mines After Viewing

6.3. Believability of Maps and Static Landscape Visualisations

The purpose of this section is to evaluate whether participants found the 2D maps (draped over Google Earth terrain, viewed in plan or oblique view) or the static 3D landscape visualisations more believable, in order to provide insights to practitioners about how much effort should be devoted to different types of landscape representation in communicating large industrial projects to the general public. The follow up questionnaire asked the same question about the believability of the maps and of the static landscape visualisation images. The Wilcoxon Signed-Ranks Test was selected to assess whether or not there was a significant difference in the believability of the 2D maps compared to static 3D landscape visualisation images. No specific questions were asked about the interactive full 3D landscape visualisations.

As shown in Figure 99, more participants thought the maps were "Mostly believable" and "Highly Believable" while more participants thought the landscape visualisation images were "Intermediate" or "Mostly Unbelievable". Two participants thought the maps were "Mostly unbelievable", but they may have misinterpreted the question since these participants stated in the open ended questions that they found the maps believable. The difference in the believability of the maps and images is significant (.007).

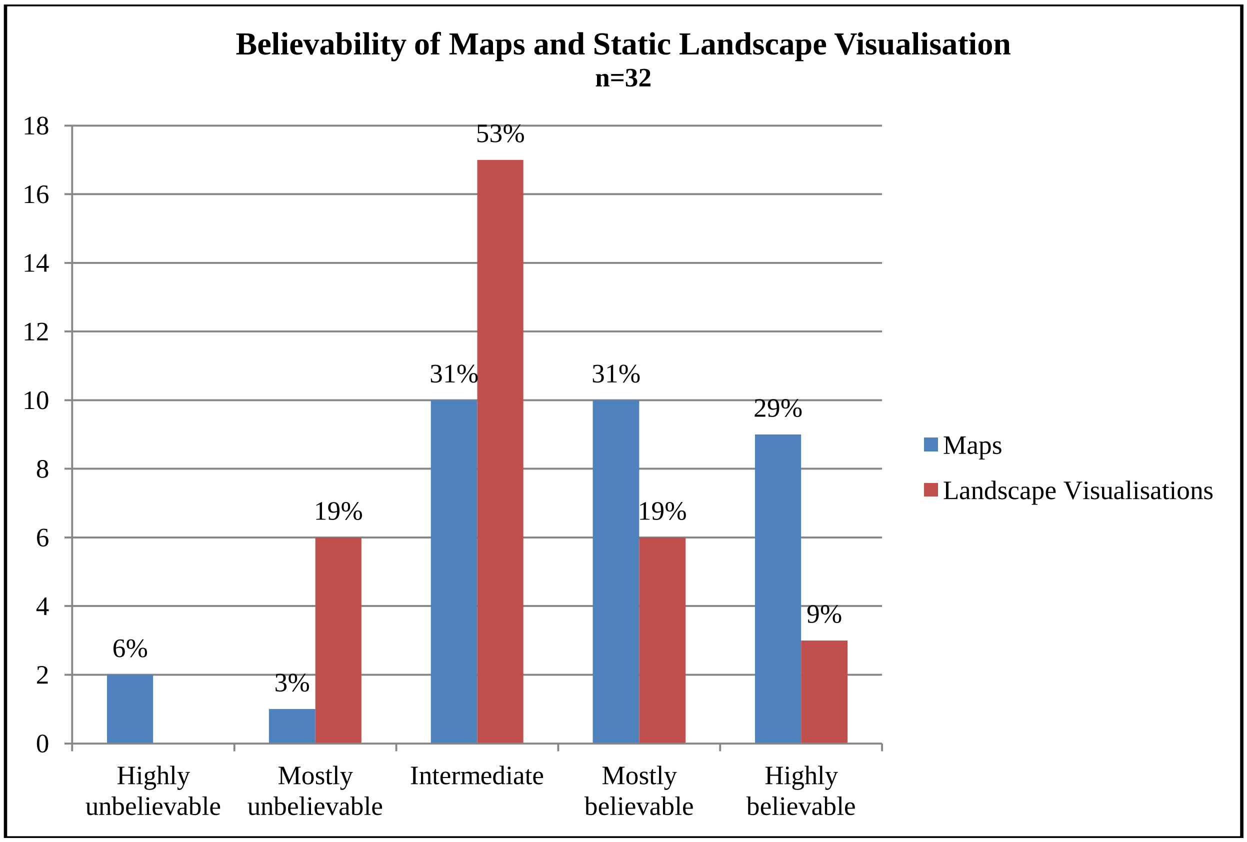


Figure 99 Believability of Maps and Landscape Visualisations

6.4. Correlation Among Questionnaire Variables

The purpose of this section is to analyse the significance of the correlations among quantitative questionnaire variables that identify potential associations between participant characteristics and their perceptions and opinions about the tar sands open pit mines as well as the Google Earth project. Correlations were tested separately for ordinal variables and for nominal variables.

6.4.1. Correlations Among Ordinal Variables Concerning Scale, Opinion, and Evaluation of the Google Earth Project

As shown in Table 46, it was hypothesized that there might be correlations between the socio-demographic characteristics of the participants and their perceptions and opinions of the tar sands open pit mines as well as the Google Earth project itself. Therefore, the significance of eleven socio-demographic variables was tested against nineteen variables that measure participants' perceptions and opinions about the tar sands open pit mines as well the Google Earth project.

In addition, it was hypothesized that there might be correlations between the participants' perception of geographic area and growth of the tar sands open pit mines and their opinion about the tar sands open pit mines. Therefore, the significance of an additional ten variables measuring the participants' perceptions of the geographic area and growth of the tar sands open pit mines was tested against four variables measuring the participants' opinions of the tar sands open pit mines.

In total, 249 hypothetical cross-tabulated pairs were tested for significance using the ordinal cross-tabulation function in SPSS software (International Business Machines Corp., n.d.-b), which generated the following statistical tests of significance and strength of correlations:

1) Chi-square;
2) Gamma;
3) Somers' d;
4) Kendall's tau-b; and
5) Kendall's tau-c.

These tests are described in more detail in Appendix "P".

The evaluation of the significance from these tests was adjusted using the Bonferroni correction, which divides the significance level (.05) by the number of hypothetical cross-tabulated pairs that are tested for each independent variable (Abdi, 2007). For the ordinal variables there were up to nineteen pairs tested for each of the twenty-one independent variables, as shown in Table 46. Therefore, the adjusted significance level was calculated as .05÷19=0.0026315. Those correlations that had at least one test equal to or below the adjusted significance level were considered significant. However, SPSS Software only calculates significance level to the third decimal place so ordinal tests that were ≤ .002 were considered significant.

Table 46 Cross-Tabulation Between Experience, Scale, Social Profile and Evaluation, Opinion, and Scale N=No Significant Correlation Y=Significant Correlation (Highlighted in Red)

		Independent Variables																				
		Previous Experience								Social			Scale									
	Dependent Variables	1. Using Maps	2. Using Computers	3. Using Google Earth etc.	4. Seen Photos	5. Seen Video or Film	6. Read Articles or Books	7. Seen Maps	8. Knowledge of Area	9. Age	10. Education	11. Involved	12. Area Existing Before	13. Area Approved Before	14. Area Planned Before	15. Increase Approved Before	16. Increase Planned Before	17. Area Existing After	18. Area Approved After	19. Area Planned After	20. Increase Approved After	21. Increase Planned After
Scale	1. Area Existing Before	N	N	N	N	N	N	N	N	N	N	N										
	2. Area Approved Before	N	N	N	N	N	N	N	Y	N	N	N										
	3. Increase Approved Before	N	N	N	N	N	N	N	N	N	N	N										
	4. Area Planned Before	N	N	N	N	N	N	N	N	N	N	N										
	5. Increase Planned Before	N	N	N	N	N	N	N	N	N	N	N										
	6. Area Existing After	N	N	N	N	N	N	N	N	N	N	N										
	7. Area Approved After	N	N	N	N	N	N	N	N	N	N	N										
	8. Increase Approved After	N	N	N	N	N	N	N	N	N	N	N										
	9. Area Planned After	N	N	N	N	N	N	N	N	N	N	N										
	10. Increase Planned After	N	N	N	N	Y	N	N	N	N	N	N										
Opinion	11. Opinion Existing Before	N	N	N	Y	N	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N
	12. Opinion Future Before	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	13. Opinion Existing After	N	N	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	N
	14. Opinion Future After	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	15. Changed Opinion	N	N	N	N	N	N	Y	N	N	N	N										
Evaluation	16. New Knowledge	N	Y	N	N	N	N	N	N	N	N	N										
	17. Useful Google Earth	N	N	N	N	N	N	N	N	N	N	N										
	18. Maps Believable	N	N	N	N	N	N	N	N	N	N	N										
	19. Images Believable	N	N	N	N	N	N	N	N	N	N	N										

Eleven out of 249 hypothetical correlations were significant for at least one of the correlation tests using the adjusted significance level. The cross-tabulations and test results for these correlations among 32 participants are shown in more detail in Appendix “P”.

1) *Using Computers * New Knowledge*: After viewing the Google Earth project, a significantly greater percentage of participants with more experience using computers stated that they gained more new knowledge about geographic area or scale of the open pit mines compared to participants with less experience. Twenty-three participants (71.9%) who had some or much experience using computers stated that they gained much or in-depth new knowledge.

2) *Seen Photos * Opinion Existing Before*: Before viewing the Google Earth project, a significantly greater percentage of participants who had seen more photographs of the open pit mines were more opposed to existing open pit mines compared to participants who had seen fewer photographs. Nine participants (28%) who had seen some photographs were somewhat or extremely opposed while nine (28%) participants who had seen none were neutral or somewhat supportive.

3) *Seen Photos * Opinion Future Before*: Before viewing the Google Earth project, a significantly greater percentage of participants who had seen more photos of the open pit mines were more opposed to future open pit mines compared to participants who had seen fewer photos. Nine participants (28%) who had seen some photographs were somewhat or extremely opposed while nine (28%) participants who had seen none were neutral or somewhat supportive.

4) *Seen Photos * Opinion Existing After:* After viewing the Google Earth project, a significantly greater percentage of participants who had seen more photos of the open pit mines were more opposed to existing open pit mines compared to participants who had seen fewer photos. Ten participants (31%) who had seen few or some photographs were extremely opposed while five participants (16%) who had seen none were neutral.

5) *Seen Video or Film * Increase Planned After*: A significantly greater percentage of participants who had previously seen more TV broadcasts, videos, or films about the open pit mines thought, after viewing the Google Earth project, that the planned open pit mines would be three times the geographic area of the existing open pit mines, which is the spatially correct answer. Eleven participants (34%) who had see few or some video or film answered correctly while eight participants (25%) who had seen no video or film thought the geographic area of the planned tar sands open pit mines would increase ten times.

6) *Seen Maps * Opinion Existing Before*: Before viewing the Google Earth project, a significantly greater percentage of participants who had previously seen more maps showing the open pit mines were more opposed to existing open pit mines compared to participants who had seen fewer maps. Six participants (19%) who had seen some or few maps were extremely opposed while nine participants (28%) who had seen no maps were neutral.

7) *Seen Maps * Opinion Existing After*: After viewing the Google Earth project, a significantly greater percentage of participants who had previously seen more maps showing the open pit mines were more opposed to future open pit mines compared to participants who had seen fewer maps. Nine participants (28%) who had seen few or some maps were extremely opposed while ten participants (31%) were somewhat opposed or neutral.

8) *Seen Maps * Changed Opinion*: After viewing the Google Earth project, a significantly greater percentage participants who had previously seen ***fewer*** maps showing the open pit mines thought they had changed their opinions more compared to participants who had previously seen ***more*** maps. Nine participants (28%) who had seen few maps thought their opinion was not or little changed while thirteen participants (41%) of participants who had seen no maps thought their opinion was very or somewhat changed.

9) *Knowledge of Area * Area Approved Before:* Before viewing the Google Earth project, a significantly greater percentage of participants who stated that they had less previous knowledge about the size or geographic area of the open pit mines thought the approved open pit mines were smaller than did participants who stated they had more previous knowledge. Eight participants (25%) who thought they had some knowledge of the geographic area of the tar sands thought the geographic area of the approved tar sands open pit mines was as about as large as a “World metropolitan city” or a “Western province or state”, which are not the spatially correct answers.

10) *Involved * Opinion Existing Before*: Before viewing the Google Earth project, a significantly greater percentage of participants who stated that they were more involved in promoting their opinions about tar sands development were more opposed to the existing open pit mines. Six participants (19%) who were slightly or moderately involved were extremely opposed while fourteen (44%) participants who were not involved were neutral or somewhat supportive.

*11) Increase Approved After * Opinion Existing After*: After viewing the Google Earth project, a significantly greater percentage of participants who thought the growth of the ***approved*** tar sands open pit mines would be greater were more were more opposed to the ***existing*** tar sands open pit mines after viewing the Google Earth project. Eighteen participants (56%) who thought the ***approved*** tar sands open pit mines would increase three times, which is not the spatially correct answer, were extremely or moderately opposed to the ***existing*** tar sands open pit mines.

As shown in Table 46, the independent variables which appear to have the most consistent influence include previous exposure to photographs and maps of the tar sands, both of which tended to increase opposition to the open pit mines. The dependent variables which appear to have been most consistently influenced include opinion of the existing tar sands open pit mines, both before and after involvement with the Google Earth project.

6.4.2. Correlations Among Nominal Variables Concerning Scale, Opinion, and Evaluation of the Google Earth Project

As shown in Table 109 within Appendix “P”, it was hypothesized that there might be correlations between the nominal socio-demographic characteristics of the participants and their perceptions and opinions of the tar sands open pit mines as well as the Google Earth project. Therefore, the significance of six socio-demographic variables was tested against 39 variables that measured participants’ perceptions and opinions about the tar sands open pit mines as well the Google Earth project.

In addition, it was hypothesized that there might be correlations between participants who had seen the open pit tar sand mines from the ground and their province of residence or occupation. It was also hypothesized that there might be correlations between the participants’ province of residence and their gender or occupation.

In total, 240 hypothetical cross-tabulated pairs were tested for significance using the nominal cross-tabulation functions in SPSS software (International Business Machines Corp., n.d.-b), which generated the following statistical tests of significance and strength of correlations:

1) Chi-square;
2) Contingency coefficient;
3) Phi and Cramer’s V;
4) Lambda;
5) Goodman and Kuskal tau; and
6) Uncertainty coefficient.

These tests are described in more detail in Appendix “P”.

The evaluation of the significance from these tests was adjusted using the Bonferroni correction, which divides the significance level (.05) by the number of hypothetical cross-tabulated pairs that are tested for each independent variable (Abdi, 2007). For the nominal variables there were up to 39 pairs tested for each of the 41 independent variables, as shown in As shown in Table 109, the significant cross-tabulated pairs are highlighted in red.

Table 109 within Appendix “Q”,. Therefore, the adjusted significance level was calculated as .05÷39=0.001282. Those correlations that had at least one test equal to or below the adjusted significance level were considered significant. However, SPSS Software only calculates significance level to the third decimal place so ordinal tests that were ≤ .001 were considered significant.

It should be noted that none of the cross tabulations comparing participants from British Columbia and Alberta showed a significant difference or correlation using the adjusted significance level. As well, none of the cross tabulations comparing male to female showed a significant difference or correlation using the adjusted significance level.

As shown in more detail in Appendix “Q”, there were only three cross-tabulated pairs that had a significant correlation using the adjusted significance level:

1) *Lived Nearby * Area Approved Before*: Before viewing the Google Earth project, a significantly greater percentage of participants who had ***not*** lived nearby the open pit mines thought the geographic area of the approved open pit mines was larger compared to the one participant who had lived nearby.

2) *Lived Nearby * Maps Believable*: A significantly greater percentage of participants who had ***not*** lived nearby the open pit mines thought the maps were more believable compared to the one participant who had lived nearby.

Since there was only one participant who lived nearby, these two correlations are not statistically meaningful.

3) *Occupation * Age*: All participants with occupations listed as “Student” were age 20-29, all “Unemployed” were age 40-49, and both of the two (2) “Sales etc.” were age 30 to 39. All “Retired” were older than 50. All “Management etc.” were younger than 50. All “Science etc.” were between the ages of 30 to 59. These correlations do not add any value to the interpretation of the results.

6.5. Screenshot Analysis

The purpose of this section is to analyse the frequency of screenshots that participants found interesting or compelling. Overall, it is assumed that the screenshots that were selected more frequently were more interesting or compelling than screenshots that were selected less frequently, although various other influences may have had an effect and are noted in the interpretation of the results below.

As shown in Table 47, 43% of the screenshot images were in focus group “VB” (554 out of 1,299) while 29% were in focus group “VA” (373 out of 1,299) and focus group “E” (371 out of 1,299). Using the Chi-square test the difference in number of screenshots between focus groups is significant (.000). However, it is unknown why there were significantly more screenshots taken in focus group “VB”.

Table 47 Screenshot Images by Focus Group

Focus Group	**Number of Screenshot Images**	**Percent of Total**
Focus Group “VB” – University of British Columbia, Robson Square, August 13, 2012	554	43%
Focus Group “VA” – University of British Columbia, Robson Square, August 14, 2012	374	29%
Focus Group “E” – University of Alberta, August 16, 2012	371	29%
TOTAL	**1,299**	**100.0%**

A total of 1,299 screenshots were taken.[30] The descriptive statistics for the number of screenshot images captured by each focus group participant are shown in Table 48:

Table 48 Screenshots Captured Per Participant

Mean	40.6
Median	29.0
Standard Deviation	32.4

Using the Chi-square test, the difference between the numbers of screenshots captured per participant is significant (.000). However, it is unknown why some participants took so many more screenshots than others. In order to identify the most important or compelling viewpoints compared to the most important or compelling topics, all the screenshots were classified and counted in two separate groups. "Viewpoints" refer to different perspectives of the visual material regardless of the content. "Topics" refer to the contents of visual material regardless of the viewpoint. Using NVivo qualitative analysis software (QSR International, 2013), screenshot images were classified, according to descending number of screenshot images, into two corresponding data structures (i.e. both containing the same screenshot images) for "viewpoints" and "topics". Examples of screenshot images are shown in Appendix "R".

6.5.1. Viewpoints

The components within "viewpoints" are defined in Table 49.

Table 49 Viewpoints

Viewpoint	Definition
Vertical Maps	Screenshot image showing any contents from a perpendicular (90 degree) angle at any viewing elevation.
Static Landscape Visualisations	Screenshot image showing the static landscape visualisation in the Google Earth "pop-up balloon" in a standard web-browser accessed through an "HTML hyper-link"
Oblique Maps	Screenshot image showing any contents from elevated viewpoints at an oblique (non-perpendicular) angle displaying a standard or custom draped map on the standard 3D terrain in Google Earth. Oblique viewpoints were pre-defined at the same elevation and angle as each static landscape visualisation. Google Earth software enabled users to navigate to any oblique viewpoint they wished.
Interactive Landscape Visualisations	Screenshot image at any viewing angle or elevation (e.g. oblique view of entire open pit mine or ground-level view of mining machinery) showing 3D models terrain, trees, mining machinery, or people.
Metadata Hyperlinks	Screenshot image of a pop-up balloon showing metadata information about geo-data displayed in the Google Earth project.

[30] There are twenty-five missing screenshot images from focus group participant E2 or 2% of the total.

As shown in Figure 100, arranged in descending number of screenshots, 59% of the screenshot images were “Vertical Maps”. Sixteen percent of the screenshot images were “Static Landscape Visualisations” and 14% were “Oblique Maps”. Ten percent of the screenshot images were “Interactive Landscape Visualisations” and there was only one screenshot image of a “Metadata Hyperlink”. Using the Chi-square test, these differences are significant (.000). Overall, this indicates that users of virtual globes such as Google Earth may find vertical maps more interesting and compelling than other viewpoints. However, vertical maps were the first and easiest to access. Static landscape visualisations were the second most popular medium. Oblique maps seemed not to be as interesting as vertical maps by a factor of almost 1:4, perhaps due to the “distorting” effect of perspective views in judging scale for this exercise.

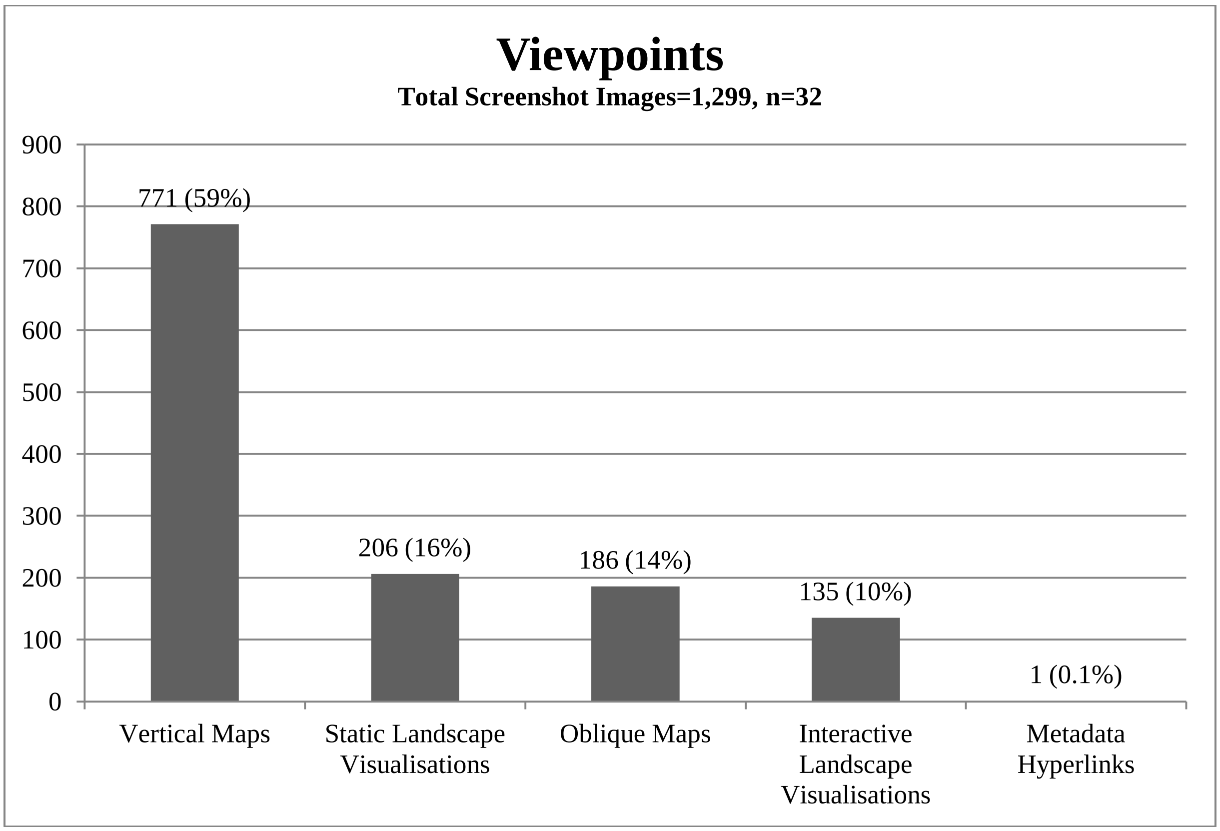


Figure 100 Viewpoints

6.5.1.1. Vertical Maps

As shown in Figure 101, arranged in descending number of screenshot images, 24% of the vertical map screenshot images were “Standard Google Earth Imagery”, 21% were “Regulatory Approval Maps” and 19% were “Comparison to Cities”. Fifteen percent of the screenshot images were “Open Pit Scenarios”, 12% were “Pipelines”, and 9% were “Leases”. Using the Chi-square test, these differences are significant (.000). Overall, participants may have found standard Google Earth imagery the most interesting single category of vertical maps images. This may also be because participants took more screenshots at the beginning of each focus group session when they were practising navigation and viewing Google Earth without any custom overlays. However, approximately 64% of vertical images captured were of customised overlays of the tar sands area. Also, city outlines were the third most popular type of vertical image.

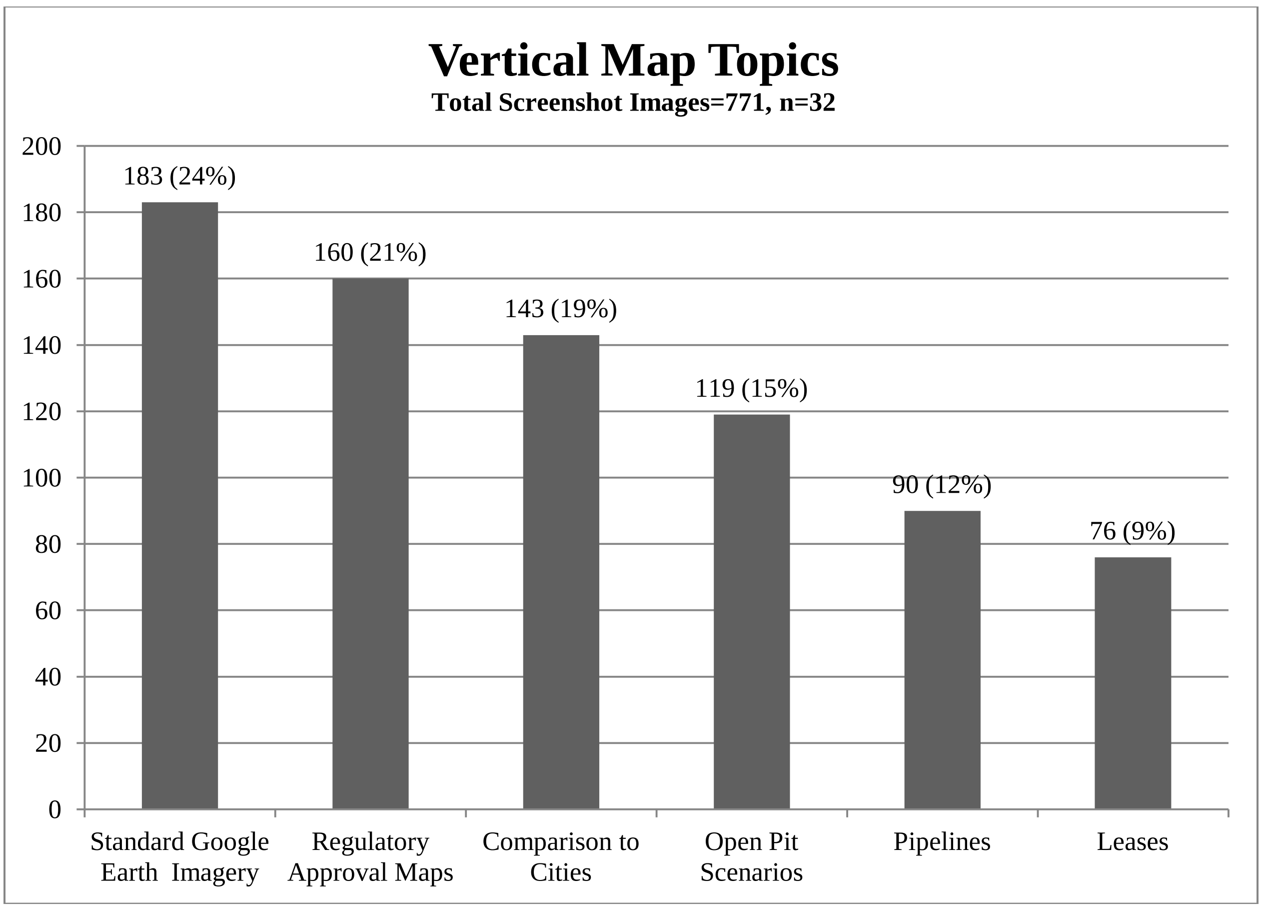


Figure 101 Vertical Map Topics

6.5.1.2. *Static Landscape Visualisations*

As shown in Table 50, the “Static Landscape Visualisations” screenshot images were almost equally distributed between standard web-pages using “HTML Hyperlinks” and Google Earth style “Popup Balloons”. Using the Chi-square test, this difference is not significant. Overall, this indicates that users of virtual globes such as Google Earth may find viewing static landscape visualisations using standard web-pages with “HTML Hyperlinks” or using Google Earth style “Popup Balloons” similarly interesting and compelling. In “Popup Balloons” the lower resolution and smaller images were displayed in balloon within Google Earth that covered only a portion of the screen. By clicking into an “HTML Hyperlinks” within the balloon higher-resolution images that covered the entire computer screen were displayed using a standard web-browser. Since the higher-resolution images could only be displayed following the “Popup Balloons” this may have affected their relative frequency.

Table 50 Static Landscape Visualisation Formats of Open Pit Mines

Format	**Number of Screenshot Images**	**Percent of Total**
HTML Hyperlinks (large high resolution images)	110	53.4%
Popup Balloons (small low resolution images)	96	46.6%
TOTAL	**206**	**100.0%**

6.5.1.3. *Oblique Maps*

As shown in Figure 102, arranged in descending number of screenshot images, 55% of the “Oblique Map” screenshot images were “Standard Google Earth Imagery”. Nineteen percent of the screenshot images were “Open Pit Scenarios”. Ten percent of the screenshot images were “Comparison to Cities” and “Regulatory Maps” . Five percent of the screenshot images were “Leases” and 2% were “Pipelines” . Using the Chi-square test, these differences are significant (.000). Overall, this indicates while viewing oblique maps, users of virtual globes such as Google Earth may find standard Google Earth imagery more interesting or compelling than custom overlays as with the vertical maps, or that the standard Google Earth imagery was faster or easier to access. This may also be because participants took more screenshots at the beginning of each focus group session when they were practising navigation and viewing Google Earth without any custom overlays. Overall, oblique views with custom overlay information represent about 45% of oblique screenshots. Overlays of city outlines were again the third most popular, indicating their importance; however, the proportion of oblique views of open-pit mines (19%) took second place, indicating that oblique views may be more helpful in interpreting the 3D qualities of the mines relative to the vertical maps which favoured understanding of regulatory information.

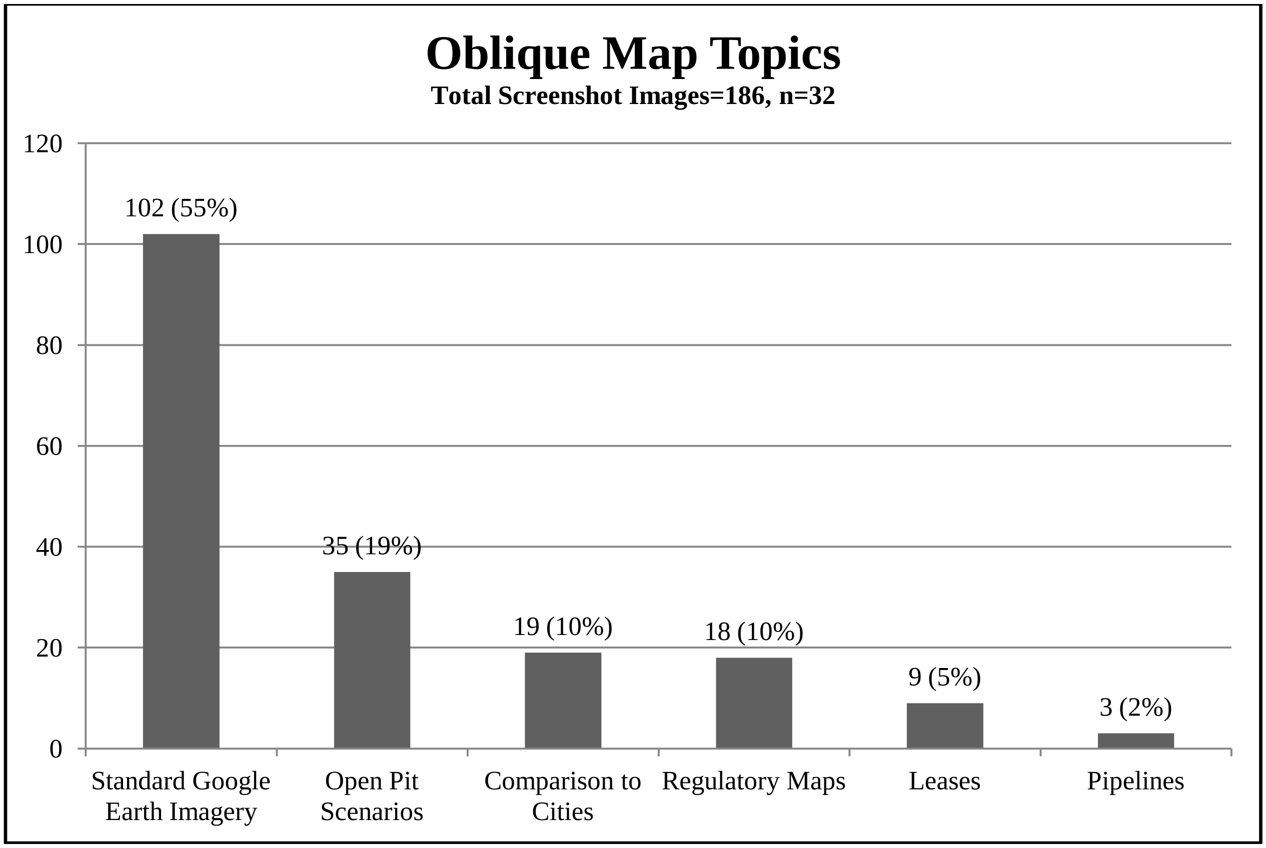


Figure 102 Oblique Map Topics

6.5.1.4. Interactive Landscape Visualisations

As shown in Figure 103, according to descending number of screenshot images, 62% of the "Interactive Landscape Visualisation" screenshot images were "Mining Equipment and People in Open Pit Mines". Twenty-four percent of the screenshot images were "Open Pit Mines Only" and 12% were "Trees Surrounding Open Pit Mines". Three percent of the screenshot images were "Athabasca River and Open Pit Mines". Using the Chi-square test, these differences are significant (.000). As discussed in detail in Section 3.5, there were three pre-set viewpoints with three levels of detail available for each of the two planned tar sands open pit mines available as interactive landscape visualisations:

1) High elevated oblique view of entire proposed open pit showing 3D terrain only;
2) Low elevated oblique view of corner of proposed open pit showing 3D terrain and 3D trees at edge of open pit; and
3) Ground-level view of corner of proposed open it showing 3D terrain, 3D trees at edge of open pit, and 3D mining equipment and people.

Once they had selected a particular viewpoint, participants were able to navigate freely while all the elements within that viewpoint were still being shown (e.g. participants could move from the pre-set ground-level view showing the 3D mining equipment to an elevated viewpoint while still seeing the 3D mining eqipment). Therefore, this classification is based on the objects rather than specific viewpoint. Overall, this indicates that in viewing interactive landscape visualisations users of virtual globes such as Google Earth may find ground-level or slightly elevated views showing objects and people more interesting than more elevated oblique viewpoints showing industrial landscape disturbance, trees, and rivers. There could also be an order effect here, since these visualizations were shown towards the end of the session, after considerable exposure to higher-level plan view and oblique visualizations.

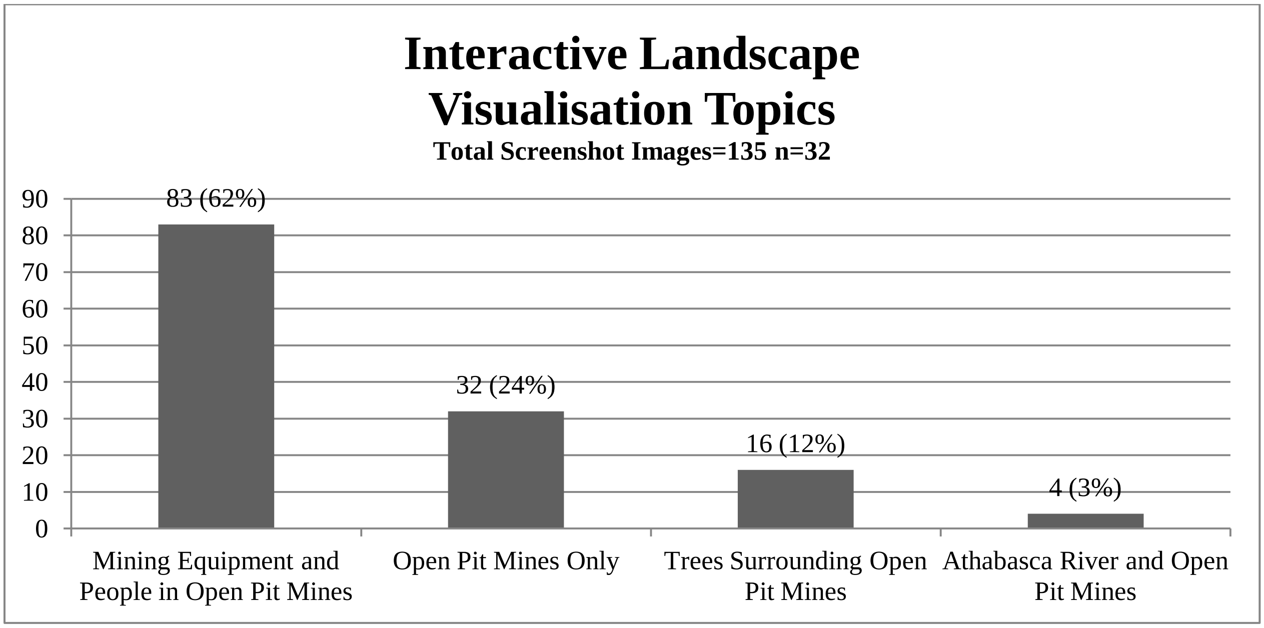


Figure 103 Interactive Landscape Visualisation Topics

6.5.1.5. Metadata Hyperlinks

There was only one screenshot image of a "metadata hyperlink", which were only available for the source data of the city boundary outlines. In the Google Earth "places" menu, a blue and underlined text for a hyperlink would open a balloon, which contained additional hyperlinks to the Canadian and American Census web-pages containing the metadata for the urban area boundary files used for the city outlines. When the participant clicked on the hyperlinks contained in the balloons, a web-page would open in a standard browser. This features was not described in the presentation, which may be the reason only one participant showed interest in this feature. Participants may also have been more interested in the images than background technical information.

6.5.2. Topics

The components within "topics" are defined in Table 51.

Table 51 Topics

Topic	Definition
Open Pit Scenarios	Screenshot image of a custom tar sands open pit mine (existing, approved, or proposed) in any format (i.e. maps, static landscape visualisation, or interactive landscape visualisation) and any viewing angle or elevation .
Standard Google Earth Imagery	Screenshot image of standard Google Earth imagery including existing tar sands open pit mines, at any viewing angle or elevation.
Regulatory Approval Maps	Screenshot image of regulatory approval maps at any viewing angle or elevation.
Comparison to Cities	Screenshot image of city outlines with any other contents at any viewing angle or elevation.
Pipelines	Screenshot image of the existing, planned, and conceptual network of continental pipelines at any viewing angle or elevation.
Leases	Screenshot image of tar sands leases at any viewing angle or elevation.
Metadata Hyperlinks	Screenshot image of a pop-up balloon showing metadata information about geo-data displayed in the Google Earth project.

As shown in Figure 104, according to descending number of screenshot images, 38% of screenshot images were "Open Pit Scenarios". Twenty-two percent the screenshot images were "Standard Google Earth Imagery" . Fourteen percent of the screenshot images were "Regulatory Approval Maps" and 14% were "Comparison to Cities". Seven percent of the screenshot images were "Pipelines" and similarly for "Leases". Using the Chi-square test, these differences are significant (.000). Overall, this indicates that users of virtual globes such as Google Earth may find "Open Pit Scenarios" of industrial landscape disturbance most interesting and compelling, regardless of viewpoint selected. However, "Open Pit Mines" may have been selected more frequently than other topics because more time was spent discussing them in the focus groups . Also, "Standard Google Earth Imagery" may have been selected second most frequently, because it was discussed first in the workshop.

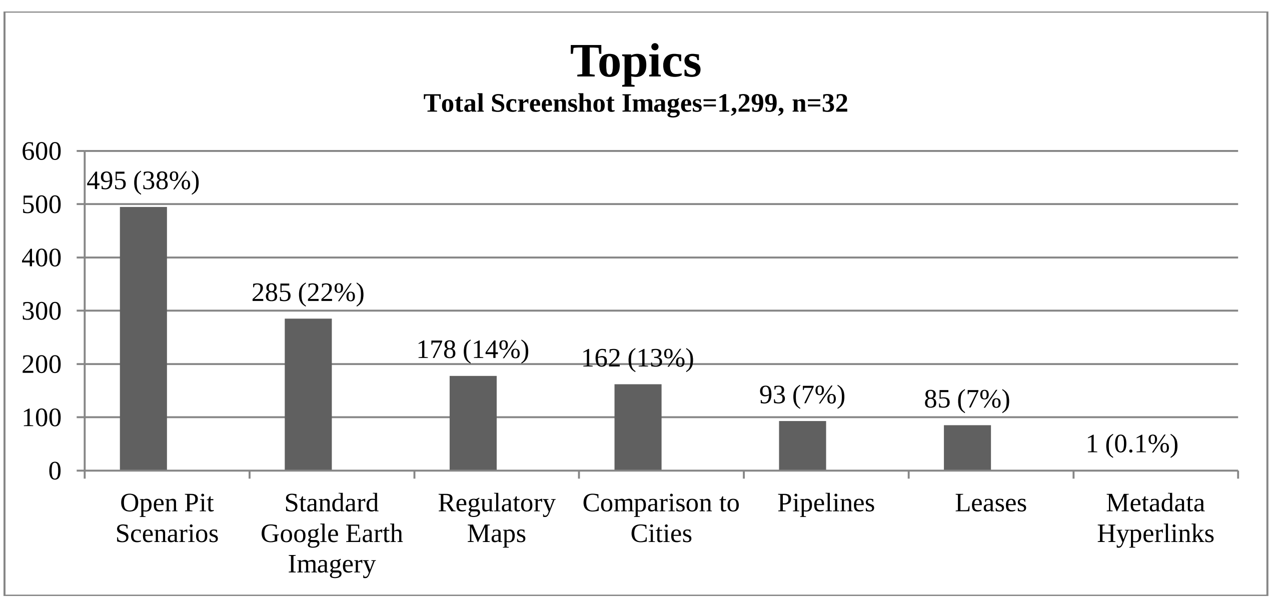


Figure 104 Topics

6.5.2.1. *Open Pit Scenarios*

As shown in Figure 105, according to descending number of screenshot images, 42% the “Open Pit Scenarios” were “Static Landscape Visualisations”. Twenty-seven percent were “Interactive Landscape Visualisations” and 24% were “Vertical Maps”. Seven percent of the screenshot images were “Oblique Maps”. Using the Chi-square test, these differences are significant (.000). Overall, this indicates that participants may have found find static landscape visualisations of industrial landscape disturbance more interesting and compelling than interactive landscape visualisations, vertical maps, or oblique maps. Once the screenshot data are isolated for the topic of “Open pit scenarios” only, this pattern is a reversal of earlier trends described in Section 6.4.1. where participants favoured vertical maps. Participants may have selected static and interactive landscape visualisations over vertical and oblique maps because the visualisations showed 3D trees and modified 3D terrain for future conditions. Alternately, participants may have selected the static landscape visualisations most frequently simply because they were easier to access.

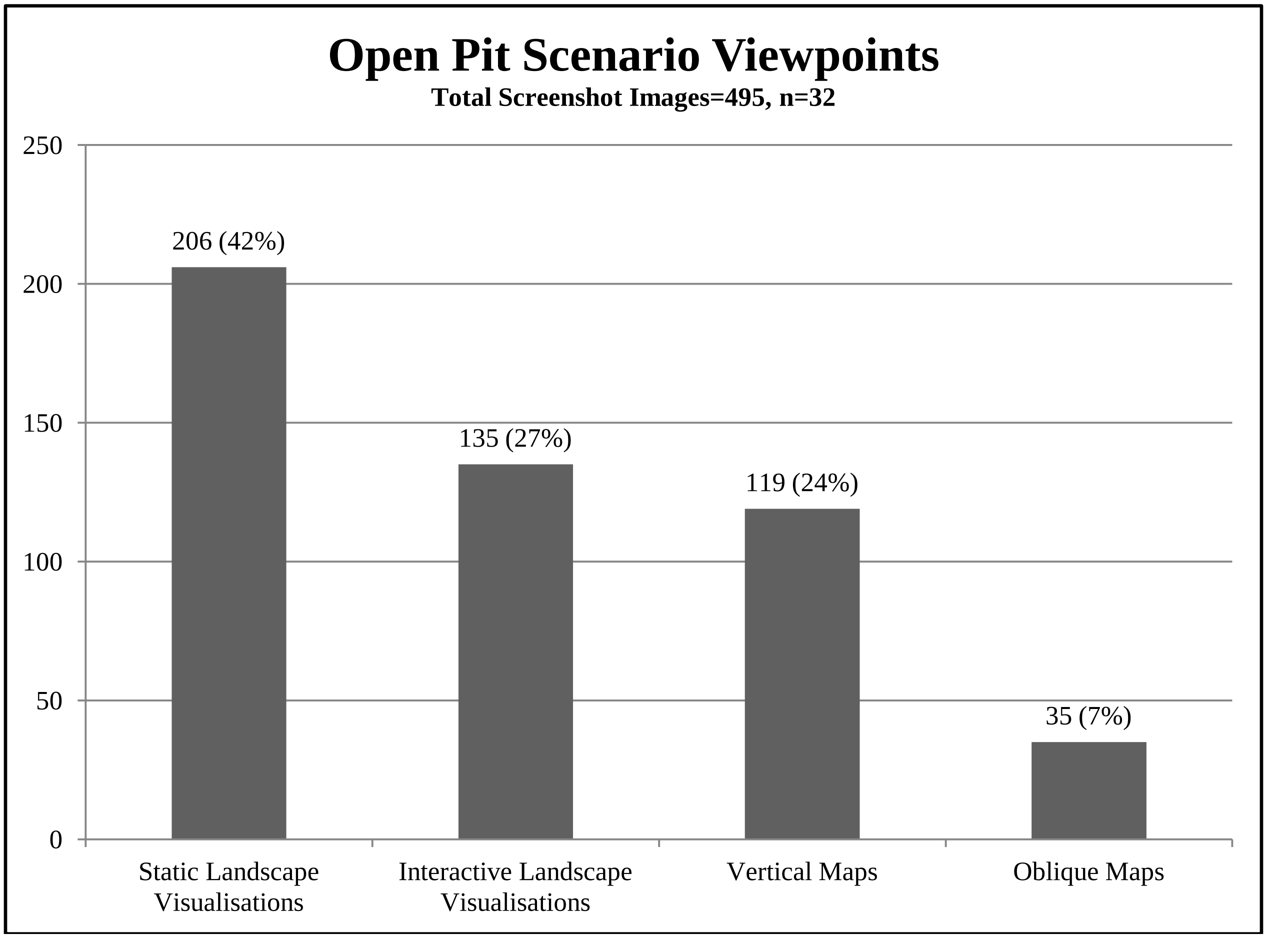


Figure 105 Open Pit Scenario Viewpoints

6.5.2.2. Standard Google Earth Imagery

As shown in Table 52, 64% of the “Standard Google Earth Imagery” screenshot images were “Vertical Maps” and 36% the screenshot images were “Oblique Maps” (102 out of 285). Using the Chi-square test, this difference is significant (.000). Overall, this indicates that participants may have found viewing standard Google Earth imagery using vertical maps more interesting and compelling than using oblique maps. Alternately, participants may have found the found the navigational tools easier/quicker to use or orientate with in vertical mode than when in oblique or perspective fly-through mode. Also, vertical mode provides full coverage of a given area, whereas the oblique view seems more selective towards the foreground where one could miss something interesting.

Table 52 Standard Google Earth Imagery Viewpoints

Viewpoint	Number of Screenshot images	Percent of Total
Vertical Maps	183	64%
Oblique Maps	102	36%
TOTAL	**285**	**100%**

6.5.2.3. Regulatory Maps

As shown in Table 53, 90% of the “Regulatory Map” screenshot images were “Vertical Maps” and 10% of the screenshot images were “Oblique Maps”. Using the Chi-square test, this difference is significant (.000). Overall, this indicates that participants may have found viewing regulatory map overlays more interesting and useful using vertical maps than oblique maps.

Table 53 Regulatory Map Viewpoints

Viewpoint	Number of Screenshot images	Percent of Total
Vertical Maps	160	90%
Oblique Maps	18	10%
TOTAL	**178**	**100%**

6.5.2.4. Comparison to Cities

As shown in Table 54, 88% of the “Comparison to Cities” screenshot images were “Vertical Maps” and 12% of the screenshot images were “Oblique Maps”. Using the Chi-square test, this difference is significant (.000). Overall, this indicates that participants may have found viewing comparison to city outlines more informative and easy to interpret in terms of judging scale than oblique perspective views. Users may also be more familiar with city boundaries in conventional maps than in oblique perspective views.

Table 54 Comparison to Cities Viewpoints

Viewpoint	Number of Screenshot images	Percent of Total
Vertical Maps	143	88%
Oblique Maps	19	12%
TOTAL	**162**	**100%**

6.5.2.5. *Pipelines*

As shown in Table 55, 97% all of the "Pipeline" screenshot images were "Vertical Maps" and 3% were "Oblique Maps". Using the Chi-square test, this difference is significant. While the pipelines were clearly visible on the oblique maps, overall this indicates participants may have found continental scale infrastructure such as pipelines more compelling using vertical maps which are more comprehensive, informative, and familiar.

Table 55 Pipeline Viewpoints

Viewpoint	Number of Screenshot images	Percent of Total
Vertical Maps	90	97%
Oblique Maps	3	3%
TOTAL	**93**	**100%**

6.5.2.6. *Leases*

As shown in Table 56, 90% of the "Lease" screenshot images were "Vertical Maps" and 10% were "Oblique Maps". Using the Chi-square test, this difference is significant. Overall, as with other mapped content described above, participants may have found viewing resource dispositions and land ownership more informative, familiar, and compelling using vertical maps than oblique maps.

Table 56 Lease Viewpoints

Viewpoint	Number of Screenshot images	Percent of Total
Vertical Maps	76	89.4%
Oblique Maps	9	10.6%
TOTAL	**85**	**100.0%**

6.6. Concluding Comments

In this chapter, the quantitative analysis of the following data has been presented:

1) Comparison of initial and follow up questionnaire results, which identified the following changes for perception and opinion:

    a) After viewing, the largest number of participants over-estimated the geographic area of existing, approved, and planned tar sands open pit mines as about the geographic area of one of the "World's largest metropolitan cities" instead of the correct geographic area of a "Canadian metropolitan city". Because the tar sands open pit mines are not contiguous, participants may have used a "convex hull" concept to estimate the area;

    b) After viewing, the largest number of participants over-estimated the growth of the approved tar sands open pit mines as three times the geographic area of the existing mines, when the correct answer is two times. However, the largest number of participants correctly estimated the growth of the approved/planned tar sands open pit mines. Participants may have been able to estimate the growth of the mines more accurately if the existing, approved, and planned scenarios were also displayed individually;

c) After viewing, significantly more participants thought they knew the geographic area and growth the tar sands open pit mines; and

d) After viewing, participants became significantly more opposed to future tar sands development.

2) Comparison of believability of maps and static landscape visualisation images, where participants found the maps significantly more believable than the static landscape visualisation images. Sixty percent of participants found the maps “Mostly believable “ and “Highly believable” while 28% of participants found the static landscape visualisations “Mostly believable” or “Highly believable”;

3) Correlation among questionnaire variables, which identified the following significant relationships:

   a) Both before and after viewing, participants who had seen more photographs and maps had significantly more negative opinions about the existing tar sands open pit mines;
   b) Before viewing, participants who had seen more photographs and maps had significantly more negative opinions about the future tar sands open pit mines; and
   c) After viewing, participants who had seen fewer maps thought they changed their opinions significantly more than participants who had seen more maps.

4) Screenshot Analysis where the number of screenshots taken by participants was ranked as follows:

   a) Classified by “viewpoints”, the majority of screenshots were “Vertical Maps”;

   b) Classified by “topics”, the largest number of screenshots were “Open Pit Scenarios”; and

   c) For viewing the “Open Pit Scenarios”, the largest number of screenshot “viewpoints” were “Static Landscape Visualisations” followed by “Interactive Landscape Visualisations”.

More detailed interpretation of the quantitative data is provided in “Chapter 8: Discussion and Conclusions”. In the following “Chapter 7: Qualitative Analysis”, analysis of the qualitative data from the open-ended questions in the initial and follow up questionnaires as well as the transcripts from the focus group discussions is presented.

CHAPTER 7: QUALITATIVE ANALYSIS

7.1 Introduction to Qualitative Analysis

The purpose of this chapter is to analyse the qualitative data in order to identify the most common perceptions and opinions about the tar sands open pit mines as well as the Google Earth project itself, both before and after viewing the visual material. This contributes to the objectives of this study to develop ways to improve communication about the cumulative development of large projects with the general public. In this chapter, the following qualitative data are analysed:

1) Written answers to open ended-questions in the initial and follow up questionnaires;
2) Transcripts of the focus group discussions; and
3) Presentations by focus group participants describing screenshots that they found most compelling and informative, recorded as part of transcripts.

The answers to the open-ended questions from the questionnaires and the transcripts of the focus group discussions were imported into NVivo software (QSR International, 2013). In order to identify the most common perceptions and opinions about the tar sands open pit mines as well as the Google Earth project itself, word frequency analysis was tested using NVivo software, but did not yield any meaningful word combinations. Instead, the comments and questions were classified into thematic categories that were structured in a hierarchical "tree" format on the basis of themes and sub-themes. Each comment or question from the open-ended questions and discussions was coded according initial or follow up questionnaire, focus group, and participant personal identification number. Most participants could not be identified during the transcription of the audio recording of the focus group discussions. Based on general similarities between socio-economic profiles of participants in focus group sessions, the comments were pooled across groups for qualitative analysis and reporting. Questions were asked by participants of the researcher in the focus group discussions, not in the questionnaires.

In order to understand participant's opinions about the tar sands and their use of the Google Earth project, their comments and questions were classified into themes. Thematic classification was carried out manually and followed an iterative process where comments and questions were first classified into general categories and then more specific categories. Noteworthy comments were selected to illustrate both representative and extreme opinions from the participants and are identified as such in the analysis. Using the "Nodes" function in NVivo software, the data were coded using the following thematic structure, which identifies the most common perceptions and opinions about the tar sands open pit mines and the Google Earth project itself. As shown in Table 57, the thematic classification structure lists the most frequently mentioned themes and sub-themes in descending order. There were eight duplicate comments that fit into more than one theme. Seven of the eight were classified into two themes while one comment was classified into three themes.

Table 57 Thematic Classification Structure for Qualitative Analysis

Tar Sands, Energy, Supplies, and Pipelines	Environmental Impact of Tar Sands	Negative Environmental Impact (~ “opposed”)
		Neutral Environmental Impact[31]
		Positive Impact on Employment and Economy (~ “supportive”)
	Energy Supplies	Natural Gas Use
		Need for Alternative Energy
		Need for Tar Sands
	Questions About Tar Sands	Questions About Surrounding Communities
		Questions About Waterbodies
		Questions About Open Pit Mines
		Questions About Tailings Ponds
	Pipelines	Negative Opinion About Pipelines
		Questions About Pipelines
Google Earth Features[32]	3D Visualisation	Interactive 3D Visualisation
		Static 3D Visualisation in Pop-up Balloons
	Maps	Complimentary Comments About Maps
		Critical Comments About Maps
		Questions About Maps
	Navigation[33]	Questions About Navigation
		Complimentary Comments About Navigation
		Critical Comments About Navigation
Research Process		
Screenshots Presented		

[31] “Neutral Environmental Impact” refers to comments that express a lack of opinion or knowledge about the environmental impact of the tar sands.
[32] “Google Earth Features” refers to the elements of the software or the contents communicated in the presentations and interactive focus group sessions. Although landscape visualisations were generated using other software such as ArcGIS (Environmental Systems Research Institute, 2008) and Visual Nature Studio (3D Nature LLC, n.d.), the images were all presented using Google Earth (Google Corporation, 2007) software.
[33] “Navigation” refers to the user’s ability to move through the virtual landscape in Google Earth while selecting different images and viewpoints.

The following codes are used in the tables showing the comments and questions:

Focus Group Participants

Focus group participants are listed according to their unique code. Unknown participants are listed with the focus group code followed by “Unknown”. The focus group codes are:

VB = UBC Robson Square, Vancouver, BC, August 13, 2012
VA = UBC Robson Square, Vancouver, BC, August 14, 2012
E = University of Alberta, Edmonton, AB, August 16, 2012

Where an unknown participant asked a question or engaged in discussion, they are listed as “Unknown”. Where a known participant asked a question or engaged in discussion, they are listed according to their unique participant code.

Source

The following codes are used for the sources of the qualitative data:

Q1 = Initial Questionnaire
Q2 = Follow Up Questionnaire
FG = Focus Group Discussion comments or questions

Other Codes

Other codes that are used in the transcripts are:

PC = Petr Cizek (Researcher)
KW = Kyle Whiting (Technical Assistant)
SS = Stephen Sheppard (Dissertation Advisor)

A total of 427 comments and questions were made or asked by thirty-two participants who filled out both the initial and follow up questionnaires and attended an entire focus group from start to finish.[34] This includes answers to open-ended questions in both questionnaires as well as comments made during the focus group. For context, comments from the researcher, technical assistant, and dissertation advisor are also included in response to participants’ questions or problems, but they are not coded or counted separately. Part of the interpretation of the qualitative results uses quantitative methods as it is assumed that if certain types of comments are made more frequently they are more important overall. Using SPSS software, Chi-square tests were conducted to determine whether there are significant differences between the number of comments and questions between:

1) Themes and sub-themes;
2) Focus Group Sessions; and
3) Initial and Follow-Up Questionnaires.

[34] One additional participant (E01) arrived late and did not fill out either the initial or follow up questionnaires. However, he did contribute three comments and questions.

The results of the Chi-square test are reported only where they are significant (≤0.05). The frequency of the number of comments and questions in each theme may reflect the guidance in the focus group research protocol and the questionnaires where a space was provided to answer an open-ended question. Answers to open-ended questions are distinguished from comments and questions in the focus group discussion in the coding shown in Appendix "S", but not in the summary reporting of results. Specifically, there were three open-ended questions in the initial questionnaire and twelve open-ended questions in the follow up questionnaire.

7.2 Summary Results of Qualitative Analysis

During the focus group discussions, thirteen "key moments" were identified where participants verbally expressed emotion. As shown in Table 58, the key moments occurred when the specific information listed below was displayed:

Table 58 Summary of Key Moments

Theme	Key Moments Identification Numbers (Described in Detail in Sections Below)[35]	Frequency
Outline of Cities	#1,#5,#6	3
Athabasca River	#2, #8	2
Frustration with lack of political action	#10, #13	2
Need to see scenarios side-by-side instead of sequentially	#11, #12	2
Tailings Ponds	#9	1
3D Trees	#3	1
3D Mining Machinery	#4	1
Difficulty loading interactive 3D	#7	1

The key moments are described in detail within each following theme. The frequency of key moments in each theme may indicate the relative significance of each theme. However, this is also indicated by the overall frequency of comments and questions as discussed below.

[35] The key moment numbering is chronological based on the sequence of the focus group workshops (i.e. "VB" on August 13, 2012; "VA" on August 14, 2012; and "E" on August 16, 2012.

The comments and questions were grouped into four major themes as summarized in Figure 106. Over four-fifths of the comments and questions were about the substantive aspects of “Tar Sands, Energy Supplies, and Pipelines” and “Google Earth” features combined. The number of comments and questions in the “Tar Sands, Energy Supplies, and Pipelines” theme and the “Google Earth Features” theme was similar and not significantly different. Overall, this may indicate that participants expressed about the same concern or interest about Google Earth and the tar sands. Fewer than one-sixth of the comments and questions were about the research process. Thirteen screenshots taken by twelve individual participants were presented back to the focus groups, along with comments from the presenting participants.

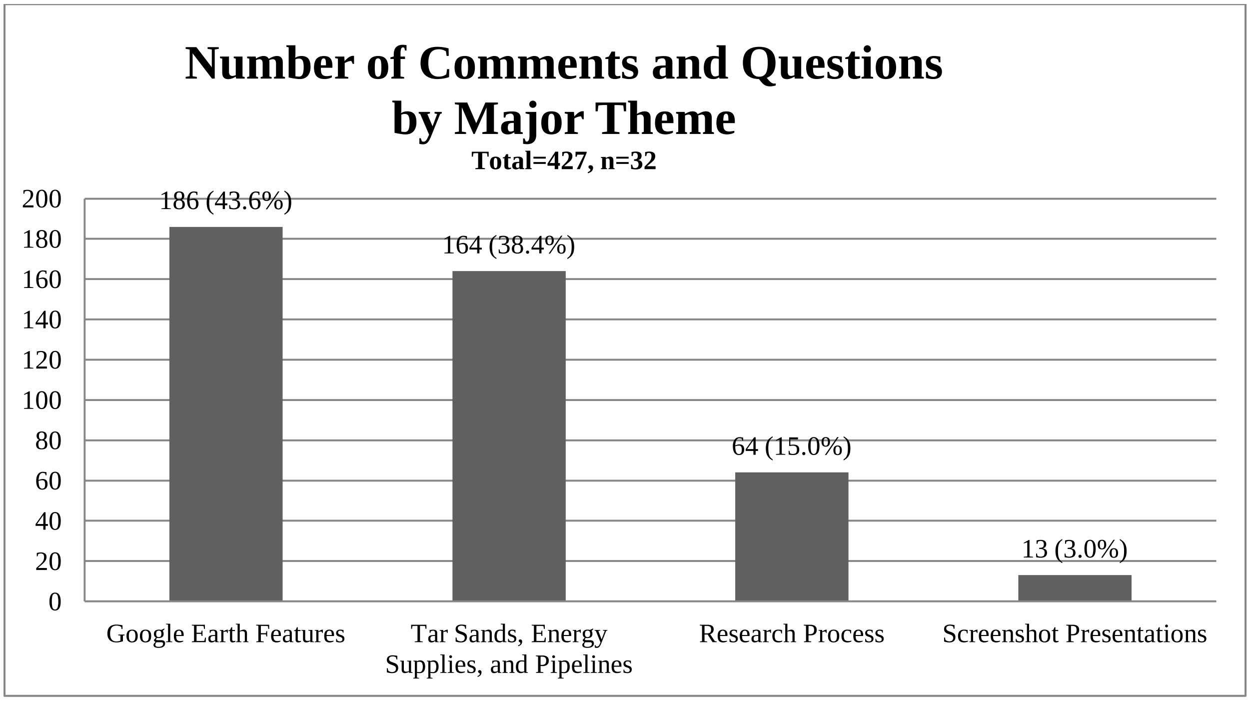


Figure 106 Comments and Questions by Major Theme

The number of comments between focus group sessions was similar and distributed within a range of 10%. However, the difference between the number of comments in the initial and follow up questionnaire was significant using the Chi-square test (0.019), which may indicate that viewing the Google Earth project may have stimulated participants to make more comments but also reflects the fact that there were four times the number of open-ended questions in the follow up questionnaire than in the initial questionnaire.

7.3. Comments and Questions About Tar Sands, Energy Supplies, and Pipelines

A total of 164 comments and questions were made or asked about "Tar Sands, Energy Supplies, and Pipelines". These comments and questions were grouped into four categories, as shown in Figure 107. Over three-quarters of the comments and questions were about the "Environmental Impact" of the tar sands, where "environment" includes both the biophysical and socio-economic environments. Just over ten percent of the comments and questions were about "Energy Supplies". Just under one-tenth of the comments and questions were "Questions About the Tar Sands". There were only three comments about "Pipelines". Using the Chi-square test, the differences between the comments and questions are significant (.000). Overall, this indicates that participants may have been concerned about the environmental impact of the tar sands compared to energy supplies or pipelines, which is not surprising give the time spent and focus on the tar sands open pit mines compared to energy supplies and pipelines.

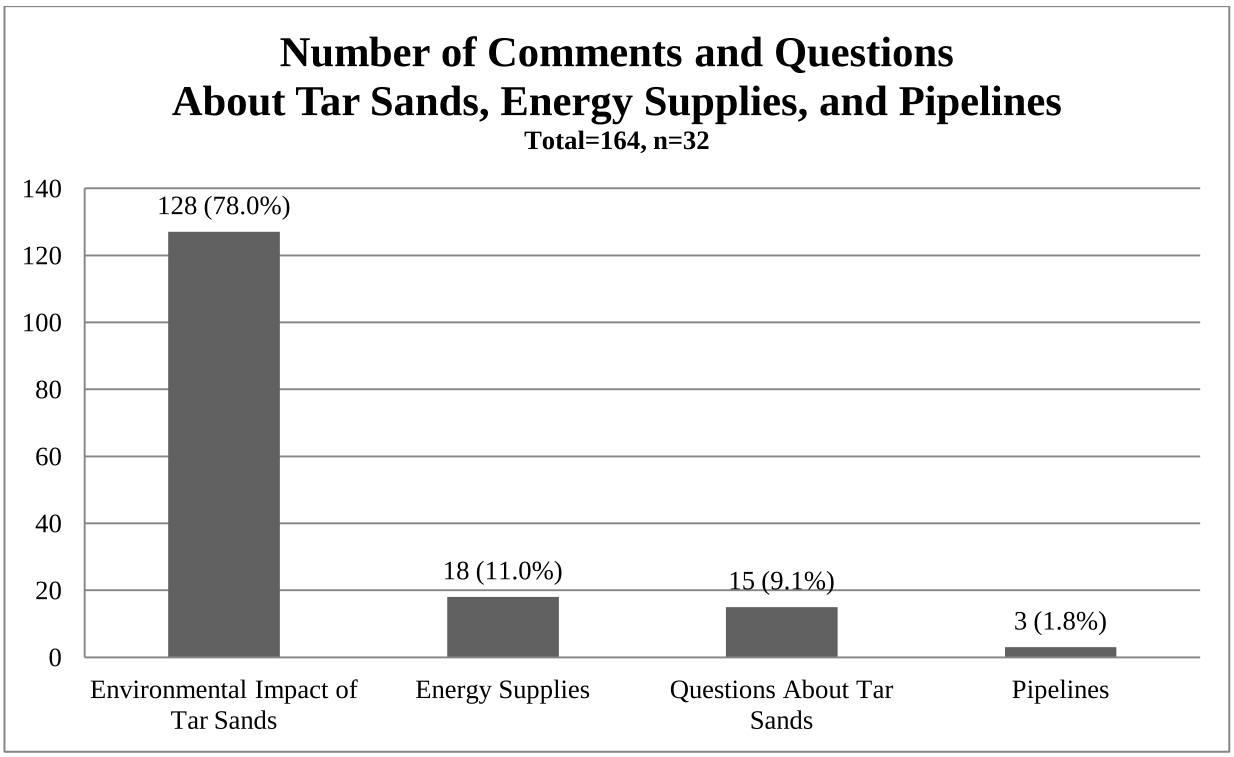


Figure 107 Comments and Questions About Tar Sands and Associated Energy Supplies and Pipelines

The number of comments and questions about tar sands was distributed between the focus group sessions within a range of less than 5%. However, the difference between the number of comments in the initial and follow up questionnaire was significant using the Chi-square test (0.004), which could mean that viewing the Google Earth project may have stimulated participants to make more comments about the tar sands.

7.3.1. Environmental Impact

A total of 128 comments were made about the "Environmental Impact" of the tar sands.[36] These comments were grouped into three categories, as shown in Figure 108. Over four-fifths of the comments were about the "Negative Environmental Impact" of the tar sands from 26 known participants. Less than ten percent of the comments were about the "Neutral Environmental Impact" of the tar sands and the "Positive Impact on Employment and Economy" each. Using the Chi-square test, the differences between the comments are significant (.000). Overall, this indicates that significantly more participants were concerned about the negative environmental impact of the tar sands. In comparison, the Canadian Association of Petroleum Producers conducted an opinion survey in Edmonton and Toronto where they found that "46% of respondents believe the oil sands companies have not done a good job at balancing the environment and the economy. Only 22% believe that the industry has been able to achieve this balance to date." (Canadian Association of Petroleum Producers, 2009), which indicates that the focus groups were somewhat more opposed to the tar sands than the general public in Toronto and Edmonton.

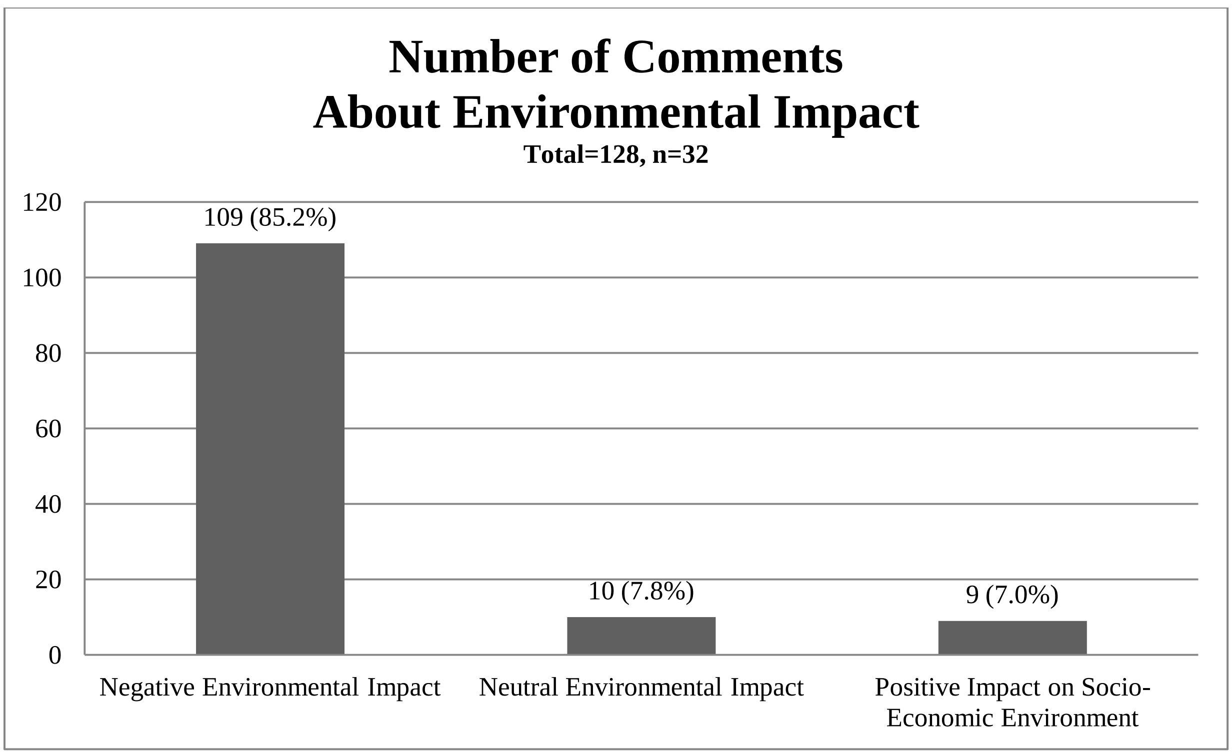


Figure 108 Comments About Environmental Impact

The number of comments about environmental impact was distributed evenly between the focus group sessions, within a range of less than 5%.

[36] "Environmental Impact" is defined as including both biophysical and socio-economic components.

7.3.1.1. *Negative Environmental Impact*

A total of 109 comments were made about the "Negative Environmental Impact" of the tar sands. These comments were grouped into ten categories, as shown in Figure 109. Almost two-fifths of the comments were about the "General negative impact".[37] The four categories "Cumulative negative impact", "Water negative impact", "Lack of reclamation", and "Land negative impact" each represented about one-tenth of the comments. Fewer than six percent of the comments were about each of the remaining categories: "Air and climate negative impact", "Animals negative impact", "Too close to river", "Aesthetics negative impact", and "Economy negative impact". Using the Chi-square test, the differences between the comments are significant (.000). Overall, this indicates that participants had a wide variety of specific concerns about negative environmental impacts, but many may not have known or were not readily able to express the details about specific negative environmental impacts.

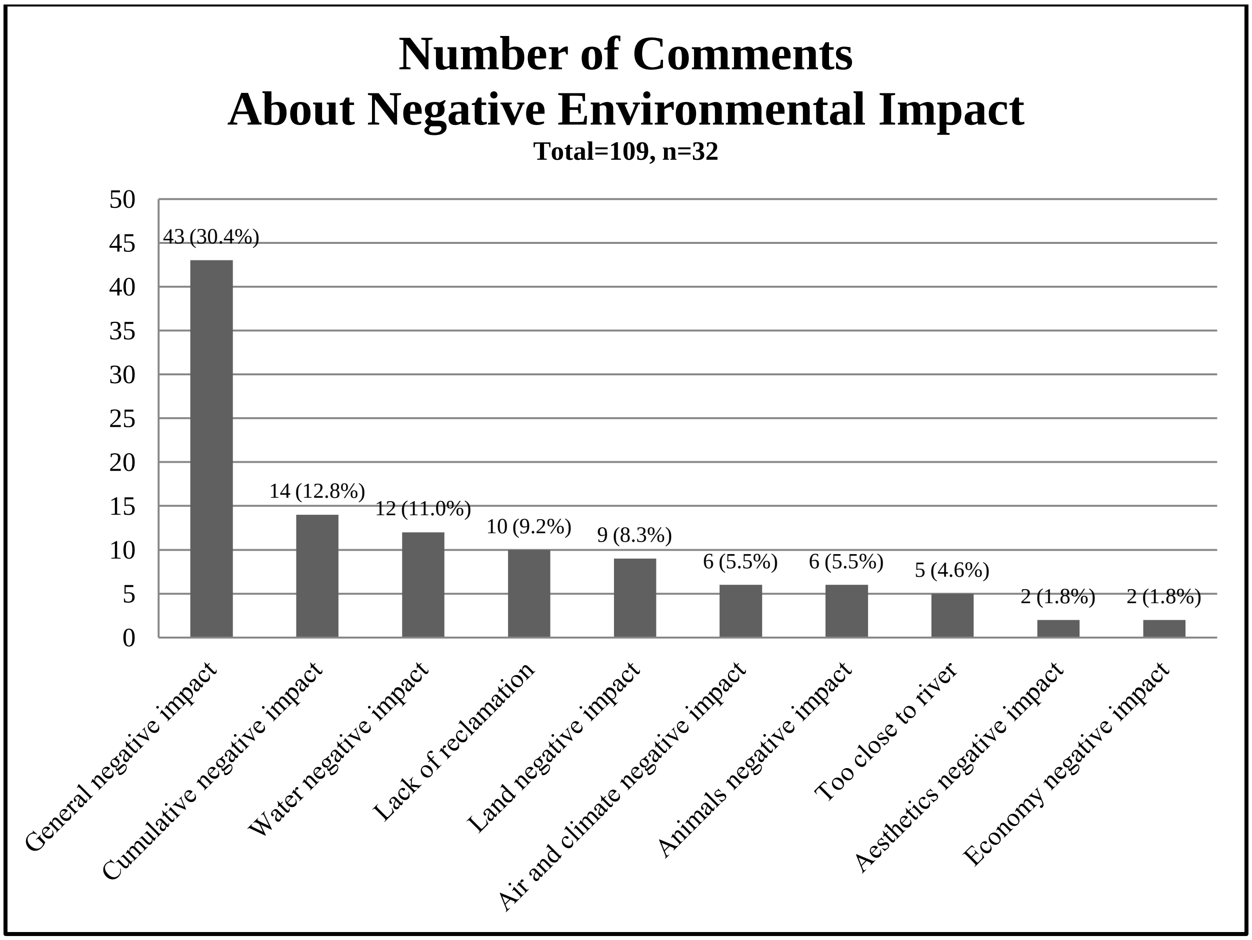


Figure 109 Comments About Negative Environmental Impact

[37] "General negative impact" means negative environmental impacts that were not specified.

There was no significant difference in the distribution of these comments between the focus group sessions. There were almost twice as many comments and questions about negative environmental impact in the follow up questionnaire compared to the initial questionnaire, which is a significant difference using the Chi-square test (.001). This indicates that viewing the maps and images may have stimulated the participants to think about the negative environmental impact of the tar sands. Using the Chi-square test, there was a also significant increase in the number of comments in the follow up questionnaire compared to the initial questionnaire concerning “Cumulative negative impact” (.033) and “Too close to river” (.025). This indicates that viewing the Google Earth project may have stimulated participants to think specifically about these issues.

7.3.1.1.1. General Negative Impact

Seventeen individual participants made 43 comments about “General negative impact.” The comments about “General Negative Impact” are shown in Table 116 within Appendix “S”.

7.3.1.1.2. Cumulative Negative Impact

Cumulative negative impact refers to comments about the perceived combined impact of the geographic area or scale of multiple existing, approved, or planned open pit mines. Ten individual participants made fourteen comments about “Cumulative negative impact.” There were almost four times more comments about “Cumulative negative impact” in the follow up questionnaire than in the initial questionnaire, which is a significant difference using the Chi-square test (.033). This indicates that viewing the maps and images may have stimulated participants to think about the cumulative impact of the tar sands. The comments about “Cumulative Negative Impact” are shown in Table 117 within Appendix “S”.

7.3.1.1.3. Water Negative Impact

Seven individual participants made twelve comments about “Water negative impact”. The comments about “Water Negative Impact” are shown in Table 118 within Appendix “S”.

7.3.1.1.4. Lack of Reclamation

Five individual participants made ten comments about the lack of reclamation. Two of these participants noted the geographic area or scale of the area yet to be reclaimed. The comments about “Lack of reclamation” are shown in Table 119 within Appendix “S”.

7.3.1.1.5. Land Negative Impact

“Land negative impact” is defined as negative impact on the landscape through the removal of natural land cover and soils. Seven individual participants made nine comments about “Land negative impact”. The comments about “Land Negative Impact” are shown in Table 120 within Appendix “S”.

7.3.1.1.6. Air and Climate Negative Impact

There were three comments about "Air and Climate Negative Impact" in each of focus group "VA" and "VB" and none in focus group "E". Four individual participants made six comments, four of which were in the follow up questionnaire. The comments about "Air and climate negative impacts" are shown in Table 121 in Appendix "S".

7.3.1.1.7. Animals Negative Impact

There were five comments about "Animals Negative Impact" in focus group "VB" and one comment in focus group "E". Five individual participants made six comments in total. There were twice as many comments about "Animals Negative Impact" in the initial questionnaire compared to the follow up questionnaire. There were no comments about "Animals Negative Impact" in the focus group discussions. The comments about "Animals negative impact" are shown in Table 121 within Appendix "S".

7.3.1.1.8. Too Close to River

Four comments about "Too Close to River" were in focus group "E" and one was in focus group "VA". Four individual participants made five comments in total.

All the comments about "Too Close to River" were made after viewing the maps and images in the follow up questionnaire, which is significant using the Chi-square test (0.0253). This indicates that viewing the maps and images may have stimulated the participants to think about how close the tar sands are to the Athabasca River. There was one comment made about "Too Close to River" in the screenshot presentations (See Section 7.4.4.). The following noteworthy comments about "Too Close to River" were selected from all the comments, as shown in Table 123 within Appendix "S".

In response to the question "If you wish, please provide any additional comments about the Google Earth tool's ***strengths*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features" in the follow up questionnaire, participant E06 stated:

> *E04, Q2: The shock value of how close the river and the sense of scale.*

However, gaining this new knowledge did not affect the opinion of participant E04 as she was "Extremely Opposed" to both the ***existing*** open pit mines and ***future*** approved and planned open pit mines in both the initial and follow up questionnaires.

In response to the question "If you feel opposed or supportive, please explain why" about the future approved and proposed open pit mines in the follow up questionnaire, participant E06 stated:

> *E06, Q2: Wasn't aware how big the projects are and how close to the rivers.*

Gaining this understanding also did not affect the opinion of participant E06 as she remained "Somewhat Opposed" to the ***existing*** open pit mines in both the initial and follow up questionnaires and was "Extremely Opposed" to the ***future*** approved and planned open pit mines in both the initial and follow up questionnaires. While the opinions of either participants E04 or E06 did not change by viewing the maps and images, both participants said that they gained a greater understanding of the size of the existing and future open pit mines and their proximity to the Athabasca River after viewing the maps and images.

7.3.1.1.9. Aesthetics Negative Impact

There were only two comments about "Aesthetics Negative Impact". Both comments were made after viewing the maps and images in the follow up questionnaire indicating that these participants may not have been aware of the aesthetics of the open pit mines prior to attending the focus group. While the opinions of the two participants did not change by viewing the maps and images, both participants commented about the "Aesthetic negative impact" only after viewing the maps and images; this may have influenced their aesthetic perception of the open pit mines. The comments about "Aesthetics negative impact" are shown in Table 124 within Appendix "S".

7.3.1.1.10. Economy Negative Impact

There were only two comments about "Economy Negative Impact". As both comments were made in the initial questionnaire before viewing the maps and images, these participants must have arrived at this opinion before attending the focus group. The comments about "Economy negative impact" are shown in Table 125 within Appendix "S".

7.3.1.2. Neutral Environmental Impact

"Neutral environmental impact" is defined as a comment where participants either did not know about the environmental impact of the tar sands or did not think the impact was important or significant. Six individual participants made ten comments about "Neutral environmental impact." There were three times as many comments about "Neutral Environmental Impact" in focus group "VA" compared to either focus group "E" or focus group "VB". There were the same number of comments about "Neutral Environmental Impact" comments in the initial questionnaire and the follow up questionnaire. The comments about "Neutral environmental impact" are shown in Table 126 within Appendix "S".

7.3.1.3. Positive Impact on Socio-Economic Environment

Six individual participants made nine comments about "Positive impact on socio-economic environment." Four comments about "Positive Impact on Socio-Economic Environment" were made in each of focus groups "VA" and "VB". One comment about "Positive Impact on Socio-Economic Environment" was made in focus group "E". The difference between the focus group sessions is not significant. Five comments about "Positive Impact on Socio-Economic Environment" were made in the initial questionnaire while four comments made in the follow up questionnaire. The comments about "Positive Impact on Socio-Economic Environment" are shown in Table 127 within Appendix "S".

7.3.2. Energy Supplies

Nine individual participants made eighteen comments made about energy supplies related to the tar sands. These comments were grouped into three categories, as shown in Figure 110. The comments about energy supplies were almost evenly distributed in the three categories within a range of 12.1% and the differences are not significant.

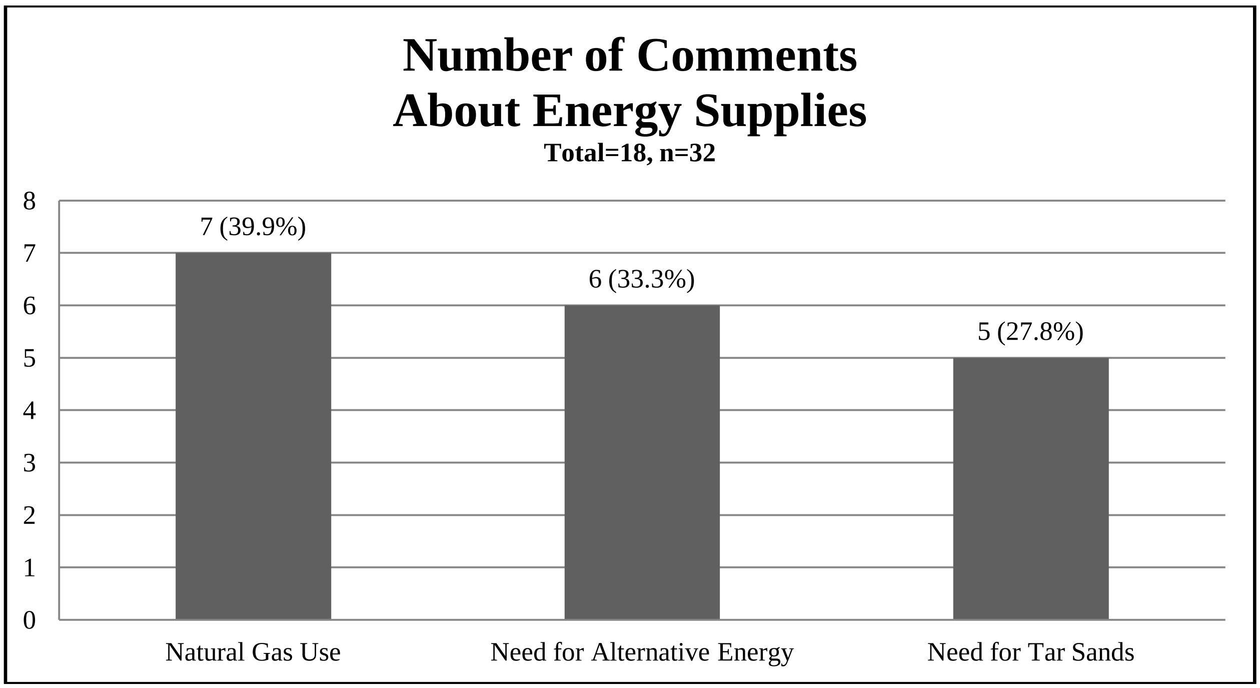


Figure 110 Comments About Energy Supplies

There were eleven comments about "Energy Supplies" in focus group "E", six comments in focus group "VA", and three in focus group "VB". These differences are not significant. There were the same number comments about "Energy Supplies" in the follow up questionnaire as in the initial questionnaire. No comments about "Energy Supplies" were made in the focus group discussions.

7.3.2.1 Natural Gas Use

Six individual participants made seven comments about “Natural gas use”. There were five comments about “Natural Gas Use” in focus group “E” and two comments focus group “VA”. There were no comments about “Natural Gas Use” in focus group “VB”. There were over twice as many comments about “Natural Gas Use” in the follow up questionnaire compared to the initial questionnaire, but this is not a significant difference. The comments about “Natural Gas Use” are shown in Table 128 within Appendix “S”.

7.3.2.2 Need for Alternative Energy

Three individual participants made six comments about “Need for alternative energy.” There were twice as many comments about “Need for Alternative Energy” in focus group “E” compared to focus group “VA”. There were no comments about “Need for Alternative Energy” in focus group “VB”. The same number of comments about “Need for Alternative Energy” was made in the initial questionnaire as in the follow up questionnaire. No comments about “Need for Alternative Energy” were made in the focus group discussions. The comments about “Need for Alternative Energy” are shown in Table 129 within Appendix “S”.

7.3.2.3 Need for Tar Sands

Three participants made five comments about the “Need for tar sands”. Two comments were in focus group “E” and three comments were in focus group “VB”. Four of the comments were made in the initial questionnaire and one was made in the follow up questionnaire. The comments about “Need for Tar Sands” are shown in Table 130 within Appendix “S”.

7.3.3. <u>Questions About Tar Sands</u>

A total of fifteen questions were asked verbally about the tar sands. The number of individual participants who asked questions is not known since the participants could not be identified while transcribing the audio recording. The questions were grouped into four categories, as shown in Figure 111. One-third of the questions were asked about “Surrounding Communities” and about “Waterbodies”. One-fifth of the questions were asked about “Open Pit Mines” and just over one-tenth of the questions were asked about “Tailings Ponds”. These differences are not significant.

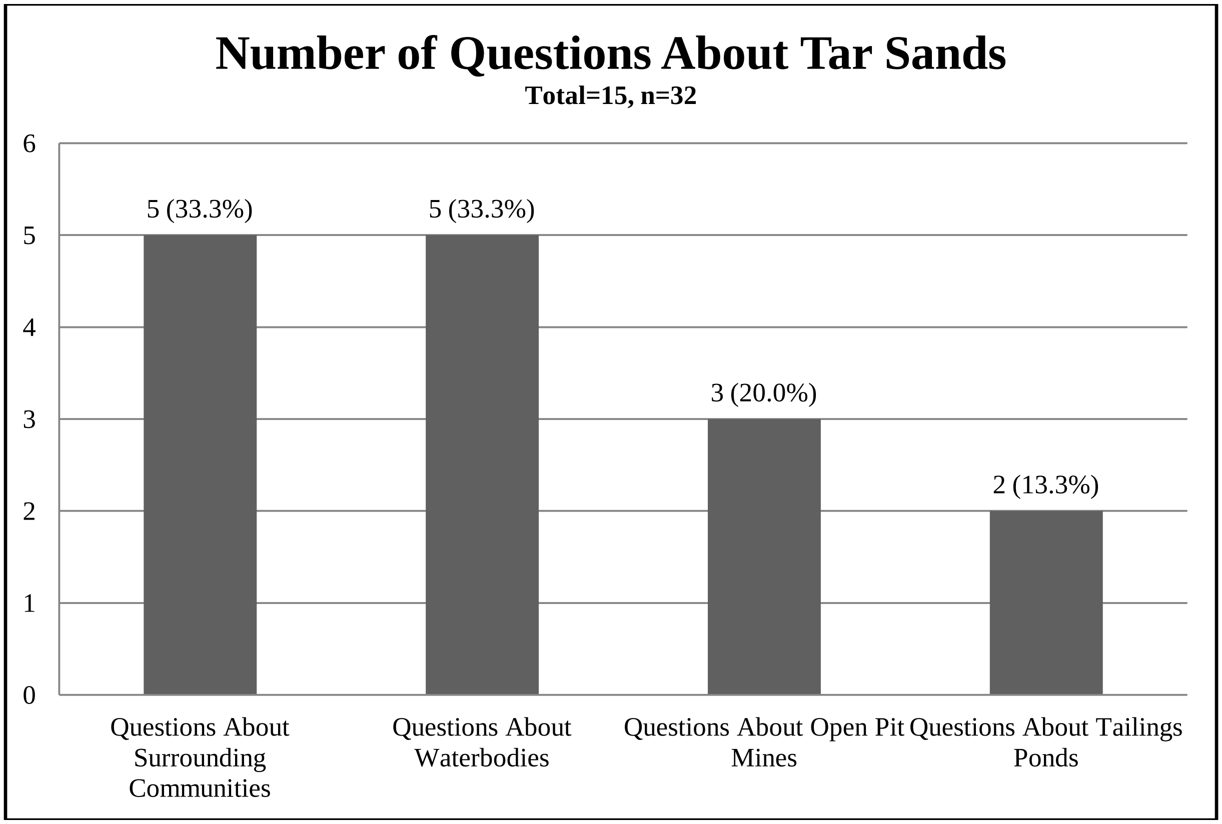


Figure 111 Questions About the Tar Sands

Overall, the number of questions about surrounding communities and waterbodies may suggest interest and possibly concern about potentially sensitive areas or features, as important contextual features, as well as indicating the need to include labels.

7.3.3.1. Questions About Surrounding Communities

Five participants asked "Questions about surrounding communities." Three participants from focus group "E" and two participants from focus group "VB" asked "Questions about surrounding communities". The following noteworthy questions about "Surrounding Communities" were selected from all the questions, as shown in Table 131 within Appendix "S".

To avoid clutter, the maps and images did not include any labels for the communities surrounding the open pit mines, including Fort McMurray. Nevertheless, up to five participants were interested in the location of Fort McMurray and Fort Chipewyan to provide geographic context to the open pit mines. While this was not mentioned in the research protocol, participants in focus group "E" may have also asked about the location of Fort Chipewyan because they had heard about the community's concerns with downstream water quality through the news media prior to attending the focus group.

Participant E02 wondered not only about the location of Fort Chipewyan but also other First Nation communities affected by both open pit and in-situ tar sands development:

E02
I was thinking about the native reserves and I'm wondering if you could have an overlay showing…I don't even know what groups there are besides the ones at Fort Chip and what their area of, I don't know what, operations of community compared to these regions on the map how much they overlap with the in-situ stuff down in Cold Lake or the other place..

PC
Peace River?

E02
Peace River yeah. Of all these things, one or two percent of the land doesn't mean anything because we're in the city but for the natives it's a big deal and that's the kind of thing I was thinking of. I don't know if it makes any difference to anybody else, I'm just saying that. Maybe a hunter cares. I don't know, but I'm sure the natives care.

Participant E02 wanted to see the First Nation communities and their hunting, fishing, trapping, and gathering territories on the maps to show their overlap with existing and future tar sands development. Participant E02 was also "Extremely Opposed" to ***existing*** open pit mines and ***future*** approved and planned open pit mines in both the initial and follow up questionnaires.

7.3.3.2. Questions About Waterbodies

Four of the questions about "Waterbodies" were in focus group "VA" and one question was in focus group "VB". The following noteworthy questions about "Waterbodies" were selected from all the questions, as shown in Table 132 within Appendix "S".

To avoid clutter, the maps and images also did not include any labels for "Waterbodies" near the open pit mines including the Athabasca River. Five participants were interested in the location of "Waterbodies" to provide geographic context to the open pit mines. Participants may also have been particularly interested in the Athabasca River due to its close proximity to the open pit mines.

Comments included three on the use of water, two on the spatial location, and one on the identification of features. "Key Moment #2" took place right after the researcher identified the Athabasca River in the middle of open pit mines in focus group "VB" this sparked a great deal of discussion and interest among participants. So many participants talked at once that what they were saying became indistinct in the audio recording. They were all surprised at the proximity of the open pit mines to the Athabasca River. This suggests that the presence of a major water course so close to the open pits and tailing ponds was an issue of considerable interest and possibly concern to participants, and also that the Athabasca River should have been labelled on all the maps and 3D visualisations.

An unknown participant in focus group VA also wondered if the mines extended underneath the Athabasca River.

Q
But they're not mining under the river?

PC
No, they're not mining under the river; they're within 50 to 100 metres. Here they seem to be within about 250 metres of the river. We might be able to see how that looks in 3D, because I said they're not mining under the river, but they're mining lower than the river. (PC SHOWS IN 3D in Figure 112)

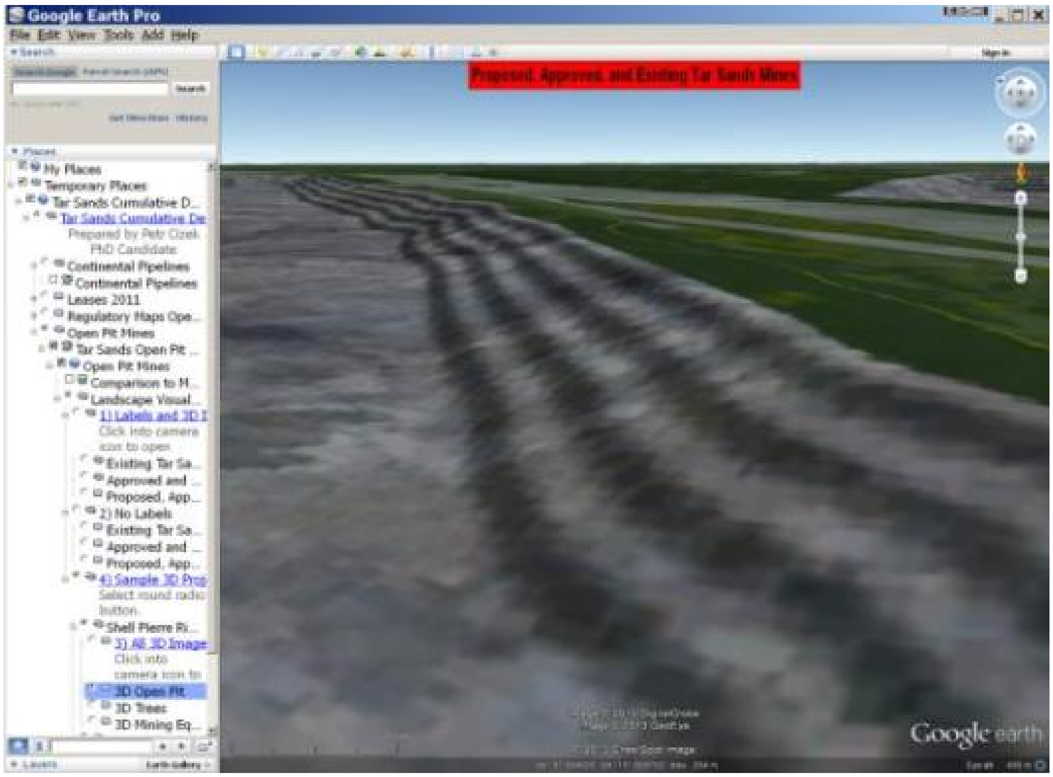


Figure 112 Elevation of Proposed Shell Pierre River Open Pit Mine Compared to Athabasca River

This example illustrates how 3D visualization can be used within Google Earth to demonstrate a spatial and topographical relationship with nearby waterbodies. However, upon viewing this image, there was no audible reaction (e.g. surprise or chatter) from the participants perhaps because in this view the river is relatively a small and distant feature. This example indicates the challenges of communicating variations in elevation, especially in a relatively flat landscape.

7.3.3.3 Questions About Open Pit Mines

There were two "Questions about open pit mines" in focus group "VA" and one question in focus group "VB". There were not questions in focus group "E". All the questions were in the focus group discussions.

Two unknown participants in focus group "VB" and focus group "VA" both wanted to know how long it would take to fully excavate the open pit mines. Even though the length of time (i.e. up to 50 years) had been stated twice in the researcher's presentation according to the research protocol, this indicates a desire to view a finer time-series sequence showing the progressive excavation of each open pit mine in the maps and images.

One unknown participant in focus group “VA” asked about the depth of the open pits even though this was also stated twice in the researcher’s presentation. This may also indicates a desire to use a vertical measuring device in Google Earth although this is not presently technically possible.

7.3.3.4 Questions About Tailings Ponds

There were two “Questions about tailings ponds” in focus group “E” and none in focus group “VA” or “VB”. “Key Moment #9” occurred after participant E02 asked about the area of the ***existing*** tailings ponds:

> E02
> You had mentioned that there were 170 square km of tailings ponds. I have a hard time visualizing where these are and I don’t know where 170 square km is with respect to some lake that I know about.
>
> KEY MOMENT #9: INSDISTINCT MUTTERING FROM SEVERAL PEOPLE. COMMENT SPARKS SOME INTEREST. DIFFERENT PEOPLE PROVIDING THEIR OWN ESTIMATES OF SIZE.

Participant E02 expressed two concerns. First of all, he said that he did not know how to identify the ***existing*** tailings ponds. Secondly, he wondered about how the combined size of the ***existing tailings*** would compare to a lake that he was familiar with. Other participants may have felt the same way as this sparked a great deal of discussion and interest among participants. So many participants talked at once that the discussion was indistinct in the audio recording.

In response to questions about how close the tailings ponds are to the Athabasca River, the researcher showed two 3D viewpoints of Suncor’s Pond #1, which is immediately adjacent to the Athabasca River. As shown in Figure 113, the first viewpoint was 500m above ground-level. As shown in Figure 114, the second viewpoint was at ground-level simulating the view from a boat floating on the Athabasca River. There was no vertical exaggeration in either image. The purpose of showing the ground-level image was to see if there might be a reaction to the height of the tailings dam above the Athabasca River.

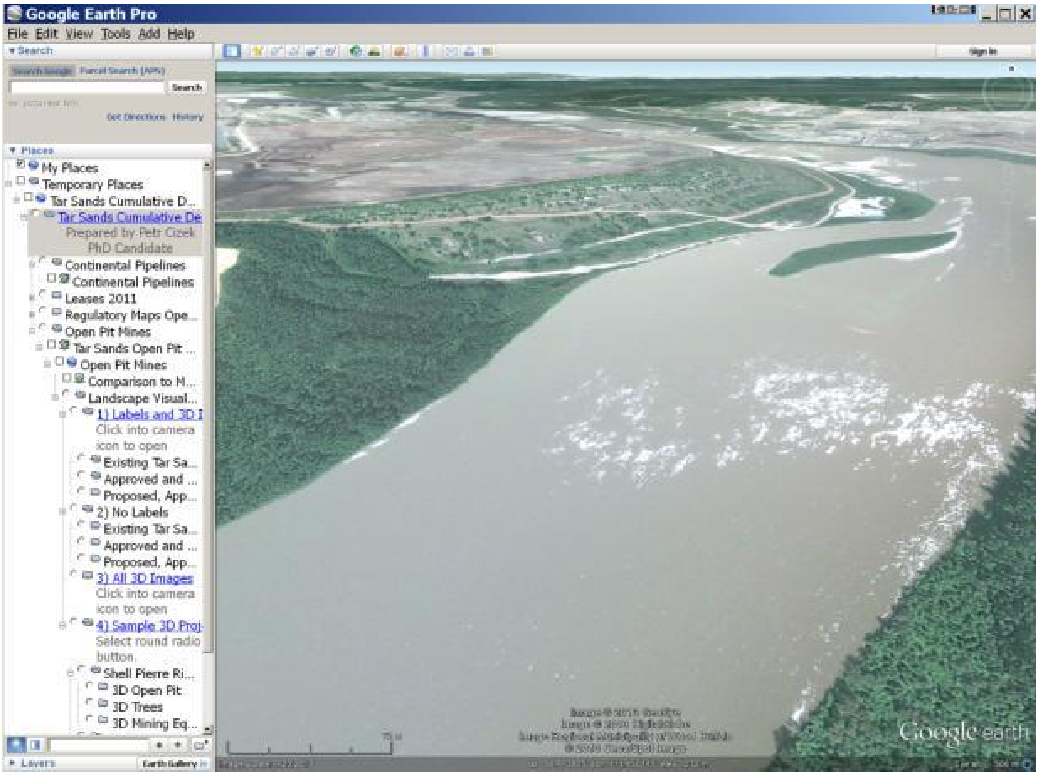


Figure 113 Suncor Tailing Pond 1 Viewpoint at 500m Above Ground Level

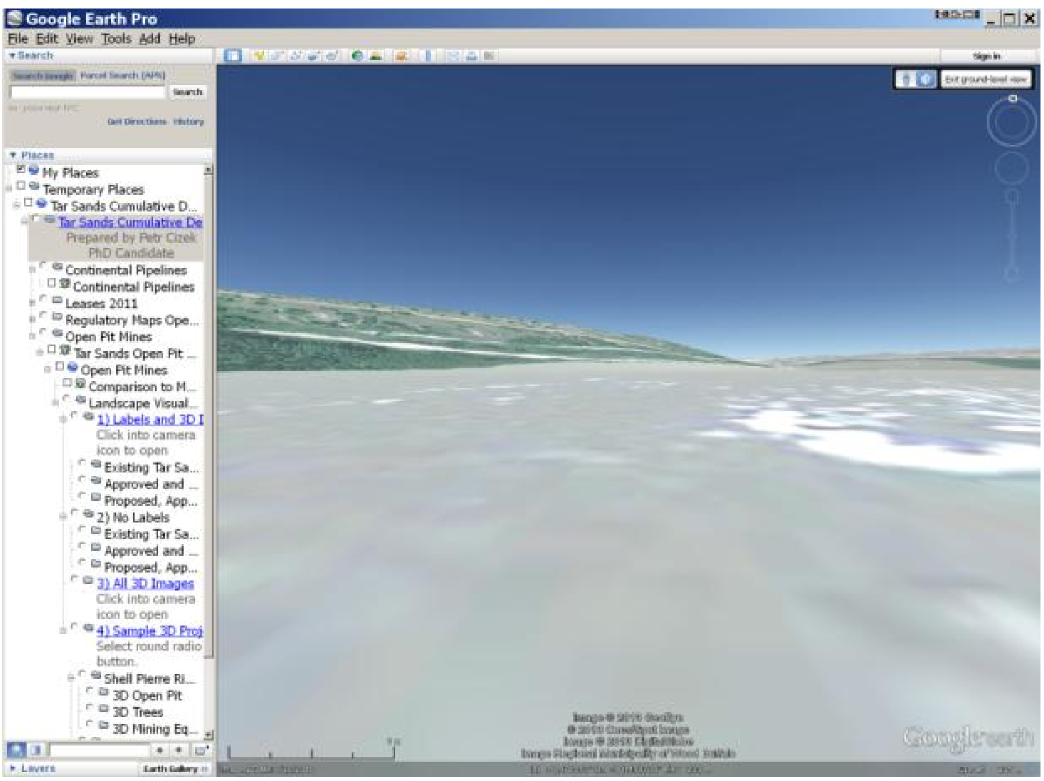


Figure 114 Suncor Tailings Pond 1 Viewpoint at Ground-Level (Athabasca River)

However, unlike the previous questions about the location and size of the tailings ponds, this demonstration did not elicit any audible response from focus group participants. This example also illustrates the challenges of communicating variations in elevation, especially in a relatively flat landscape.

7.3.4. Pipelines

7.3.4.1. Negative Opinion of Pipelines

There were only two comments about "Negative Opinion of Pipelines", both from the Vancouver focus groups in the follow up questionnaire. These comments are shown in Table 135 within Appendix "S".

7.3.4.2. Questions About Pipelines

There was only one set of questions about pipelines from focus group "VB" during the focus group discussion. An unknown participant wanted clarification about the Kinder-Morgan Trans-Mountain pipeline from northern Alberta to the tanker terminal at Burnaby in the Vancouver area even though it was labelled on the map. Also, the Kinder-Morgan Trans-Mountain pipeline is actually light purple on the map – it is the tanker route to California which is the solid green line. The same unknown participant wanted clarification about whether or not the continental scale pipeline map shows all the pipelines and refineries in Canada even though the researcher had already stated this as part of the research protocol. This set of questions underlines the difficulty in presenting the complex information in the pipeline map at the continental scale so that it can be easily understood.

7.4. Google Earth Features

"Google Earth Features" refers to the elements of the software or the contents communicated by the software.[38] "Maps" refers to 2D maps displayed within Google Earth that are draped over the standard Google Earth terrain. "3D Visualisation" refers to both static landscape visualisations, which are images displayed in pop-up balloons or in standard web-browsers, as well as interactive landscape visualisations, which show 3D terrain, trees, mining machinery, and people displayed directly within Google Earth. "Navigation" involves moving around Google Earth and/or selecting different overlays. Focus group participants made a total of 186 comments and questions about their use of "Google Earth Features". These comments were grouped into three categories, as shown in Figure 115. There were almost the same number of comments and questions about "3D Visualisation" and "Maps". When combined, "Maps" and "3D Visualisation" represented over six-sevenths of comments and questions about Google Earth Features. The comments and questions about "Navigation" represented less than one-sixth of the comments and questions about Google Earth features. Using the Chi-square test, the differences between the number of comments and questions are significant (.000).

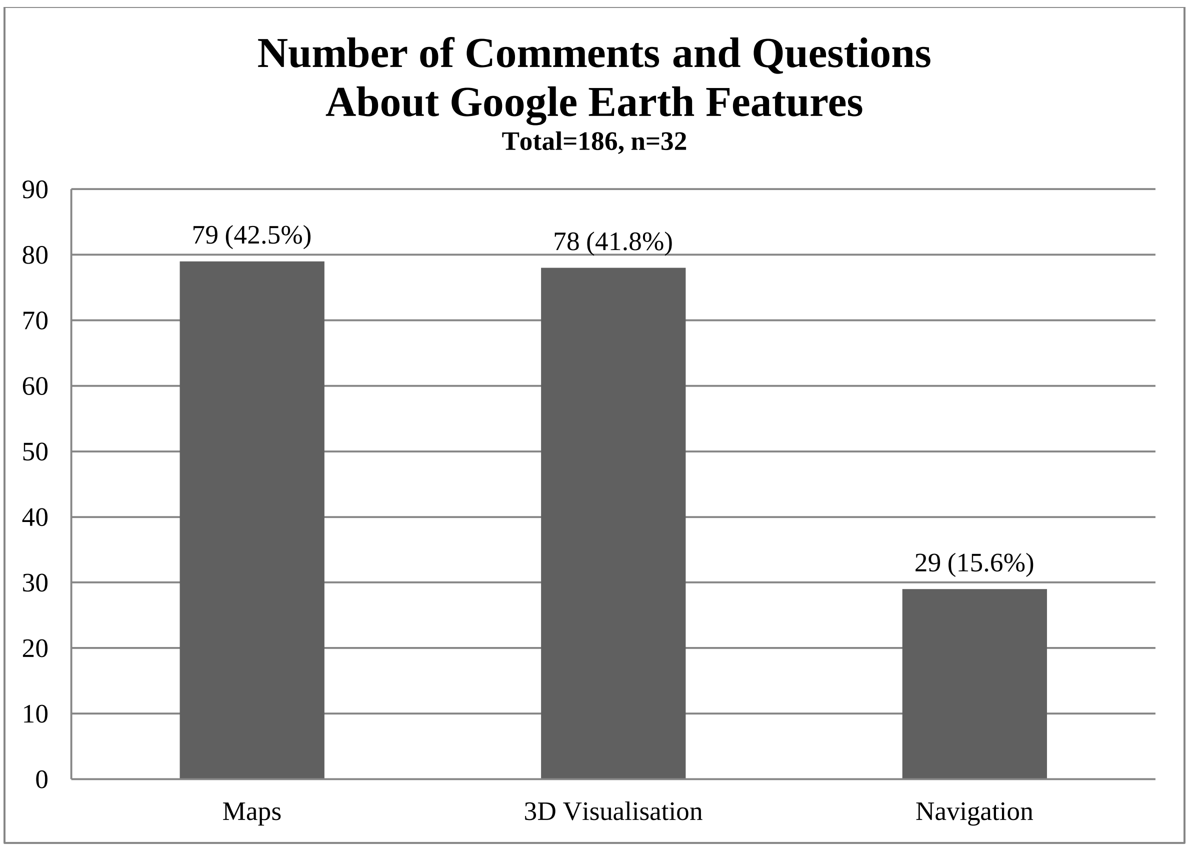


Figure 115 Comments and Questions About Google Earth Features

[38] Although landscape visualisations were generated using Visual Nature Studio software (3D Nature LLC, n.d.), these images were all presented using Google Earth software (Google Corporation, 2007).

The distribution of comments and questions about Google Earth features according to type of comment or question (i.e. “Critical Comments”, “Complimentary Comments”, and “Questions”) are shown in Table 59 and Figure 116. Over half the critical comments were about “3D Visualisation” and about one-third were about “Maps”. Less than 5% of critical comments were about “Navigation”. In contrast, over half of complimentary comments were about “Maps” and about one-third were about “3D Visualisation”. Less than one-sixth of positive comments were about “Navigation”. One-fifth of questions were about “3D Visualisation” and “Maps” each while three-fifths were about “Navigation”. Using the Chi-square test, the differences in the number of comments and questions within 3D Visualisation (.000), Maps (.000), and Navigation (.043) are all significant. Overall, this indicates that participants were most critical about 3D visualisations and were most complimentary about maps. Participants also asked the most questions about Google Earth navigation.

Table 59 Type of Comments and Questions About Google Earth Features

Type	Category	Number of Comments/Questions	Percent of Type
Critical Comments	3D Visualisation	51	58.0%
	Maps	33	37.5%
	Navigation	4	4.5%
TOTAL		***88***	***100.0%***
Complimentary Comments	3D Visualisation	22	30.1%
	Maps	41	56.1%
	Navigation	10	13.7%
TOTAL		***73***	***100.0%***
Questions	3D Visualisation	5	20.0%
	Maps	5	20.0%
	Navigation	15	60.0%
TOTAL		***25***	***100.0%***

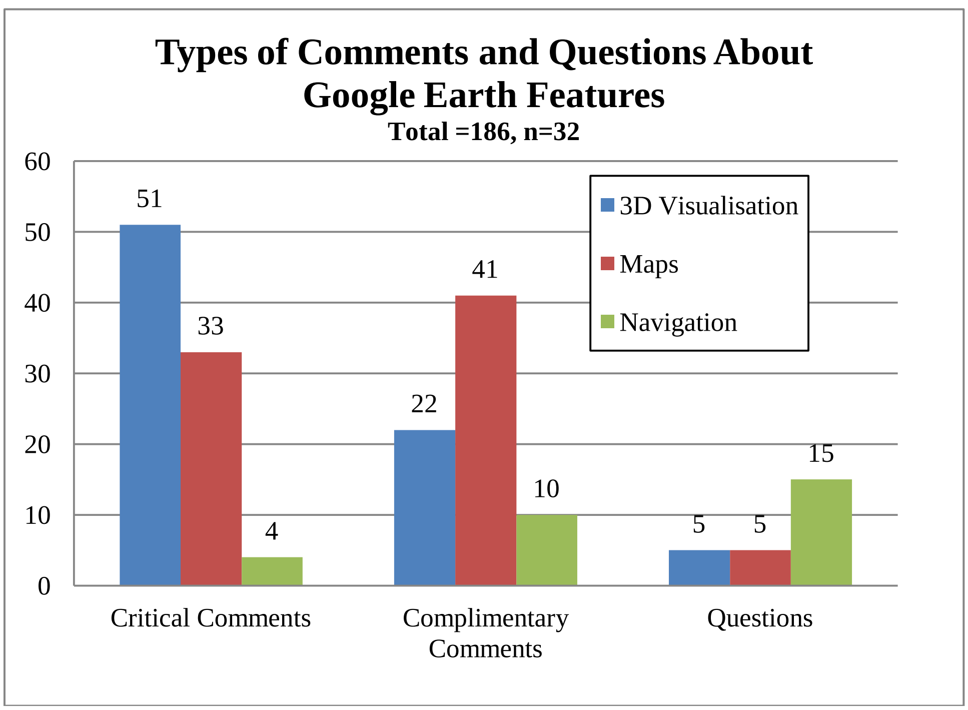


Figure 116 Types of Comments and Questions About Google Earth Features

The number of comments and questions was distributed between the focus group sessions within a range of less than 10%. All the comments or questions about Google Earth features were in the follow up questionnaire and the focus group discussions since the participants had not yet seen the Google Earth project before completing the initial questionnaire.

7.4.1. 3D Visualisation

Twenty-eight known individual focus group participants made or asked a total of seventy-eight comments and questions about “3D Visualisation”. These comments and questions were grouped into two categories “Interactive 3D Visualisation” and “Static 3D Visualisation”, as shown in Table 60. “Interactive 3D Visualization” is a simulation of two sample proposed open pit mines – Shell Pierre River and TOTAL/Sinopec Northern Lights. These two open pit mines can be viewed directly within Google Earth from any viewpoint selected by the user (e.g. planimetric, oblique, or ground views). “Static 3D Visualization” is a simulation of all fourteen existing, approved, and proposed open pit mine as oblique aerial images taken from a single viewpoint for each open pit mine. These “Static 3D Visualisations” can be viewed as medium resolution “jpg” images within geo-located pop-up balloons in Google Earth. The pop-up balloons also include hyper-links to higher-resolution “jpg” images that can be viewed within the Google Earth web-browser or with a standard web-browser.

As shown in Table 60, almost two-thirds of the comments and questions concerning “3D Visualisation” were about “Interactive 3D Visualisation” and just over one-third of the comments and questions were about “Static 3D Visualisation”. Using the Chi-square test, the difference in the number of comments and questions is significant (.024).

Table 60 3D Visualisation Comments and Questions

Category	Number of Comments/Questions	Percent of Total
Interactive 3D Visualisation	49	62.8%
Static 3D Visualisation	29	37.1%
TOTAL	78	100.0%

The number of comments and questions was distributed between focus group sessions within a range of less than fifteen percent (15%) and the difference is not significant. As shown in Table 61, there were over three times as many comments and questions in the follow up questionnaire as in the focus group discussion. This indicates that participants may have had more opportunity to comment in the follow up questionnaire than in the focus group discussions.

Table 61 Comments and Questions About 3D Visualisation by Source

Source	Number of Comments/Questions	Percent of Total
Q1 = Initial Questionnaire	0	0.0%
Q2 = Follow up Questionnaire	59	75.6%
FG = Focus Group Discussion	19	24.3%
TOTAL	78	100.0%

7.4.1.1. Interactive 3D Visualisation

Twenty-two known focus group participants made or asked a total of 49 comments and questions about interactive 3D visualisation. These comments and questions were grouped into three categories, as shown in Figure 117. There were three times as many "Critical Comments" as "Complimentary Comments". Using the Chi-square test, the differences between the number of all the comments or questions are significant (.000) and the difference between the number of critical and complimentary comments is also significant (.001).

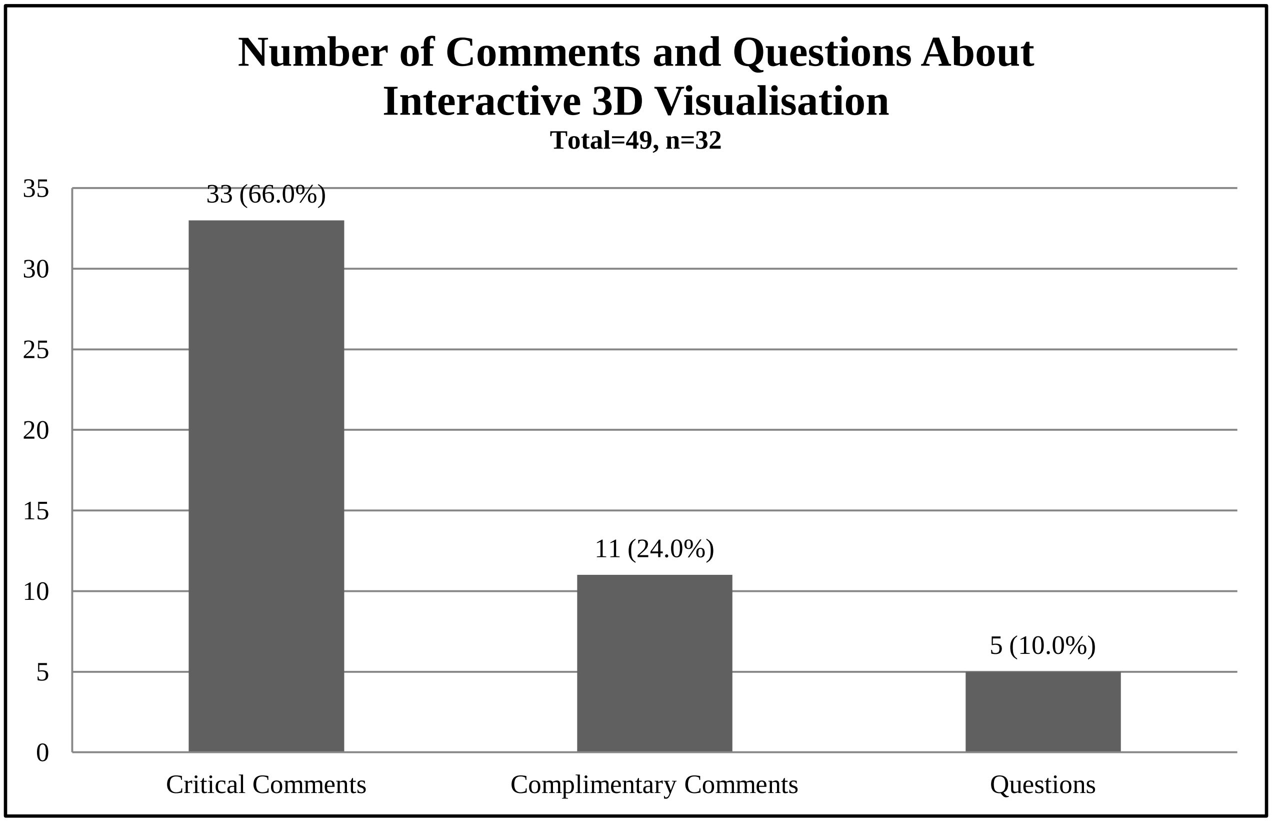


Figure 117 Interactive 3D Visualisation Comments and Questions

The distribution of comments and questions between focus group sessions was within a range of fifteen percent (15%) and the differences are not significant. There were almost one-third more comments and questions in the follow up questionnaire compared to the focus group discussion.

7.4.1.1.1. Critical Comments About Interactive 3D Visualisation

Twenty known participants made 33 “Critical Comments About Interactive 3D Visualisation”. Twice as many “Critical Comments About Interactive 3D Visualisation” were made in the follow up questionnaire compared to the focus groups discussions.

Regarding interactive 3D visualisation, focus group participants were critical of two areas:

1) Some focus participants thought that the interactive 3D visualisation was not sufficiently realistic.

2) Some participants in focus group “VA” and “VB” thought that computer graphic processing speeds were too slow.

The following noteworthy “Critical Comments About Interactive 3D Visualisation” were selected from all the comments, as shown in Table 137 within Appendix “R”.

As shown in Figure 118, participant VB06 thought ground-based viewpoint in the interactive 3D visualisation was “sad” due to the contrast between the disturbed ground in the foreground and the trees in the background, but she did not think that this image was realistic.

> *VB06*
> *What I found interesting was the texture like it looks like very soft earth there at the forefront and then in the background… it looks very barren in the front and then in the back you got all the trees so in a way it’s kind of a sad picture because you don’t see the trees anymore in the forefront…at least that’s my take on it.*
>
> *PC*
> *So you’re thinking about the comparison between the disturbed ground and the trees on the edge?*
> *VB06*
> *Yeah that’s right*
>
> *PC*
> *Do you think that the background texture that you see in this image looks realistic?*
>
> *VB6*
> *No it doesn’t, it looks almost like parts of it is paved. It doesn’t look realistic to me at all.*
>
> *PC*
> *Have you seen real pictures of these open pits?*
>
> *VB06*
> *No I haven’t.*

Figure 118 Mining Equipment in Proposed Shell Pierre River Open Pit Mine

During the focus group discussion, participant VB06 replied that she had not seen any photographs of the open pits. However, in the initial questionnaire she stated that she had actually seen “Some” photographs of the “open pit tar sands project” but it is not known from what viewpoint.

Soon thereafter in the focus group discussion, another unknown participant suggested using photographs instead of a simulated 3D visualisations, which provoked giggles from participant VB06 and possibly other participants as well.

> *PC*
> *Why didn’t we just use photographs of the proposed?*
>
> *VB Unknown*
> *Thinking of looking to get realistic, the question is what the pits look like.*
>
> *PC*
> *The point is we’re trying to show you pits that don’t exist yet.*
>
> *VB Unknown*
> *But there are pits that do exist and they’re going to look like pits that will exist. They’re not going to be nice and clean like the pits that you display here, they’re going to be like the dirty old pits that everyone’s showing you.*
> *FEMALE GIGGLES IN BACKGROUND*
>
> *PC*
> *Sure there’s all sorts of photographs of the ones that are there.*

VB Unknown
This lady didn't like the look of the pits the way they are now. If you show the pits the way they really were, she'll like them even less.

LOTS OF GIGGLES IN BACKGROUND

Although the researcher pointed out that the open pit mines shown in the interactive 3D visualisation did not yet exist, the unknown participant remained in favour of using photographs to show the open pit mines instead of the interactive 3D visualisations. While participant VB06 stated in the focus group discussion that she did not find the interactive 3D visualisations realistic, in response to the question in the follow up questionnaire "Which maps do you find most compelling or informative" participant VB06 later replied "The people and the machinery. The pits looked very large."

Participant E01 arrived late to the focus group and did not complete the questionnaires. He thought that the interactive 3D visualisations were extremely unrealistic and instead should be shown with a video on "YouTube".

E01
When I look at this, A simple 3D program or video is sooooo much more accurate to give you an idea of what this would look like than this.

PC
A simple 3D…?

E01
I think the graphics are still extremely flat and rudimentary…a video would give you a much better idea of what this looks like.

PC
OK, now you're talking about existing?

E01
Yeah. You can put this kind of stuff on YouTube. It looks so fake that it…

PC
OK, but you can't interact with a TV program

E01
That's true.

Participant E01 brushed off the researcher's statement that videos could only be provided for existing open pit mines. However, participant E01 did acknowledge that the viewer could not interact with a video in the same way as interacting with a 3D visualisation.

Participant E04 wanted to see photographs of the mining machinery and infrastructure that would be associated with each future open pit mine, including an estimate of how many pieces of heavy equipment would be present.

E04
Yeah! I don't know if you could just put a photo of the CAT and then say 40 of those are going to be on site at this location. This CNRL Horizon that's existing how have on site on average.

PC
So you want more information?

E04
The infrastructure that's going to be required, the roads that are going to go in there, the people that are going to go in there. The amount of roads, yeah.

Participant E05 also suggested providing some sample photographs of open pit mines to provide users a better idea of what the open pit mines actually look like.

PC
OK, any other comments about whether this 3D approach is at all helpful.

E05
I think it would be better if you provided some real photos….

PC
Of existing projects? You understand that of what you see there I can't provide you a photo.

E05
I mean not everywhere, but sometimes to give you an idea…INDISTINCT

Participant E05 seemed to understand that it was only possible to provide photographs of ***existing*** projects. Participant E05 further stressed that she simply wanted to see some photographs to give her a better idea of what the open pit mines actually look like.

Seven participants in focus groups "VA" and "VB" were critical of computer graphics processing speed. Following these focus groups, it was discovered that the computers in the lab at UBC Robson Square did not have dedicated graphics processing cards. In contrast, there were no comments about computer graphics processing speed in focus group "E" as the computers in the University of Alberta Technology Training Centre lab had state-of-the-art graphics processing cards (See Chapter 4 "Social Research Methods" for more detail about the differences between the computer laboratories.)

In response to the question "If you wish, please provide any additional comments about the Google Earth tool's ***weaknesses*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features." in the follow up questionnaire the following participants stated:

VA03, Q2: The 3D graphics of mining pits were too slow.

VA09, Q2: 3D rendering was too slow to be usable.

VA10, Q2: 3D was frustrating-->too slow to load and too much seizing up!

VB11, Q2: Difficulty with slow processing speed. Lack of detail on the tar sands make it difficult to zoom.

VB12, Q2: People, mining machinery, trees: mine wouldn't load, could not view properly. Couldn't get all images to load. Need side by side comparison of existing/future views. Fairly accurate, yet some people may be cynical/doubtful of accuracy.

In response to the question “Which **3D computer simulations** shown in the “balloons” in the Google Earth tool did you find most compelling or informative?” in the follow up questionnaire, participant VA10 stated:

> *VA10, Q2: My computer froze too often to engage with the 3D portion.*

Since participant VA10 was able to select 14 screenshots of the ***static*** 3D visualisations as recorded on her computer, participant VA10 was probably thinking of the ***interactive*** 3D visualisation rather than the ***static*** 3D visualisations in response to this question.

The researcher noted the difficulty loading the interactive 3D visualisation in focus group “VA”. Overall, there was more difficulty and delay in loading the interactive 3D visualisation in focus group “VA”, held August 14, 2012 compared to focus “VB”, which was held on August 13, 2012 ***prior to*** focus group “VA”. Four out of seven of the critical comments about graphics processing speed were from focus group “VA” and the frustration that was heard in the background was also in focus group “VA”. To ensure that each computer had to re-load all the Google Earth data from the internet, the researcher cleared the Google Earth cache on all computers prior to starting focus group “VA” on August 14, 2012. [39] Nevertheless, the computers may have accumulated other “cache” data during focus group “VB” the previous day on August 13, 2012, which caused them to run more slowly the following day.

All the “Critical comments about interactive 3D visualisation” are shown in Table 137 in Appendix “S”. Overall, the key points mentioned were the lack of realism. In the Vancouver focus groups, the difficulty of loading the graphics was also mentioned.

7.4.1.2.2. Complimentary Comments About Interactive 3D Visualisation

Seven known participants made eleven “Complimentary comments about interactive 3D visualisation”. Seven of these comments were in focus group “VB”. Using the Chi-square test, the differences between the number of comments are almost significant (0.078). It is not known why there were more “Complimentary comments about interactive 3D visualisation” in focus group “VB”.

The following noteworthy “Complimentary Comments About Interactive 3D Visualisation” were selected, as shown in Table 138 within Appendix “S”.

In response to a question about what kind of forest surrounds the open pit mines, when the researcher zoomed into the trees surrounding the proposed Pierre River open pit mine, there was an emotional expression of “OOOOH!” in the background of the audio recording from several focus group participants. This was “Key Moment #3” with lots of chatter among participants.

Soon thereafter, participant VB11 commented about how the interactive 3D visualization profoundly illustrated the contrast between the scale of the mining machinery at ground level compared to the scale of the open pit mines in an aerial view, which prompted “Key Moment #4”.

[39] The following commands were used in Google Earth to clear the cache: “Tools→Options→Clear memory cache and Clear disk cache”

VB11
Just a comment, just having seen pictures of the tar sands it always struck me how enormous the vehicles are. I feel like the scale and how huge the wheels are and that kind of thing. Whereas if you look into the pit, the vehicles look so tiny (VB11 GASPS!) and so insignificant…to keep in my head the photograph and like the…

PC
Which angle are you looking at it? Do you think at this point of view the vehicles look tiny and toy like? I just selected one point of view, of course you can navigate wherever you like.

VB11
Hmmmm. Hmmm.

PC
And the people were put there for the sense of scale. Do they still look tiny and toy like?

VB11
Yeah, because we've been spending so much time above, like, looking at it from such an unnatural scale that zooming in it's sort of hard for me to reconcile how big these machines look to me seriously you know what I mean?

Participant VB11 further noted the cognitive challenge of simultaneously understanding the scale of the mining machinery and the scale of the entire open pit mines. The researcher then zoomed in and out of the mining machinery and the open pit mines to see if this improved understanding of the relative scales. Participant VB11 replied that she thought it would improve her understanding if the zooming in and out was slower.

Overall, the following quote illustrates a noteworthy participant reaction to viewing the interactive 3D visualisations:

E09, Q2: Little information makes someone naive about the topic "What you don't know won't hurt you!" But with this information and visual effects make it easier to understand the magnitude of the project.

7.4.1.1.3. Questions About Interactive 3D Visualisation

Up to five individual participants asked "Questions about interactive 3D visualisation." Four out of five of the questions about interactive 3D visualisation were in focus group "VA" while one was in focus group "VB". All the questions about interactive 3D visualisation were in the focus group discussions. The questions about interactive 3D visualization are shown in Table 139 within Appendix "S".

7.4.1.2. *Static 3D Visualisations*

Eighteen focus group participants made a total of 29 comments about “Static 3D Visualisation”. As shown in Table 62, there were almost twice as many “Critical Comments” as there were “Complimentary Comments”.

Table 62 Interactive 3D Visualisation Comments and Questions

Category	**Number of Comments/Questions**	**Percent of Total**
Critical Comments	18	62.1%
Complimentary Comments	11	37.9%
TOTAL	29	100.0%

The comments were distributed between the focus group sessions within a range of less than 20%. All comments were in the follow up questionnaire.

7.4.1.2.1. Critical Comments About Static 3D Visualisations

Twelve known participants made eighteen “Critical comments about static 3D visualisations”. The “Critical Comments About Static 3D Visualisations” are shown in Table 140 within Appendix “S”. Overall, participants stated that they wanted more realistic images or that they wanted the images to be interactive.

7.4.1.2.3. Complimentary Comments About Static 3D Visualisations

Ten individual participants made eleven “Complimentary comments about static 3D visualisations. There were five comments in focus group “E”, four comments in focus group “VB” and two comments in focus group “VA”. These differences are not significant. The “Complimentary Comments About Static 3D Visualisations” are shown in Table 141 within Appendix “S”. Overall, participants stated that the static 3D visualisations helped illustrate the size and depth of the open pit mines.

7.4.2. Maps

Thirty individual focus group participants made or asked a total of 79 comments and questions about the 2D maps that were overlaid on top of the raw Google Earth satellite imagery. These comments and questions were grouped into three categories, as shown in Figure 119. Over half the comments or questions were "Complimentary Comments" and over two-fifths were "Critical Comments." There were only five "Questions". Using the Chi-square test, the difference between the complimentary or critical comments is not significant.

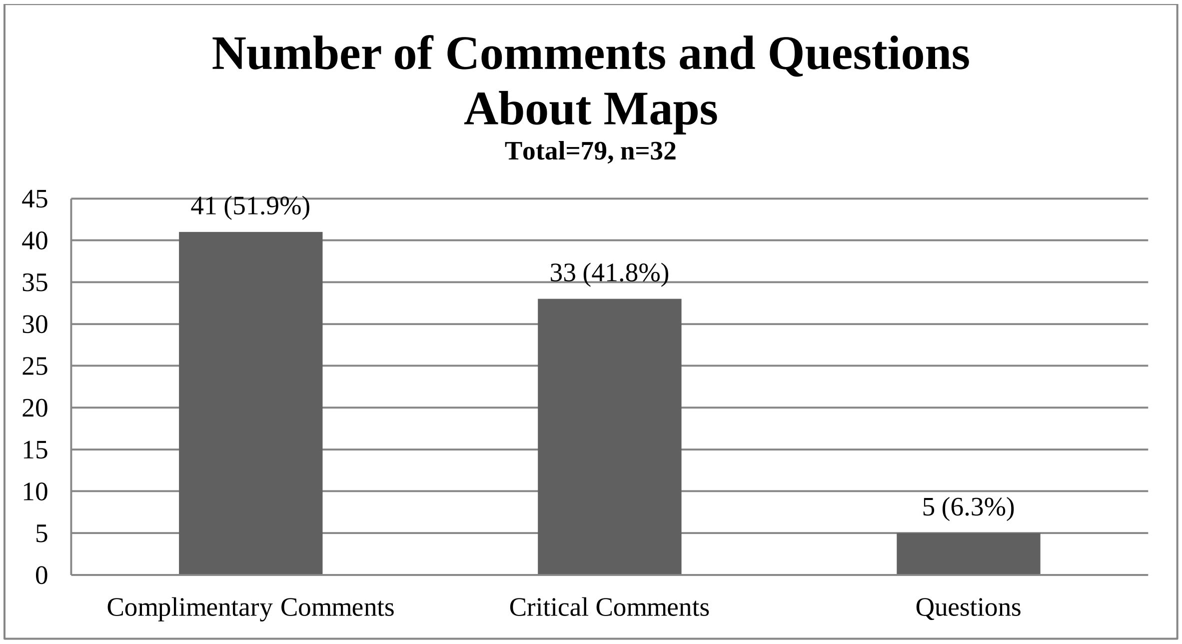


Figure 119 Comments and Questions About Maps

There were nine comments in the focus group discussions and 70 comments in the follow up questionnaire where participants may have had more opportunity to comment in the follow up questionnaire than in the focus group discussions.

7.4.2.1. Complimentary Comments About Maps

Twenty-seven individual participants made 41 "Complimentary comments about maps." Over half (15 out of 27) of the participants who provided "Complimentary comments about maps" thought the maps were "Mostly believable" or "Highly believable". The comments were distributed among focus groups within a range of less than 15%.

The following noteworthy "Complimentary Comments About Maps" were selected from the comments shown in Table 142 within Appendix "S". These comments illustrate the importance of the following points:

1) Comparison to cities;
2) Shock or surprise at the geographic area or size of tar sands open pit mines;
3) Understanding of cumulative development of tar sands open pit mines;
4) Revelations about the secrecy of government and industry;

5) Proximity of tar sands open pit mines to Athabasca River;
6) Usefulness of labelling;
7) Comparison of scenarios;
8) Access to a variety of information; and
9) Ability to zoom across scales.

7.4.2.1.1. Comparison to cities

Just over half (21 out of 41) of the "Complimentary Comments About Maps" mentioned that the comparison to the cities was helpful in demonstrating the size of the open pit mines. In the follow up questionnaire, cities were also selected most frequently out of the nine options in response to the multiple-choice question "What images or features were most helpful in expressing the ***scale*** of the open pit tar sands projects?". For example participant E02 stated:

> *EO2, FG: The real strength of what you've done here is to make the comparisons. I mean putting the city image on any map or any figure or anything by itself so that you can compare it to. And you've done a nice job of making something we can understand that we can compare it to…*

Participant V09 also stated:

> *V09, Q2: I had no idea the projects were so large. Without the comparisons to urban cities, the pits seemed like little campgrounds out in the forest. Compared to Vancouver, though, I was shocked at the scale, especially of future projects.*

7.4.2.1.2. Shock or surprise at the geographic area or size of tar sands open pit mines

There were six comments that indicated shock or surprise at the geographic area or size of tar sands open pit mines. "Key Moment #5" occurred when the researcher first showed the comparison of the ***existing*** open pit mines to Vancouver and a female participant was heard squealing on the audio recording. This indicates shock and surprise at suddenly become aware of the size of the open pit mines.

For example, participant E09 also stated that she was surprised by the geographic area or size of the open pit mines:

> *E09, FG: I didn't realize how big it was in comparison to the cities and the location close to the river. I didn't know that before. It gave me a good visual awareness… I knew it was bigger than Fort McMurray but I had no idea of the total land mass in comparison to Fort McMurray.*

7.4.2.1.3. Understanding of cumulative development of tar sands open pit mines

Participants made ten comments related to the improved understanding of the cumulative development of the tar sands open pit mines. In response to the question "If you wish, please provide any additional comments about the Google Earth tool's ***strengths*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features:" in the follow up questionnaire, participant E05 noted that it was helpful how the maps showed the cumulative development of all the individual open pit mines shown only in the government maps.

E05, Q2: The combination of maps is really helpful in realizing which're actually covered in the maps of development from the government.

Nevertheless, participant E05 only thought that the maps were "Intermediate" in response to the question "How ***believable*** did you find the ***maps*** shown in the Google Earth tool?" in the follow up questionnaire.

Participant VA08 made a passionate comment related to learning about the cumulative development of the tar sands open pit mines:

VA08, Q2: Better informed about scope of projects, size, closeness to rivers. I now believe that this is already out of control, a complete disaster area.

In addition, participant E06 also stated:

E06,Q2: Map summarizing all projects because the information has never been presented together.

7.4.2.1.4. Revelations about the secrecy of government and industry

There were three comments where participants stated their concerns about the secrecy of government and industry concerning the cumulative development of the tar sands open pit mines. In response to the question "If you wish, please provide any additional comments on the tar sands, the Google Earth tool, or the overall research session:" in the follow up questionnaire participant E06 pointed out how the maps showing cumulative development unveil the secrecy of government and industry.

E06, Q2: In order to have a productive discussion about development, the facts/maps presented are necessary. The maps shed light on a black box that industry and government don't explain.

Participant E06 may have been influenced by comments made by the researcher explaining that industry and government maps do not show the cumulative development of the open pit tar sands, as discussed in more detail in the following Section 7.2.2.3. Nevertheless, participant E06 thought that the maps were "Highly unbelievable" in response to the question "How ***believable*** did you find the ***maps*** shown in the Google Earth tool?" in the follow up questionnaire. However, this participant E06 may have misinterpreted the question since this participant made other complimentary comments about the maps including comments #7 and #8, as shown in Table 142 within Appendix "S".

In response to the question "Please explain why:" related to "Has your opinion about open pit tar sands projects changed as a result of this focus group?" in the follow up questionnaire, participant VB04 expressed emotional reactions of disappointment and fear of government due to new knowledge that she gained from viewing the maps.

VB04, Q2: I did not know what was happening re: open pit tar sands. I am disappointed that it is not common knowledge and I fear secrecy by our government because it is on crown land and they may not feel they have to be totally and easily accessible re: tar sands activities (development).

Participant VB04 thought that the maps were "Highly believable" in response to the question "How ***believable*** did you find the ***maps*** shown in the Google Earth tool?" in the follow up questionnaire.

Finally, participant VB11 stated:

> *VB11, Q2: Very interesting to see everything together as the gov't maps create distance and no emotion or any awareness of the implications of the projects.*

7.4.2.1.5. Proximity of tar sands open pit mines to Athabasca River

Two participants made comments about how the maps showed the proximity of the tar sands open pit mines to the Athabasca River. Participant E09 stated:

> *E09, FG: I didn't realize how big it was in comparison to the cities and the location close to the river. I didn't know that before. It gave me a good visual awareness.*

Participant VA08 also stated:

> *VA08 Better informed about scope of projects, size, closeness to rivers.*

7.4.2.1.6. Usefulness of labelling

One participant mentioned the usefulness of labels on the tar sands open pit mines:

> *E06, Q2: Easy to use. Effective to see features written on map (ie. labelling mine sites on map of Alberta).*

7.4.2.1.7. Comparison of scenarios

There were six comments where participants mentioned the comparison of scenarios showing existing, approved, and planned tar sands open pit mines or pipelines. Three of these comments mentioned the pipelines.

For example, participant VA07 stated:

> *VA07, Q2: Superimposing the major cities over the existing and proposed open pit mines provided an idea of the overall impact of this project and usefulness of these maps.*

Related to the pipelines at a continental scale, participant VB04 stated:

> *VB04, Q2: I found the "borders" ie Alberta (Canada provinces etc.) very helpful in conceptualizing areas affected by open pit tar sands. I kind of already understood present pipelines in Canada but proposed USA and Canada refineries and pipelines and gas and oil development made me see with respect to my lifetime.*

7.4.2.1.8. Access to a variety of information

One participant made one comment related to this point:

> *VA08, Q2: I liked having access to a variety of info and visuals to compare and explore.*

7.4.2.1.9. Ability to zoom across scales

One participant made two comments related to this point:

VB08, Q2: Maps that start as a country on the globe and can take you down to a street or a building.

VB08, Q2: Google Earth is amazing for the detail that you can get down to.

7.4.2.2. Critical Comments About Maps

Twenty-four participants made 33 "Critical comments about maps". The comments were almost evenly distributed among focus groups within a range of less than 10%. Most comments were in the follow up questionnaire. Using the Chi-square test, this difference is significant (.000). This may indicate that participants had more time to comment in the questionnaires or felt more comfortable making critical comments in private.

The following noteworthy "Critical Comments About Maps" were selected from all the 33 comments, as shown in Table 143 within Appendix "S".

7.4.2.2.1. Lack of context to maps

Only one participant became very emotional during the focus group discussion because he felt that the maps did not provide sufficient context. Participant E07 also seemed to be frustrated that the focus group was not leading towards political activism about the tar sands.

E07
I'm just saying that's all that I'm being shown. Smaller or bigger.

PC
OK, but you've never been shown that before.

E07
No, I knew it was coming. You don't have to show me to know that they're leasing more oil sands that more people are building these kind of sites. I don't need to necessarily see it to understand it.

Later on, participant E07 interrupted another discussion with other participants.

PC
You want to do anything about it?

E07 VERY EMOTIONAL
I would like to see the reclamation and why they're not cleaning it up as they're going. Why they're tearing up the entire face of the moon and then placing the sticks back when they've got all the money out it. Which strikes me as insane. That's like saying we'll keep creating Sahara desert until we just take all Africa out. But you can disregard all that…like all we're seeing are these maps. Like maps by themselves like whether something is close to a river or not, that river's probably dead anyway it looks like they probably poured the stuff into the tailings ponds and oozed into the river…whereas I see a map…I want more context. This by itself is a waste of time!

Nonetheless, in response to the question "Please explain why:" related to "Has your opinion about open pit tar sands projects changed as a result of this focus group? in the follow up questionnaire, participant E07 was ambivalent about engaging in any political activism himself.

E07,Q2: Maybe I should do something – although I see no chance of making a difference. Look who is stacked up against any real change – government, industry, workers, unions, the USA, China…!!

Furthermore, in contrast to the comments that he made during the focus group discussion, participant E07 also stated that he gained "Much New Knowledge" in response to the question "How much ***new*** knowledge did you gain about the ***size or geographic area*** of ***open pit*** tar sands projects near Fort McMurray, Alberta?" in the follow up questionnaire.

7.4.2.2.2. View maps side by side instead of sequentially

Participant E11 stated that he wanted to see the changes between the existing, approved, and proposed all in one map.

> *E11*
> *I think it would be very useful if you showed the proposed, approved, and existing and if it is possible to get the differences between them. So then you have the proposed and then you have the have a separate map showing how much that is more than the existing. Rather than showing the two of them so that we can at least subtract.*
>
> *PC*
> *You'd like to see a calculated area?*
>
> *E11*
> *That would be nice too, but I don't know if you're able to do it to subtract one map from another.*
>
> *E Unknown*
> *It's not very helpful because when you when you click on one and then the other proposed, it's very hard to remember one from the other.*

These comments refer to the capacity of a viewer's "working memory" (Salter, 2005) while alternating between sequences of existing, approved, and proposed open pit mines using the "radio" buttons. In response to the comments from participant E11, the researcher also showed how the three maps could actually be displayed top to bottom in a "pop-up" balloon or in a web-browser, as shown in Figure 120, which an unknown participant said was an improvement.

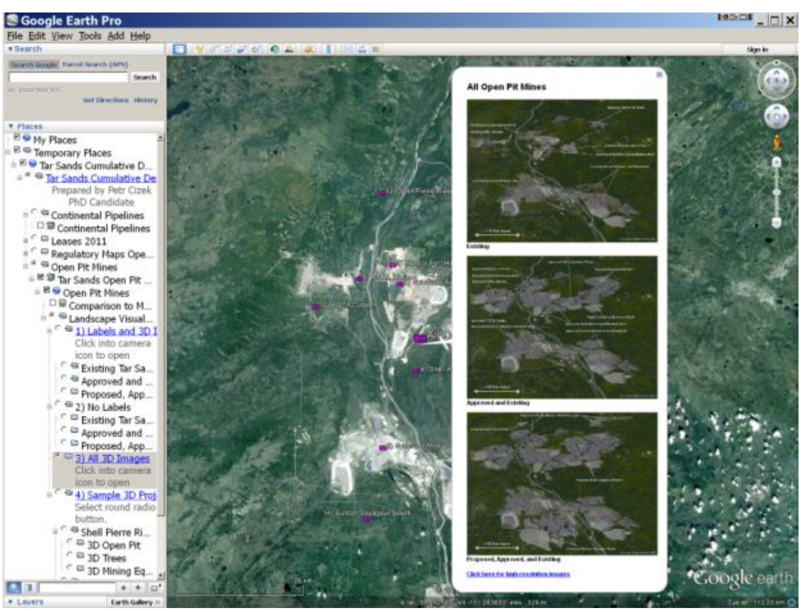


Figure 120 Side by Side Image of Existing, Approved, and Planned Tar Sands Open Pit Mines

7.4.2.2.3. Show scenarios all in one map

Four participants made similar requests in the follow up questionnaire to show the changes between existing, approved, and proposed all in one map. For example, participant VB11 stated:

> *VB11, Q2: To be able to see the tar sands individually outlined (as opposed to in satellite image on block-filled in) as navigating may have been easier.*

This would require using a symbolic vector maps rather than the raster maps that simulated real colours and textures.[40]

7.4.2.2.4. Time scale of proposed tar sands open pit mine construction

Only one participant requested a time scale of proposed tar sands

> E03, Q2: It would be nice if there was a time scale in which I could identify the length of time in which the proposed projects might begin construction.

The Google Earth time-slider tool (Google Corporation, n.d.-b) could be used to create a more detailed temporal sequence of construction.

7.4.2.2.5. Relationship to global warming and contextual comparison

Two participants wanted to see a greater relationship to global warming and a contextual comparison:

> *E12, Q2: The physical maps are only a small part of the larger issue of the relationships to global warming and degradation of environment and use of scarce resources as well as possible/likely pollution through tanker and pipeline spills.*

> *VA04, Q2: Perhaps some cross-reference academic kind of like wikipedia; compare Venezuela heavy oil fields etc. environmental health controversies.*

7.4.2.2.6. More detail, realism, videos, and photographs

Nine participants made ten comments wanting to see more detail, realism, videos, or photographs. For example, participant VB02 stated:

> *VB02, Q2: Video overlays of 3D areas would be good. For existing sites to see a video of the area will be helpful. Maps of proposed areas lack detail. Just looks like grey blobs. Boring!*

7.4.2.2.7. More labels

Three participants wanted to see more labels on the maps.

---

[40] An example of a symbolic vector map showing the changes between existing, approved, and proposed open pit mines is available at http://oilsandstruth.org/mineable-oil-sands-existing-approved-and-proposed-projects.

7.4.2.3. *Questions About Maps*

Up to five individual participants asked five "Questions about maps." The differences between the focus group sessions are not significant. All the "Questions About Maps" were in the focus group discussions.

The following noteworthy "Questions About Maps" were selected from all the questions, as shown in Table 144 within Appendix "S".

In response to a question from an unknown participant in focus group "VA" about the accuracy of the government regulatory maps, the researcher used the "Adjust opacity" slider bar in Google Earth to fade out a government regulatory map to show how it had been accurately geo-referenced against the standard Google Earth satellite imagery. This feature generated some interest in the focus group indicated by the increased background chatter heard in the audio recording. The focus group participants then wanted to try out this feature.

> *VA Unknown*
> *Are the maps to scale to the satellite map?*
>
> *PC*
> *The maps as you can see have a grid. I used that grid to put them in the accurate position. There's an additional feature that you can use to check the accuracy of the map about how well they're placed. If you click down here in your places bar you can see this slider bar that says "Adjust opacity" that allows you to make the map transparent.*
>
> *LOTS OF CHATTER FOR TRANSPARENCY FEATURE*

This "Adjust opacity" feature was so interesting that an unknown participant in focus group "VA" started using the feature on the existing, approved, and proposed overlays of the open pit mines to compare it with the standard Google Earth satellite imagery.

> *PC*
> *Oh look at that, you're using the slider on that as well. I hope that you share that with the group. I just found something very interesting. She's using the slider on this. I just thought that you could use it on the regulatory maps but you can also show how proposed compares to the existing underneath on the raw Google Earth imagery. Click into here the slider make sure the "Proposed" is selected and then it will fade this out just like it fades the "Regulatory" maps. Put the slider back in the overlay otherwise you won't see what you were looking at before.*

The "Adjust opacity" feature allowed participants both to also confirm the accuracy of the existing, approved, and proposed overlays and also to examine the landscape change between the raw Google Earth imagery showing approximate existing conditions at very high (i.e. ≤ 1 metre) resolution. [41]

[41] The raw Google Earth satellite imagery shows only "approximate" existing conditions because the dates of the Digital Globe 1m resolution imagery within the open pit mining area range from 2006 to 2010.

7.4.3. <u>Navigation</u>

Navigation involves moving around Google Earth and/or selecting different overlays. Up to twenty-five individual participants made or asked a total of twenty-nine comments and questions about navigation. These comments and questions were grouped into three categories, as shown in Figure 121. Over half the comments or questions were "Questions" and just over one-third were "Complimentary Comments". Less than one-sixth were "Critical Comments." Using the Chi-square test the differences between the number of all the comments and questions is significant (.043) but the difference between the number of complimentary and critical comments is not significant. Participants seemed to have many more questions about navigation (relative to comments) than they did about maps or visualizations.

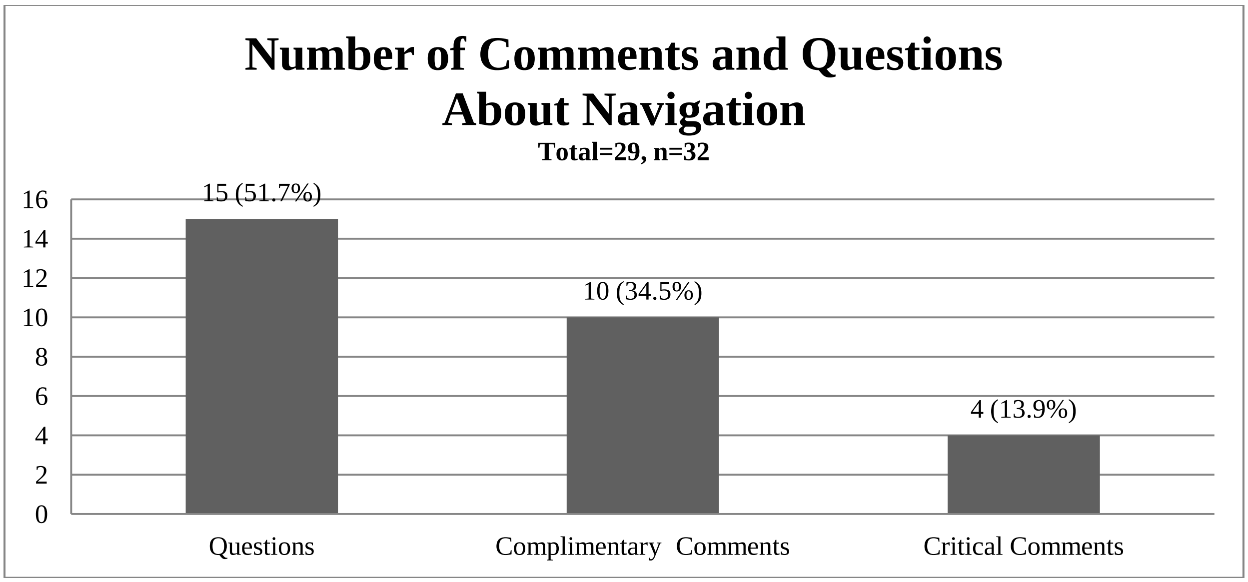


Figure 121 Comments and Questions About Navigation

There were eighteen comments and questions about navigation in focus group "VB", three in focus group "VA", and eight in focus group "E". Using the Chi-square test, the differences between the comments are significant (.002). Participants in focus group "VB" had more average experience using computers than focus groups "VA" and "E" and also had more average experience using mapping programs than focus group "VA" and only slightly less than focus group "E". The computers in focus group "VB" and "VA" were also the same. Therefore, it is not known why there were significantly more comments and questions about navigation in focus group "VB". There was a similar number of comments about navigation in the follow up questionnaire and in the focus group discussion.

7.4.3.1. Questions About Navigation

Up to fifteen individual participants asked questions about navigation. The following noteworthy "Questions About Navigation" were selected from all the questions, as shown in Table 145 within Appendix "S".

"Key Moment #1" occurred in focus group "VB" following the researcher's demonstration of overlaying the city outlines on the existing open pit mines, there was a great deal of group discussion about navigation.

In at least one instance, the open pit mine overlay did not load on a participant's screen. The image had to be refreshed by selecting the upper-level "Tar Sands Cumulative Development Network Link" folder and pressing "Revert" to re-load the whole project from the internet server.

The researcher also noticed that three participants were looking at images that were not part of the tar sands study area. An unknown participant in focus group "VA" was looking at Africa. An unknown participant in focus group "E" was also looking at something else. Demonstrating the cliché that Google Earth users "want to go home", the researcher noticed that participant E09 was in "Streetview" looking at a suburban house. Based on a review of this participant's screen video recording, participant E09 had initially selected the Edmonton "Tar Sands Overlay" and then clicked into "Actual Location", which automatically moved the Edmonton outline over the Edmonton satellite image, as shown in Figure 122.

Figure 122 Edmonton Outline Overlaid on Actual Location

Then participant E09 manually zoomed into the Edmonton satellite image to find her neighbourhood, as shown in Figure 123.

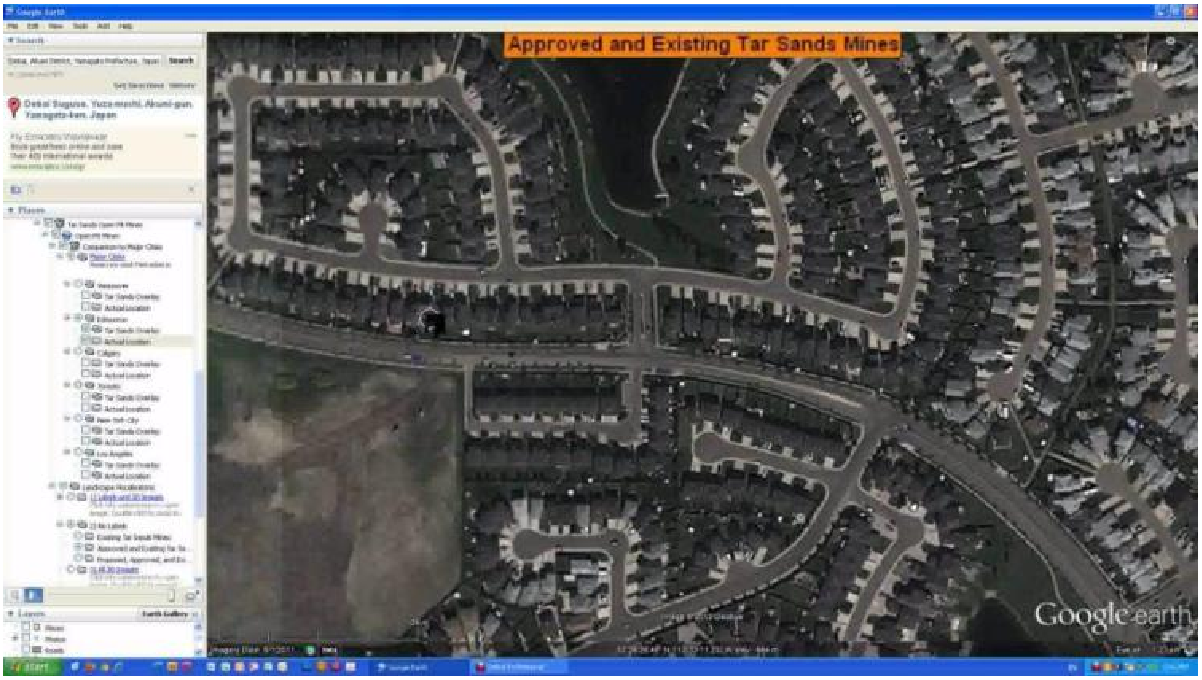


Figure 123 Manual Zoom into Participant's Neighbourhood in Edmonton

Finally, participant E09 went into "Streetview" to look at her house, as shown in Figure 124.

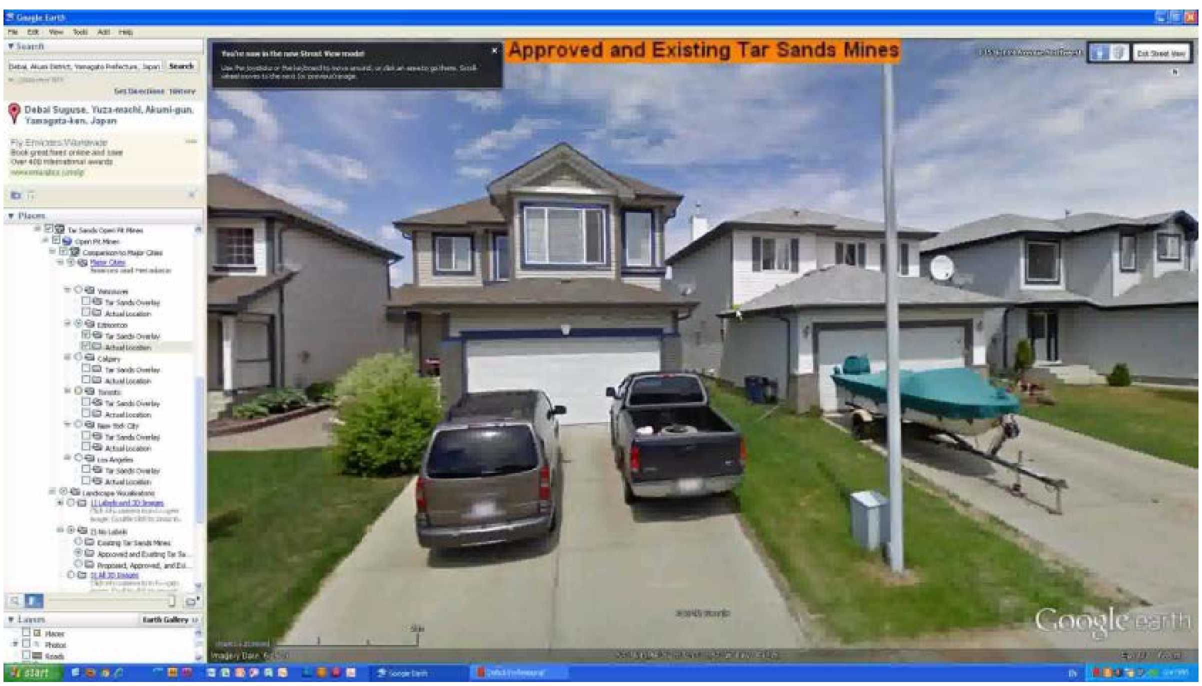


Figure 124 Participant's House in Streetview in Edmonton

These three examples illustrate how participants were attracted to Google Earth's navigation potential, ability to zoom between scales, and explore various themes. The third example where participant E09 zoomed to her suburban house illustrated how the use of Google Earth demonstrates place-attachment.

All the above participants who viewed locations that were not part of the tar sands study area were able to return to the open pit mining area without any assistance by double-clicking into any of the "Open Pit Mine" folders in the "Places" menu. These navigation skills indicate that these participants had earlier experience with Google Earth or other computer mapping programs prior to attending the focus group. For example, in response to the question "What level of experience do you have in ***using Google Earth or other computer mapping programs*** in your work or leisure time?" in the initial questionnaire participant E09 stated that she had "Some Experience".

7.4.3.2. Complimentary Comments About Navigation

Up to ten individual participants made ten "Complimentary comments about navigation". The following noteworthy "Complimentary Comments About Navigation" were selected from all the comments, as shown in
Table 146 within Appendix "S".

In response to the question "If you wish, please provide any additional comments on the tar sands, the Google Earth tool, or the overall research session:" in the follow up questionnaire, participant E11 stated:

> *E11, Q2: The Google Earth applications are quite helpful in understanding the scale of these very large projects.*

In response to the question "If you wish, please provide any additional comments about the Google Earth tool's ***strengths*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features:" in the follow up questionnaire, participant VB02 stated:

> *VB02, Q2: Gives good sense of scale. Allows you to walk however you like. Lets you explore.*

As both participants checked the "Zoom Tool" in response to the question "What images or features were most helpful in expressing the ***scale*** of the open pit tar sands projects? Please check all that apply." in the follow up questionnaire, this navigation feature was likely the most helpful in understanding the geographic area of the open pit mines since the open pit mines could be viewed interactively at multiple scales.

Overall, two participants mentioned how Google Earth navigation gave them an appreciation of geographic area or scale. Six participants mentioned the ease of use of Google Earth. One participant though that zooming in Google Earth and the use of overlays was "cool".

7.4.3.3. Critical Comments About Navigation

Three participants made four "Critical comments about navigation".

A key point was made by participant VB04 who stated:

> *VB04, Q2: I don't think it can be understood by general population (many may not use computers). It is probably necessary to be taught how to use program (difficult to be self-taught for most people, I believe).*

In response to the question “What level of experience do you have in ***using Google Earth or other computer mapping programs*** in your work or leisure time?” in the initial questionnaire, participant VB04 stated that She had “Little Experience”. The two other participants who made “Critical comments about navigation” also both stated that they had “No Experience”. This indicates that some participants who had little experience with computer mapping programs had trouble navigating in Google Earth.

7.5. Research Process

Twenty-seven individual participants made or asked a total of 64 comments and questions about the research process. These comments and questions were grouped into five categories, as shown in Figure 125. Over one-third of the comments were "Neutral", less than one quarter were "Complimentary", and just over one-fifth were "Critical". "Questions" about the research process were less than one-seventh of the total and "Computer Malfunctions" were less than one-tenth of the total. Using the Chi-square test, the differences between the number of comments and questions are significant (.012).

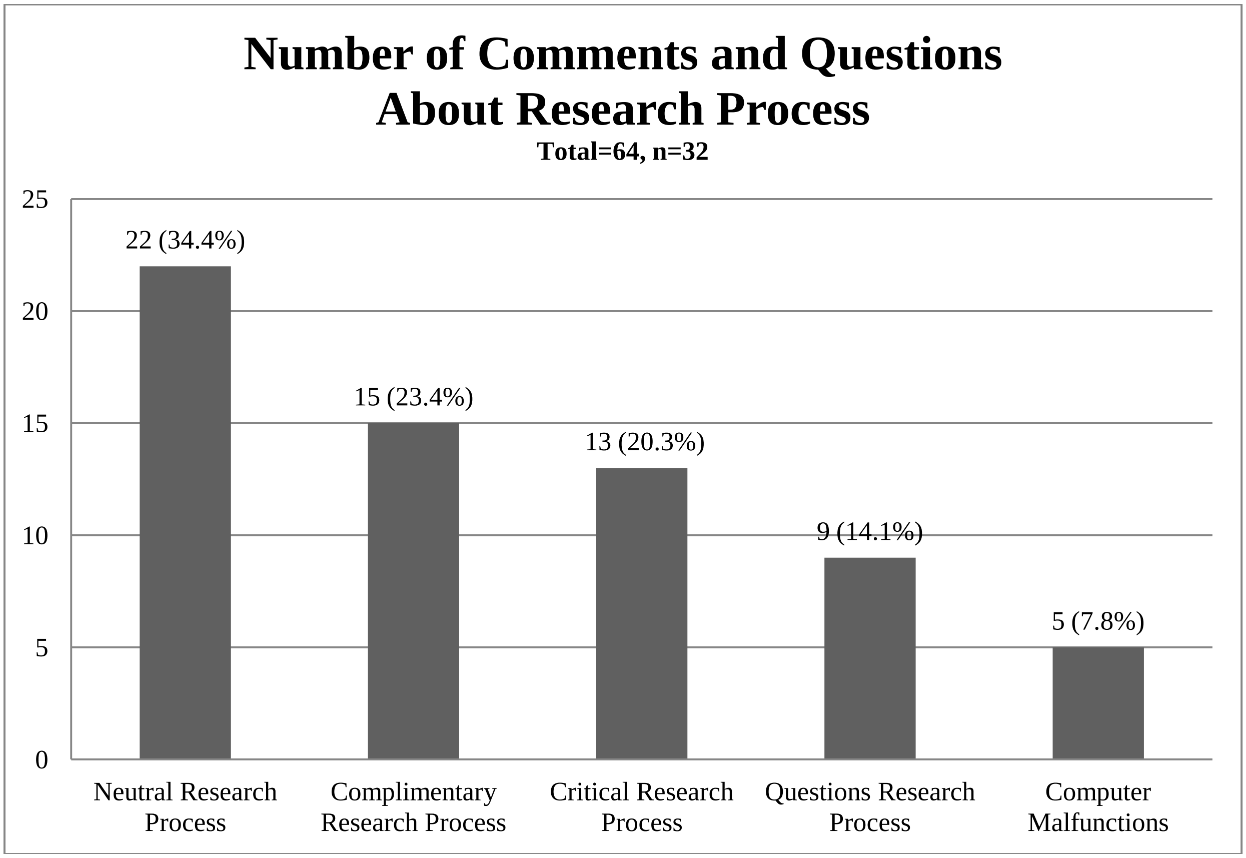


Figure 125 Comments and Questions About Research Process

Most (42) of the comments and questions about the research process were in the follow up questionnaire. Using the Chi-square test, the differences between the neutral, complimentary, and critical comments about the research process are not significant.

7.5.1. Neutral Comments About Research Process

Neutral comments are defined as instances where participants made impartial comments or answered "No" to the open-ended question that asked if they had additional comments about the questionnaires or the research process. Eighteen individual participants made 22 "Neutral comments about research process." There were eighteen comments in the follow up questionnaire and four comments in the initial questionnaire. The "Neutral Comments About Research Process" are shown in Table 148 within Appendix "S".

7.5.2. Complimentary Comments About Research Process

Eleven individual participants made fifteen complimentary comments about the research process. There were seven comments in both focus group "VA" and "VB". There was only one comment in focus group "E". These differences are not significant. Most (11) of the comments were in the follow up questionnaire. Using the Chi-square test, the differences in the number of comments are significant (.014). This indicates that the participants had an overall positive experience in the research process.

The following noteworthy "Complimentary Comments About Research Process" were selected from all the comments, as shown in Table 149 within Appendix "S".

In response to the question "If you wish, please provide any additional comments on the tar sands, the Google Earth tool, or the overall research session:" in the follow up questionnaire, participant VA03 stated:

> *VA03, Q2: Thank you for illustrating the size and scope of the tar sands projects. There are also a lot of ideological positions implicit in the term "oil sands" and "tar sands", and this is very informative because the public is not aware of these subtle changes in the terms.*

Participant VA03 demonstrated an advanced understanding of the connotations associated with the words "tar " (i.e. dirty and negative) versus "oil" (i.e. clean and positive). As shown in Figure 126, the change in terminology was referenced in Slide #3 of the researcher's presentation to the focus group just after the initial questionnaire was completed. This was one of only two remarks in the focus groups about the term "tar sands" versus "oil sands". The other remark, possibly by the same participant, is discussed below in Section 3.3 "Questions About Research Process".

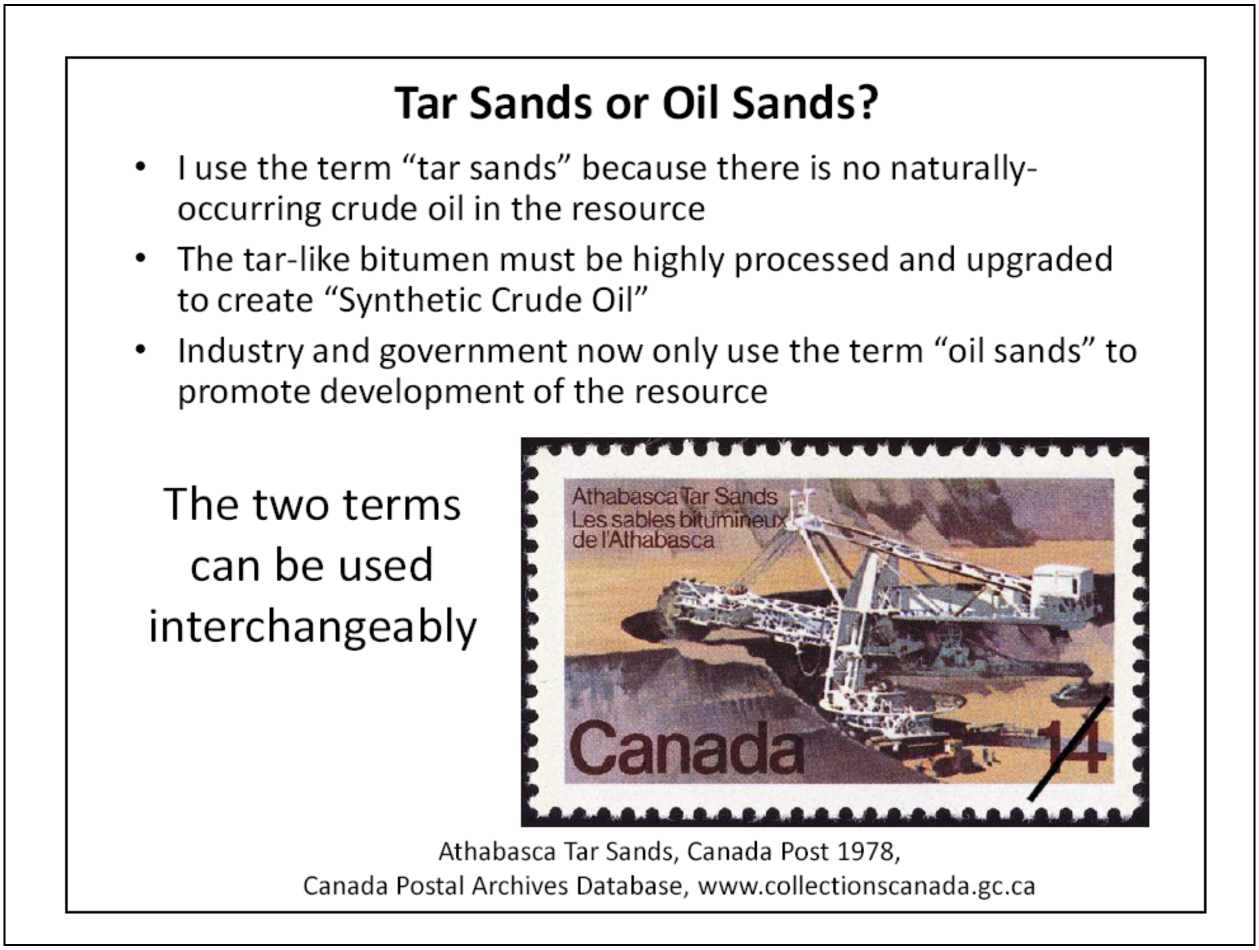


Figure 126 Slide #2 "Tar Sands or Oil Sands?" from Researcher's Presentation to Focus Group

In response to the question "Please explain why:" related to the question "Has your opinion about open pit tar sands projects changed as a result of this focus group?" in the follow up questionnaire, participant VB02 stated:

> *VB02, Q2: I've gone from knowing nothing to knowing the full scale of the tar sands impact.*

In response to the question "How much ***new*** knowledge did you gain about the ***size or geographic area*** of ***open pit*** tar sands projects near Fort McMurray, Alberta?" participant VB02 also stated that he had gained "Much New Knowledge". This also indicates the educational value using Google Earth to illustrate the cumulative development of the tar sands open pit mines. However, it is not known whether the same type of learning might have been achieved if only maps had been presented.

7.5.3. Critical Comments About Research Process

Nine participants made thirteen critical comments about the research process, all in the follow up questionnaire. Eight of the comments were in focus group "VB" but the differences between the focus group sessions are not significant. The "Critical Comments About Research Process" are shown in Table 150 within Appendix "S". Almost one-third (4 out of 13) of the "Critical Comments About Research Process" came from one focus group participant.

Participant VA10 asked a key ethical question about the use of mapping and 3D visualisations:

> *VA10, Q2: I'm not entirely clear what outcomes are being explored here. Are we researching future methods of informing the public and if so, would government and corporations use these methods to sway and control public opinion?*

7.5.4. Questions About Research Process

Up to nine individual participants asked questions about the research process, all of which were in the focus group discussions. All the "Questions About Research Process" are shown in Table 151 within Appendix "S".

7.5.5. Computer Malfunctions

There were five computer malfunctions. Two took place in each of focus groups "E" and "VA" while one took place in focus group "VB". All the computer malfunctions took place during the focus group discussions.

7.6. Screenshot Presentations

According to the research protocol, participants were asked to present screenshots that they found most interesting back to the rest of the focus group for discussion. Twelve individual participants made thirteen presentations to the rest of the group about selected screenshots. These presentations were grouped into five categories, as shown in Figure 127. Over half the presentations were about “Comparison to Cities”. Less than one-seventh of the presentations were about “Deforestation” or “Continental Pipelines”. There was only one presentation about “Proximity to River” and “Comparison to Florida”. With the exception of “Proximity to River”, which used a ***static*** 3D visualisation, all the screenshot presentations used 2D maps with vertical viewpoints. Using the Chi-square test, the differences between the types of presentations are significant (0.046).

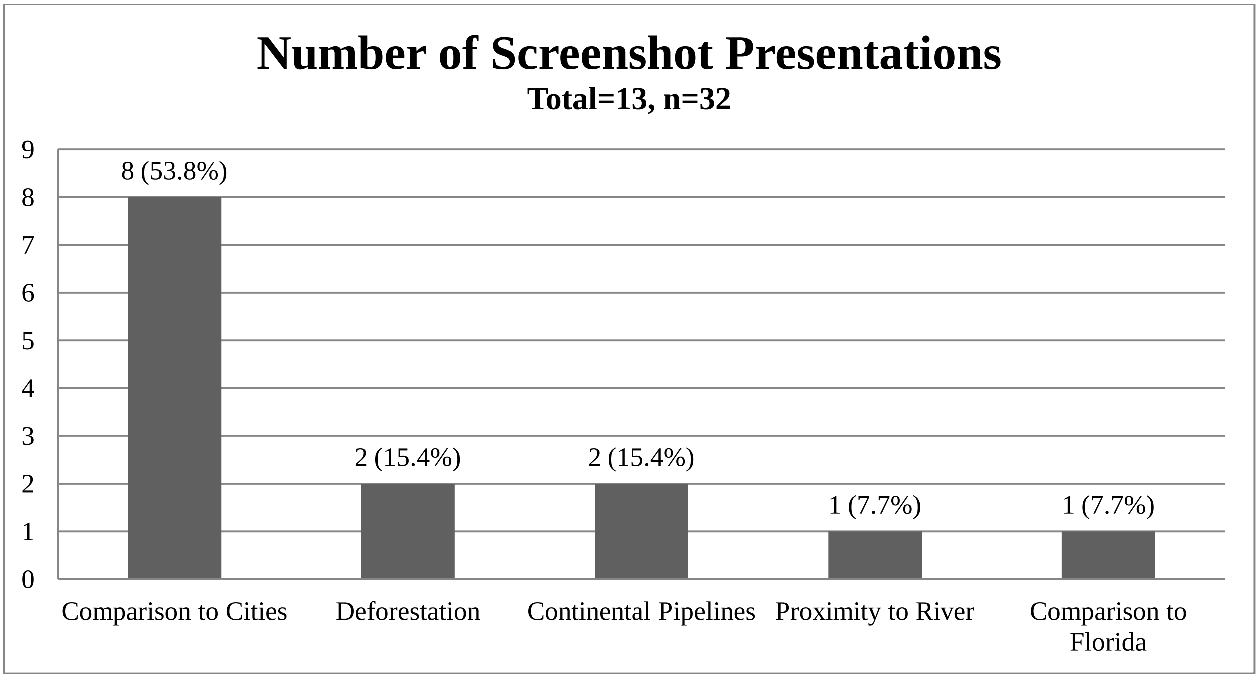


Figure 127 Screenshot Presentation Categories

Since there were no screenshots of the interactive 3D visualisations and only one screenshot of a static 3D visualisation, there may have been an order effect where participants where participants became more tired or frustrated later on in each focus group session. At all times, the researcher needed to make strong efforts to encourage participants to volunteer to make presentations back to the group.

Six screenshot presentations took place in focus group “VB”, four in focus group “VA” and three in focus group “E”, all during the focus group discussions.

7.6.1. Comparison To Cities

Up to seven individual participants made seven screenshot presentations about "Comparison to Cities". Four presentations were in focus group "VB", two were in focus group "VA", and one was in focus group "E". The differences in the presentations between focus group sessions are not significant. The following noteworthy presentations about "Comparison to Cities" were selected from all the presentations, as shown in Table 153 within Appendix "S".

Except for participant VB11, all focus group participants who made presentations about "Comparison to Cities" viewed the entire city outlines in their entirety from the pre-set viewpoint in the Google Earth project. However, participant VB11 zoomed into the outline of the city of Vancouver overlaid on the proposed open pit mines to get an idea of how long it would take to walk from her home in the Kitsilano neighbourhood to downtown Vancouver. As shown in Figure 128, the Kitsilano neighbourhood and downtown Vancouver are annotated in green within the red outline of the City of Vancouver.

Figure 128 Zoomed in Vancouver Outline Overlaid on Proposed Open Pit Mines

> *VB11*
> *I felt like even with the cities it was sort of still a bit hard being able to really conceptualize how big they were so I zoomed in on the, this the arm on the right is downtown Vancouver and then that's my neighbourhood Kitsilano right in the middle; so I just sort of thought about if you are walking on that street how long would it take me to take to walk for a couple of hours.*

The actual distance from Kitsilano to downtown Vancouver is about 5 km, which would take about one hour to walk. Therefore, participant VB11 may have overestimated the distance or she meant that it would that long for a return trip.

While they both viewed the outlines of the entire cities from the pre-set viewpoints overlaid on top of the open pit mines, two other participants also explained that they also thought about travel times within New York and Los Angeles to better imagine the actual size of the open pit mines. In focus group "VA", an unknown participant used the example of how long it would take to travel from downtown New York (i.e. Manhattan) to the surrounding "boroughs".

> *PC*
> *Have you ever been to New York?*
>
> *VA Unknown*
> *Yes I have, Yeah. I was thinking about the time it took to go to the boroughs.*

Participant VB05 used the example of the length of time it takes to drive from the edge of the Los Angeles metropolitan area to downtown Los Angeles.

> *VB05*
> *I found fascinating the amount of area the tar sands encompasses all of Los Angeles.*
>
> *PC*
> *Have you ever been to Los Angeles?*
>
> *VB05*
> *No I never have*
>
> *PC*
> *Does it look big to you on there? How big do you think it is?*
>
> *VB05*
> *I've heard it takes two hours from when you're entering the Los Angeles sign until you're actually in downtown Los Angeles so I think it's quite large. It's very large.*

The distinction between the size of a metropolitan urban area and the city core within it was highlighted by participant VA12 who thought that the open pit mines were as big as the City of Vancouver prior to viewing the Google Earth project. After overlaying the outline showing the City of Vancouver (in red) and the Vancouver metropolitan area (in white), as shown in Figure 129, participant VA12 estimated that the open pit mines were two to three times larger than he thought. Following this comment, "Key Moment #6" occurred when a female participant in the background gasped "No!" possibly reacting in astonishment by realizing the actual size of the tar sands open pit mines.

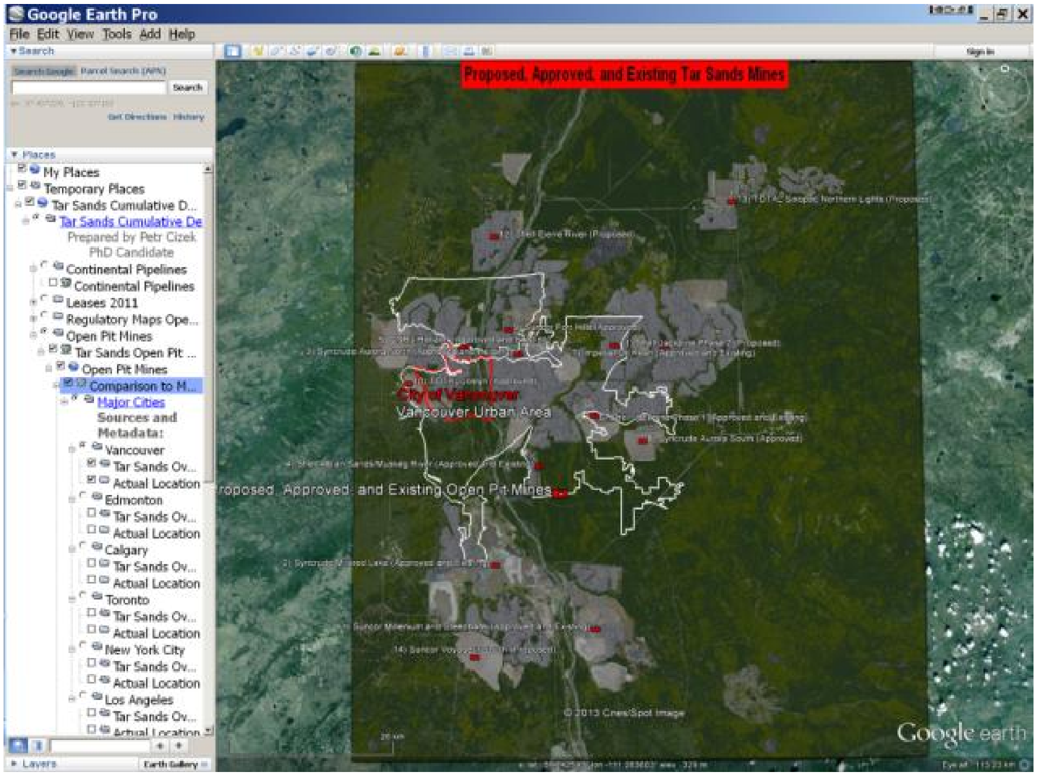


Figure 129 Outline of City of Vancouver and Metropolitan Area Overlaid on Proposed, Approved, and Existing Open Pit Mines

PC
Did you think they were that big?

VA12
No. Perhaps I was just thinking the city proper of Vancouver, but not the metro. So I do think it was two times, perhaps three times bigger than I thought

KEY MOMENT #6: WOMAN IN BACKGROUND ALSO GASPS "NO!!" POSSIBLY REACTING TO SIZE OF OPEN PIT MINES

PC
Where did you hear that information?

VA12
No, I was only speculating.

However, participant VA12 still underestimated the geographic area of the open pit mines. The City of Vancouver has a geographic area of 115 km^2 (City of Vancouver, 2013). Therefore, the existing open pit mines are actually about five (5) times larger than the City of Vancouver and the proposed, approved, and existing mines would be about thirteen (13) times larger. In response to the question "Have you ever seen or been to the ***open pit*** tar sands projects near Fort McMurray? (Please check all that apply)" in the initial questionnaire, participant VA12 was the only person in all three focus groups who stated that he had seen the open pit mines "from a plane or helicopter", "from the ground", and "lived nearby for a period time". This example indicates that even people who had regularly seen the open pit mines both from the ground and the air may have difficulty of comprehending their actual geographic area.

7.6.2. Deforestation

"Deforestation" refers to the temporary or permanent removal of natural tree cover. There were two screenshot presentations about "Deforestation" and both were in focus group "VB". As shown in Figure 130 and Figure 131, participants asked what these images represented.

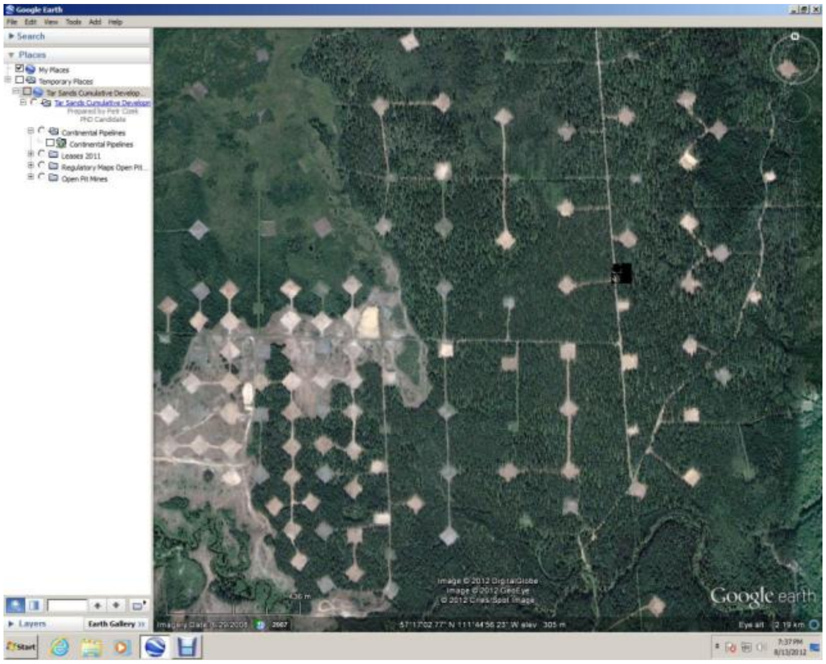


Figure 130 Screenshot of Exploratory Drilling

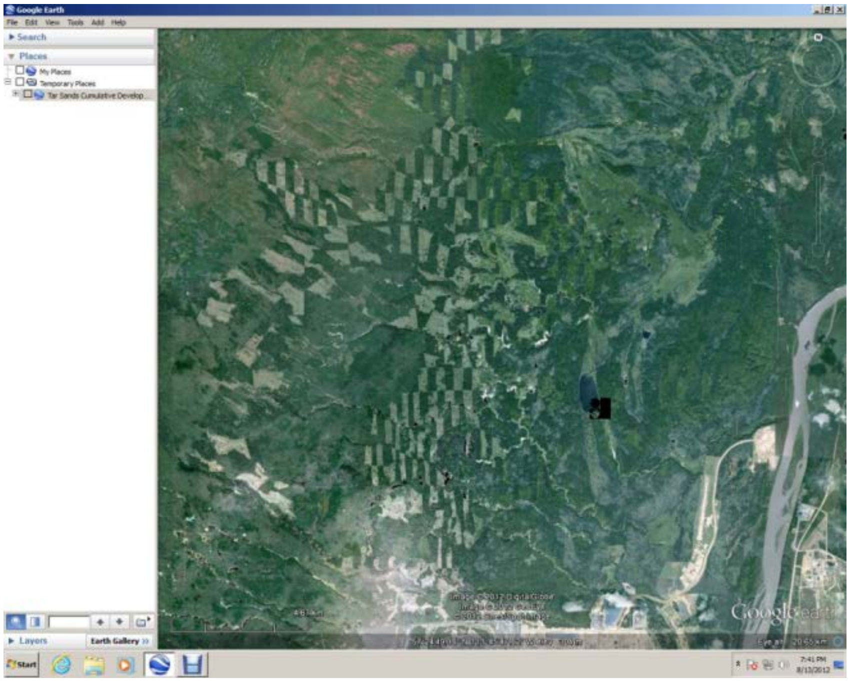


Figure 131 Screenshot of Block Cuts

These two screenshot presentations illustrate the difficulty that the general public may have in interpreting satellite imagery of human-caused landscape change in northern Canada. These screenshots also illustrate the extent of landscape disturbance surrounding the open pit mines even before open pit mines are actually excavated.

7.6.3. Continental Pipelines

There were two screenshot presentations about "Continental Pipelines". One screenshot presentation was in focus group "VB" and the other was in focus group "VA".

In focus group "VB", participant VB10 thought that the arctic natural gas pipelines could not be built because of the negative impact they would have on caribou herds.

> *VB10*
> *As far as I know, there's caribou that runs through this area? And I thought these pipelines can't be built because of the environmental impact they will have on the caribou herds, now the caribou they run, they travel hundreds of miles to the birthing grounds and the pipelines will cut right through their migration pattern.*

Participant VB10 presented the screenshot shown in Figure 132.

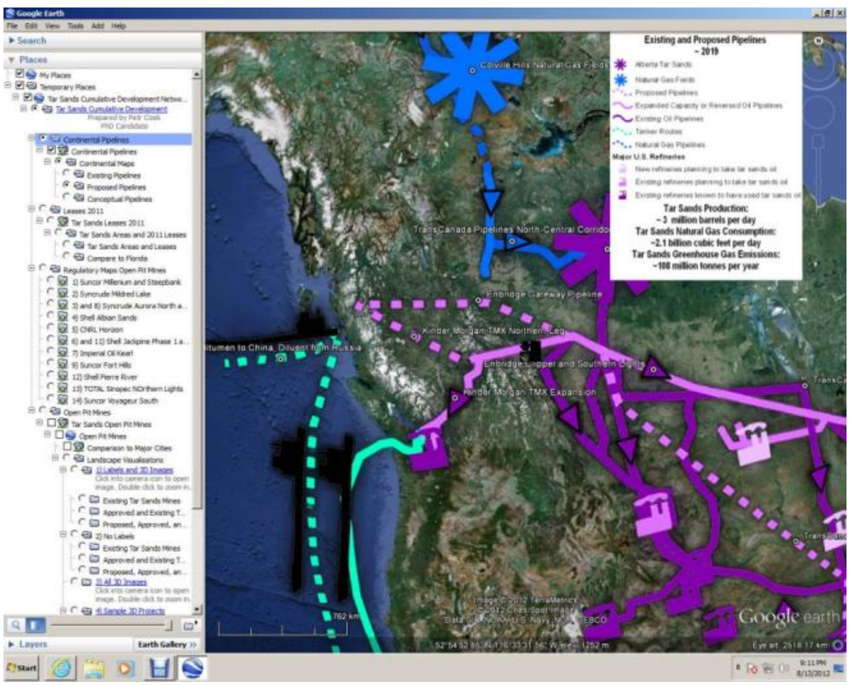


Figure 132 Screenshot of Continental Pipelines

The researcher pointed out that the Mackenzie Valley natural gas pipeline has already been approved and that the Alaska natural gas pipeline would follow existing pipeline and highway corridors. The researcher suggested that participant VB10 might have been thinking about the proposals to drill for oil, not natural gas, in the calving grounds of the Porcupine Caribou herds in the "1002" lands of the Arctic National Wildlife Refuge in Alaska. This example illustrates how complex northern resource extraction and pipeline issues are easily confused by the general public.

In focus group "VA", an unknown participant used the standard Google Earth imagery to point out that the Alberta tar sands are equidistant between the Pacific Ocean and Hudson's Bay implying that an export pipeline could just as easily be built to Hudson's Bay, as shown in Figure 133.

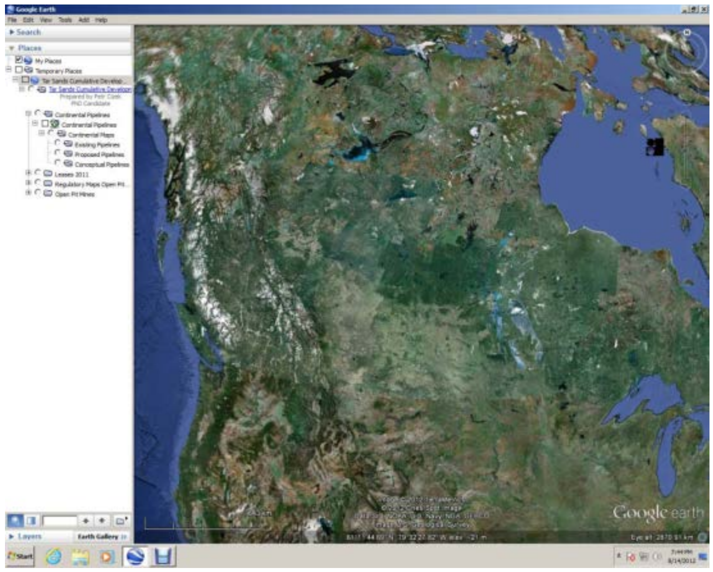


Figure 133 Screenshot of Standard Google Earth Imagery of Western Canada

The researcher probed the focus group about what might be the problems shipping tar sands bitumen out from Hudson's Bay, expecting that they might mention the short shipping season due to ice cover.

However, participant VA04 replied:

> *VA4*
> *Well there's no export market from Hudson's Bay right, they have to go out west to the Pacific Ocean they want to ship it to Asia; so to go to Asia you have to go to the Pacific ocean there's no point .*

The researcher then mentioned that another proposed possibility was to ship the tar sands bitumen north along the Mackenzie Valley to the Arctic Ocean, as recently proposed by the Premier of the Northwest Territories (Smith, 2012) The researcher used Google Earth to illustrate the proposed route through the Beaufort Sea north of Alaska and south down the Bering Strait. Participants thought that this was "treacherous" and reminded them of the Exxon Valdez oil spill. When the researcher finally mentioned that the shipping season was rather short, the focus group participants laughed. This example illustrates how Google Earth can be used at multiple scales with multiple viewpoints to illustrate the continental or global implications of regional resource extraction issues.

7.6.4. Proximity to River

There was one screenshot presentation about "Proximity to River" in focus group "E", as shown in Figure 134.

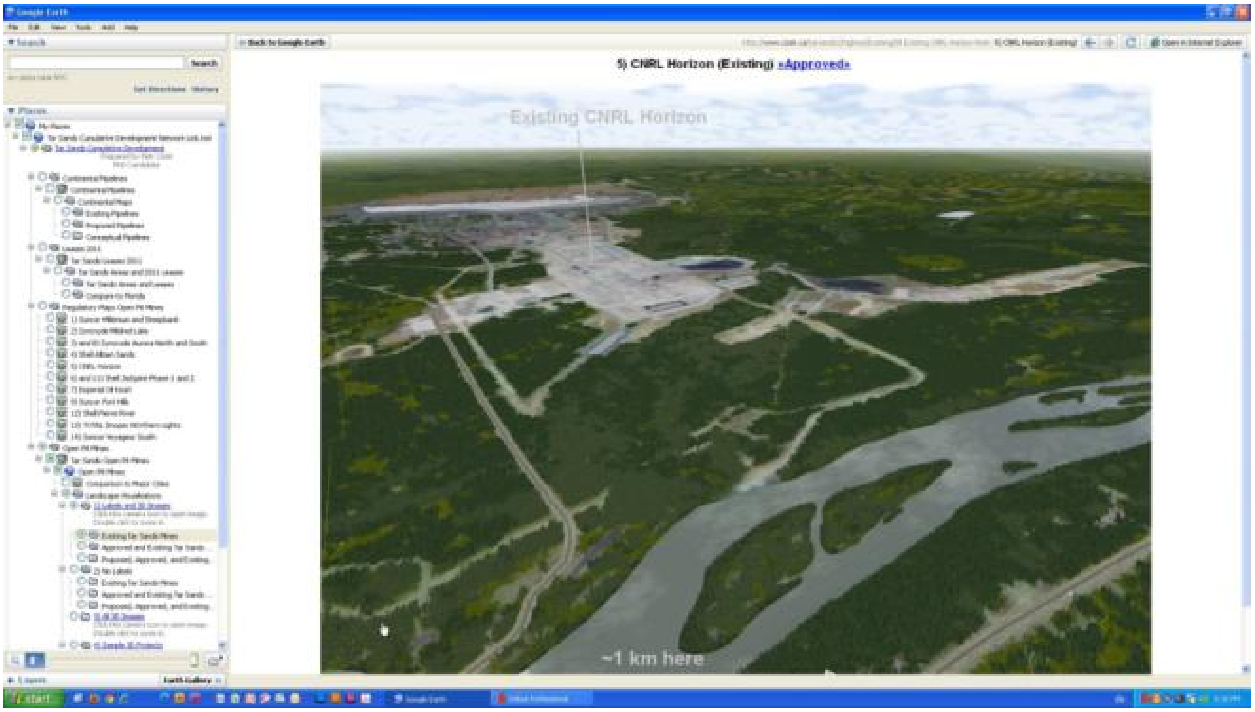


Figure 134 Screenshot Presentation Existing CNRL Horizon Static 3D Visualisation

This is the only screenshot presentation that used a ***static*** 3D visualisation. Participant E06 presented a high-resolution image of the ***existing*** CNRL Horizon mine, which has not yet been fully excavated. The researcher noticed that the scale bar was not visible in the screenshot ".jpg" image so he opened up the image in his own Google Earth project. When asked by the researcher, participant E06 accurately estimated that the distance from the existing CNRL Horizon mine to the shore of the Athabasca River is about 1 km. When the researcher clicked the "Approved" hyperlink to show the fully excavated CNRL Horizon mine, as shown in Figure 135, participant E06 exclaimed "Wow!". This was "Key Moment #8".

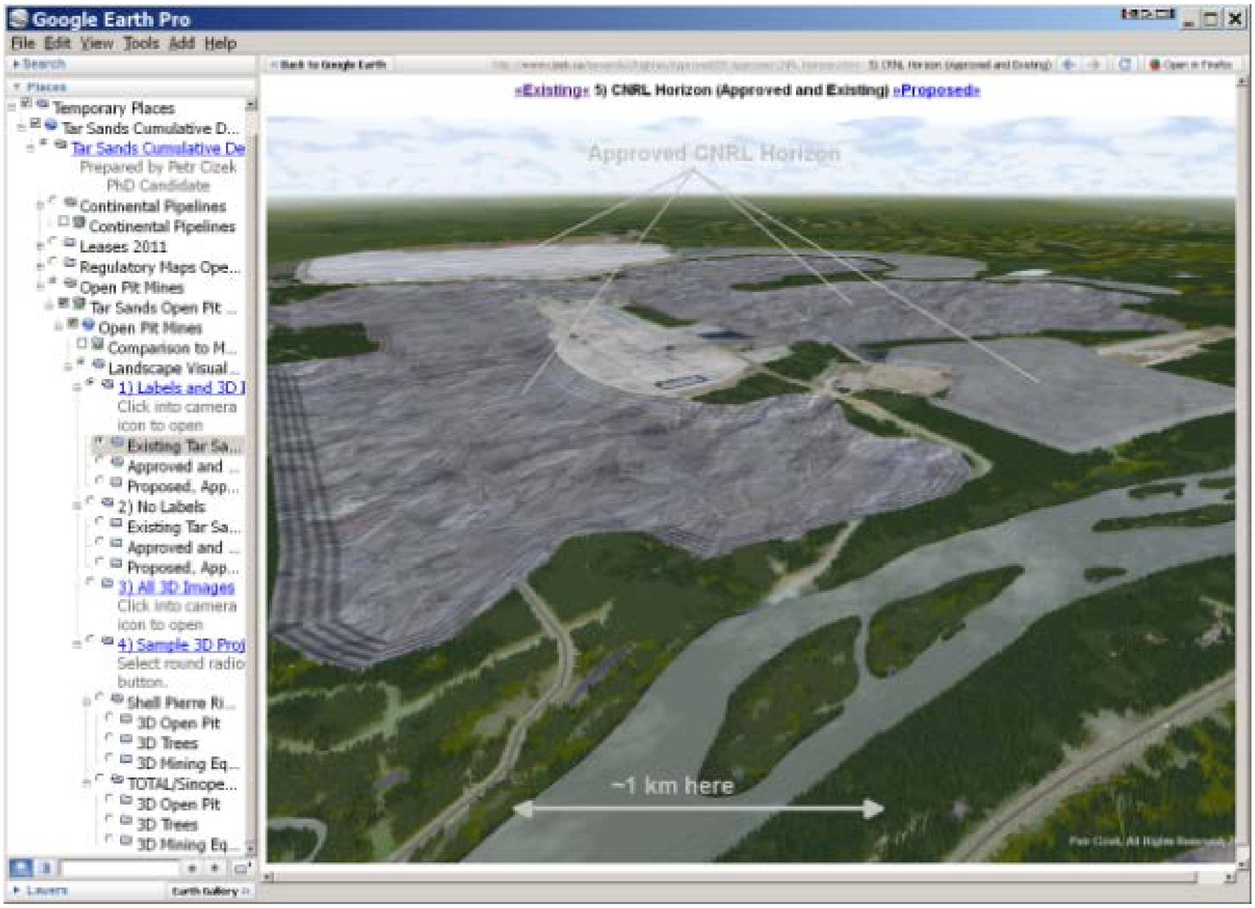


Figure 135 Approved CNRL Horizon Static 3D Visualisation

Participant E06 speculated that the open pit was so close to the Athabasca River that it could flood into the open pit. This example illustrates how the hyper-linked static 3D visualisations can generate interest by moving through time.

7.6.5. <u>Comparison to Florida</u>

In response to prompting from the researcher, participant E06 also mentioned that she found the comparison of to the state of Florida interesting as shown Figure 136.

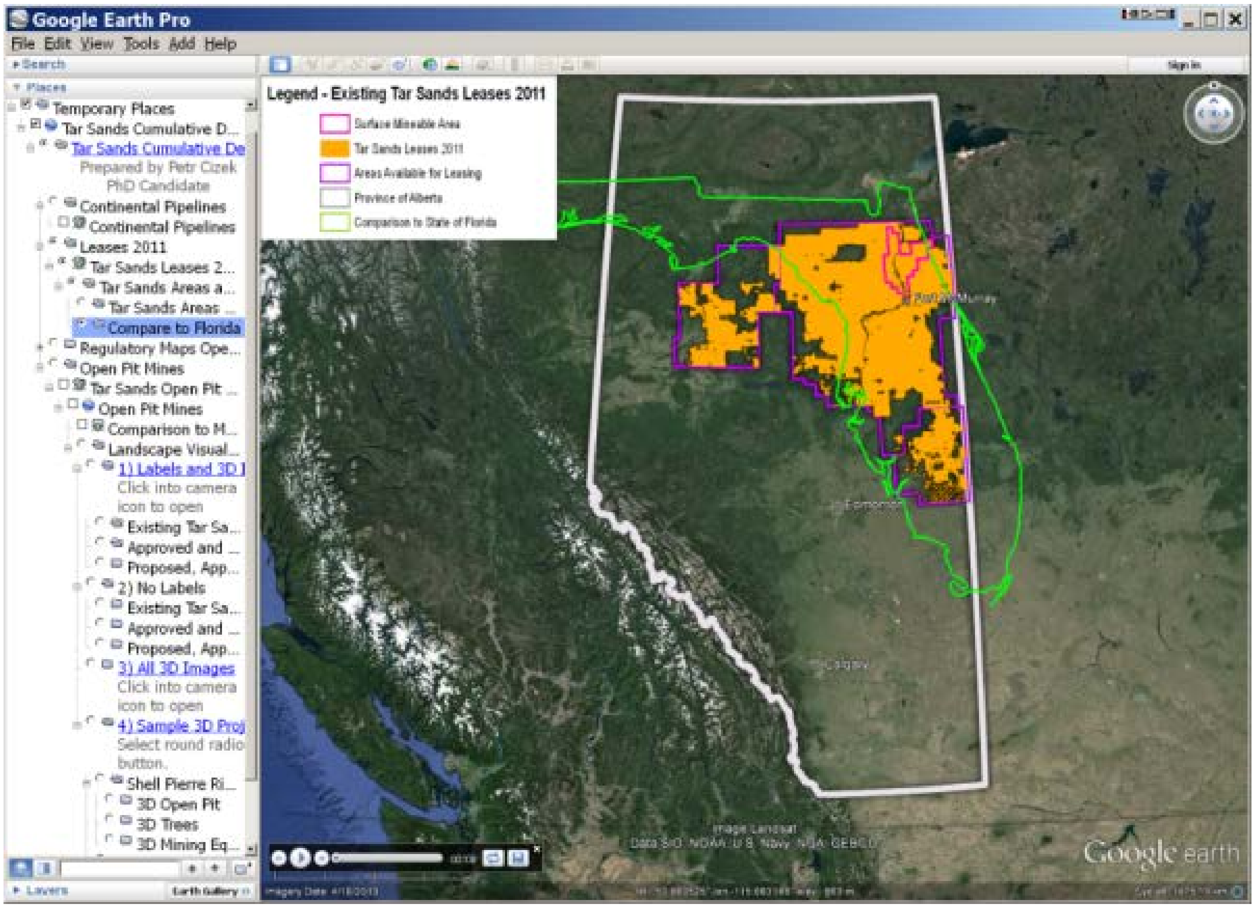


Figure 136 Comparison of 2011 Tar Sands Leases to the State of Florida

When asked by the researcher, participant E06 confirmed that she knew that the open pit mines were not as large as the state of Florida, but she was surprised to find out that the entire tar sands area (open pit mines and *in-situ* projects) were as large as the state of Florida. This was the only remark about the tar sands leases and the comparison to the state of Florida.

7.7. Concluding Comments

In the qualitative analysis, the participants' comments and questions in the theme areas of tar sands, Google Earth features, research process, and screenshot presentations have been analysed. The number of comments and questions in each theme and sub-theme were compared. Noteworthy comments and questions representing both typical and extreme positions were highlighted and discussed. In the following final Chapter 8 "Discussion and Conclusions" the findings of the research are summarized, the theoretical implications of the case study are consider, interim guidelines for the use of virtual globes are proposed, and directions for future research are suggested.

CHAPTER 8: DISCUSSION AND CONCLUSIONS

In Chapter 1: “Introduction”, the following research questions were posed:

1) What are people’s cognitive, attitudinal, and affective responses before and after viewing very large resource extraction complexes such as the tar sands complex, as represented in interactive multi-scale media? How are these responses related to people’s socio-demographic characteristics and their perceptions and opinions of the tar sands open pit mines?;

2) Can interactive, multi-scale visualisation using virtual globes affect peoples' cognitive and affective responses to existing and future development of a very large resource extraction project or linked large projects, as in the case examined here?; and

1) How effective are these new tools (i.e. 2D digital maps, static and interactive 3D visualisations) and different viewpoints (i.e. plan view, oblique, and ground-based) presented in virtual globes in meaningfully informing the general public (as defined in Chapter 2.4) about very large resource extraction projects?

A Google Earth project was prepared showing the existing, approved, and planned tar sands open pit mines along with associated pipelines at continental scales. The Google Earth project used a combination to 2D maps as well as static and interactive landscape visualisations to present the cumulative development of the tar sands open pit mines. Three focus group sessions were held in typical computer laboratories with a total of 32 participants in Vancouver and Edmonton. Participants completed initial and follow up questionnaires as well as engaging in discussion while viewing the Google Earth project on individual computers. Participants were also asked to take screenshots of images they found compelling. The focus group sessions were audio-recorded while the participants’ computer screens were video-recorded. Combinations of quantitative and qualitative methods were used to analyse the data.

In this Chapter, the findings from the focus groups, together with limitations on study methods and findings, are discussed in three thematic areas:

1) Cognition and Learning (addressing Research Questions 1 & 2);
2) Attitudes, Affect, and Behavioural Intent (addressing Research Questions 1 & 2); and
3) Evaluation of the Communications Medium (primarily addressing Research Question 3).

This study is then compared to nine other recent relevant studies and theoretical implications are identified. Based on the foregoing, interim design guidelines are proposed and directions for future research are suggested, as well as implications for mapping and visualisation practice. To conclude the chapter answers to the three central research questions are provided.

8.1. Cognition and Learning

In this study, it is revealed that the members of the public engaged in both Vancouver and Edmonton had for the most part very limited knowledge or understanding of the tar sands, prior to the virtual globe presentation. The majority were poorly informed. Approximately two-thirds had seen few to no photographs, seen few to no TV broadcasts or videos, or read few to no articles or books about the tar sands. About 60% had not seen any maps showing tar sands open pit mines. Only 12% had actually seen the projects, mostly in views from the ground. There were no significant differences between the Vancouver and Edmonton focus groups regarding their knowledge about or exposure to the tar sands. Three-quarters of participants reported little or no knowledge about the geographic area of the tar sands open pit mines. When asked to estimate the total geographic area of the existing tar sands open pit mines, 22 % said they didn't know. Among those who did attempt an estimate, answers ranged from the size of a neighbourhood to the size of a Western Province or state. Thirty-four percent estimated or guessed the size of the existing tar sands open pit mines to be about as large as a Canadian metropolitan city, which is spatially correct, with 22% thinking it was bigger, and 22% thinking it was smaller.

Before the presentation, participants generally were even more unsure of future expansion plans for the tar sands open pit mines. Forty-four percent said they didn't know how much the area of the tar sands open pit mines would grow if all approved projects were built in addition to existing pits (actually about a doubling of area), and 47% did not know the amount of growth if both approved and planned projects were included (actually about a tripling). The majority of participants who did make an estimate overestimated the geographic area and the amount of growth for both the approved and planned expansions. For example, 78% of these more confident participants overestimated the size of the approved tar sands open pit mines, and 65% overestimated the growth of the approved tar sands open pit mines (from 3 to 10 times bigger).

While the participants recruited may have represented a self-selected sample of participants who were interested in the tar sands because they already had negative opinions, these results suggest that they were not very knowledgeable, were probably guessing quite a lot, and that their estimates were widely spread and for the most part not very accurate. In all cases related to existing, approved, and proposed geographic area or growth of the tar sands open pit mines before viewing the Google Earth project, a greater percentage of participants from Alberta selected correct answers compared to participants from British Columbia. However, the differences between participants from Alberta and British Columbia were not significant.

After experiencing the focus group sessions and viewing the Google Earth project, most focus group participants experienced cognitive changes, with more people feeling able to estimate geographic area and the growth of the open pit mines, but with variable effects on the accuracy of scale estimates of the tar sands open pit mines. It is possible that longer and more repeated viewing than what was possible in the 2.5 hour focus group session may have increased participant accuracy. After viewing the Google Earth project, most focus group participants also reported specific learning outcomes, as described below.   Overall, this indicates that the experience of the focus group exercise featuring the ability to navigate across scales using Google Earth software, may have led to considerable awareness building and learning about the tars sands open pit mines, though not necessarily improved spatial estimates of area and growth of the tar sands open pit mines. Key findings on changes in cognition are discussed below.

8.1.1. Perceived Geographic Area of Mines, Before and After Viewing

The geographic area of the open pit mines indicates the degree of landscape disturbance and deforestation, but is not likely to be a comprehensive indicator of positive or negative cumulative effects. The changes in perception of the geographic area of the existing, approved and planned tar sands open pit mines are summarized in Table 63. After experiencing the Google Earth project, there were very few participants, on average eight (26%) fewer, who said they did not know the geographic area of the tar sands open pit mines.

Before viewing the Google Earth project, an average of six participants (20%) correctly estimated that the geographic area of the existing, approved, or planned open pit mines was about as large as a “Canadian metropolitan city”. After viewing, there were slightly more participants on average (24%) who chose the spatially correct answer.

While there were slightly fewer participants who underestimated the geographic area of the open pit mines, on average nine more participants (28%) overestimated the area of the open pit mines after viewing the Google Earth project. Before viewing, some 40% on average over-estimated the actual size of the existing, approved, and planned open pit mines, but after viewing this became the majority of participants (on average 22 participants or 68%) Most of these participants thought that all the open pit mines in combination for each phase were as large as one of the “World’s largest metropolitan areas (about 100 km across)”, when in fact the open pit mines combined in each phase are actually as large as a “Canadian metropolitan city (about 25 km across)”, as calculated using GIS.

Table 63 Summary of Changes in Perception of Geographic Area of Tar Sands Open Pit Mines by Number of Participants

Participant Response n=32		Scenario			***Mean Number of Participants Changed Perception***
		Existing	**Approved**	**Planned**	
Did Not Know	Before Viewing	7	8	13	
	After Viewing	0	2	1	
	Changed Perception	***-7***	***-6***	***-12***	***-8.3***
Underestimated Area	Before Viewing	7	2	2	
	After Viewing	2	2	1	
	Changed Perception	***-5***	***0***	***-1***	***-2.0***
Answered Correctly	Before Viewing	11	6	2	
	After Viewing	12	5	6	
	Changed Perception	***+1***	***-1***	***+4***	***+1.3***
Overestimated Area	**Before Viewing**	7	16	15	
	After Viewing	18	23	24	
	Changed Perception	***+11***	***+7***	***+9***	***+9.0***

There were substantial differences in the accuracy of scale estimation between the phases (scenarios) of development. As shown in Table 64, the mean perceived geographic area[42] of the

[42] The comparative geographic data for the areas of the existing, approved, and planned tar sands open pit mines are ordinal. Therefore calculating a mean perceived area is not a mathematically accurate calculation. The mean perception and changes are shown for illustrative purposes only.

existing and ***approved*** tar sands open pit mines increased by 12% and 2% respectively after viewing the Google Earth project. The median and mode perceived geographic area of the ***existing*** tar sands open pit mines changed from the spatially correct answer rank "4 (Canadian metropolitan city)" to rank "5 (World metropolitan city)", but did not change for the ***approved*** mines. Therefore, the mean perceived geographic area of the ***existing*** open pit mines in particular became less accurate after viewing the Google Earth project. However, the mean perceived geographic area of the ***planned*** tar sands open pit mines declined by 3% and became more accurate after viewing the Google Earth project. In the planned scenario, the median and mode perceived geographic areas did not change after viewing the Google Earth project

Table 64 Changes in Measures of Central Tendency in Perceived Geographic Area of Tar Sands Open Pit Mines, Before and After Viewing

Scenario		Mean	Mean Percent Change	Median	Mode
Existing (Spatially correct answer=4 "Canadian metropolitan city")	Before Viewing (n=25)	4.08	+11.1%	4	4
	After Viewing (n=32)	4.59		5	5
Approved (Spatially correct answer=4 "Canadian metropolitan city")	Before Viewing (n=24)	4.79	+1.6%	5	5
	After Viewing (n=30)	4.87		5	5
Planned (Spatially correct answer=4 "Canadian metropolitan city")	Before Viewing (n=19)	5.05	-3.0%	5	5
	After Viewing (n=31)	4.90		5	5

In order to determine whether those who felt more knowledgeable were less subject to over-estimating scale of open pit mines, and to calculate the statistical significance of changes in perception (as discussed in Chapter 6), further analysis was applied to segregate those participants who thought they knew the geographic area of the open pit mines before viewing the Google Earth project. Among those twenty-five participants who attempted to estimate the geographic area of the ***existing*** open pit mines before viewing, ten participants (31% of the total sample) after viewing perceived the existing open pit mines as having a greater geographic area than before viewing, which was a significant change in perceived scale. However, the largest number of participants who thought they knew the geographic area of the existing mines before viewing, correctly estimated the existing area as equivalent to a "Canadian metropolitan city" both before and after viewing, as shown in Table 65.

Among those 24 participants who thought they knew the geographic area of the ***approved*** open pit mines before viewing, the largest number of participants (12 or 50%) perceived the geographic area of approved open pit mines as the ***same*** after viewing. Among those nineteen participants who thought they knew the geographic area of the ***planned*** open pit mines before viewing, the largest number of participants (8 or 42%) perceived the geographic area of planned open pit mines as ***smaller*** after viewing though this was not a significant change. Overall, the perception of these more knowledgeable or confident participants changed significantly regarding the scale of existing open pit mines but not about the approved and proposed open pit mines. This may be due to small sample size, but may also indicate that participants who thought they knew the geographic area at the outset were less likely to over-estimate geographic area of approved and proposed open pit mines when viewing the Google Earth project. It is not clear why they tended to over-estimate existing mine scale after viewing

Nonetheless, even when the data are segregated between participants who thought they knew the geographic area before viewing and those who did not, the modal answers to the geographic area were generally over-estimated as “World metropolitan city” for both groups. The exception was the case (see above) of those thinking they knew the size of the existing mines, who correctly estimated both before and after the session. In all scenarios, participants who did not know the geographic area of the tar sands open pit mines before viewing, over-estimated the geographic area of the mines after viewing. In all scenarios, the modal choices of those who knew the size of mines before viewing did not change after viewing the Google Earth project. However, some participants who thought they knew the geographic area of mines before viewing continued to select extreme alternatives after viewing, which indicates that these participants may have held on strongly to their established perceptions.

Table 65 Change in Perceived Modal Geographic Area of Tar Sands Open Pit Mines, Before and After Viewing

Knowledge of Geographic Area Before Viewing	Mode of Perceived Geographic Area EXISTING Tar Sands Open Pit Mines		Mode of Perceived Geographic Area of APPROVED Tar Sands Open Pit Mines		Mode of Perceived Geographic Area of PLANNED Tar Sands Open Pit Mines	
	Before Viewing	**After Viewing**	**Before Viewing**	**After Viewing**	**Before Viewing**	**After Viewing**
Participants Who Thought They Knew Area Before Viewing	11=“Canadian metropolitan city” (spatially correct)	11=“Canadian metropolitan city” (spatially correct)	10=“World metropolitan city”	14=“World metropolitan city” (spatially correct answer decreased by 3; extreme over-estimate decreased by 1)	8=“World metropolitan city”	11=“World metropolitan city” (spatially correct answer increased by 1; extreme over-estimate decreased by 3)
Participants Who Did Not Know Area Before Viewing	n/a	6=“World metropolitan city”	n/a	4=“World metropolitan city”	n/a	7=“World metropolitan city”

Key

	Modal Estimated Geographic Area
(green)	= Spatially Correct Answer
(pink)	= Spatially Over-estimated

There are several possible explanations for the tendency of many participants to over-estimate the actual size of the open pit mines in combination. Firstly, because the open pit mines are not contiguous (unlike a city) their combined area may appear larger in plan view. Focus group participants were able to visually compare the open pit mines only to the outlines of the contiguous metropolitan areas. Participants may have used a “convex hull” concept (de Berg, van Kreveld, Overmars, & Schwarzkopf, 2000) around the open pit mines to make the comparison, rather than the actual area of the open pit mines themselves.

As shown in Figure 137, four hypothetical areas of disturbance shown in black are enclosed by a "convex hull" shown by a red line. The combined area of the mines is smaller than the area enclosed by the "convex hull" or the "minimum convex polygon". The effect may increase because the scattered tar sands open pit mines have irregular shapes, which are harder to add up in the viewer's mind. When overlaid with a city boundary of the same cumulative size, some of the spatially dispersed mines would inevitably project beyond the city boundary, perhaps reinforcing the perception of increased scale.

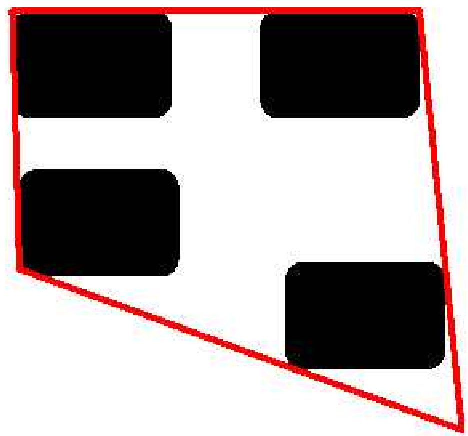


Figure 137 Convex Hull or Minimum Convex Polygon

The impact of the perspective view of the open pits, especially in the foreground, may also contribute to an increased perceived scale, although this presumably reflects actual perceived scale if viewers could get on the ground or fly over the sites. In fact, it is arguable that a spatially correct estimation of mine scale by GIS measurement ***under-estimates*** the true perceived scale of the tar sands operations and the wider distribution of disturbance, which should be evident in both the Google Earth view and the actual plan-view or oblique perspective view obtainable at the site. This raises the question of response equivalence or representational validity (Sheppard, 2001; Daniel & Meitner, 2001) as a truer measure of perceived scale than objective scalar measurements.

Also, participants may have had different understanding of the boundaries of metropolitan areas. While the Canadian metropolitan urban areas all have about the same geographic area, the City of Vancouver is about one-third the size of the cities of Edmonton and Calgary. While the metropolitan urban areas of New York and Los Angeles all have about the same geographic area, the City of Toronto is about the same geographic area as the City of New York or the City of Los Angeles. Therefore, there may have been confusion between city and metropolitan scales as well confusion between the geographic area of "Canadian metropolitan cities" and "World metropolitan cities".

In the Google Earth project, just one outline of a "Canadian metropolitan area" was placed in the centre of the map in all scenarios, which may have confused viewers since they would have to conceptualize multiples of the area for the approved (doubled area) and planned (tripled area) scenarios. To improve the accuracy of viewer perception, several outlines of "Canadian metropolitan cities" could be placed side-by-side depending on the scenario:

1) In the existing scenario, one outline could be placed in the centre;

2) In the approved scenario, two outlines could be placed side-by-side; and

3) In the planned scenario, three outlines could be placed side-by-side.

Alternately, both the outlines of a "Canadian metropolitan city" and "World metropolitan city" could be shown at once so that viewers could compare the tar sands open pit mine scenarios to them simultaneously. This may provide viewers with a more accurate understanding of the geographic area and growth between the existing, approved, and planned scenarios.

8.1.2. Perceived Growth of the Geographic Area of Mines, Before and After Viewing

Before viewing, many participants did not feel able to estimate among of future growth of the tar sands open pit mines, and among those who did, the majority substantially overestimated the amount of growth. The changes in perception of the growth of the geographic area of the tar sands open pit mines before and after viewing are summarized in Table 66. After viewing the Google Earth project, there were on average 13 (41%) fewer participants who did not know the growth of the geographic area of the tar sands open pit mines. There were on average 6.5 (20%) more participants who answered correctly and on average 5.5 (17%) more participants who overestimated the growth of the geographic area of the tar sands open pit mines after viewing the Google Earth project.

Table 66 Changes in Perceived Growth of Tar Sands Open Pit Mines by Number of Participants, Before and After Viewing

Participants n=32		**Scenario**		***Mean Number of Participants Changed Perception***
		Growth of Approved Area	**Growth of Approved Area and Planned Area**	
Did Not Know	Before Viewing	14	15	
	After Viewing	1	2	
	Changed Perception	***-13***	***-13***	***-13.0***
Underestimated Growth	Before Viewing	0	1	
	After Viewing	1	2	
	Changed Perception	***1***	***1***	***+1.0***
Answered Correctly	Before Viewing	4	5	
	After Viewing	5	17	
	Changed Perception	***+1***	***+12***	***+6.5***
Overestimated Growth	Before Viewing	14	11	
	After Viewing	25	11	
	Changed Perception	***+11***	***0***	***+5.5***

As shown in Table 67, the mean perceived growth of the ***approved*** and the ***approved and planned*** tar sands open pit mines projects decreased by 24% and 11% respectively after viewing the Google Earth project. In both cases, the mean perceived growth became more accurate after viewing the Google Earth project but still remained higher than the spatially correct answers. In the case of the increase of the ***approved*** tar sands open pit mines, the median and the mode of the perceived growth remained the same and both were greater than the spatially correct answer after viewing the Google Earth project. In the case of the increase of the ***approved and planned*** tar sands open pit mines, the median and mode of the perceived growth declined and both were the spatially correct answer after viewing the Google Earth project.

Table 67 Changes in Measures of Central Tendency in Perceived Growth Geographic Area of Tar Sands Open Pit Mines, Before and After Viewing

Scenario		Mean	Mean Percent Change	Median	Mode
Increase Approved (Spatially correct answer=2x the existing size)	Before Viewing (n=18)	4.2	-24%	3	3
	After Viewing (n=31)	3.2		3	3
Increase Approved and Planned (Spatially correct answer=3x the existing size)	Before Viewing (n=17)	6.2	-11%	5	10
	After Viewing (n=30)	5.5		3	3

Among those eighteen participants who thought they knew the growth of the ***approved*** open pit mines before viewing, the largest number of participants (8 or 44%) perceived the growth of the approved open pit mines as ***smaller*** than before viewing, though this was not a significant change. Among those seventeen participants who thought they knew the growth of the planned and approved open pit mines before viewing, the largest number of participants (8 or 47%) also perceived the growth of the planned and approved open pit mines as ***smaller*** than before viewing though this was not a significant change. Again, this demonstrates that viewing the Google Earth project reduced the perceived growth of approved and proposed open pit mines among those participants who thought they knew the geographic area before viewing. However, after viewing, the majority of all 32 focus group participants still over-estimated the total size or geographic area of the combined open pit tar sands projects, expecting it to increase three times if the approved open pit mines were built in addition to existing mines. However, the total size or geographic area of the combined open pit mines would actually only increase two times. Nevertheless, after viewing, the majority of participants correctly estimated that the total size or geographic area of the combined open pit projects would increase three times if the planned and approved open pit mines were built in addition to the existing mines.

When the data are segregated between those participants who thought they knew the growth before viewing and those who did not, the largest number of participants, who thought they knew the growth of the tar sands open pit mines before viewing, over-estimated the growth of the ***approved*** tar sands open pit mines but correctly estimated the growth of the ***approved and planned*** tar sands open pit mines after viewing, as shown in Table 68.

Overall, these results indicate that participation in the focus groups combined with viewing the Google Earth project had some effect in improving the accuracy of perception among participants who thought they knew the growth of the tar sands open pit mines before viewing. However, this effect was only significant in the case of the existing open pit mines, possibly due to the smaller number of participants who thought they knew the geographic area and growth before viewing. In the case of the approved tar sands open pit mines, the number of extreme over-estimates was reduced by five. In the case of the planned tar sands open pit mines, the mode shifted from the extreme over-estimate of “More than ten times” to the spatially correct answer of “About three times”.

Conversely, the majority of participants who did not know the growth of the tar sands open pit mines before viewing did not provide a spatially correct response after viewing. In the case of the ***approved*** tar sands open pit mines, the majority of participants over-estimated the growth. In the case of the ***planned*** tar sands open pit mines the modal response was split between the spatially correct answer and an extreme over-estimate.

Table 68 Change in Perceived Modal Growth of Tar Sands Open Pit Mines

Knowledge of Growth of Geographic Area Before Viewing	**Mode of Perceived Growth of Geographic Area of Approved Tar Sands Open Pit Mines**		**Mode of Perceived Growth of Geographic Area of Planned Tar Sands Open Pit Mines**	
	Before Viewing	**After Viewing**	**Before Viewing**	**After Viewing**
Participants Who Thought They Knew Growth Before Viewing	6=Tied between “About 3 times” and “About 5 times”	14=About 3 times (spatially correct answer decreased by 1; extreme over-estimates decreased by 5)	7=More than 10 times	11=About 3 times (extreme over-estimates decreased by 6)
Participants Who Did Not Know Growth Before Viewing	n/a	9= “About 3 times” (spatially over-estimated)	n/a	6=“About 3 times” (spatially correct)
				6=“About 10 times” (spatially over-estimated)

Key

	Modal Estimated Growth
	= Spatially Correct Answer
	= Spatially Over-estimated

Overall, there were similar results for changes in perception of geographic area and growth of the tar sands open pit mines after viewing among participants who thought they knew the answer before viewing. The largest number of these participants perceived the geographic area of the existing tar sands open pit mines correctly, both before and after viewing. The largest number of these participants over-estimated the geographic area of the approved and planned tar sands open pit mines as well as the growth of the approved tar sands open pit mines. However, in the case of the growth of the combined approved and planned tar sands open pit mines, the largest number of these participants provided the correct answer after viewing. In all cases, the number of these participants who made extreme over-estimates decreased. This indicates that viewing the Google Earth project may simultaneously cause the perception of future project spatial scale to be somewhat over-estimated while reducing the number of extreme over-estimates.

8.1.3. <u>Self-Reported Learning</u>

In this section, the evidence for self-reported learning culled from responses to ordinal rating scale questions in the follow up questionnaire, open-ended questions in the follow up questionnaire, and transcribed comments from the focus group discussions is summarized.

After viewing the Google Earth project, an average of 8 more focus group participants stated that they knew the area of existing, approved, and planned open pit mines. This change was significant for existing and planned open pit mines only.

After viewing the Google Earth project, an average of 13.0 more focus group participants stated that they knew the rate of geographic growth of the approved open pit mines and the planned and approved open pit mines. This change was significant for both cases.

After viewing, the largest number of participants thought they knew the geographic area of the existing open pit mines. This was followed, in descending order, by the geographic area of the approved open pit mines, the geographic area of the planned open pit mines, the growth of the approved open pit mines, and the growth of the combined approved and planned open pit mines. However, there were no significant differences between the numbers of participants among these cases.

8.1.3.1. New Knowledge Gained

After viewing the Google Earth project, 75% of focus group participants stated in questionnaire responses that they gained "Much New Knowledge" or "In-Depth New Knowledge" about the size or geographic area of the open pit mines. Based on the open-ended questions in the follow up questionnaire, half of the focus group participants commented that they gained important new knowledge about the geographic area or scale of the open pit mines. Only three participants (9%) said that they did not learn much or anything at all.

After viewing the Google Earth project, a significantly greater percentage (75%) of focus group participants with more experience using computers stated that they gained more new knowledge about the size or geographic area of the open pit mines, compared to focus group participants with less experience using computers. This indicates that users with more experience using computers may learn more about very large projects using virtual globes than users with less experience using computers.

8.1.3.2. Overall Change in Awareness

Among the fifteen participants who made "Complimentary Comments About Research Process" in the open-ended questionnaire, four participants (27%) stated that they experienced a noteworthy change in awareness about the open pit mines as a result of viewing the Google Earth project. One of these four participants became much more strongly supportive about further expansion of the tar sands open pit mines. Three (9%) participants stated that they felt the same way as when they came in.

8.1.3.3. Aids to Learning on Specific Issues

Based on the multi-option variable question in the follow-up questionnaire where participants were asked to select any images or features as being most helpful in expressing the geographic area or scale of the tar sands open pit mines, outlines of cities were selected by almost 80% of focus group participants. Over half (54%) of the screenshot presentations were about "Comparison to Cities". This indicates that comparing estimates of spatial extent using transplanted outlines of city boundaries appears to be a powerful aid to learning about the geographic area of very large projects. Based on the open-ended questions in the follow-up questionnaire, half the focus group participants also explicitly stated that they gained important new knowledge about the geographic area or scale of the open pit mines by comparing them to outlines of major cities.

Only 6% of focus group participants stated that they gained important new knowledge about the geographic area and scale of open pit mines and pipelines in relation to provincial borders as a result of viewing the Google Earth project. Compared to the open pit mines, the provincial boundaries may have been too large to be useful for most participants.

8.1.3.4. Specific Questions on Scale and Sense of Place

Based on the open-ended questions in the follow-up questionnaire, 22% of group participants (7 out of 32) explicitly stated that they gained important new knowledge about the proximity of the rivers to the open pit mines as a result of viewing the Google Earth project. Two of these participants explicitly referred to the static 3D landscape visualisations as being helpful in demonstrating the proximity of the rivers to the open pit mines.

In responding to the open-ended questions in the follow-up questionnaire and in the focus group discussions, six participants (19%) expressed shock and surprise at learning about the size of the tar sands open pit mines.

In the focus group discussions, two-thirds (10 out of 15) of the questions asked by participants about the tar sands were about contextual geographic features: “Surrounding Communities” (5 out of 15) and “Water-bodies” (5 out of 15). Participants did not seem confused or disoriented but appeared to be interested in gaining greater knowledge about the landscape context for the development of the tar sands open pit mines. This suggests a demand for more information on the context of potentially sensitive receptors.

8.1.3.5. Prior Knowledge and Media Exposure About Open Pit Mines

Two significant relationships were found affecting perceived scale of the tar sands open pit mines: correlations between prior knowledge and media exposure. In the initial questionnaire, participants were asked how much knowledge they had about the size or geographic area of the open pit tar sands projects near Fort McMurray, Alberta. Before viewing the Google Earth project, a significantly greater percentage of participants who stated that they had ***less previous knowledge*** about the size or geographic area of the open pit mines thought the approved open pit mines were ***smaller*** than participants who stated that they had more previous knowledge. The greatest percentage of participants who stated that they had “No Knowledge” thought the geographic area of the approved open pit mines was as large as a “Canadian metropolitan city”, which is the spatially correct answer. The greatest percentage of participants who stated that they had “Some Knowledge” thought geographic area of the approved open pit mines was as large as a “World metropolitan city”, which is not correct. This is congruent with the findings discussed in Section 8.1.1, where those participants who thought they knew the geographic area of the approved tar sands open pit mines also over-estimated it both before and after viewing.

Before viewing the Google Earth project, there was no significant correlation between prior media exposure and perception of the geographic area or growth of the tar sands open pit mines. However, after viewing the Google Earth project, a significantly greater percentage of participants who had previously seen ***more TV broadcasts, videos, or films*** about the open pit mines thought that the planned and approved open pit mines would increase three times the geographic area of the existing open pit mines, which is correct. The greatest percentage of participants who had not previously seen any TV broadcasts, videos, or films thought that the geographic area of the open pit mines would increase ten times the geographic area of the existing open pit mines, which is not correct.

The findings from these two correlations are contradictory. On one hand, before viewing the Google Earth project participants with ***more*** knowledge over-estimated the size or geographic area of the approved tar sands open pit mines while participants with less knowledge were correct. On the other hand, after viewing the Google Earth project, participants with ***less*** exposure to TV media/videos etc. over-estimated the growth of the approved and planned tar sands open pit mines, while participants with more knowledge were correct. This indicates TV broadcasts, videos, or films may exaggerate the actual size or geographic area of the approved tar sands open pit mines. Despite the fact that the researcher explained the difference between the ***in-situ*** and open pit tar sands at the beginning of the focus group, participants who had seen ***fewer*** TV broadcasts, videos, or films about the tar sands may have thought the growth of the approved and planned tar sands would increase ten times was because they confused the ***in-situ*** and open pit tar sands projects. This indicates that TV broadcasts, videos, or films may explain the difference between the open pit and ***in-situ*** tar sands projects effectively.

8.2. Attitudes, Affect, and Behavioural Intent

Participants were generally opposed to both existing and future tar sand open pit mines before viewing the Google Earth project. Over half the participants (56%) were “Somewhat Opposed” or “Very Opposed” to ***existing*** tar sands open pit mines and almost two-thirds (63%) were “Somewhat Opposed” to ***future*** tar sands open pit mines. There were no significant variations in opinion about existing and future tar sands open pit mines that correlated with participant residence in British Columbia or Alberta.

In comparison, in a survey of 2,000 Canadians 42% thought that “the oil sands should continue to be developed”, 41% thought that “the oil sands should continue to be developed but more slowly than today”, and 16% thought that “the oil sands should not be developed” (CROP Inc., 2013). This indicates that the participants in the focus groups were somewhat more opposed to the tar sands than Canadians as a whole.

After viewing the Google Earth project, the opinion of focus group participants about existing and future open pit mines generally became more negative. Those participants with more prior media exposure had a more negative opinion about existing and future open pit mines than participants with less prior media exposure. In the open-ended questions and the discussions, the most frequent concerns expressed about tar sands and pipelines were general negative impact, cumulative negative impact, water negative impact, and lack of reclamation. There were few comments in the open-ended questions and discussion about socio-economic benefits of the tar sands. Some participants made explicitly emotional comments in the open-ended questions or discussions. There were also several "key moments" when participants expressed vocal emotional reactions while viewing the Google Earth project.

8.2.1. Change in Opinion of Existing and Future Mines, Before and After Viewing

After viewing the Google Earth project, focus group participants became more opposed to existing open pit mines than before viewing but this change was not significant. After viewing the Google Earth project, focus group participants became significantly more opposed to ***future*** open pit mines than before viewing. Before viewing the Google Earth project, focus group participants did not have a significantly different opinion about ***existing*** open pit mines compared to future open pit mines. However, after viewing the Google Earth project, focus group participants were significantly more opposed to ***future*** open pit mines compared to ***existing*** open pit mines. Focus group participants were also significantly more opposed to ***future*** open pit mines after viewing the Google Earth project compared to ***existing*** open pit mines before viewing the Google Earth project.

As noted in Section 8.1.1, the number of participants who over-estimated the geographic area and growth of the tar sands open pit mines increased after viewing, so it is possible that this may have influenced the participants' opinions. While "acceptance" or "acceptability" was not measured explicitly, the findings indicate that participants may be more willing to accept existing open pit mines than future open pit mines, but it is not possible to say whether this was due to the increased size of the open pit mines (as visualized and perceived) or whether any limits of acceptable change were exceeded.

8.2.1.1. Prior Media Exposure and Opinion of Open Pit Mines

Before viewing the Google Earth project, a significantly greater percentage of focus group participants who had seen ***more photos*** of the open pit mines were ***more opposed*** to ***existing and future*** open pit mines compared to participants who had seen fewer photos. After viewing the Google Earth project, a significantly greater percentage of participants who had seen ***more photos*** of the open pit mines were ***more opposed*** to ***existing*** open pit mines compared to participants who had seen fewer photos.

Before viewing the Google Earth project, a significantly greater percentage of participants who had seen ***more maps*** showing the open pit mines were ***more opposed*** to ***existing*** and ***future*** open pit mines compared to participants who had seen fewer maps. After viewing the Google Earth project, a significantly greater percentage of participants who had seen ***more maps*** showing the open pit mines were ***more opposed*** to ***existing*** open pit mines compared to participants who had seen fewer maps.

After viewing the Google Earth project, a significantly greater percentage of participants who had previously seen ***fewer maps*** showing the open pit mines reported they had changed their opinions ***more*** compared to participants who had previously seen ***more maps***. The significant correlations between prior media exposure and opinion about tar sands open pit mines are summarized in Table 69.

Table 69 Significant Correlations Between Prior Media Exposure and Opinion About Tar Sands Open Pit Mines

	Negative Opinion of Existing Tar Sands Open Pit Mines	**Negative Opinion of Future Tar Sands Open Pit Mines**	**Self-report Changes in Opinion About Tar Sands Open Pit Mines**
Before Viewing	Seen More Photographs Seen More Maps	Seen More Photographs Seen More Maps	
After Viewing	Seen More Photographs Seen More Maps		Seen Fewer Maps

These findings indicate the influence of prior exposure to photographs and maps on the negative opinion of participants about the ***existing*** and ***future*** open pit mines ***before viewing*** the Google Earth project. However, ***after viewing*** the Google Earth project there was only a significant correlation between more prior exposure to photographs and maps and greater negative opinion of ***existing*** open pit mines but not ***future*** open pit mines. This indicates that viewing the Google Earth maps may have influenced participants who had previously seen ***fewer*** photographs and maps to develop a more negative opinion about ***future*** open pit mines. This is also corroborated by the finding that a significantly greater percentage of participants who had previously seen ***fewer*** maps thought they had changed their opinions more than participants who had seen more maps.

8.2.1.2. Prior Involvement and Opinion of Open Pit Mines

Before viewing the Google Earth project, a significantly greater percentage of participants who stated that they were ***more involved in promoting their opinions*** about tar sands development were ***more opposed*** to the existing open pit mines. However, it is impossible to say whether involvement in promoting one's opinions leads to greater opposition to existing open pit mines or whether opposition to the existing open pit mines leads to greater involvement in promoting one's opinions.

8.2.1.3. Major Concerns About Tar Sands and Pipelines

Including before and after viewing of the Google Earth project, 85% (109 out of 128) of the comments in the open-ended questions and the focus group discussions were about the "negative environmental impact" of the tar sands, where "environment" includes both "biophysical" and "socio-economic" components.

As coded by the researcher, 40% (43 out of 108) of the "negative environmental impact" comments in the open-ended questions were about "General Environmental Impact". Almost two-thirds of these comments (26 out of 43) were made after viewing the Google Earth project. The three top specific concerns about "negative environmental impact" were "cumulative environmental impact", "water negative impact", and "lack of reclamation" (combined 33% or 36 out of 108 comments). Approximately 75-80 % of these comments were made ***after*** viewing the Google Earth project, indicating that this experience may have strongly influenced participant opinions. Just over one-tenth of the comments were about negative "Cumulative Environmental Impact", of which almost four-fifths were made after viewing the Google Earth project. This may suggest that the maps and virtual globe displays enabled the viewing of the "big picture", a holistic view of the tar sands open pit mines, perhaps for the first time ever for participants.

8.2.1.4. Benefits of Tar Sands

Based on open-ended questions in initial and follow-up questionnaires, less than one-tenth of the comments from six participants were about the positive impact of the tar sands on the socio-economic environment. Almost the same numbers of comments were made before and after viewing the Google Earth project. After the process, two participants remained supportive of the tar sands open pit mines. However, three other participants (half of the group) changed their opinion about either ***existing*** or ***future*** open pit mines from supportive to opposed, suggesting that some supporters may change their opinions because of changed perceptions resulting from viewing very large projects displayed in virtual globes.

8.2.2. Expressions of Affect

Among the total of 109 recorded comments about negative environmental impact, there were only four explicitly emotional verbal statements made by four participants, three of which came after viewing the Google Earth project. There were also thirteen "key moments" within the three focus group discussions where participants expressed non-verbal vocal emotional reactions.

These occurred more than once when:

1) The outlines of cities were overlaid in comparison to the open pit mines and participants expressed shock and surprise;

2) Participants expressed shock and surprise when they realized how close the open pit mines were to the Athabasca River;

3) Participants asked about the need to view the scenarios side-by-side rather than sequentially and this generated lively chatter. A participant also suggested that the growth of future open pit mines be shown as outlines;

4) The same participant twice expressed anger and frustration by raising his voice about the absence of political action against tar sands development shown in the maps and landscape visualisations; and

5) The 3D trees and 3D mining machinery appeared during the demonstration of the interactive landscape visualisations. Participants seemed to be shocked and surprised by the depth of the open pits compared to the 3D trees and 3D mining machinery (despite other comments about lack of realism of the interactive landscape visualisation).

Other key moments occurred only once, when:

1) Participants asked about the size and height of the tailings ponds and this generated lively chatter. Participants seemed to be surprised at how large and high the tailings ponds

were. A participant suggested that the tailings ponds could be compared to some known lakes; and

2) Participants expressed frustration over the length of time it took to load the interactive landscape visualisations in one of the Vancouver sessions.

Overall, these findings demonstrate that viewing the Google Earth project generated some intense emotional reactions in all three focus groups, with four “key moments” taking place in focus group “VB”, three in focus group “VA”, and six in focus group “E”.
The triggers for the key moments can be classified according to the following categories:

1) There were four triggers due to the disclosure of key aspects of the tar sands:

    a) Outlines of cities;
    b) Proximity to Athabasca River;
    c) Size and height of tailings ponds; and
    d) Comparison to 3D trees and 3D mining machinery

2) There were two triggers due to benefits of the display medium:

    a) Optional viewing of scenarios both sequentially and side-by-side; and
    b) Interactive viewing of 3D trees, 3D mining machinery, and sample planned open pits.

3) There was one trigger due to an external policy issue: frustration with lack of political action against tar sands development.

4) There was one trigger due to a technical problem: slow loading of interactive landscape visualisations.

The implications of emotional reactions to viewing the material cannot be known without further questioning of the participants and is beyond the scope of this study. While the emotional reactions did not appear to overwhelm valid cognitive responses, it is possible that emotional reactions may lead to political actions such as calls for comprehensive cumulative effects assessment of the full build-out scenario. Ideally, this assessment should be conducted by an independent scientific agency, which provides the public with full and transparent access to all data.

8.2.3. Behavioural Intent

Participants were not specifically asked about their behavioural intent in response to viewing the Google Earth project, but any behavioural intent was to be noted. Although one participant exhibited frustration at the lack of political action, no other participants stated that they would change their behaviour as a result of viewing the Google Earth project. This may indicate perceived lack of agency in the ability of participants to influence decisions on the tar sands, but no firm conclusions on the relationship of virtual globe use to behaviour of participants can be drawn.

8.3. User Evaluation and Effectiveness of the Google Earth Focus Project

In Section 2.4, various criteria were laid out for evaluating the effectiveness of visualization tools in meaningfully informing the general public about very large extraction projects. In this section, the usability and credibility of the Google Earth communications medium, based on explicit user evaluation on those issues, and user recommendations on improvement are discussed. The other criteria are discussed based on the researcher's visualization methods, researcher observations of the focus group processes, and interpretation of results laid out in Sections 8.1 and 8.2.

8.3.1. Usability of the Tool

The usability of the Google Earth project tool is evaluated based on the variables of usefulness, overall satisfaction (as determined by complimentary versus critical comments), and ease of use, according to responses from focus group participants. Overall, most participants found the process useful and were satisfied with the Google Earth project tool, though three (9%) participants with less experience using Google Earth had difficulty with navigation.

Based on the follow-up questionnaire, 78% of the focus group participants (25 out of 32) thought the Google Earth project was "Mostly Useful" or "Very Useful" overall. Based on the open-ended questions and discussion, there were slightly more complimentary comments (15 out of 50) than critical comments (13 out of 50) about the research process. The complimentary comments were generally appreciative about the opportunity to learn about the tar sands. The broader critical comments generally expressed confusion about the purpose of the research process. Most of the comments about the research process were neutral (22 out of 50), generally stating that participants had no further comments about the research process.

All but two of the 32 participants made 41 complimentary comments about 2D maps, compared to 33 critical comments. Twelve participants also made 18 critical comments about ***static*** 3D landscape visualisations, compared to 11 complimentary comments. Participants were not asked to evaluate the ***interactive*** 3D landscape visualisations in specific ranking questions, but participants made comments about them in the open-ended questions and focus group discussions. Twenty-two participants made 33 critical comments about the ***interactive*** 3D landscape visualisations, compared to 11 complimentary comments. Although the three types of representations were not formally ranked by users, these qualitative results show that participants were most critical of the ***interactive*** 3D landscape visualisations, and least critical of the 2D maps.

Based on the open-ended questions in the follow-up questionnaire, there were four critical comments about the ease of navigating in Google Earth from three focus group participants. All these three focus group participants stated that they had "little experience" or "no experience" using Google Earth or other computer mapping programs. In general, these comments expressed a need for more time to learn the navigation system. About one-fifth of focus group participants (7 out of 32) stated that the 3D rendering in the interactive 3D landscape visualisation was too slow. All these participants used computers without dedicated graphics cards in the Vancouver sessions. These findings demonstrate that both high internet speeds and up-to-date computers with dedicated graphics cards are required to ensure a satisfactory user experience in viewing the interactive 3D visualisations.

8.3.2. Credibility of the Maps and Visualisations

Overall, significantly more participants thought the 2D maps were believable than those who thought the static 3D visualisations were believable, and some participants wanted to see real photos and videos.

Almost 60% of participants (19 out of 32) thought the 2D maps shown in the Google Earth were “Mostly believable” or “Highly believable”. However, less than one-third of focus group participants (9 out of 32) thought static 3D landscape visualisations shown in the “balloons” in the Google Earth tool were “Mostly believable” or “Highly believable”. Six participants thought the 3D landscape visualisations were “Mostly unbelievable” while three participants thought the 2D maps were “Mostly unbelievable” or “Highly unbelievable”.[43] The largest number of participants thought the 3D landscape visualisations were “Intermediate”, while equal numbers of participants thought the 2D maps were “Intermediate” and “Mostly believable”.

Participants may have found the 2D maps more believable than the 3D landscape visualisations since they were more familiar with viewing this representation. Participants may have also been critical of the 3D landscape visualisations because of their exposure to very high resolution “computer-generated imagery” in mass media. Nevertheless, only 6 out of 32 found the static 3D landscape visualisations to be “Mostly unbelievable”, and no participants found them to be “Highly unbelievable”. This suggests that the realism of the static 3D landscape visualisations may have been sufficient to for them to form opinions on the cumulative development of the tar sands open pit mines.

Based on the open-ended questions in the follow-up questionnaire and the discussions, almost half the focus group participants (14 out of 32) thought the interactive and static 3D landscape visualisations were insufficiently realistic. Most of these participants (11 out of 14) were in the Edmonton session where all the computers had dedicated graphics cards, which allowed for smooth movement within the landscape simulated by the interactive 3D visualisation. Only four participants provided explanations about why they thought the interactive or static landscape visualisations were insufficiently realistic. Two participants thought the surface textures were “too clean” in the interactive 3D landscape visualisations. Two participants thought the static 3D landscape visualisations lacked atmosphere and depth of field. Nevertheless, participants still selected 3D visualisation screenshots of open pit mine scenarios more frequently than 2D maps. Perhaps the 3D visualisations may have been sufficiently realistic to depict deforestation and terrain modification better than 2D maps.

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[43] As discussed in Section 6.2, the two participants who thought the 2D maps may have misinterpreted the question since these participants stated in the open ended questions that they found the maps believable.

8.3.3. User Recommendations on Improving the Visualisation Content, Media or Interface

In addition to criticizing unsatisfactory aspects of the Google Earth project, a few participants made some explicit recommendations on improving the visualization content, media or interface.

Inclusion of mining machinery, people, and surrounding 3D trees in the interactive 3D landscape visualisation of the open pit mines appeared to satisfy most of the 32 focus group participants, but two wanted to be able to compare the depth of the open pit mines to an additional known object. Perhaps these participants wanted to be able to compare the depth of the open pit mines to larger objects or to be able to see it in additional open pits or places. The challenges of comprehending the vertical dimension, especially in a generally flat landscape are illustrated in Section 7.1.3.4., where the researcher attempted to demonstrate the height of the tailings dam next to the Athabasca River. As there was no reaction in the focus groups, it was not clear whether the participants understood the extent of the terrain modification.

Also, 13% of focus group participants wanted to see real photos or videos of open pit mines in addition to 2D maps and 3D visualisations. Although the researcher explained to participants that only ***existing*** tar sands open pit mines could be shown through that medium, participants replied that there was no substitute for the realism of photographs or videos. This underlines the credibility of photographs and video compared to simulated representations.

Although this was available as a feature in the Google Earth project, 13% of focus group participants stated that they wanted to see maps and images “side-by-side” as well as sequentially, so that the differences could be more readily compared. One participant also wanted to see the changes between the open pit mine scenarios on one map, which would require using outlined vector polygons to depict landscape disturbance rather than realistic colours and textures. These findings highlight the limited capacity of a viewer’s “working memory” (Salter, 2005) while alternating between sequences of existing, approved, and proposed open pit mines using the “radio” buttons. In graphic design, the use of “multiples”, which are side-by-side images showing change, is considered a useful technique to communicate change (Tufte, 1990). Overall, it may be useful to provide viewers multiple options to visualise landscape change including interactive image sequences, side-by-side images, and outlined vector polygons.

8.3.4. Researcher’s Evaluation of Effectiveness of the Google Earth Project

In this section, the evaluation criteria influenced primarily by the researcher’s visualisation methods (accuracy, representativeness, and contextualization), those assessed through the researcher’s observations of the focus group sessions (user engagement and perceived image clarity), and those interpreted from user response results described above are addressed.

8.3.4.1. Accuracy of the imagery in depicting actual and projected conditions

The following methods, as discussed in detail in Chapter 3 “Mapping and Landscape Visualisation Methods”, were used to ensure the accuracy of the 2D maps and 3D landscape visualisations:

1) Existing disturbance was based on automated classification of medium-resolution satellite imagery;

2) Existing land-cover was based on publicly-available government data based on medium-resolution satellite imagery;

3) Colours and textures for 3D landscape visualisation images were calibrated to two representative oblique aerial photographs at known heights and geographic locations; and

4) Future conditions were based on government and industry maps that were geo-referenced using the provincial sectional survey grid.

8.3.4.2. Representativeness of the imagery

Representativeness refers to the ability of users to see a variety of typical and meaningful views and conditions in the visual media (Sheppard, 2001). Accessing an interactive virtual globe enables users to select the views which they find meaningful or important. The focus group sessions ensured that all participants would experience the full range of viewpoints, from global 'views from space' to foreground views within open-pit mines from viewpoints on the ground. Determining what views the users prioritized was achieved through analysis of the significant viewpoints and scenarios selected most frequently by participants as "screenshots". The majority of participants (72%) selected screenshots with the full range of viewpoints from the continental scale to on the ground-level views of interactive 3D landscape visualisations.

In terms of ***topics or content***, the most frequently selected screenshots (38%) were open pit scenarios (i.e. images of existing, approved, and planned open pit mines). The next largest number of screenshot topics were "Standard Google Earth Imagery"(22%)[44], "Regulatory Approval Maps" (14%), and "Comparison to Cities" (13%). The relatively high frequency of screenshots showing the "Regulatory Approval Maps" is surprising and may indicate that participants were interested in the process through which governments approve tar sands open pit mines.

In terms of ***viewpoints or media***, the majority of the screenshot viewpoints were "Vertical Maps" (59%) (i.e. plan-views of 2D maps) followed by "Static Landscape Visualisations" (16%), "Oblique Maps" (14%), and "Interactive Landscape Visualisations (10%). The majority of the contents of these screenshots of vertical views of 2D maps were standard Google Earth satellite images. However, the majority of ***viewpoints or media*** used for the screenshots of open pit scenarios were static and interactive 3D landscape visualisations combined.

The largest number of screenshot viewpoints used for the "Open Pit Scenarios" were "Static Landscape Visualisations" (42%) followed by "Interactive Landscape Visualisations" (27%), "Vertical Maps" (25%) and "Oblique Maps" (7%). The fact that the majority of screenshots of the open pit mine scenarios (i.e. images of existing, approved, and planned open pit mines) used 3D landscape visualisations stands out in contrast to the opinions expressed by participants that

[44] Primarily satellite images of primarily forests, tar sands open pit mines, and the City of Fort McMurray.

the 3D landscape visualisations were significantly ***less*** believable than the 2D maps, as noted above. This indicates that, despite their lower perceived believability than 2D maps, 3D landscape visualisations may be more suited than 2D maps to depict complex landscape change involving deforestation and terrain modification at the local site-specific scale (e.g. lower elevation oblique views and ground-level views in open pits).

The actual selection of screenshots may have been influenced by the order of the focus group presentations. The 2D maps were presented first in the focus group agenda when participants were most energetic, while the interactive 3D landscape visualisations were presented last when participants may have been more tired. Also, the usability of the interactive 3D landscape visualisations, which focussed on close-ups of two proposed tar sands open pit mines, was limited by the speed of the computer graphics cards in the Vancouver focus groups, which may have constrained the selection of screenshots of this type. The central focus of the sessions may also have contributed to the dominance of the open pit mines in the screenshot selections.

Based on the screenshot selection methods that were used in the focus groups, it is impossible to determine precisely which topics or viewpoints were the most meaningful since there were numerous uncontrolled variables, as noted above and discussed more detail in Chapter 6 "Quantitative Methods". To determine scientifically the most meaningful topics or viewpoints, would require asking participants to rank a series of images, which would then be analysed using a "Q-sort" (Previte, Pini, & Haslam-McKenzie, 2007). However, based on the available data, it appears that the most meaningful viewpoints for large geographic areas (i.e. viewpoints from high elevations) may be 2D maps while viewpoints for smaller site-specific geographic areas (i.e. viewpoints from low or ground elevations) may be static or interactive 3D visualisations. This underlines the important feature of virtual globes such as Google Earth, which allow for seamless transition between these viewpoints, possibly enabling improved comprehension of both global and local implications of very large industrial projects such as the Alberta tar sands.

8.3.4.3 Contextualization of the imagery

The Google Earth project was designed to enable meaningful comparisons with other objects of known scale and relationship to key features such as rivers, other mines, etc. The user comments in Section 8.3.3 above and more generally in suggest that some additional contextualization (e.g. more labels of local features, side by side comparisons, and other scale objects) is desired by some users.

8.3.4.4 Engagement of participants with the tool

Based on observations from the researcher, the assistant, and the observers, virtually all participants seemed engaged and interested in all focus groups. There was so much participant enthusiasm that the researcher often had to limit the discussion actively in order to make sure that all questions were answered.

8.3.4.5. Credibility of imagery used

A minority of participants did not find the images to be credible – 9% percent found the 2D maps and 19% found the static 3D landscape visualisations to be "Mostly unbelievable" or "Highly unbelievable". Significantly more participants (60%) found the 2D maps to be "Mostly believable" or "Highly believable" than the static 3D landscape visualisations (28%). The credibility of interactive 3D landscape visualisation was not specifically measured. However, there were three times as many critical comments about interactive 3D landscape visualisation than complimentary comments. Overall, this indicates that the 2D maps and static 3D landscape visualisations were sufficiently credible, but that the interactive 3D landscape visualisation may have not been sufficiently credible; the fact that the computer capabilities in the Vancouver sessions limited smooth access to interactive visualizations may also have played a role.

8.3.4.6. Clarity of imagery used

Observation of the focus group participants during the sessions suggested that most imagery was readily understandable and clearly distinguished, with little evidence that participants were confused by what they saw. There were some questions raised by participants on image content that were answered by the researcher, which generally appeared to satisfy them.

8.3.4.7. Gain and bias in cognition

These issues have been described in depth in Section 8.1 above. Participants improved their knowledge by learning key information about the tar sands open pit mines. They improved their understanding of the geographic area of the open pit mines, their proximity to the Athabasca River, and the relationship to pipelines at a continental scale. However, there was some considerable over-estimation of the geographic area and growth in relation to city boundaries in some cases, though these might also be expected from real-world, photograph, or film viewing of the tar sands open pit mines. Nevertheless, there was no significant correlation between participants' perceived geographic area or growth of the tar sands open pit mines and participants' opinions. The problem of over-estimation may be resolvable by placing outlines of Canadian metropolitan cities side-by-side around the approved and planned tar sands open pit mines, as discussed in more detail in Section 8.1.1. Further user testing is required to determine whether this approach reduces the over-estimation issue.

8.4. Theoretical Implications of Case Study

As mentioned in Chapter 2 "Conceptual and Practical Background", only nine academic papers with user evaluations of virtual globes were found. Sheppard & Cizek (2009) suggested the following key benefits of using virtual globes to present landscape visualisations:

1) Access to visual information – Open free access for all Internet users with high-speed connections and reasonably up-to-date computers.

2) Interest – More meaningful and enjoyable engagement in viewing or manipulating information, plus increased interest with viewing familiar locations.

3) Representativeness – Freedom to view places or features from any angle or height, and from any number of views[45], instead of the more conventional limited selection of static views determined by the creator of the visualisations.

However, Sheppard & Cizek (2009:2108-2109) also cautioned about the following risks:

1) Emotional meanings (valid or invalid) may overwhelm valid cognitive responses.

   As discussed in Section 8.2.2., there were four explicitly emotional verbal statements and fourteen "key moments", but these did not appear to interfere with cognition.

2) Low data resolution in low-elevation or on-the ground visualisations affecting clarity, accuracy, and perceived realism

   As discussed in Section 8.3.1., participants were most critical about the interactive landscape visualisations which permitted viewing of two planned tar sands open pit mines on-the-ground. At higher viewing elevations, low resolution data may be sufficiently realistic due to the "defocusing effect" (MacEachren, 1995, p. 382) .

3) Mismatch of screen size and image resolution

   There were no indications of mismatches between screen size and image resolution.

4) Unsettling mismatches (inaccuracies) between 3D forms and draped satellite or orthophotographic imagery

   There were no indications of mismatches between 3D forms and draped imagery. Mismatches tend to occur primarily where imagery of tall buildings is taken from an oblique angle. There are no tall buildings in the study area.

5) Visualisation inaccuracy, unrepresentativeness, poor clarity, low credibility, and biased responses

   As discussed in Section 8.3.4., visualisation methods and focus group results generally indicate that visualisations were accurate, representative, clear, credible, and that responses were generally unbiased, although participants over-estimated geographic area and growth in some cases.

In this section, this study is compared to nine recent studies to review the evidence for the benefits and risks proposed by Sheppard and Cizek (2009) and to discuss the theoretical implications of this study.

[45] The original text states "except absolute ground-based as the lowest viewing height is often about 20 m". Since the article was submitted in 2006, Google Earth software has been updated to allow ground-based viewing.

8.4.1. Comparison of this Case Study to Recent Studies

As shown in Table 70, nine available user evaluation studies of virtual globes or Google Earth software that all used 3D features are summarized and compared to this case study.

Table 70 Comparison of this Case study to Recent Studies

User Evaluation Study	Survey Parti-cipants	Topic and Study Area	User Satisfaction with 3D Visualisation	User Preference for 3D Visualisation[46]	User Preference for 2D Maps[47]	User Cognition	User Attitudes and/or Affect	User Suggestions for Improvement
Bleisch and Dykes, 2008	99 hikers	"Genova 3D" ortho-photo draping software for hike planning in Switzerland	n/a	Overview, virtually revisiting a known region, deciding about visit	Specific route planning	Tasks without symbols or extracted data rarely solved	n/a	Additional contextual information
Clough & Read, 2008	10 students in library and information science	Use of Panoramio pictures in Google Earth and two software prototypes	Panoramio too slow to load pictures. Not enough pictures.	n/a	n/a	n/a	n/a	Options to select dates for pictures in prototype software.
Schoning et al., 2008	120 general public	User survey in Munster, Germany	n/a	Used most frequently for "Looking at my house" and looking at other places.	Used most frequently for navigation and finding a business.	n/a	n/a	n/a
Schroth et al., 2009	38 open house participants (domain experts and general public)	Visualisation of local impacts of climate change in Kimberly, British Columbia	89% of participants thought the 3D visualisation "helped me a little" or "helped me a lot"	Virtual globe (Google Earth) ranked first 16 times and last 11 times showing bimodal distribution.	Mean and median ranking of 2D maps was higher than virtual globe.	n/a	Google Earth animation of fire spread model had most emotional impact on workshop participants.	Average ranking for multi-media posters was very good; suitable complement to virtual globes
Bos, 2010	28 total users; 5 geo-information specialists, 23 "randomly picked"	3D Zoning Plan in Google Earth for Groningen, Netherlands	Navigating Google Earth was user-friendly but legend is unclear.	3D zoning plan was useful and easier to interpret than 2D maps	n/a	3D zoning plan was clear.	n/a	Add photos on existing buildings; add shadows; measuring heights;
Van Lammeren, Houtkamp, Colijn, Hilferink, & Bouwman, 2010	45 geography and planning students and domain experts	Compared use of raster cells, 2D icons, and 3D icons in Google Earth for future land use in Netherlands	Google Earth application easy to learn, functionalities easy to use, information was deemed reliable.	Future land use considered more beautiful with 3D icons than with 2D icons or raster cells.	n/a	2D-icons and 3D-icons, compared with coloured raster cells, did not improve efficiency or accuracy of participants	3D-icon visualization elicited the highest affective appraisals and positively influenced perception of environmental quality.	n/a

[46] "User preference" may include different study methodologies such as rankings, how used, content preferences etc.
[47] Ibid.

User Evaluation Study	Survey Parti-cipants	Topic and Study Area	User Satisfaction with 3D Visualisation	User Preference for 3D Visualisation	User Preference for 2D Maps	User Cognition	User Attitudes and/or Affect	User Suggestions for Improvement
Pettit, Raymond, Bryan, & Lewis, 2011	12 current users (domain experts from government agencies) and 89 future users (students in spatial information science)	Assessment of strengths and weaknesses of Google Earth application of climate change scenarios for "Lower Murray Landscape Futures" in southern Australia	*Current users*: accessibility, usefulness for planning and investment, learning concepts. *Future users*: Website functionality; amount of information; potential use for planning and management	n/a	n/a	n/a	n/a	*Current users*: lack of explanation about model assumptions, limitations, the methods used for map interpretation, and the lack of promotion. *Future users*: visual clarity, lack of communication, and the amount of technical information.
Stocker, Burke, Kennedy, & Wood, 2012	"Around 50" domain experts and general public	Participatory mapping use of Google Earth for climate adaptation for Rostness Island, Australia	Google Earth mapping activities were popular as a workshop process.	n/a	n/a	n/a	n/a	Different stages (visual, aural, interactive) interested different participants with different learning styles.
Bishop, Pettit, Sheth, & Sharma, 2013	26 domain experts	Google Earth visualisation of climate change, Victoria, Australia	Animated mapping, array of point data, pasture-yield projection hyperlink, "where is my farm", photorealistic flyover and panoramas, and inundation simulations were found to be helpful.	Most participants used 3D visualisation to view site-specific locations rather than entire regions.	n/a	Answers to questions about finding information on climate change were 77% correct.	After viewing, concerns about climate change increased slightly	Show scenarios side-by-side (rather than sequentially); Provide more contextual text and geographic information; Provide more underlying data layers (e.g. soils).
This case study.	32 general public	Google Earth visualisation of cumulative development of tar sands open pit mines, Alberta, Canada	Almost four-fifths of the participants thought the Google Earth project was "Mostly Useful" or "Very Useful".	Almost one-third of participants found 3D visualisations believable. Almost half found 3D visualisations insufficiently realistic. A minority found computer display of interactive 3D visualisation too slow.	Significantly more users found 2D maps to be more believable. Users found vertical 2D maps most interesting.	After viewing, significantly more users perceived the geographic area or scale as larger and the approved and planned growth as greater but over-estimated the geographic area or scale and growth of the approved tar sands open pit mines.	After viewing, significantly more users were more opposed to the expansion of open pit mines. In all three focus groups, there were thirteen "key moments" where participants expressed shock and surprise at 2D maps or 3D landscape visualisations or engaged in animated discussion.	Show scenarios side-by-side (rather than sequentially); Provide more contextual visual, textual, and geographic information; Provide 3D features to measure height or depth.

8.4.1.1. *Survey Participants*

Only one recent study (Schoning et al., 2008) surveyed the general public exclusively. Three recent studies (Schroth et al., 2009; Bos, 2010; Stocker et al., 2012) surveyed a combination of lay people and domain experts. The remaining five recent studies surveyed domain experts exclusively (Bleisch & Dykes, 2006; Clough & Read, 2008; van Lammeren et al., 2010; Pettit et al., 2011; Bishop et al., 2013). This case study surveyed the general public exclusively.

8.4.1.2. *Topics and Study Areas*

One recent study was about recreation (Bleisch & Dykes, 2006), two recent studies were generic software evaluations (Clough & Read, 2008; Schoning et al., 2008), two recent studies were about urban development (Bos, 2010; van Lammeren et al., 2010) and four of the recent studies were about rural development and climate change (Schroth et al., 2009; Pettit et al., 2011; Stocker et al., 2012; Bishop et al., 2013). The tar sands case study was the only one that focussed on natural resource extraction and very large projects. All nine recent studies took place in the "developed" countries and none of the studies focused on minority or disadvantaged populations. This case study was located in a remote hinterland of northern Canada, but did not survey aboriginal people within that area.

8.4.1.3. *User Satisfaction with 3D Visualisation*

In two recent studies, users made specific criticisms: there were not enough "Panoramio" pictures hyper-linked in Google Earth (Clough & Read, 2008) and the Google Earth legend was unclear (Bos, 2010). In five recent studies, most users were satisfied with the use of 3D visualisation in Google Earth (Schroth et al., 2009; van Lammeren et al., 2010; Pettit et al., 2011; Stocker et al., 2012; Bishop et al., 2013). The tar sands case study had similar findings where almost four-fifths of participants (25 out of 32) thought that the Google Earth project was "Mostly useful" or "Very Useful."

There is consistent evidence of overall user satisfaction with the 3D visualisation applications in Google Earth software between this case study and recent studies. This case study concurs with five recent studies that demonstrated high user satisfaction with 3D visualisation applications in Google Earth software (Schroth et al., 2009; van Lammeren et al., 2010; Pettit et al., 2011; Stocker et al., 2012; Bishop et al., 2013). There are some differences in findings between this case study and one recent study where users thought that there were not enough "Panoramio" pictures hyper-linked to Google Earth (Clough & Read, 2008) and another study where users thought the Google Earth legend was unclear (Bos, 2010). This discrepancy may be due to the fact that there was a sufficiently large number of hyper-linked images[48] in this case study and that the Google Earth legend was made as simple as possible.

[48] This case study did not use "Panoramio" images, which is a specific software format and server location. Instead this case study used balloons with hyper-linked static 3D landscape visualisations and photographs that resided on a private server. Nevertheless, these are similar to "Panoramio" images.

8.4.1.4. User Preference for 3D Visualisation

One recent study found that Panoramio was too slow to load pictures (Clough & Read, 2008). Another recent study found evidence for the cliché that Google Earth is used primarily for "looking at my house" and looking at other places, rather than for more practical uses (Schoning et al., 2008). In one recent study, most users stated that they preferred using 3D visualization for overview only, rather than route planning (Bleisch & Dykes, 2006). In contrast, in another recent study most users preferred using 3D visualisation for specific locations instead of the whole region (Bishop et al., 2013). Two recent studies found that users thought that 3D visualisations were easier to interpret than 2D maps (Bos, 2010) and that 3D icons were more beautiful than 2D icons or raster cells (van Lammeren et al., 2010). However, another recent study found that almost an equal number of users ranked the virtual globe (Google Earth) first or last in terms of preference (Schroth et al., 2009).

In this case study, almost half of users found static and interactive 3D visualisations insufficiently realistic, less than one-third (28.1%) of users thought the static 3D landscape were "Mostly believable" and "Somewhat believable", and some users found the computer display of interactive 3D visualisations to be too slow. However, none of the other studies evaluated the realism of 3D visualisations, while users in only one other study (Clough & Read, 2008) complained about the speed of graphical display.

Regarding user preference for 3D visualisation, there is no predominant pattern of either concurrence or discrepancy between this case study and recent studies. There is some concurrence between this case study, which found that users found 2D maps significantly more believable than 3D landscape visualisations and Schroth et al. (2009), which found bimodal preference for 3D visualisation. There is also concurrence between this case study, where some users thought that interactive 3D visualisations loaded too slowly and where users complained about the slow computer display of photographs (Clough & Read, 2008). Although these are somewhat different in content, there is some discrepancy between this case study and two other recent studies where users thought that 3D visualisations were easier to interpret (Bos, 2010) and that 3D icons were more beautiful (van Lammeren et al., 2010) than 2D maps.

There is also some discrepancy among three recent studies where most users preferred 3D visualisation for "overview only" (Bleisch & Dykes, 2006), used Google Earth for specific locations (Bishop et al., 2013), and used "looking at my house" and other places (Schoning et al., 2008).

8.4.1.5. User Preference for 2D Maps

Two recent studies found that users preferred 2D maps for practical uses such as route selection, navigation, or finding a business (Bleisch & Dykes, 2006; Schoning et al., 2008) and one recent study found that user ranking of 2D maps was higher than of virtual globes (Schroth et al., 2009). In this case study, significantly more users thought the 2D maps viewed in Google Earth were more believable than 3D visualisations. Users also found vertical viewpoints of 2D regional maps to be most informative. However, users found 3D visualisations of local project scenarios to be most informative.

There is consistent evidence of user preference for 2D maps between this case study and recent studies. This case study concurs with three recent studies which documented user preference for 2D maps (Bleisch & Dykes, 2006; Schoning et al., 2008; Schroth et al., 2009). There is no discrepancy on the use of 2D maps between this case study and other recent studies.

8.4.1.6. User Cognition

Two recent studies found that the use of Google Earth software facilitated user cognition (Bos, 2010; Bishop et al., 2013). One other recent study concluded that 3D visualisations needed symbols or extracted data to increase task accuracy (Bleisch & Dykes, 2006) and another recent study found that the addition of 3D icons did not improve the efficiency or accuracy of participants (van Lammeren et al., 2010). In this study, significantly more participants who thought they knew the geographic area of the existing open pit mines thought they were larger after viewing. After viewing, significantly more users thought they knew the geographic area and amount of projected growth of open pit mines. However, an average of 28% of users over-estimated the actual geographic area and an average of 16% of users over-estimated the projected growth of the tar sands open pit mines after viewing the Google Earth project.

Regarding user cognition, there is no predominant pattern of either concurrence or discrepancy between this case study and recent studies.

8.4.1.7. User Attitudes and/or Affect

Three recent studies found that 3D visualisation had an impact on user affect: the Google Earth animation of fire spread model had most emotional impact on workshop participants (Schroth et al., 2009); 3D icons “elicited the highest affective appraisals and positively influenced perception of environmental quality” (van Lammeren et al., 2010); and viewing the Google Earth visualisations slightly increased concerns about climate change (Bishop et al., 2013). This case study found that significantly more users became more opposed to the expansion of open pit mines after viewing the Google Earth project. In this study’s three focus groups, there were also thirteen “key moments” where participants expressed shock and surprise at 2D maps and 3D landscape visualisation or engaged in animated discussion, which appeared to be the result of visualisation content or display characteristics.

There is consistent evidence of changes to user attitudes and/or affect after viewing 3D visualisations between this case study and recent studies. This case study concurs with three (3) recent studies demonstrating changes to user affect after viewing (Schroth et al., 2009; van Lammeren et al., 2010; Bishop et al., 2013). There are no discrepancies between this case study and other recent studies.

8.4.1.8. User Suggestions for Improvement

In three recent studies, users suggested the need for more contextual information or explanations (Bleisch & Dykes, 2006; Pettit et al., 2011; Bishop et al., 2013). In another recent study, users also suggested showing scenarios side-by-side rather than sequentially (Bishop et al., 2013). Two recent studies both stated that different users have different learning styles and therefore prefer multiple media (Schroth et al., 2009; Stocker et al., 2012). Users in two studies also suggested additional software features – ability to select dates for images (Clough & Read, 2008) and adding photos to buildings as well as a tool to measure height (Bos, 2010). In this case study, users suggested adding more contextual features, users suggested showing scenarios side-by-side rather than sequentially, and users suggested adding a tool to measure the vertical dimension.

There is evidence of similar user suggestions for improvement between this case study and recent studies. There is concurrence among two other recent studies which both reported that different users have different learning style and prefer multiple media (Schroth et al., 2009; Stocker et al., 2012).

8.4.2. Discussion of Theoretical Implications

It appears contradictory that this case study and other recent studies concur that there is overall user satisfaction with 3D visualisation applications in Google Earth software while at the same time they also concur that users prefer 2D maps. However, it is possible to prefer one of two satisfactory items where one item performs better than the other.

This case study and recent studies also concur that there were changes to user attitudes and/or affect after viewing 3D visualisations. At the same time, there are discrepancies between this case study and recent studies concerning the accuracy of user cognition after viewing 3D visualisations.

A possible explanation for the overall user satisfaction of virtual globes and Google Earth software is "emotionally-centered design", which allows users to move smoothly and even simultaneously in both horizontal and vertical dimensions (i.e. flying around and zooming in and out) due to "Rich Internet Applications" that use "pre-caching of content coupled with more processing on the client side" (Norman, 2006). Other factors contributing to the emotionally and aesthetically satisfying experience of using virtual globes may be the "overview effect" and the "orienting response". The "overview effect" refers to the emotionally and spiritually profound experiences reported by astronauts upon seeing the earth from space (White, 1998), which may be simulated by virtual globes. The "orienting response" is a physiological reaction to novel or significant stimuli (Diao & Sundar, 2004), which may also be triggered through simultaneous horizontal and vertical movement while using virtual globes such as Google Earth.

In conclusion, the findings indicate that virtual globes such as Google Earth stimulate emotional reactions and are generally satisfying. Viewing these applications also influences user attitudes and/or affect about environmental change. However, the findings indicate that these experiences do not necessarily improve the accuracy of user cognition. This further underlines a parallel conclusion as made by Schroth et al. (2009) about the value of combining 3D visualisation applications in virtual globes with other media such as 2D maps to accommodate users with different learning styles.

8.5. Proposed Interim Guidelines for the Use of Virtual Globes in Engaging and Informing the Public on Cumulative Effects of Very Large Projects

Based on ethical considerations, visualisation guidelines have been proposed (Sheppard, 2012; Sheppard & Cizek, 2009; Sheppard, 2001) and methodologies for the use of visualisations in public participation have also been proposed (Pond et al., 2010; Mulder, Sack-da-Sliva, & Bruns, 2007). Unlike community or neighbourhood scales, very large projects present unique challenges to users for understanding scale or geographic area. Based on the foregoing findings on the impacts and effectiveness of the Google Earth project and the author's observations, the following interim guidelines are proposed specifically for the use of virtual globes in informing the public on the cumulative effects of very large projects. These guidelines are broadly compatible with this previous work, but incorporate the study participants' and the researcher's recommendations for improvement. They are intended both for practitioners and for researchers seeking to test or develop new visualization methods. Overall, the main principle stemming from this study's findings is that communication may be most effective if users are provided with multiple media options that accommodate their particular preferences for specific topics, scales, and viewpoints.

8.5.1. Guideline #1 – Combine 2D Maps and 3D Landscape Visualisations in Virtual Globes

As demonstrated in this case study, use a combination of 2D maps, static 3D landscape visualisations in popup balloons with hyper-links to standard web-pages, and interactive 3D landscape visualisations within virtual globes such as Google Earth. By providing access to multiple media within virtual globes such as Google Earth, users with different learning styles will be able to select the media they most prefer. Since the preparation of 3D landscape visualisations can be quite time-consuming, 2D maps should be prepared and distributed as a first priority. As data loading is relatively straightforward, these maps can also be distributed within virtual globes such as Google Earth and interactive mapping platforms such as Google Maps.

8.5.2. Guideline #2 – Create Options for Viewing On-Line Interactive 2D Maps

In addition to using virtual globes such as Google Earth, also create options to view very large projects using on-line interactive 2D mapping tools such as Google Maps with photos, videos, written descriptions, and static 3D landscape visualisations in pop-up balloons and hyper-links to standard web-pages. This will allow users who do not wish to download or use virtual globes or Google Earth software to be able to view interactive 2D maps and static 3D visualisations using standard web browsers.

8.5.3. Guideline #3 – Create Options to View 2D Maps and Static 3D Visualisations in Standard Web-Pages

In addition to using virtual globes such as Google Earth, also create options to view very large projects as static maps and static 3D landscape visualisations within standard web-pages using hyper-links between development scenarios (e.g. existing, approved, proposed). This will allow users who do not wish to use interactive 2D maps to view static 2D maps and 3D visualisations using standard web browsers.

8.5.4. Guideline #4 – Include Photos, Videos, and Written Descriptions

When using virtual globes such as Google Earth, include substantial amounts of photos, videos, and written descriptions of very large projects in popup balloons or hyper-links to web-pages. In this case study, there were only two photographs, no videos, and a limited amount of written description provided and some participants requested much more of this kind of contextual information.

8.5.5. Guideline #5 – Compare Overlays of Known Geographic Features

Compare overlays of known geographic features such as outlines of major cities to very large projects. The ability to compare scenarios of the expansion of tar sands open pit mines to outlines of known cities was the single most popular feature identified by participants. Avoid large variations between city size (e.g. City of Vancouver vs. City of Edmonton or City of Calgary) and clarify difference between "cities" and "metropolitan areas". Consider using a circle of an equal area to that disturbed by the very large project, in order to compare cities so as to minimize the convex hull effect. Consider placing multiple outlines of cities (e.g. three Edmontons) side-by-side to illustrate cumulative growth.

8.5.6. Guideline #6 – Label Contextual Geographic Features

Include labelled contextual and meaningful geographic features such as surrounding communities and water-bodies. Google Earth software provides the ability to automatically label geographic features but in this study that feature was turned off to reduce clutter on the screen. However, participants wanted to know the names of surrounding communities and water-bodies. In order to reduce the clutter from the automatic labelling of all geographic features in Google Earth, labels for the most meaningful geographic features should be added manually.

8.5.7. Guideline #7 – Show Development Scenarios as Interactive Image Sequences and Use Side-by-Side Images and Outlined Vector Polygons

Show development scenarios (e.g. existing, approved, and proposed) as interactive image sequences and side-by-side images. Also show the changes between scenarios as outlined vector polygons on 2D maps or 3D landscape visualisations. Showing visualisations as side-by-side images and changes between scenarios may reduce load on viewer's "working memory", thereby allowing them to more easily understand future landscape change.

8.5.8. Guideline #8 – Use Known 3D Objects to Compare Depth or Height

Compare the depth or height of very large projects by including known 3D objects throughout the study area in both static and interactive 3D landscape visualisations. Although 3D trees and 3D mining machinery were provided for two sample interactive landscape visualisations, participants may have wanted to see comparisons to known 3D objects throughout the study area so that they could more readily understand the depth of the open pit mines or the height of the tailings pond dykes.

8.6. Directions for Future Research

In this section, recommendations are made for application to cumulative effects assessment, comparative research, analysis of video recordings of computer screen activity, increased participant diversity, controlled studies, and internet tracking/surveys.

8.6.1. Application to Cumulative Effects Assessment

It was beyond the scope of this study to examine comprehensive cumulative effects of tar sands development which includes wildlife, vegetation, air, water, and socio-economics. It was also beyond the scope of this project to examine in-situ tar sands, as there are 187 existing, approved, and proposed in-situ projects in Alberta (Alberta Department of Energy, 2013b). With additional effort, it would be possible to also display the cumulative physical footprint of in-situ project using virtual globes and 3D landscape visualisations. On a broad geographic area, the visual effects of *in-situ* development would likely appear less extreme than open pit mining, but Google Earth is particularly useful in zooming in and out of small areas where the impact of in-situ development to landscape disturbance and forest fragmentation would be far more evident.

Using virtual globes and 3D landscape visualisations, it would be possible to display the cumulative effects of industrial projects on wildlife using "zones of influence" buffers and landscape fragmentation metrics. These have been modelled using static 2D maps for the TOTAL Josly tar sand mine (Cizek, 2010), the Mackenzie Gas Project (Cizek, 2005); the Slave Geological Province diamond mines (Cizek, 2003) and the Fort Liard natural gas area (Cizek, McCullum, & Booth, 2002). These buffers could be displayed within virtual globes using 2D and 3D maps and user responses could be evaluated. It is also possible to display greenhouse gas and pollutant emissions using 3D columns (Foster, 2012) or other visual imagery, which could also be displayed within virtual globes to evaluate user response. Finally, it is also possible to display use of water in virtual globes using 3D effects and changes to water levels using 3D landscape visualisation. However, it is more difficult to imagine how socio-economic effects could be displayed using virtual globes or 3D landscape visualisation.

Large projects in additional geographic regions in Canada where virtual globes could be used effectively to display cumulative physical footprints and effects include shale gas projects in northeastern British Columbia, hydro-electric projects in northern Manitoba, and the "Ring of Fire" chromite mining projects in north-western Ontario.

8.6.2. Comparative Research

Bishop et al. (2013, p. 219) suggest that the purpose of user evaluation of visualisation products should be to:

- ensure that as time goes by less effort is spent on visualisation products which do not meet user needs;
- provide feedback to investors and managers on the value of the generated products; and
- maximize opportunities for comparisons across study components and with other evaluation research.

Bishop et al. (2013, p. 219) also recommend that user evaluations "should include more than one technique in order to provide a level of confirmation of the interpretation of results available from a single technique" including:

- quantitative subject responses to visualisation products as either ratings (Likert scale) or rankings (preferred options);
- qualitative subjective responses to visualisation products provided by a selection of during-use running commentary[49] and/or post-use debriefing (note that use needs to be by an individual or in small groups for this to be meaningful);
- objective assessment of the user's ability to answer questions or perform tasks as a result of exposure to the visualisation products;
- before and after tests of beliefs, attitudes, and knowledge; and
- the tracking of actions during product use to reveal visibility and popularity of product elements.

As shown in Table 70 above, which compares this case study to recent studies, none of the recent studies addressed all of the following factors:

1) User satisfaction with 3D visualisation;
2) User preference for 3D visualisation;
3) User preference for 2D maps;
4) User cognition;
5) User attitudes and/or affect; and
6) User suggestions for improvement.

With the exception of Bishop et al. (2013), which is only missing "User preference for 2D maps", all recent studies are also missing at least two or more of the above factors. In order to improve theoretical understanding and better meet user needs, future comparative research should address at least all these six factors.

8.6.3. Analysis of Video Recordings of Computer Screen Activity

Bishop et al. (2013) report that they were successful in video recording computer screen activity from only seven out of twenty-six participants using Camtasia Studio software (Techsmith, 2013). This was due to the excessively large video file sizes generated through the lengthy workshops that lasted up to three hours. Furthermore, Bishop et al. (2013) point out the difficulty of reviewing the video recordings manually and suggest using "background software to record visits to specific elements of the interface, the time spent working on them, and the range of options located." These elements could be analysed using MacSHAPA observational analysis software (Sanderson, 1997), which has been applied to evaluate a 3D landscape visualisation interface (Salter, 2005).

This case study was successful in video recording computer screen activity from 26 out of 32 participants (i.e. 81.3% success rate) using Debut Video Capture shareware (NCH Software, 2013). These video recordings were purposely set in low resolution compressed format (1024 kbps in Windows Media Video) to maintain file size within an acceptable level during the 2.5

[49] "During-use running commentary" means user commentary while using the virtual globe software.

hour workshops. Nevertheless, the successful video recording all have file sizes exceeding one gigabyte each.

While these video recordings were used selectively to confirm some participants' use of the Google Earth interface, they have not yet been analysed systematically. The analysis of these results could help identify where participants got lost, where there were difficulties loading data, and which parts of the interface worked well. As there are 26 video recordings lasting 2.5 hours each, this would require reviewing 65 total hours of video. To divide up the workload, the interpretation of the videos could be undertaken by a team of research assistants using standardized forms and coding methods.

It is recommended the future studies incorporate video recordings of screen activity since this provides a useful cross-reference, regardless of whether the video recordings are analysed or not.

8.6.4. Involvement of Participants from Developing Countries, Ethno-Cultural Minorities, and Indigenous Peoples

This study mostly attracted participants with moderate opposition to the tar sands. Due to the relatively small sample size, it is impossible to generalize these findings to the wider Canadian public. There is a need to do more studies using such techniques with larger samples that match the profile of opinion across Canada, plus actual public engagement based on wider results from various visualisation studies.

At the same time, this case study and all recent studies took place in developed countries without specifically including users from ethno-cultural minorities or indigenous peoples. This omission is significant due to the "digital divide" between rich and poor that has also documented regarding the use geo-spatial technologies by Caucasians and African-Americans (Crutcher & Zook, 2009). Furthermore, there are also differences in cross-cultural perception of landscape change between indigenous peoples and Euro-Canadians (Lewis, 2011).

The Alberta tar sands open pit mines of this case study area are surrounded by indigenous communities. As well, most of Canada's natural resources (Usher, 2003) and many of the world's natural resources (International Work Group on Indigenous Affairs, 2013) are located on indigenous lands. Therefore, the effectiveness of using 3D visualisation applications in virtual globes by indigenous peoples to identify, understand, and communicate natural resource extraction on their lands could be examined. For example, the Surui Amazon tribe has used Google Earth and Android cell phones to map their territories and document illegal logging (Paiter-Surui, 2012). However, the success and limitations of these kinds of applications have not yet been formally documented.

8.6.5. Controlled Studies

As this case study was only exploratory, no controls were used to compare the effects of viewing 3D visualisations in virtual globes on user cognition and effect. Such controlled and comparative workshops have been used to evaluate the educational effectiveness of using graphically-enhanced textbooks (SEG Research, 2009). Controlled and comparative workshops could be undertaken to establish more reliable comparisons between the uses of different media in communicating environmental change.

These controlled studies could include the following alternative media:

1) Spoken word and texts only;
2) Spoken word, texts, and static 2D maps;
3) Spoken word, texts, and interactive 2D maps;
4) Spoken word, texts, and static 3D visualisations; and
5) Spoken word, texts, static and interactive 3D visualisations.

8.6.6. Internet Tracking and Surveys

The maps and visualisation products should be made publicly available on the internet. This is particularly important due the absence of publicly-available information about the cumulative development of the tar sands, as discussed in more detail in Section 8.7.2. On-line maps and visualisation products could be tracked by the number of downloads and number of page views by location of viewers. The on-line maps and visualisation products could combined with an internet survey such as those conducted for visual landscape assessment (Roth, 2006).

8.7. Implications and Constraints for Mapping and Visualisation Practice

This section discusses the technical and political constraints and opportunities of using virtual globes such as Google Earth to inform and engage members of the public about very large projects.

8.7.1. Technical Constraints and Opportunities

While limited by participant sample size and computer processing speed within the laboratories, this study has demonstrated the technical practicality and usefulness of displaying the existing and future physical footprint of the tar sands open pit mines using virtual globes such as Google Earth. A similar approach could be used for other very large projects elsewhere in the world. However, it can be quite time-consuming to develop 3D landscape visualisations and load them into virtual globe software. Therefore, 2D maps should be developed as a first priority and displayed in standard web-pages. It has also been demonstrated that communicating the cumulative physical footprint of industrial projects may be a useful first step in developing greater public understanding of a comprehensive suite of cumulative effects.

This study was constrained by the lack of available or affordable of high resolution geo-spatial data from both industry and the government of Alberta. If such data were available for other large projects, more accurate and detailed maps and 3D visualisations could be produced. The development of interactive 3D visualisations also remains problematic in virtual globes such as Google Earth. Due to internet bandwidth and client-side graphics processor limitations, only small geographic areas of terrain, vegetation, buildings, machinery, and people can be served as 3D models using data formats such as COLLADA (Khronos Group, 2013).

While the standard Google Earth imagery includes 3D trees in select areas (Google Corporation, n.d.-c), these tree models are based on Google Corporation's proprietary software and not available to the public (Askay, 2011). The ability to create better interactive 3D visualisations within virtual globes such as Google Earth will likely improve in the future with increased internet bandwidth and faster client-side graphics processors. It may also be possible to add higher resolution textures and to modify 3D terrain by excavating pits directly into the digital elevation model. Also browser-based applications such as the new Google Maps that do not require specialized client-side software are now able to display interactive 3D visualisations, but only on computers with the most up-to-date graphics cards (Google Corporation, 2013b).

8.7.2. Political Constraints and Opportunities

If governments actually practised informed democratic debate and participatory planning they would make maps and visualisations of past, existing, and future cumulative development of very large projects such as the tar sands available to the public. Instead, the governments of Alberta and Canada have become "energy security states", where secret state-industry relations are maintained to secure steadily growing supplies of fossil fuels (Nikiforuk, 2008).

For over forty years, the Alberta tar sands have been a key part of North American continental energy security policy and planning. Following the peak of American oil production in 1971 and the OPEC oil embargo in 1973, the United States embarked upon "Project Independence" to secure oil self-sufficiency through the use of unconventional fossil fuels such as tar sands, coal-to-liquids, and oil shales (Pratt, 1976).

Anticipating the impending peak of world-wide conventional oil production, the United States established the "National Energy Policy Group" headed by then Vice-President Dick Cheney in 2001. In collaboration with representatives of the oil industry, the group carried out most of its work in secret (Ruppert, 2004). Only a summary was made available to the public, which stated that the continued development of the tar sands "can be a pillar of sustained North American energy and economic security" (National Energy Policy Group, 2001). Based on this report, the United States Congress passed the "Energy Policy Act", which has a "Set America Free" sub-section that establishes "a United States commission to make recommendations for a coordinated and comprehensive North American energy policy that will achieve energy self-sufficiency by 2025 within the three contiguous North American nation area of Canada, Mexico, and the United States." (109th Congress of the United States of America, 2005).

The Energy Policy Act also established a task force to initiate "a partnership with the Province of Alberta, Canada, for purposes of sharing information relating to the development and production of oil from tar sands." The Act required the Secretary of Energy to update its assessment of domestic heavy oil resources to include "all of North America and cover all unconventional oil, including heavy oil, tar sands (oil sands), and oil shale" (109th Congress of the United States of America, 2005). These initiatives include the "Security and Prosperity Partnership", which held its first “Oil Sands Experts Working Group” in Houston, Texas, including Canadian, American, and industry officials in January 2006 (Oil Sands Experts Group, 2006).

According to confidential United States embassy cables published by Wikileaks, these energy security policies have been continued by the Obama administration. During President Obama’s first state visit to Canada in January 2009, the embassy briefing note to the President said “there is also keen sensitivity over the higher environmental footprint of oil from western Canada's oil sands and concern about the implications for Canada of your energetic calls to develop renewable energies and reduce our reliance on imported oil” (United States Embassy, Ottawa, 2009c).

In September 2009, David Goldwyn, the State Department’s “Special Envoy and Coordinator for International Energy Affairs” made the “first high-level visit by a State Department official” since the President’s visit earlier that year to Canada. Ambassador Goldwyn met with both government and industry officials, who were “concerned about the mixed message the oil sands send and difficult headlines” and were “both spending considerable time ruminating over the best approach to advocate on behalf of the oil sands”. Upon the suggestion of the Ambassador, “The Government of Canada also took on board the message to reach out to the energy security/national security audience.” (United States Embassy, Ottawa, 2009b).

In November 2009, Jim Prentice, then Canada’s federal environment minister, met with the Ambassador of the United States Ambassador Jacobson (United States Embassy, Ottawa, 2009a). Minister Prentice expressed his concern about the damage to Canada’s international reputation from negative media coverage of the tar sands. He also requested that the Ambassador arrange for a meeting with then Senator John Kerry to discuss a continental carbon market, presumably to avoid any negative trade implications for the tar sands. In 2010, an access to information request revealed that the federal and Alberta governments had set up a “secret, high-level committee to coordinate the promotion of the oilsands with Canada’s most powerful industry lobby group [the Canadian Association of Petroleum Producers]” (Lukacs, 2012).

In its most extreme manifestation, the energy security state uses counter-terrorism strategies to criminalize dissent against the tar sands (Le Billon & Carter, 2012). In 2007, the Alberta government commissioned a confidential threat assessment claiming that the “oilsands is extremely vulnerable to terrorist attacks and that ‘Alberta is not prepared’” (Nikiforuk, 2007). In response to non-violent civil disobedience by Greenpeace, the Alberta government threatened to unleash its counter-terrorism plan (Arsenault, 2009). A study commissioned by the Canadian Defence and Foreign Affairs Institute claims that “extra-legal” obstruction against the tar sands from environmentalists and First Nations is likely to continue but is “unlikely to become large scale and widespread unless these groups make common cause and cooperate with each other”, which is unlikely due to “different social characteristics and conflicting political interests” (Flanagan, 2009).

Faced with the reality of the energy security state, it remains the responsibility of civil society to make effective and ethical use of geo-spatial technologies to raise public awareness about the future growth and environmental implications of very large projects such as the tar sands. Maps and visualisations should be communicated in multiple media, including images on standard web-pages, interactive 2D maps, and virtual globes with interactive 3D visualisations. Environmental non-governmental organisations (ENGO's) also need to go beyond the timeworn "mind bomb" of image politics (Weyler, 2011; Delicath & Deluca, 2003; Hunter, 1971) to keep pace with a public that is becoming increasingly literate in the use of geo-spatial technologies (Goodchild, 2009).

8.8 Conclusions

In conclusion, answers to the major theoretical research questions are summarized below:

1) *What are people's cognitive, attitudinal, and affective responses before and after viewing very large resource extraction complexes such as the tar sands complex represented in interactive multi-scale media as described above? How are these responses related to the socio-demographic characteristics and their perceptions and opinions of the tar sands open pit mines?*

Based on the small self-selected sample of participants who were interested in the tar sands, it appears that Canadians may be generally uninformed about the geographic area and growth of the tar sands open pit mines. This contradicts the finding of a survey conducted by the Canadian Association of Petroleum Producers, which found that 67% of respondents living in Vancouver were "Very Familiar" or "Somewhat Familiar" with the "subject of oil sands development in northern Alberta" (Canadian Association of Petroleum Producers, 2010). However, this industry survey did not ask the participants for any substantive knowledge about the tar sands such as the geographic area or growth.

Based on the results of the focus group on the tar sands case study, after viewing very large resource extraction projects using interactive multi-scale media, people may:

a) Experience significant learning;
b) Perceive the geographic area of the projects as larger than before viewing;
c) Somewhat over-estimate the geographic area and growth of the very large projects;
d) Become significantly more opposed to future projects but less so to existing projects; and
e) Express emotional reactions due to disclosure of key aspects of very large project or benefits of the display medium.

Based on the significant correlations identified in the focus groups, the most important finding about relationships to socio-demographic characteristics is that people with prior media exposure to maps, photos, videos, and film about the tar sands may have more negative opinions about the tar sands. Also, people with more experience using computers may gain more knowledge from viewing the Google Earth project.

2) *Can interactive, multi-scale visualisation using virtual globes affect peoples' cognitive and affective responses to existing and future development of a very large resource extraction project?*

Overall, this study concludes that communicating the geographic area and growth of the tar sands using virtual globes such as Google Earth (that allow multiple visualization media and seamless transition between scales) affects peoples' perception and opinion of very large projects. As there was no correlation between perceived geographic area or growth and opinion, it does not appear that the specific accuracy (i.e. "Canadian metropolitan city" vs. "World metropolitan city") of the estimation of the geographic area or growth of very large projects is important in driving opinions for or against the project. However, gaining a general understanding of the geographic area and appearance/nature of the extraction project appears to be important in changing opinion of the general public about very large projects.

3) *How effective are these new tools (2D maps, static and interactive 3D visualisations) and different viewpoints (i.e. plan view, oblique, and ground-based) presented in virtual globes in meaningfully informing the general public about very large resource extraction projects?*

Based on the criteria proposed in Section 2.4., it was found that the new tools are largely effective. As discussed in Section 8.3.4., the researcher attempted to prepare a Google Earth project that was accurate, representative, and contextual. Responses from users also demonstrated that:

1) The Google Earth project was usable;
2) Participants were engaged with the tool;
3) Most images were credible and clear as perceived by the participants;
4) Participants gained in cognition; and
5) There was some bias in cognitive response over-estimating the geographic area and growth, which might be corrected by using alternative approaches to contextualizing the visualizations with clearer scale markers and questions.

Based on the findings where 60% of participants found 2D maps to be believable compared to 28% of participants who found static 3D landscape visualisations to be believable, it is safest to provide both mapping and 3D landscape visualizations, to avoid the risk of ineffective presentations, and to meet the expressed needs of users for both 2D and 3D viewing. While the Google Earth project, which combined 2D maps with static and interactive 3D visualisations, was found to be effective overall, these findings suggest that 2D maps should be prepared first before 3D landscape visualisations are attempted, especially in situations where resources are limited. Unlike architectural rendering programs and video-games, the databases and software systems available with current visual globes for visualizing very large projects interactively through the internet, with considerable detail and realism, are not yet fully mature. However, their promise and unique capabilities in displaying very large projects call for further development and application to public engagement and critical decision-making.

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0&GK=0&GRP=1&PID=101998&PRID=0&PTYPE=101955&S=0&SHOWALL=0&SUB=0&Temporal=2011&THEME=88&VID=0&VNAMEE=&VNAMEF=

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APPENDICES

APPENDIX A: GOVERNMENT AND INDUSTRY REGULATORY MAPS OF APPROVED AND PROPOSED TAR SANDS OPEN PIT MINES GEOREFERENCED IN GOOGLE EARTH

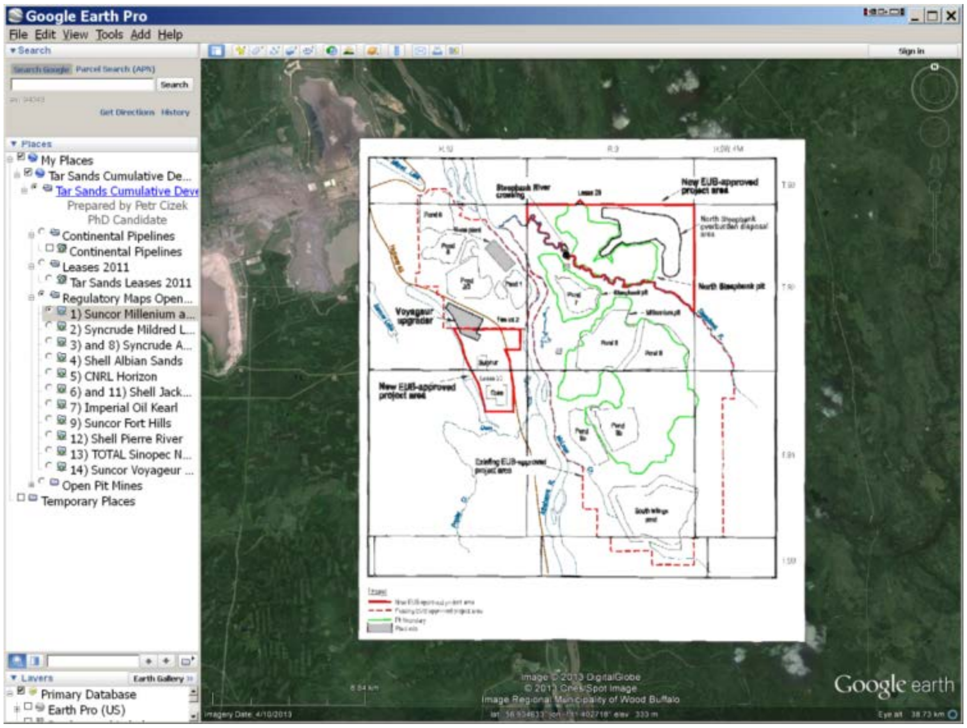


Figure 138 Approved Suncor Millenium and Steepbank Expansion

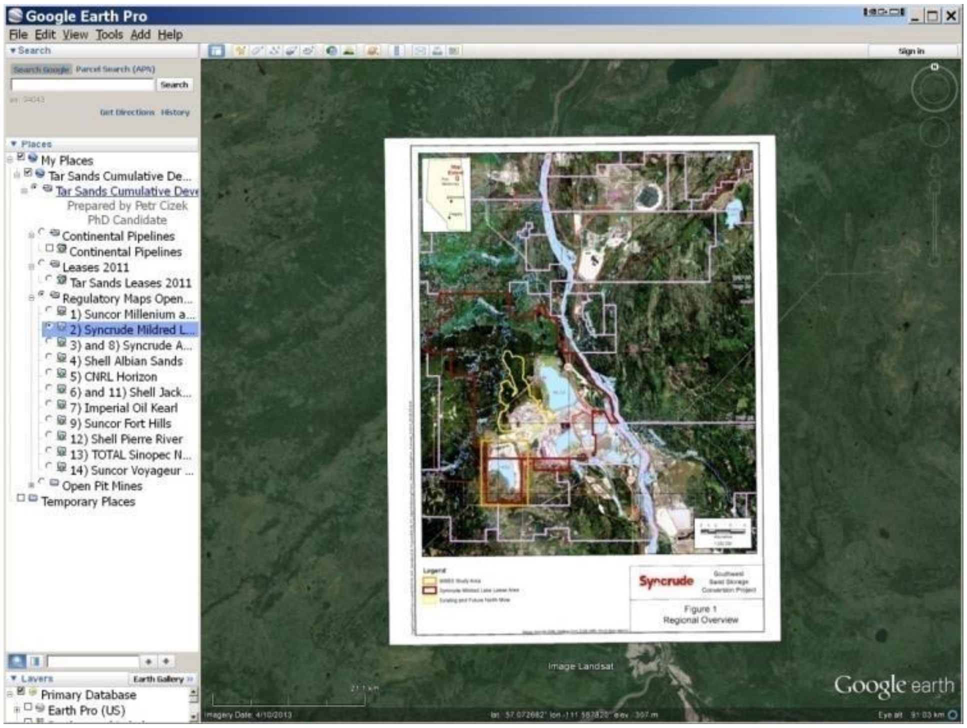


Figure 139 Approved Syncrude Mildred Lake Expansion

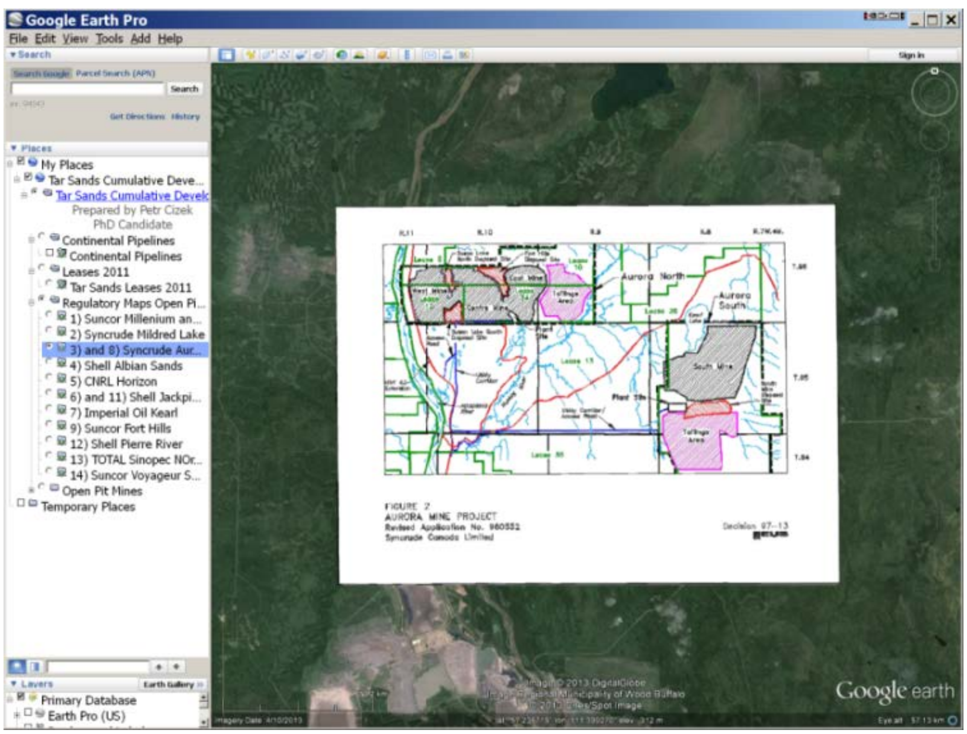


Figure 140 Approved Syncrude Aurora Mine

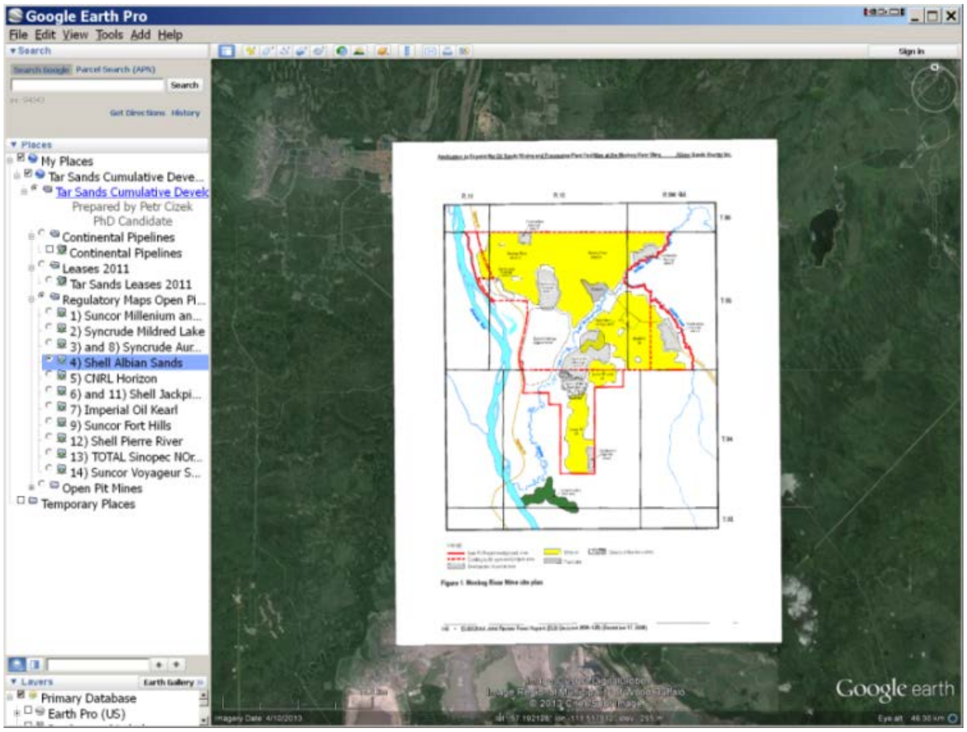


Figure 141 Approved Shell Albian Sands Muskeg River Mine

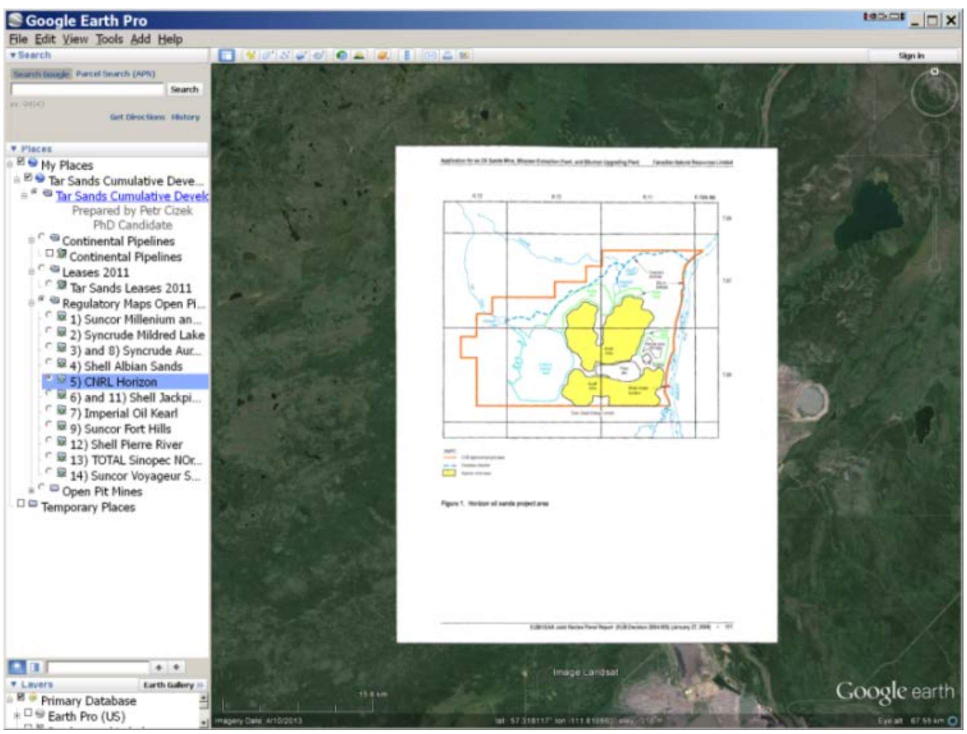


Figure 142 Approved CNRL Horizon Mine

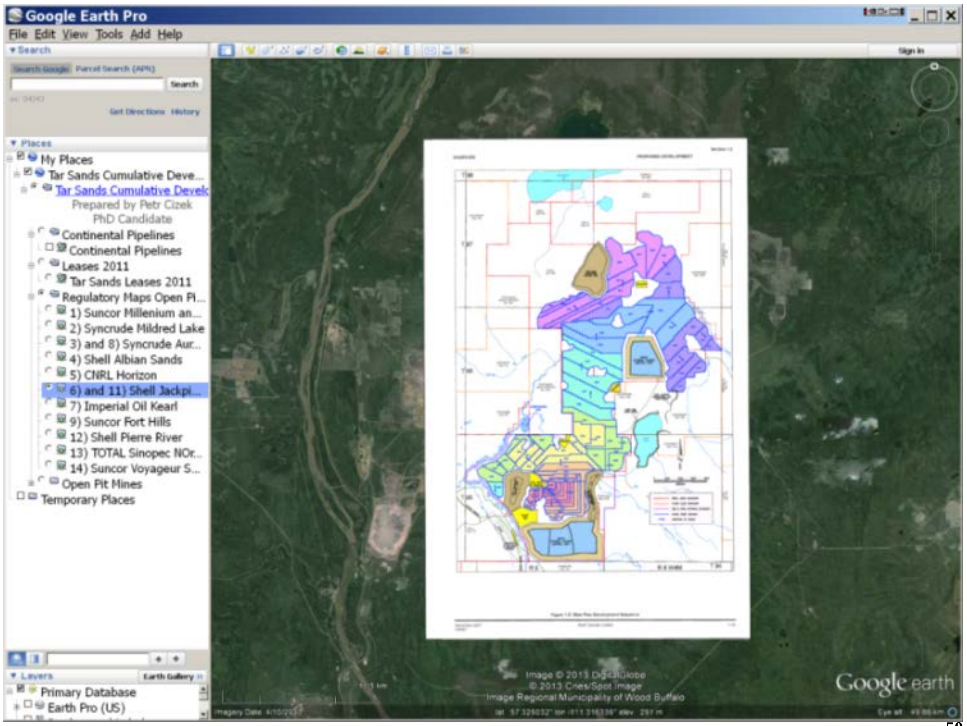


Figure 143 Approved Shell Jackpine Mine and Proposed Jackpine Mine Expansion[50]

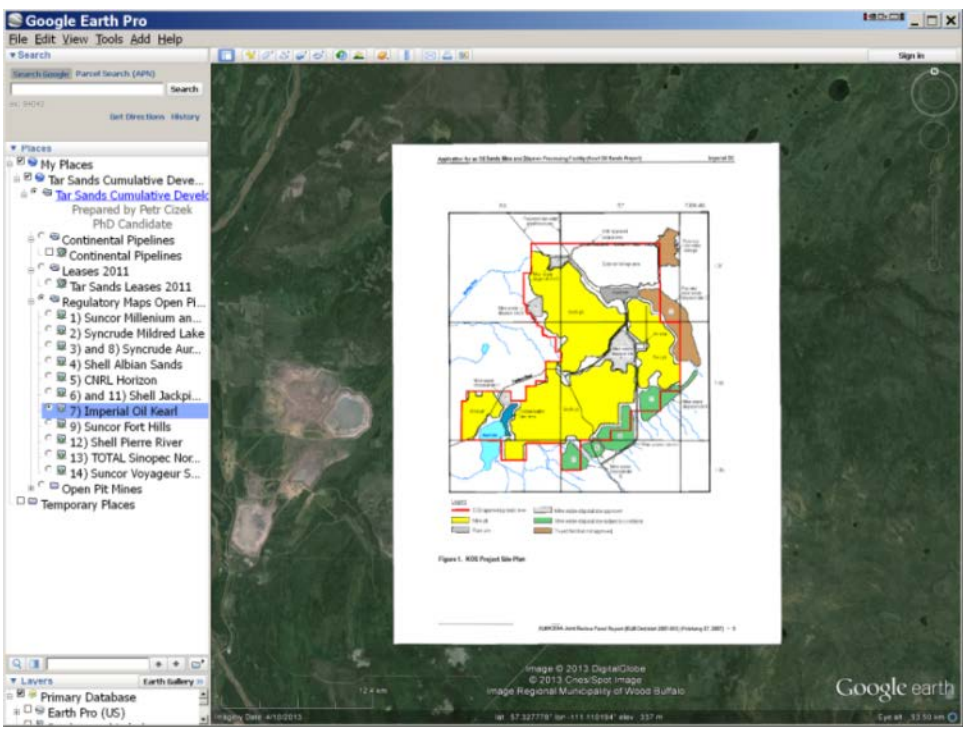


Figure 144 Approved Imperial Oil Kearl Mine

[50] The proposed Shell Jackpine Pine has since been approved.

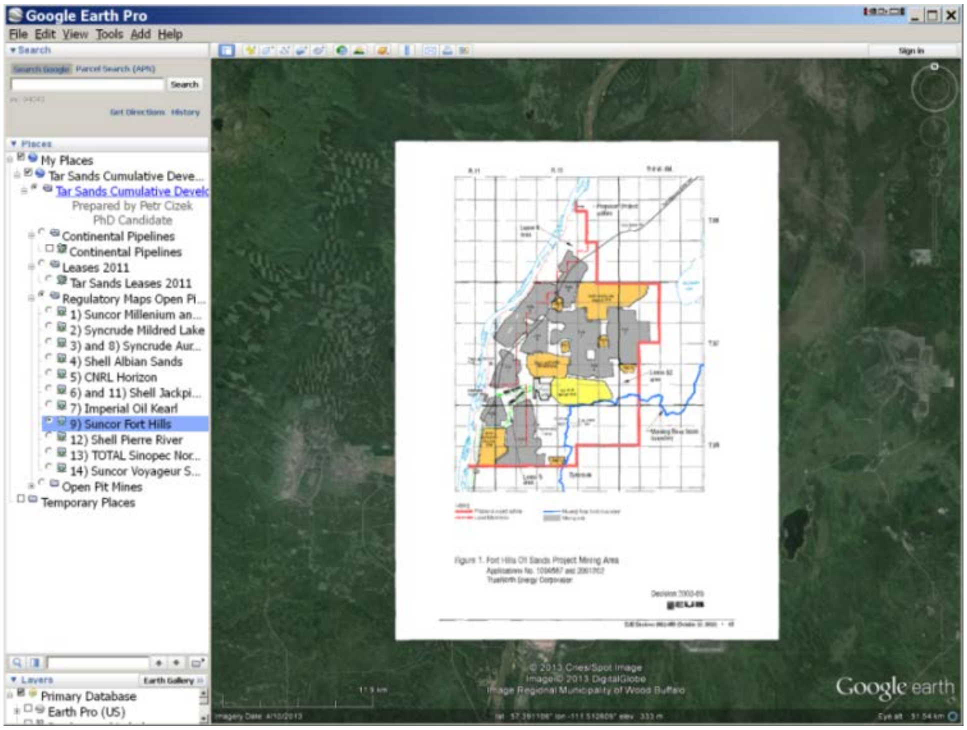


Figure 145 Approved Suncor Fort Hills Mine

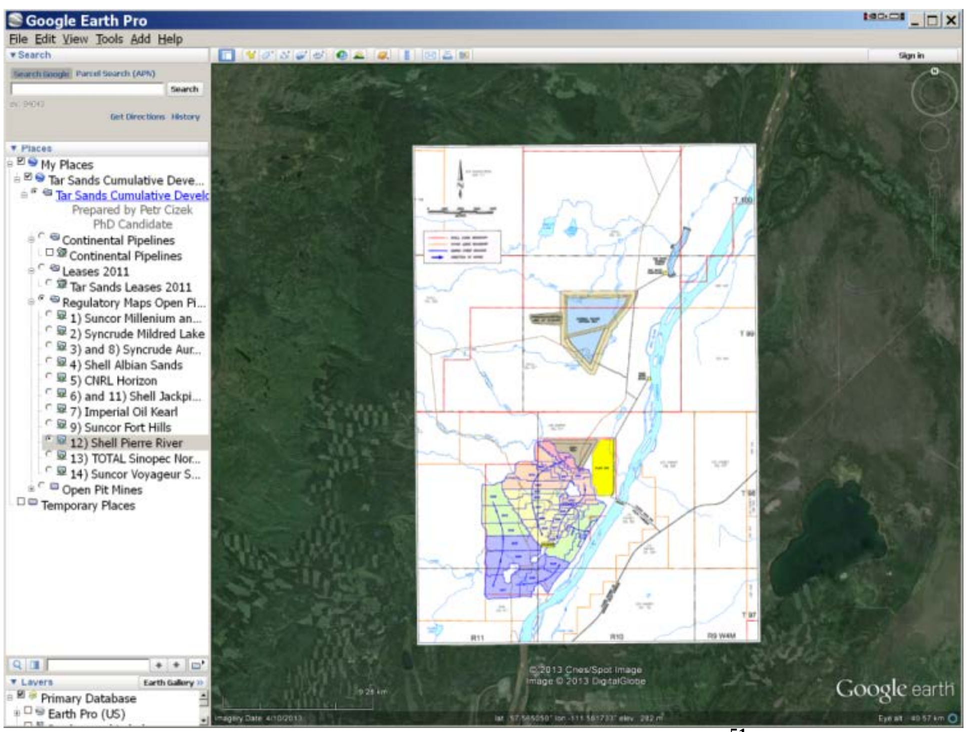


Figure 146 Proposed Shell Pierre River Mine[51]

[51] The proposed Shell Pierre River mine has since been approved.

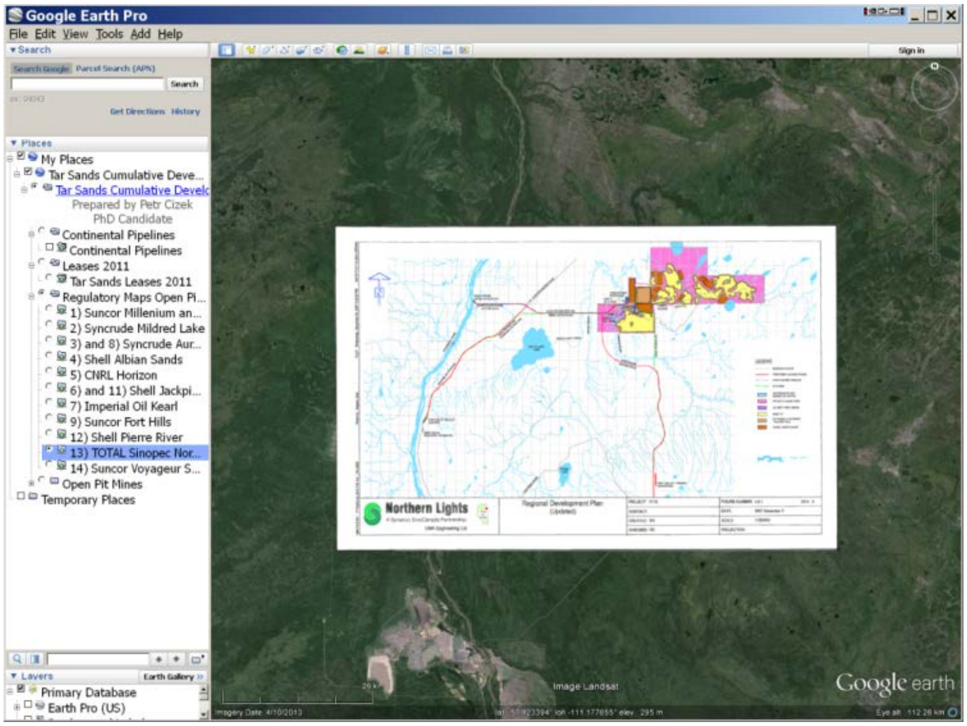


Figure 147 Proposed TOTAL Sinopec Northern Lights Mine

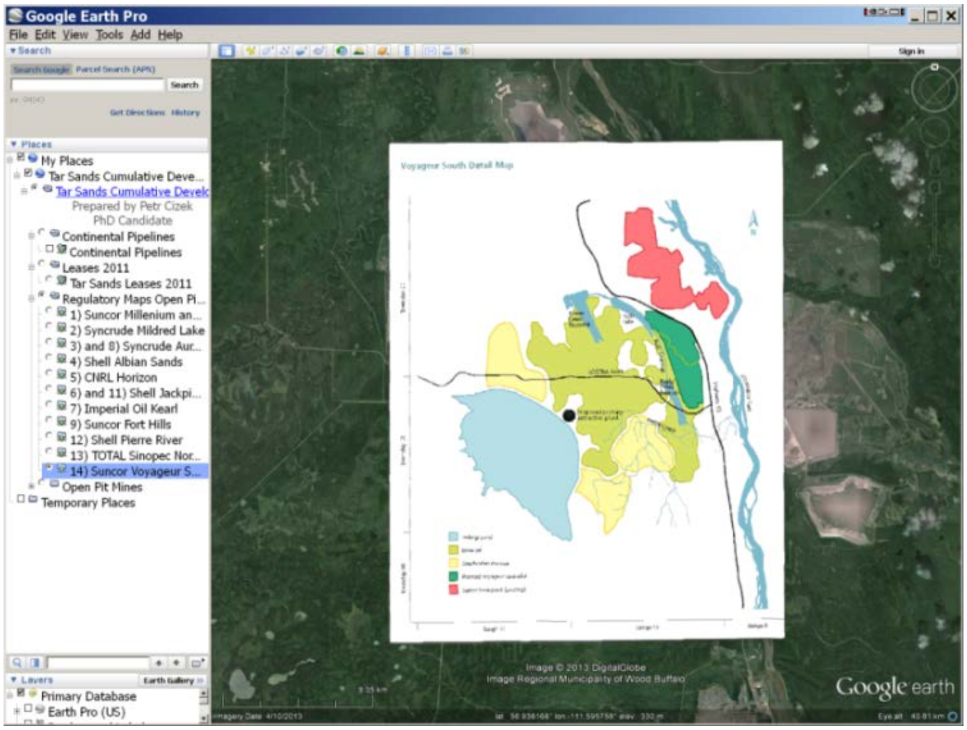
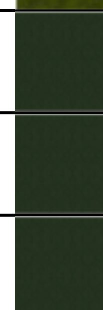


Figure 148 Proposed Suncor Voyageur South Mine

APPENDIX B: EOSD GROUND COVER TEXTURES

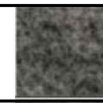
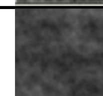
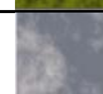
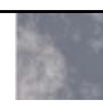
Table 71 EOSD Ground Cover Textures

EOSD Colour	Number	Class	Visual Nature Studio "Ecosystem" Ground Cover Texture
	51	Shrub Tall	
	52	Shrub Low	
	81	Wetland – treed	
	82	Wetland – shrub	
	83	Wetland – herb	
	100	Herb	
	211	Coniferous - dense	
	212	Coniferous - open	
	213	Coniferous - sparse	
	221	Broadleaf - dense	
	222	Broadleaf - open	
	230, 231	Mixedwood; Mixedwood - dense	
	232	Mixedwood - open	
	11	Cloud - Not present near central part of study area. Assigned ground cover texture for background.	
	12	Shadow - Not present near central part of study area. Assigned ground cover texture for background.	

EOSD Colour	Number	Class	Visual Nature Studio "Ecosystem" Ground Cover Texture
	20	Water - Used vector data overlay for water. Assigned ground cover texture to this EOSD class to avoid jagged edge along shorelines due to low resolution (30 m) of EOSD data.	
	31	Snow/Ice - Not present near central part of study area. Assigned ground cover texture for background.	
	32	Rock Rubble	
	33	Exposed / Barren Land	
n/a	4	Existing open pit mines extracted from classified Landsat image, May 15, 2011. Landsat natural colour image 30m resolution (United States Geological Survey, n.d.) blended with mosaic of SPOT panchromatic image 10 m resolution circa 2006 (Geobase, 2009).	Transparent to make fused satellite image visible underneath EOSD data.
n/a	99	Recent logging cut-blocks extracted from classified Landsat image, May 15, 2011.	

APPENDIX C: GROUND COVER TEXTURES FOR VECTOR DATA

Table 72 Ground Cover Textures for Vector Data

Vector Data	**Vector Data Source**	**Visual Nature Studio "Ecosystem" Ground Cover Texture**
Unpaved Roads	Alberta National Road Network, (Geobase, 2011), 12 m total buffer	
Paved Roads	Alberta National Road Network, (Geobase, 2011), 12 m total buffer	
Cleared Right of Way Roads	Alberta National Road Network, (Geobase, 2011), 60 m total buffer	
Seismic Exploration Cut-Lines	National Topographic Series 1:50,000, (Natural Resources Canada, n.d.), 8m total buffer	
Pipelines	Abacus Datagraphics, (Abacus Datagraphics Ltd., n.d.), 12m total buffer	
Trails	National Topographic Series 1:50,000, (Natural Resources Canada, n.d.), 8m total buffer	
Rivers and Lakes[52]	National Topographic Series 1:50,000, (Natural Resources Canada, n.d.)	
Existing, Approved, and Proposed Tailings Ponds	Existing tailings ponds digitized from Google Earth satellite imagery. Approved and proposed tailings ponds digitized from regulatory approvals and industry maps. Colour and texture created by sampling oblique aerial photographs.	
Approved and Proposed Open Pit Mines.	Approved and proposed tailings ponds digitized from regulatory approvals and industry maps. Colour and texture created by sampling oblique aerial photographs.	
Approved and Proposed Open Pit Mine Facilities	Approved and proposed open pit mine facilities digitized from regulatory approvals and industry maps. Colour and texture created by sampling oblique aerial photographs.	
Approved and Proposed Open Pit Mine Overburden and Disposal	Approved and proposed open pit mine overburden and disposal digitized from regulatory approvals and industry maps. Colour and texture created by sampling oblique aerial photographs.	
Approved and Proposed Open Pit Mine Water Features	Approved and proposed open pit mine water features digitized from regulatory approvals and industry maps. Colour and texture created by sampling oblique aerial photographs.	

[52] Rivers and lakes are not coloured blue because in the aerial oblique photographs, as shown in the following section, water-bodies actually appear in shades of grey.

APPENDIX D: DETAILED FLIGHT PATH FOR AERIAL SURVEY

As shown in Figure 149, the flight path began at Fort McMurray airport (YMM) southeast of the town of Fort McMurray at 11:23 Mountain Daylight Time on August 22, 2008 and proceeded northward in a clockwise direction. The existing Suncor and Syncrude tar sands project were over flown to photograph existing landscape disturbance. The flight proceeded north past the First Nations settlement of Fort McKay to the CNRL Horizon tar sands project, which is currently under construction.

The northern-most point reached during the flight was the site of the proposed Shell Pierre River mine to photograph the landscape prior to development. The flight then continued south-east to photograph the landscape prior to the development of the approved PetroCanada Fort Hills project and the proposed Shell Jackpine expansion (just north of the existing Syncrude Aurora North open pit mine). Kearl Lake was over flown to photograph the landscape prior to the construction of the approved Imperial Oil Kearl open pit mine.

The flight continued southward crossing the Clearwater River to document the existing OPTI-Nexen Long Lake "in-situ" project just east of the Métis settlement of Anzac. Just south, the existing landscape prior to the development of the proposed OPTI-Nexen Long Lake South "in-situ" project was photographed.   The southernmost point reached by the flight was the ConocoPhillips Surmont "in-situ" project. The flight retraced its path north and returned to the Fort McMurray airport skirting the north shore of Lac Gregoire just west of the settlement of Anzac, touching back down at the Fort McMurray airport at 13:01 Mountain Daylight Time.

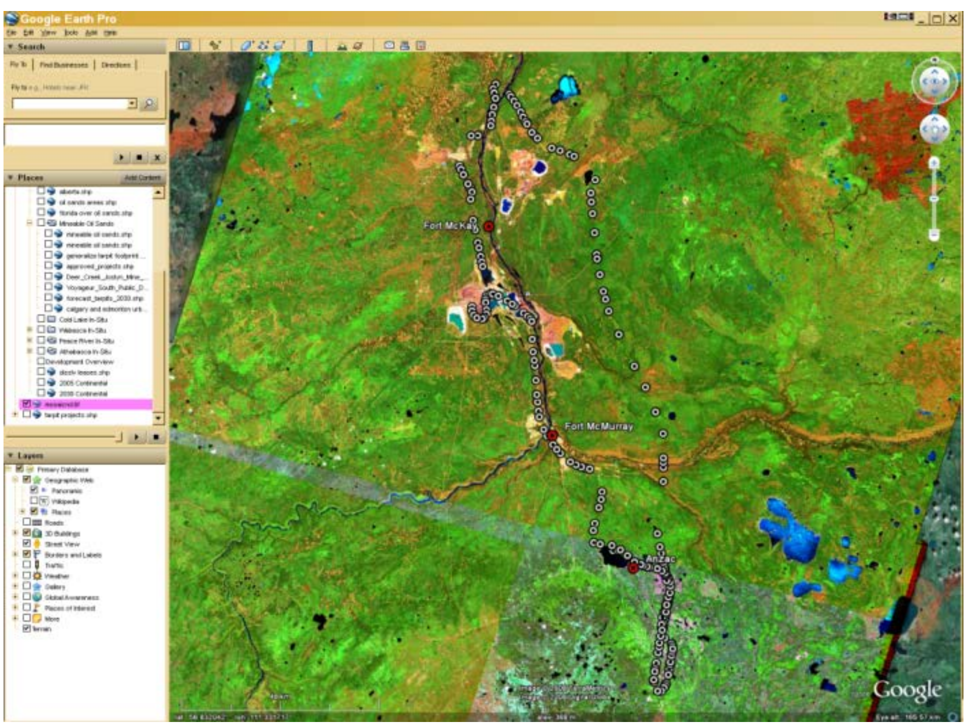


Figure 149 August 22, 2008 Flight Path (clockwise from Fort McMurray airport)

APPENDIX E: EOSD LAND COVER CLASSES AND ECOSYSTEM VARIABLES ASSIGNED FOR FOLIAGE

Table 73 EOSD Land Cover Classes and Ecosystem Variable Assigned for Foliage

EOSD Colour[53]	Number	Class	Description	Ecosystem Variables Assigned for Foliage			
				Species	*Max. Height*	*Min. Height*	*Stems/ Hectare*
	51	Shrub Tall	At least 20% ground cover which is at least one-third shrub; average shrub height greater than or equal to 2 m.	Coarse weed; Dead Conifer	10m	2m	500
	52	Shrub Low	At least 20% ground cover which is at least one-third shrub; average shrub height less than 2 m.	Coarse weed; Dead conifer	2m	0m	500
	81	Wetland – treed	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is coniferous, broadleaf, or mixed wood.	Cattails	2m	0m	50
				Spruce	20m	2m	300
	82	Wetland – shrub	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is tall, low, or a mixture of tall and low shrub.	Cattails	2m	0m	10,000
				Juniper	2m	0m	10,000
	83	Wetland – herb	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is herb.	Cattails	2m	0m	10,000

[53] This is the colour used in the EOSD land cover legend, not the actual colour used for the 3D foliage.

EOSD Colour[53]	**Number**	**Class**	**Description**	**Ecosystem Variables Assigned for Foliage**			
				Species	*Max. Height*	*Min. Height*	*Stems/ Hectare*
	100	Herb	Vascular plant without woody stem (grasses, crops, forbs, gramminoids); minimum of 20% ground cover or one-third of total vegetation must be herb.	Woodland Plants Grass	1m	0m	40,000
	211	Coniferous – dense	Greater than 60% crown closure; coniferous trees are 75% or more of total basal area.	Spruce	30m	2m	1,200
	212	Coniferous – open	26-60% crown closure; coniferous trees are 75% or more of total basal area.	Spruce	30m	2m	600
	213	Coniferous – sparse	10-25% crown closure; coniferous trees are 75% or more of total basal area.	Spruce	30m	2m	300
	221	Broadleaf – dense	Greater than 60% crown closure; broadleaf trees are 75% or more of total basal area.	Aspen	30m	2m	1,200
	222	Broadleaf – open	26-60% crown closure; broadleaf trees are 75% or more of total basal area.	Aspen	30m	2m	600
	230, 231	Mixedwood; Mixedwood – dense	Greater than 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area.	Spruce	30m	2m	240
				Aspen	30m	2m	600
	232	Mixedwood – open	26-60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area.	Spruce	30m	2m	120
				Aspen	30m	2m	300

APPENDIX F: COMPARISON TO MAJOR CITIES.

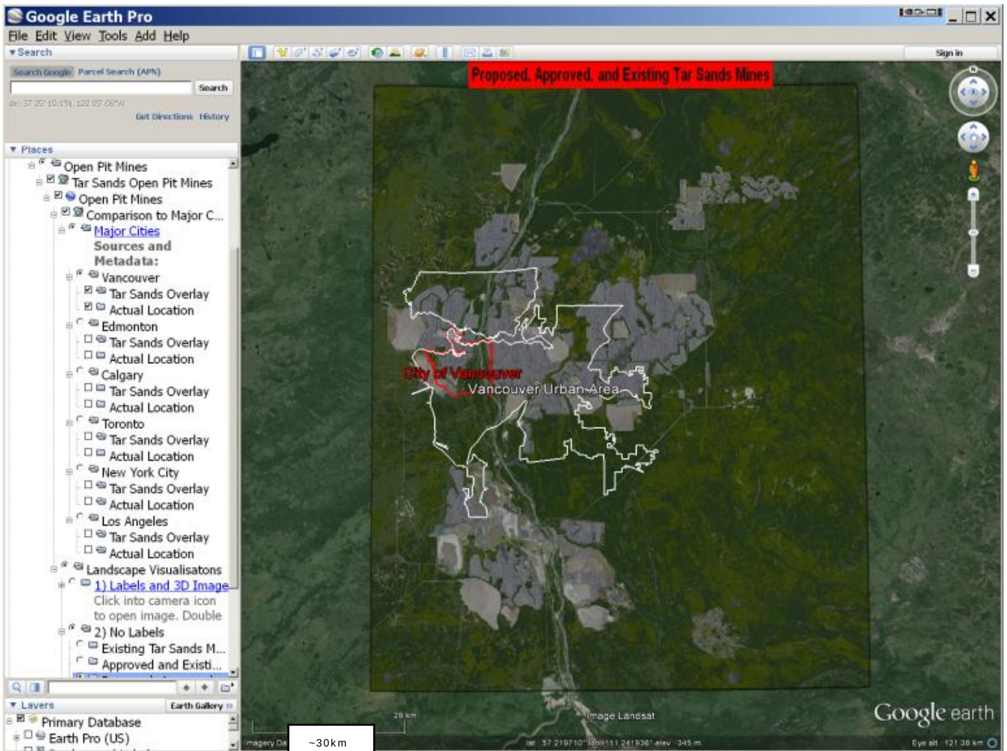


Figure 150 Vancouver Metropolitan Urban Area Compared to Proposed, Approved, and Existing Tar Sands Mines

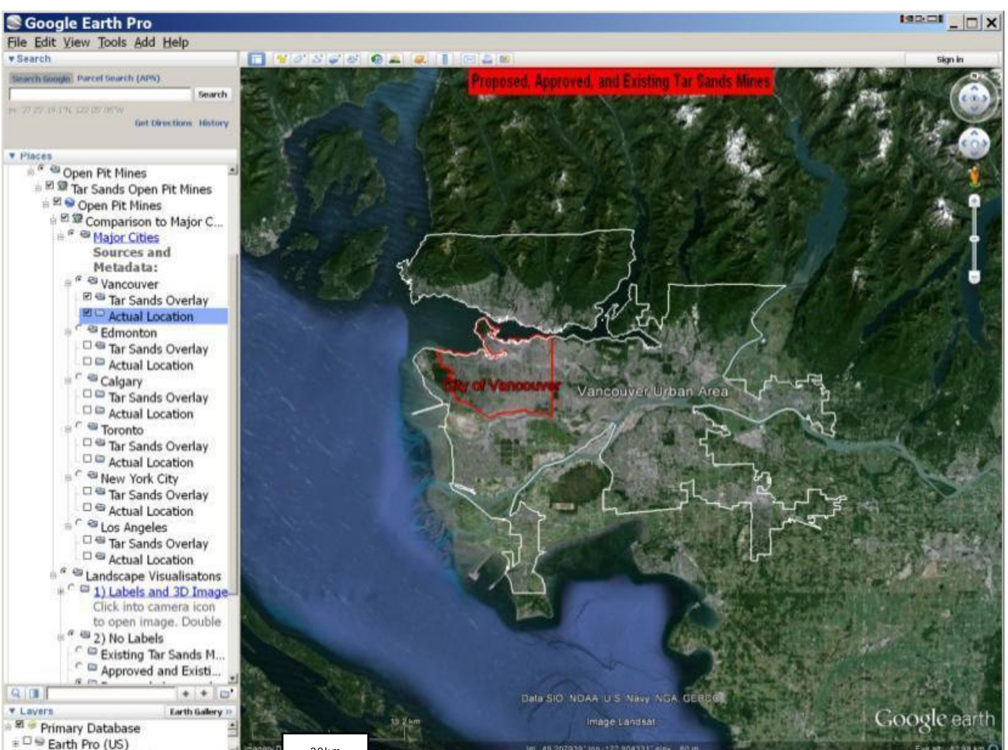


Figure 151 Vancouver Metropolitan Urban Area Outline in Actual Location

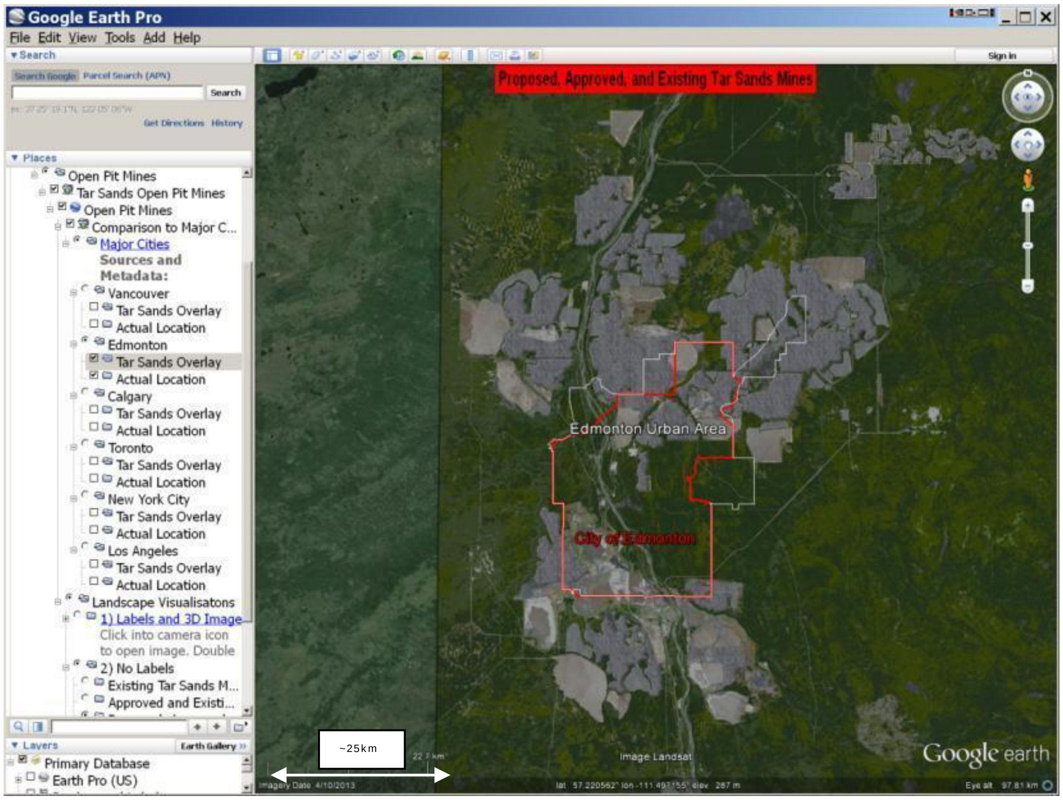


Figure 152 Edmonton Metropolitan Urban Area Outline Compared to Proposed, Approved, and Existing Tar Sands Mines

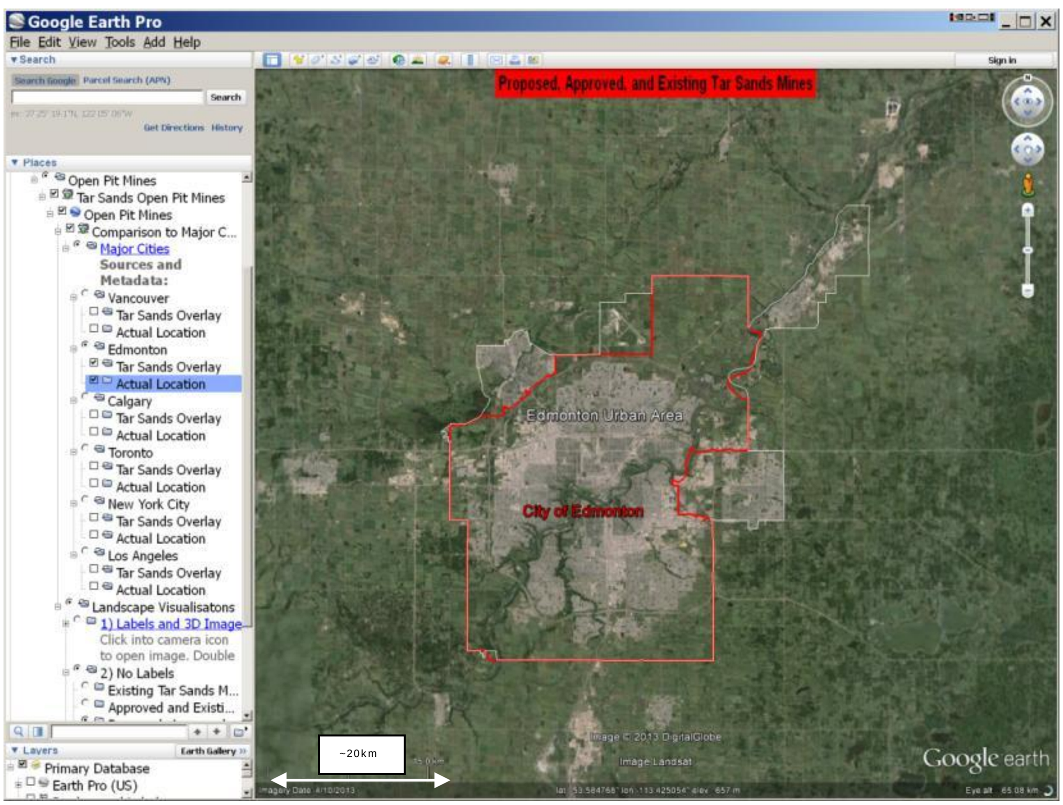


Figure 153 Edmonton Metropolitan Urban Area Outline in Actual Location

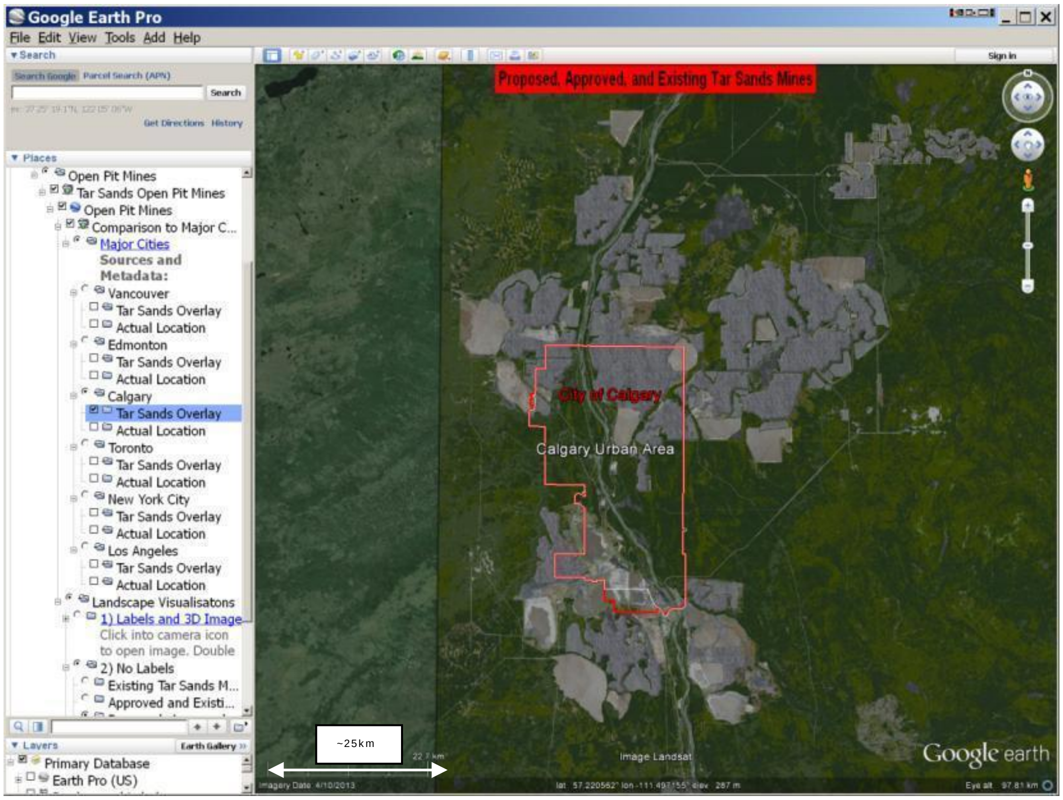


Figure 154 Calgary Metropolitan Urban Area Outline Compared to Proposed, Approved, and Existing Tar Sands Mines

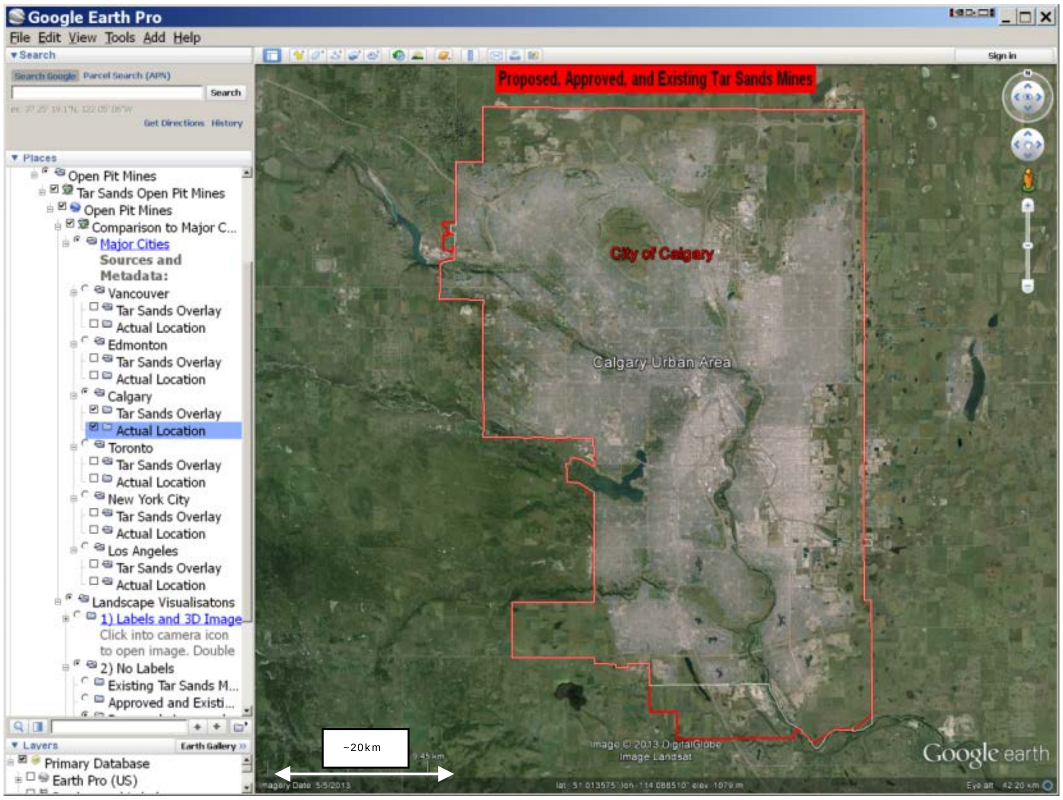


Figure 155 Calgary Metropolitan Urban Area Outline in Actual Location

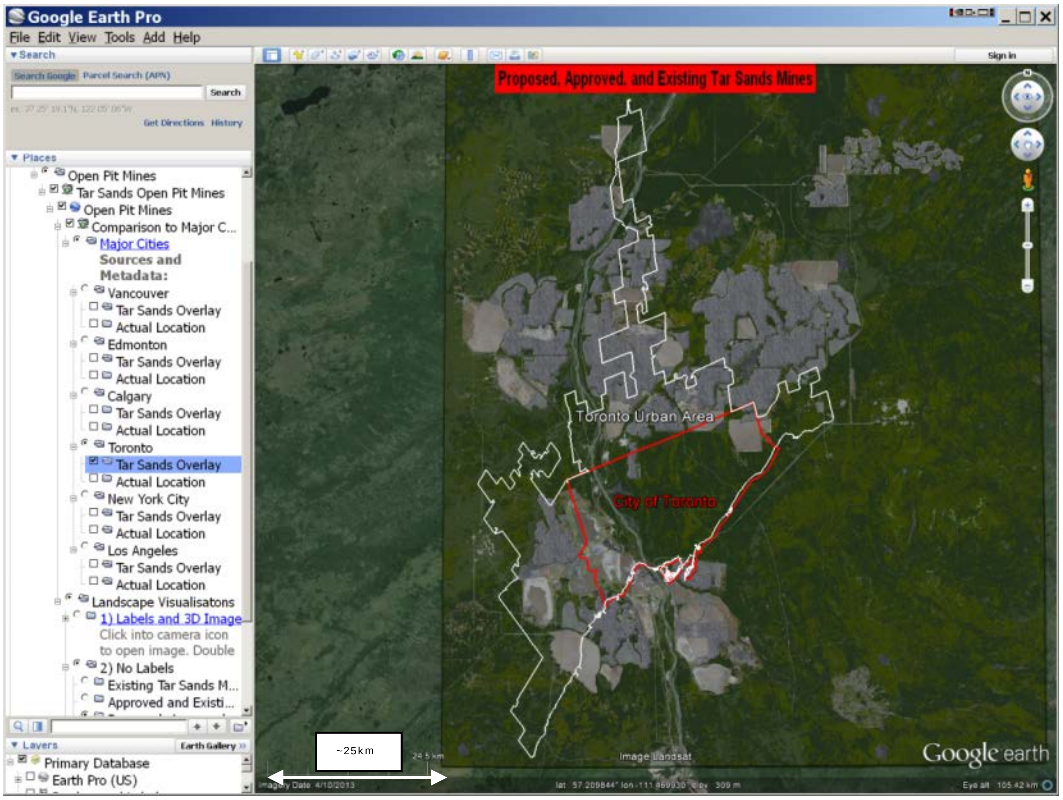


Figure 156 Toronto Metropolitan Urban Area Outline Compared to Proposed, Approved, and Existing Tar Sands Mines

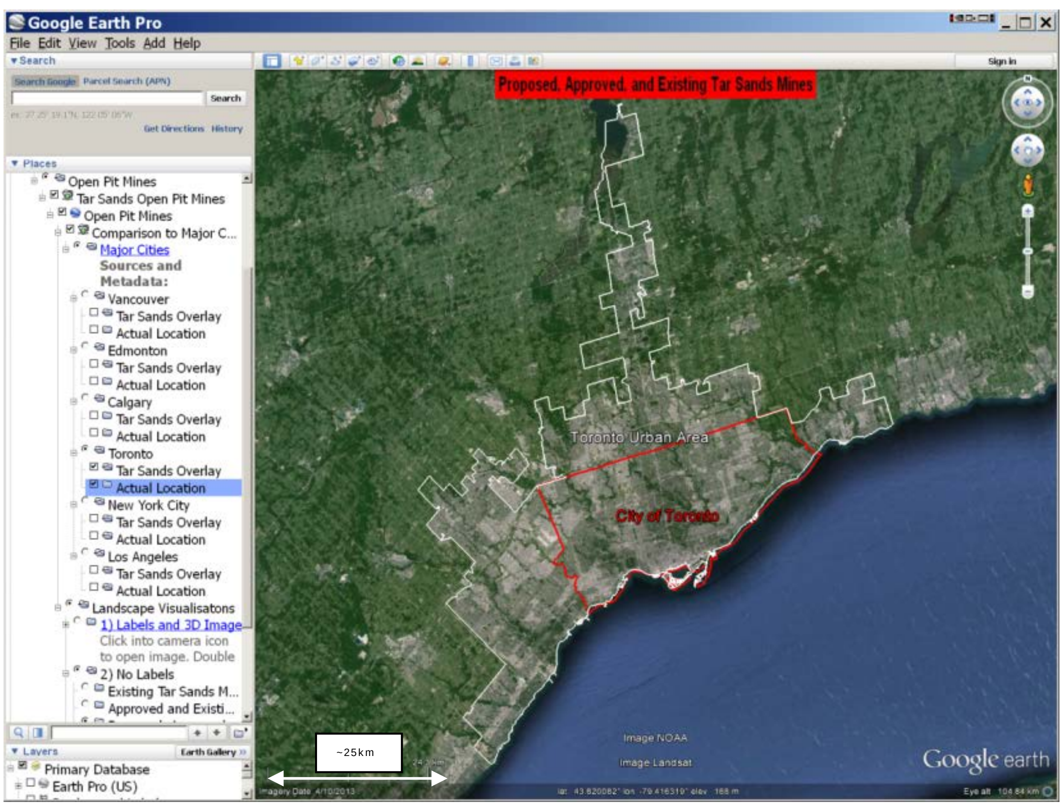


Figure 157 Toronto Metropolitan Urban Area Outline in Actual Location

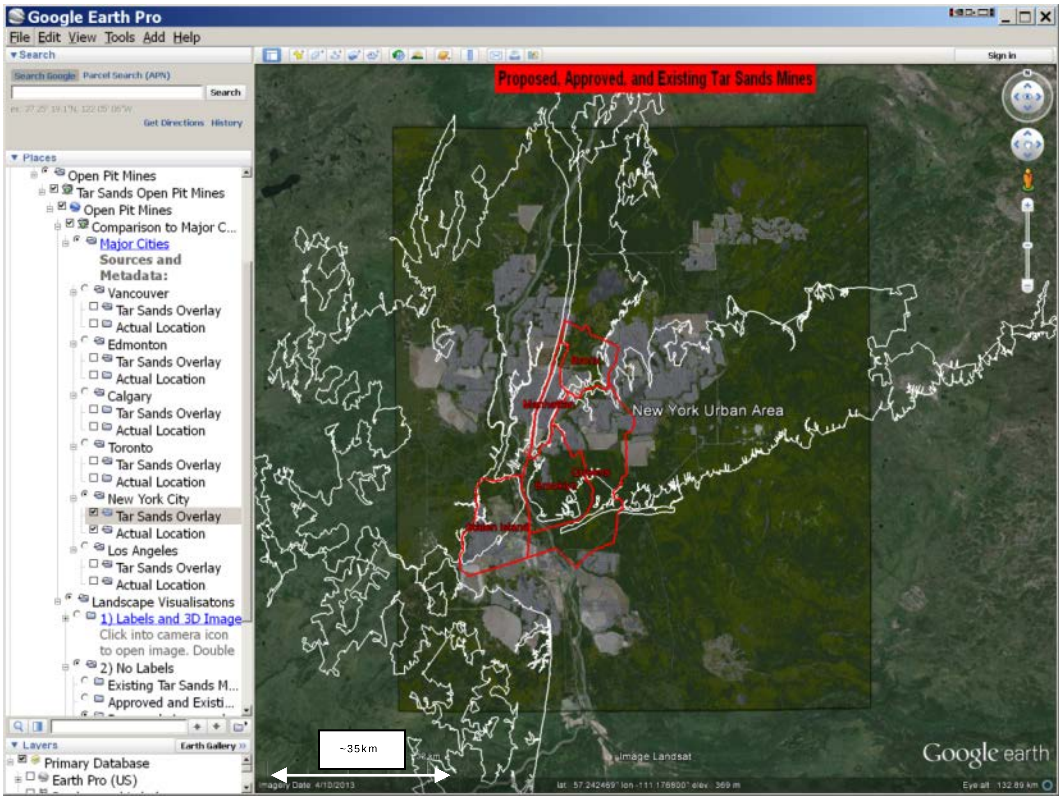


Figure 158 New York City Metropolitan Urban Outline Compared to Proposed, Approved, and Existing Tar Sands Mines

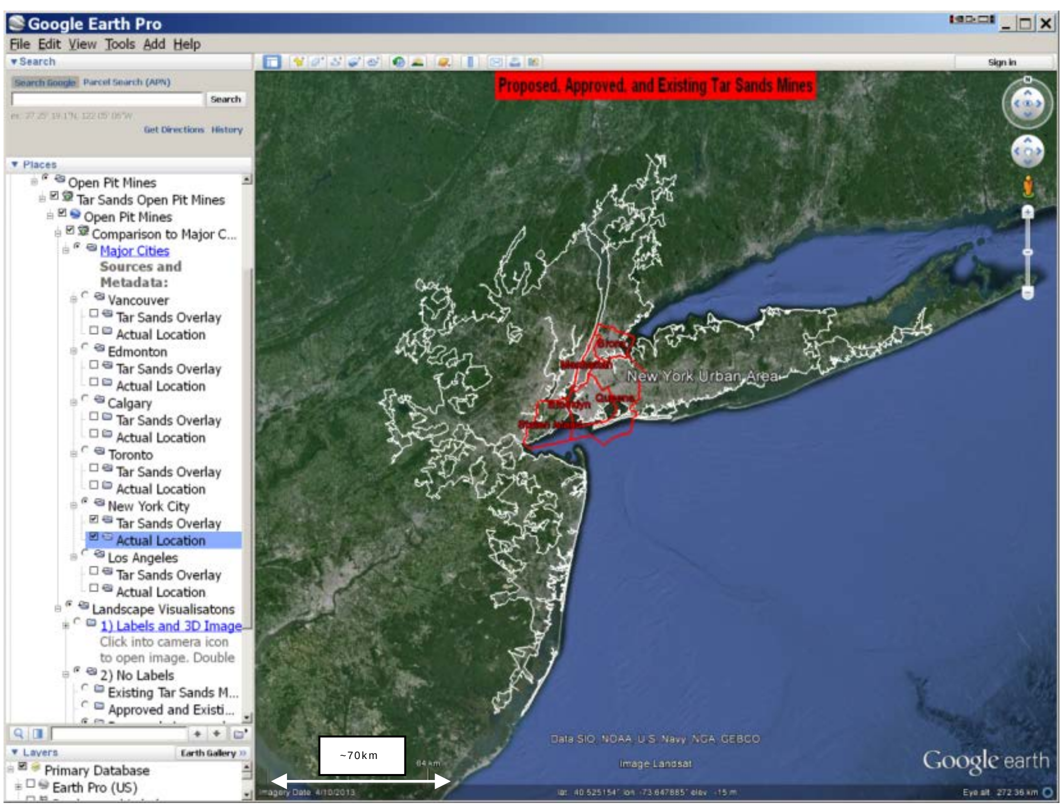


Figure 159 New York City Metropolitan Urban Area Outline in Actual Location

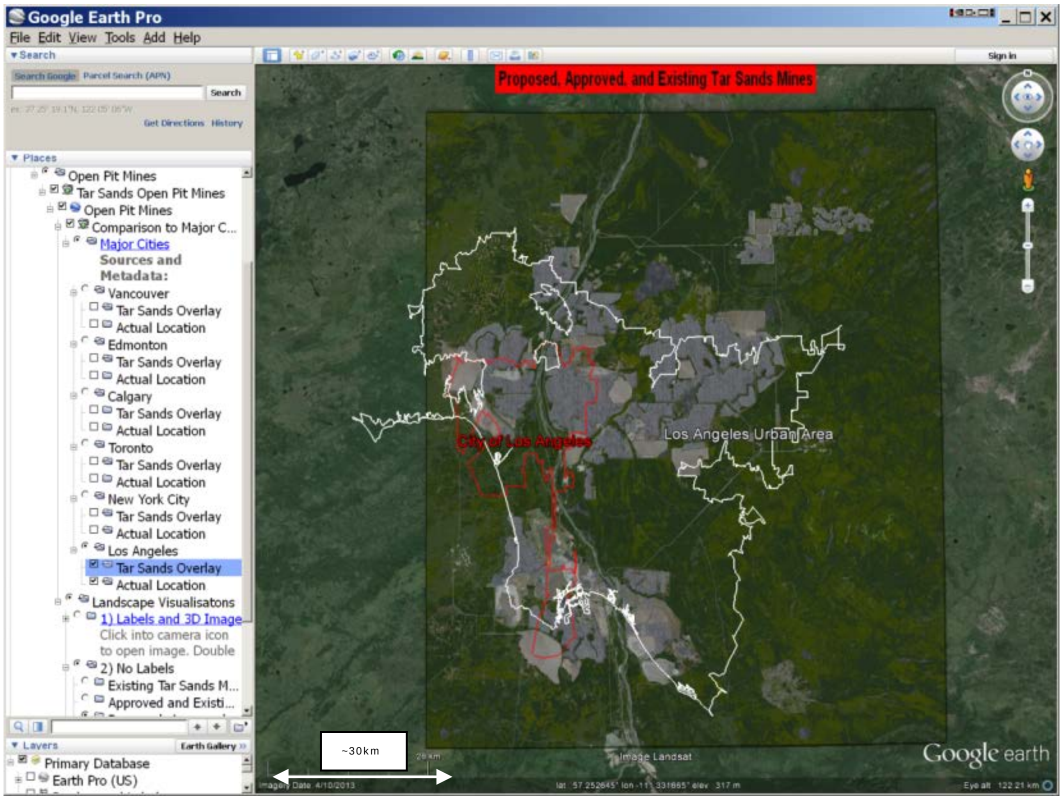


Figure 160 Los Angeles Metropolitan Urban Area Outline Compared to Proposed, Approved, and Existing Tar Sands Mines

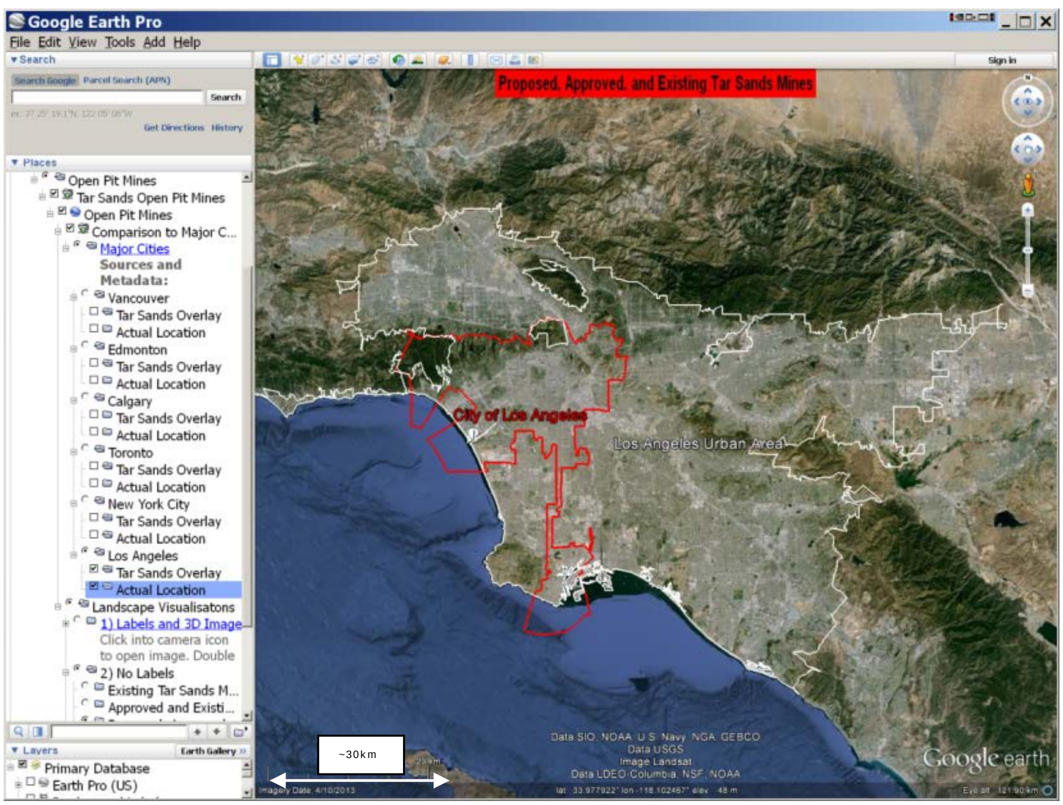


Figure 161 Los Angeles Metropolitan Urban Area Outline in Actual Location

APPENDIX G: LANDSCAPE VISUALISATIONS OF OPEN PIT MINES

Mine #1: Suncor Millenium and Steepbank – Camera Position 2,651 m above ground level

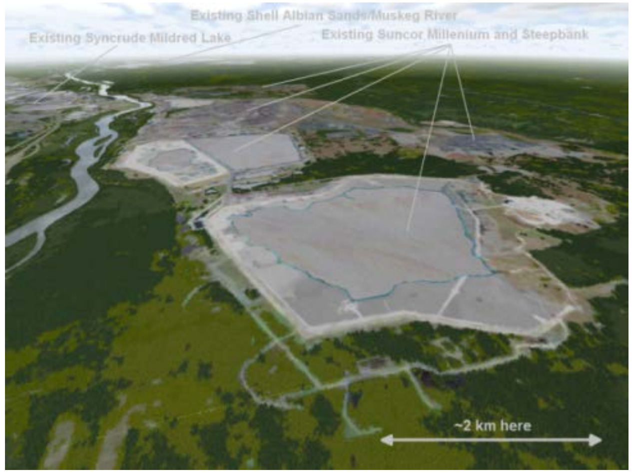


Figure 162 Suncor Millenium and Steepbank – Existing

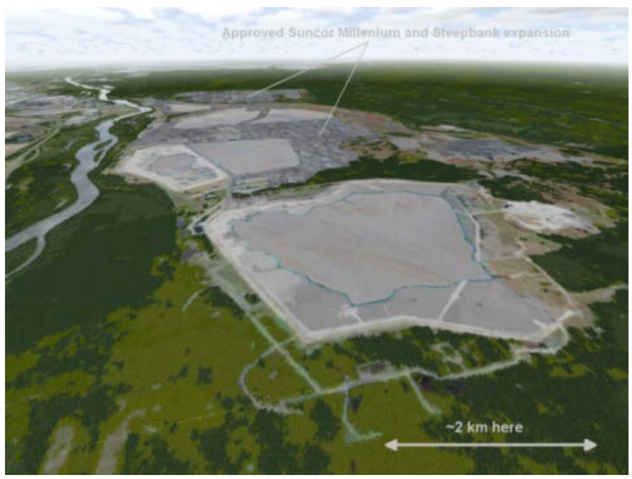


Figure 163 Suncor Millenium and Steepbank – Approved and Existing

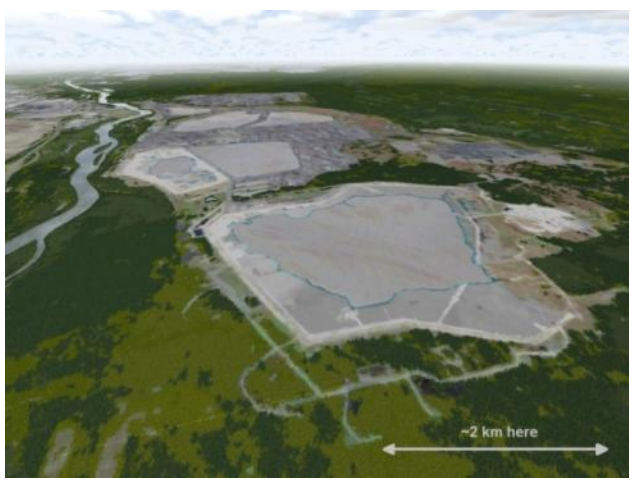


Figure 164 Suncor Millenium and Steepbank – Proposed, Approved, and Existing

Mine #2 Syncrude Mildred Lake – Camera Position 2,722 m above ground level

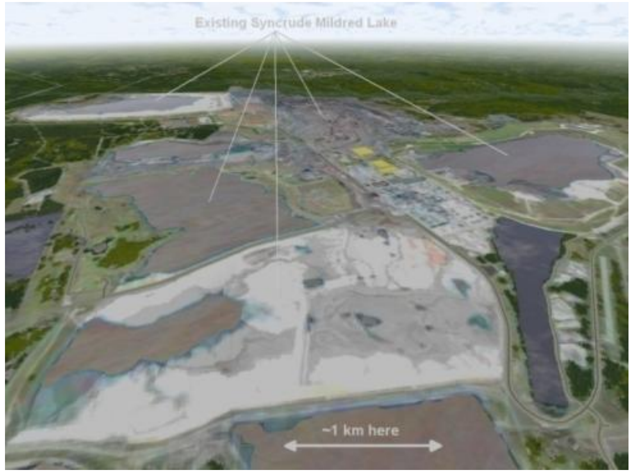


Figure 165 Syncrude Mildred Lake – Existing

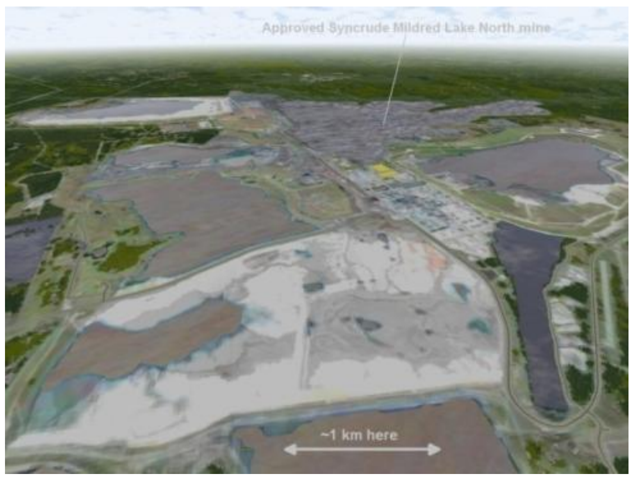


Figure 166 Syncrude Mildred Lake - Approved and Existing

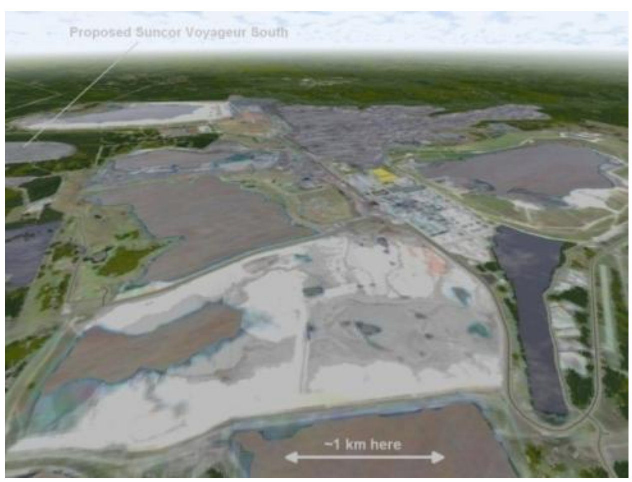


Figure 167 Syncrude Mildred Lake - Proposed, Approved, and Existing

Mine # 3: Syncrude Aurora North - Camera Position 1,712 m above ground level

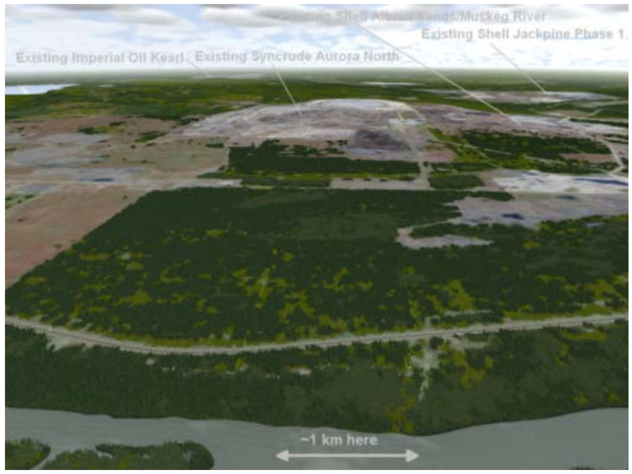


Figure 168 Syncrude Aurora North – Existing

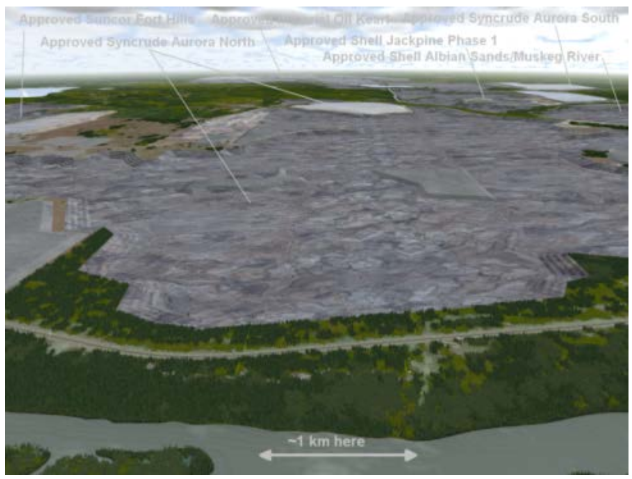


Figure 169 Syncrude Aurora North - Approved and Existing

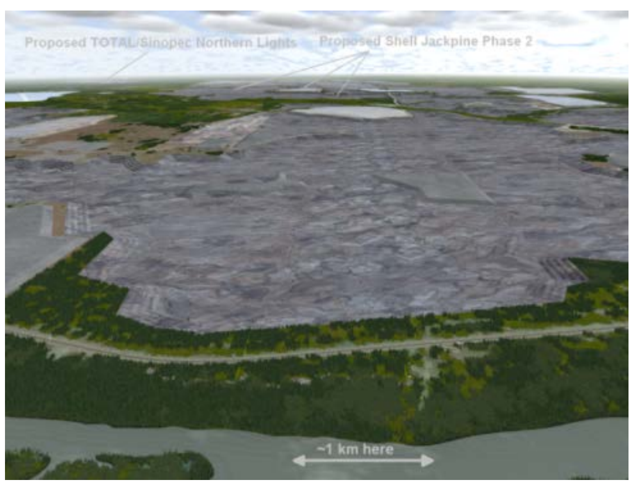


Figure 170 Syncrude Aurora North - Proposed, Approved, and Existing

Mine #4: Shell Albian Sands/Muskeg River - Camera Position 3,205 m above ground level

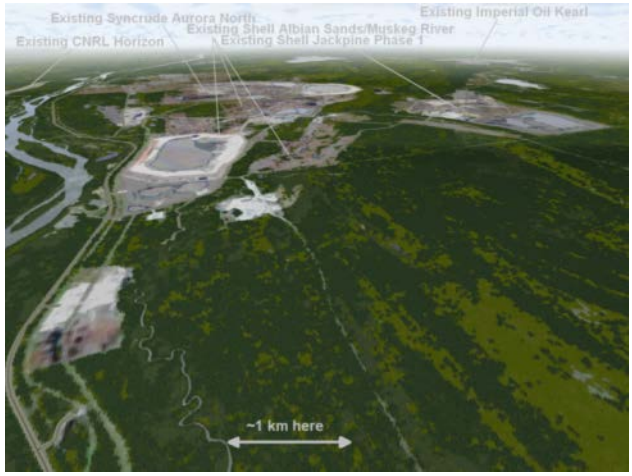


Figure 171 Shell Albian Sands/Muskeg River – Existing

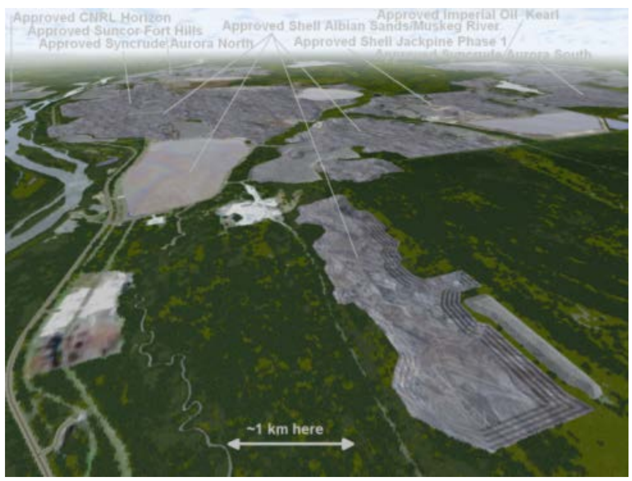


Figure 172 Shell Albian Sands/Muskeg River - Approved and Existing

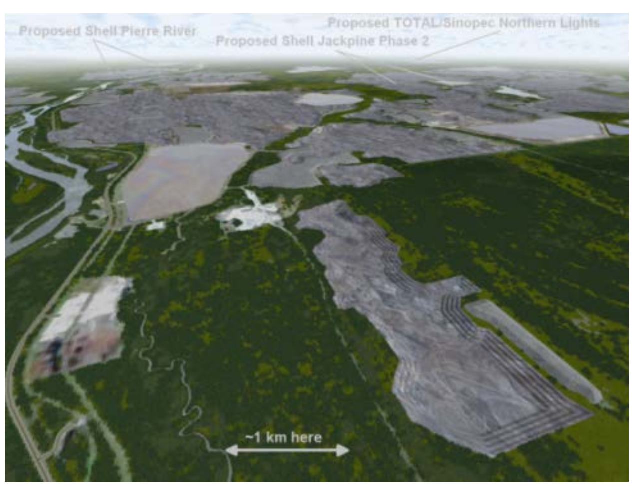


Figure 173 Shell Albian Sands/Muskeg River - Proposed, Approved, and Existing

Mine #5 CNRL Horizon – Camera Position 1,735 m above ground level

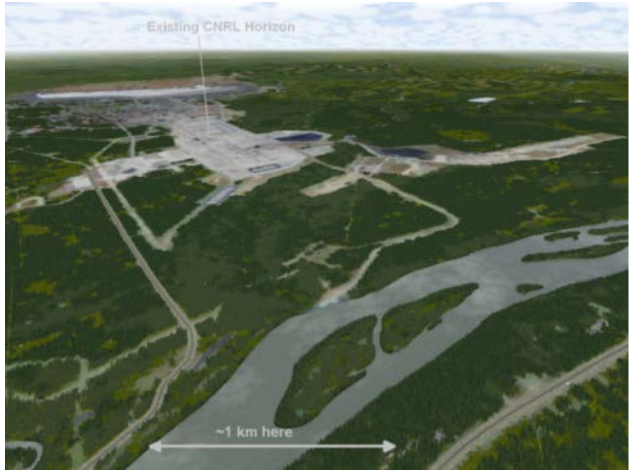


Figure 174 CNRL Horizon – Existing

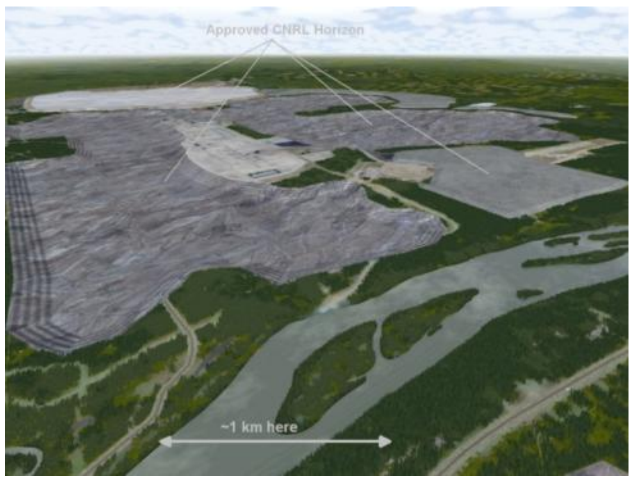


Figure 175 CNRL Horizon - Approved and Existing

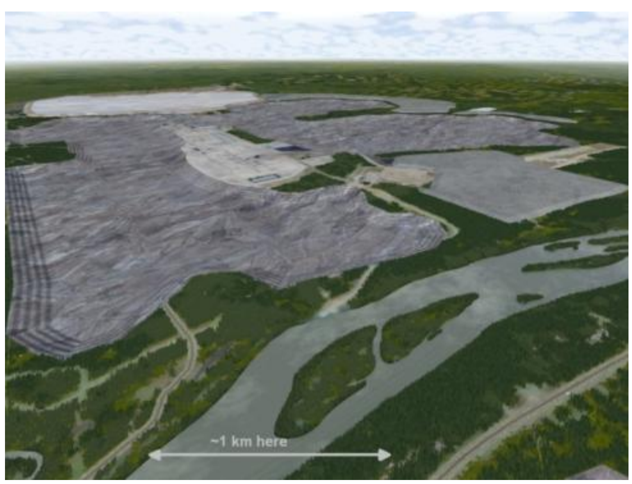


Figure 176 CNRL Horizon - Proposed, Approved, and Existing

Mine #6 Shell Jackpine Phase 1 – Camera Position 2,688 m above ground level

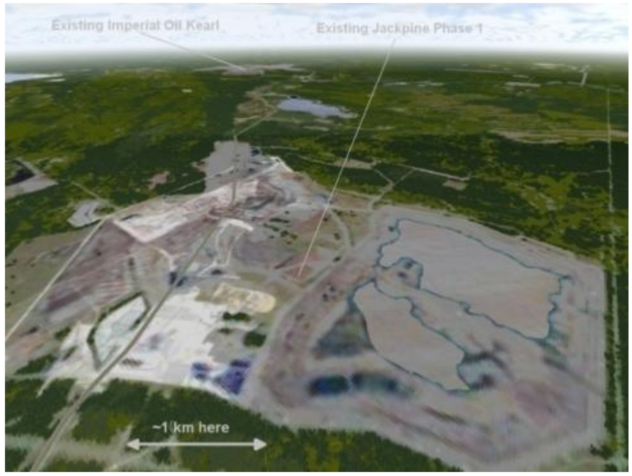


Figure 177 Shell Jackpine Phase 1 – Existing

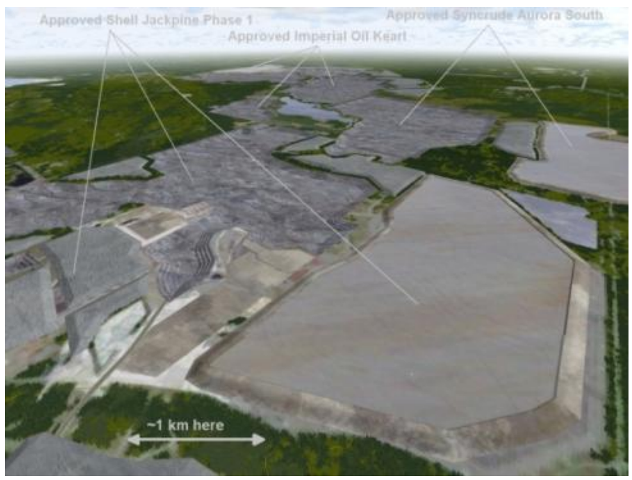


Figure 178 Shell Jackpine Phase 1 - Approved and Existing

Figure 179 Shell Jackpine Phase 1 - Proposed, Approved, and Existing

Mine #7 Imperial Oil Kearl – Camera Position 4,586 m above ground level

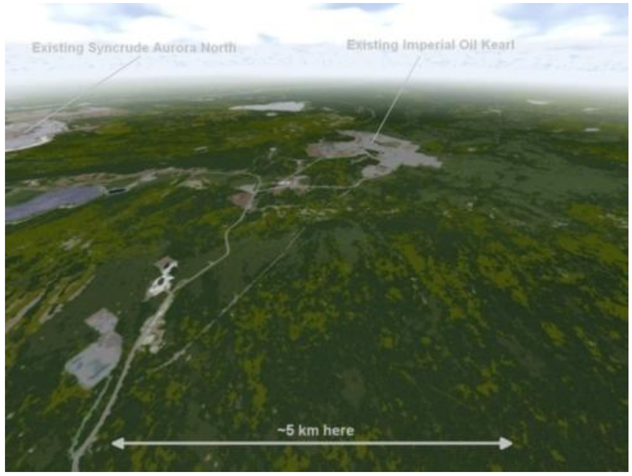


Figure 180 Imperial Oil Kearl – Existing

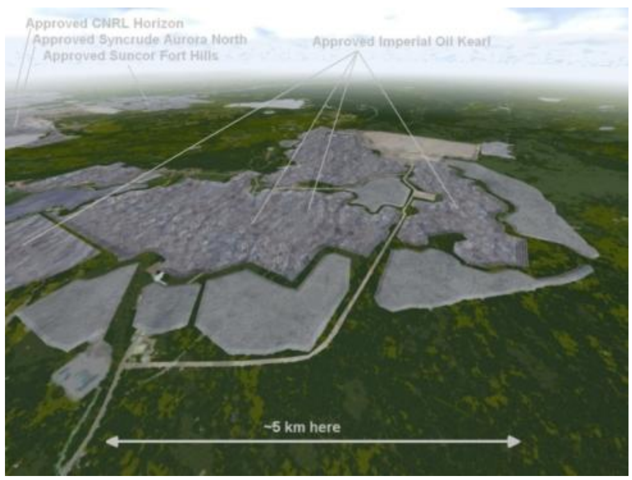


Figure 181 Imperial Oil Kearl - Approved and Existing

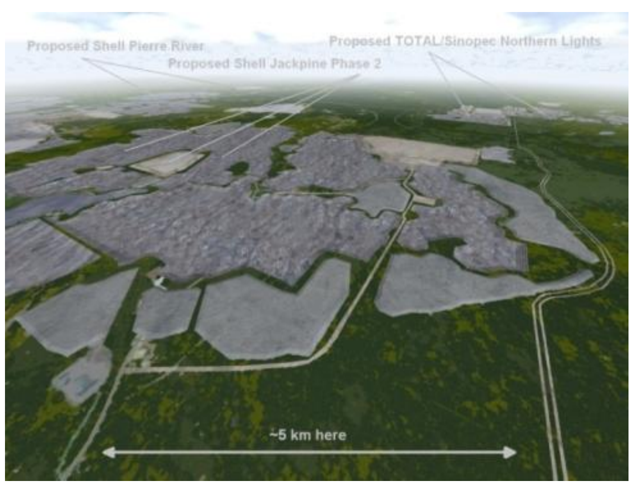


Figure 182 Imperial Oil Kearl - Proposed, Approved, and Existing

Mine #8 – Syncrude Aurora South – Approved Project – Camera Position 2,639 m above ground level

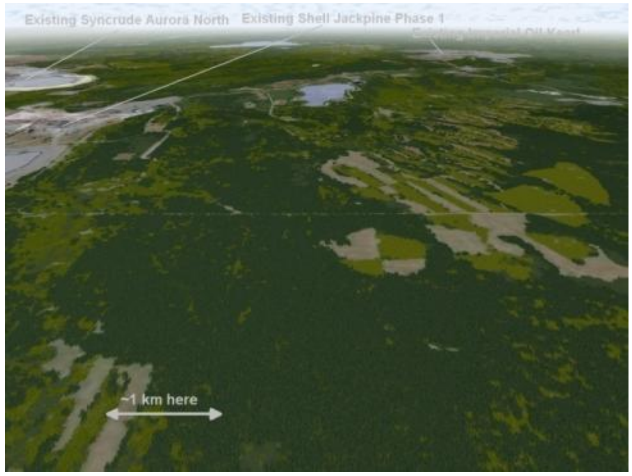


Figure 183 Syncrude Aurora South – Existing

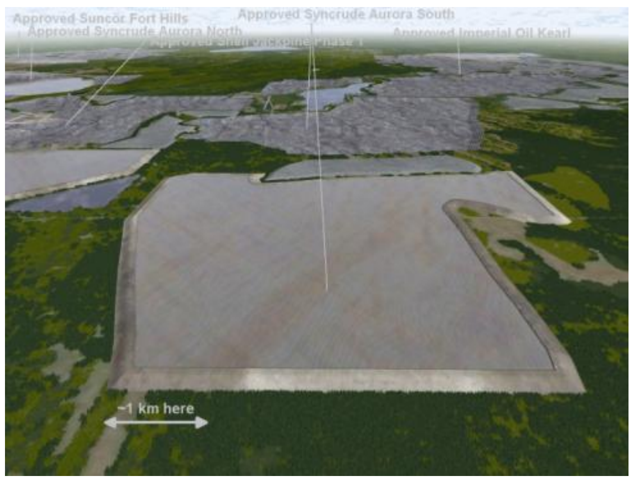


Figure 184 Syncrude Aurora South - Approved and Existing

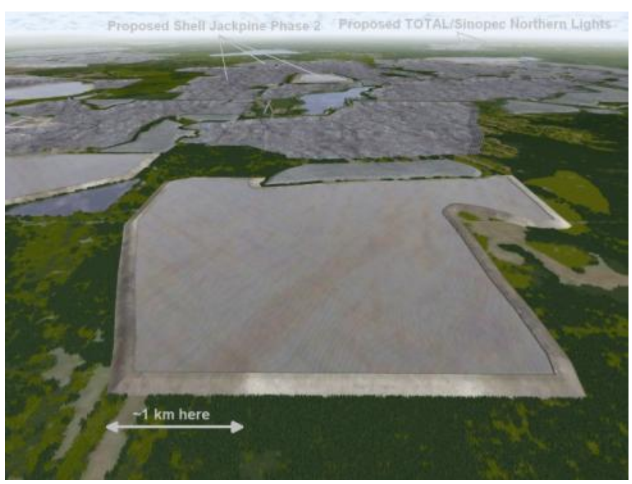


Figure 185 Syncrude Aurora South - Proposed, Approved, and Existing

Mine #9 Suncor Fort Hills – Approved Project – Camera Position 3,710 m above ground level

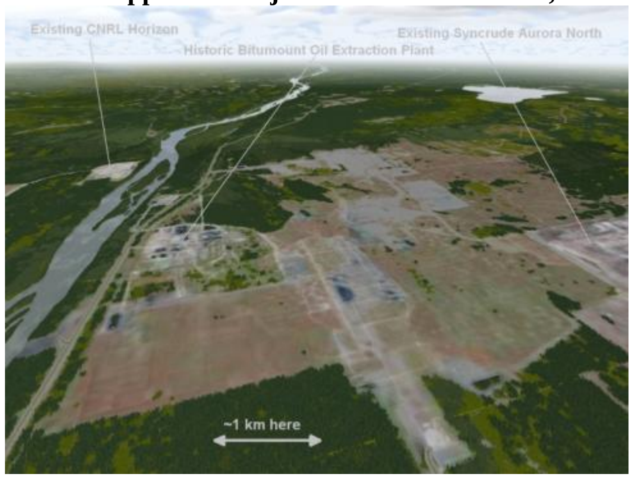


Figure 186 Suncor Fort Hills – Existing

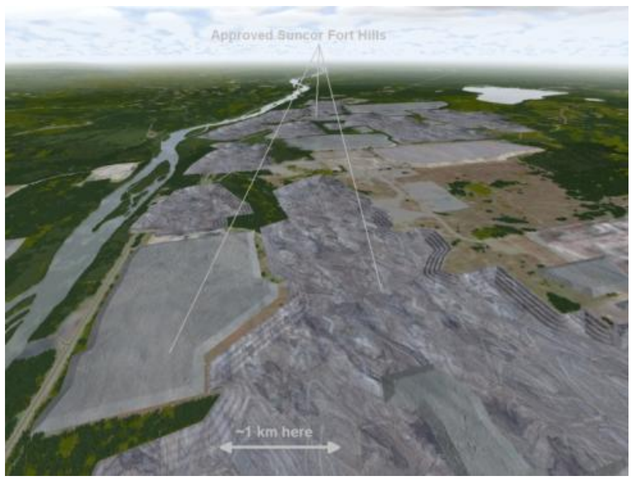


Figure 187 Suncor Fort Hills - Approved and Existing

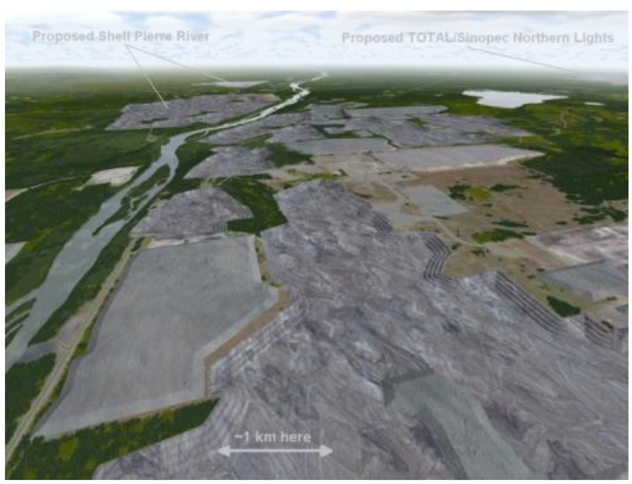


Figure 188 Suncor Fort Hills - Proposed, Approved, and Existing

Mine #10 TOTAL Joslyn – Approved Project – Camera Position 2,676 m above ground level

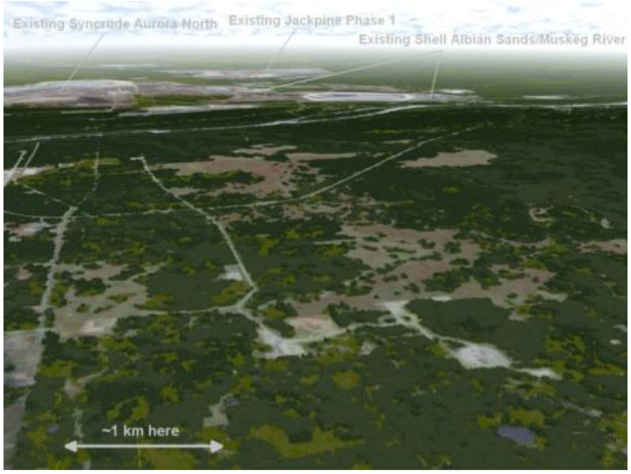


Figure 189 TOTAL Joslyn – Existing

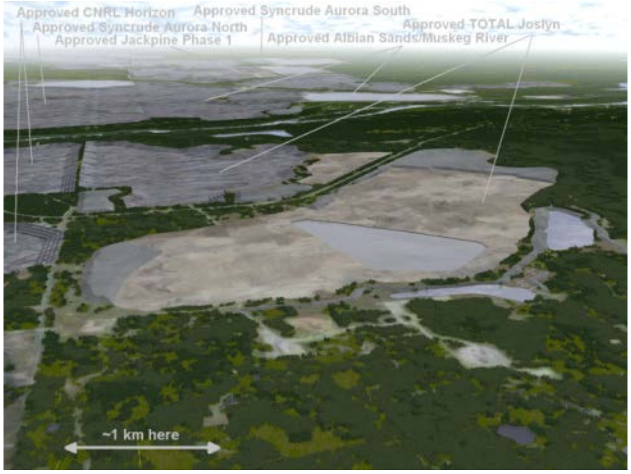


Figure 190 TOTAL Joslyn - Approved and Existing

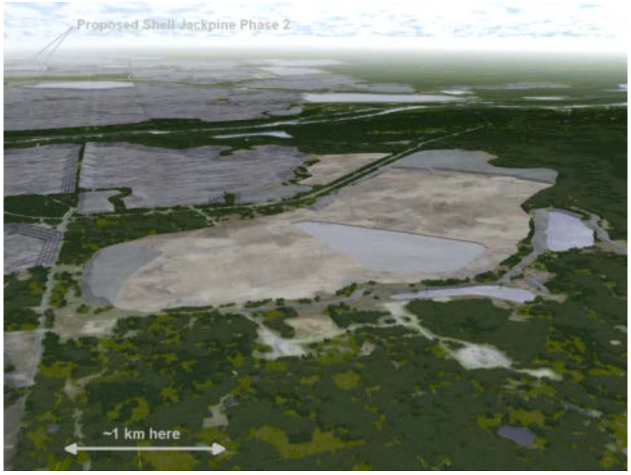


Figure 191 TOTAL Joslyn - Proposed, Approved, and Existing

Mine #11 Shell Jackpine Phase 2 – Proposed Project[54] - Camera Position 2,719 m above ground level

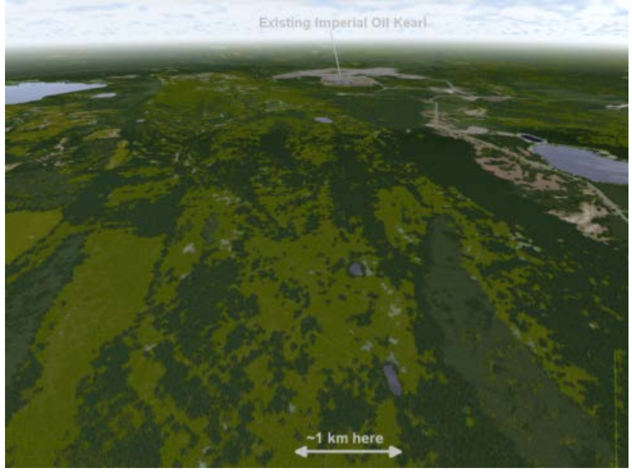


Figure 192 Shell Jackpine Phase 2 – Existing

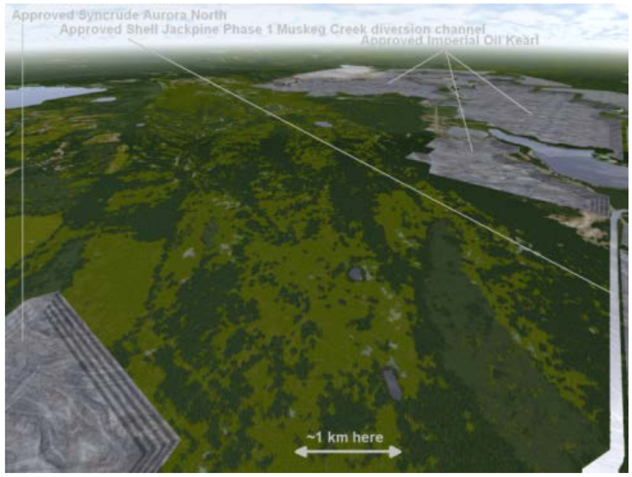


Figure 193 Shell Jackpine Phase 2 - Approved and Existing

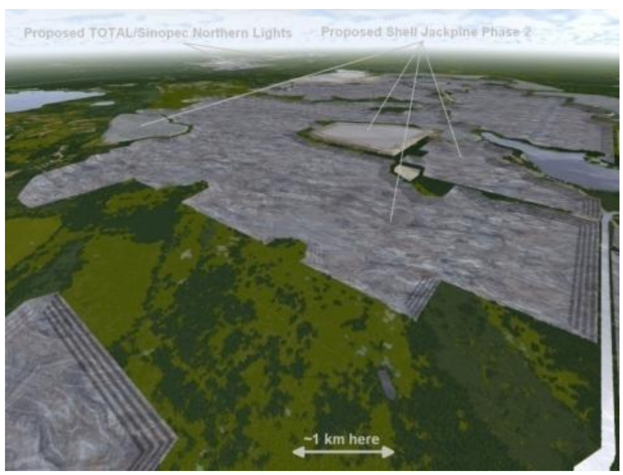


Figure 194 Shell Jackpine Phase 2 - Proposed, Approved, and Existing

[54] The Shell Jackpine Phase 2 mine has since been approved.

Mine #12 Shell Pierre River – Proposed Project[55] -- Camera Position 1,697 m above ground level

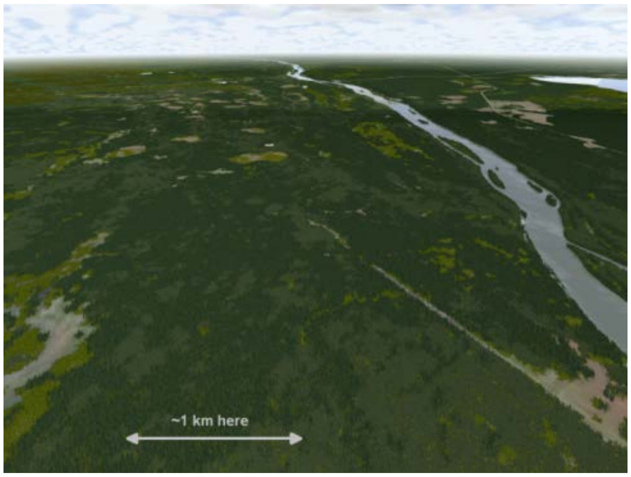


Figure 195 Shell Pierre River – Existing

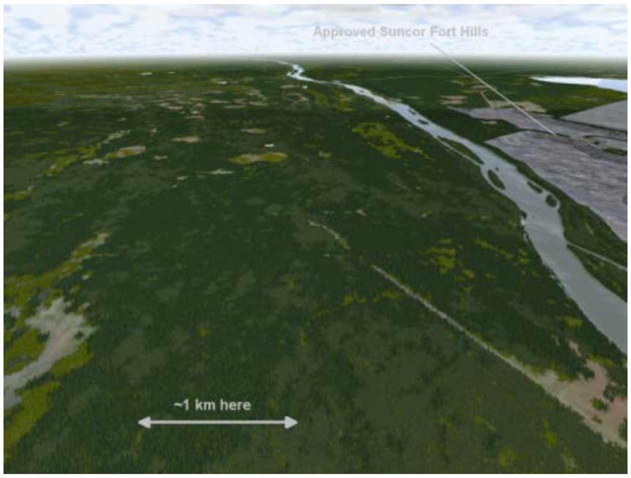


Figure 196 Shell Pierre River - Approved and Existing

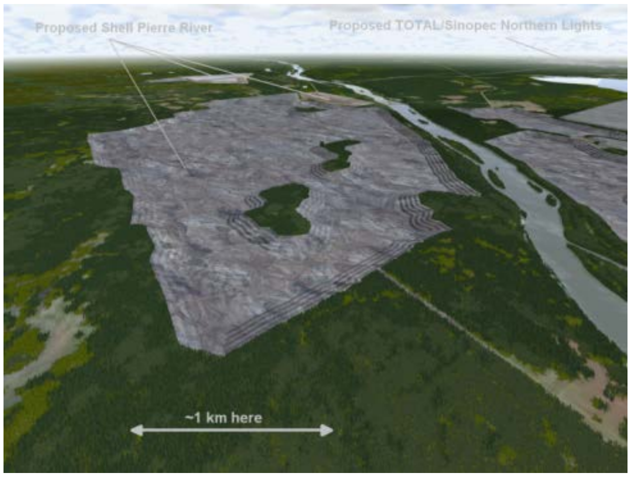


Figure 197 Shell Pierre River - Proposed, Approved, and Existing

[55] The Shell Pierre River mine has since been approved.

Mine #13 Suncor Voyageur South – Proposed Project -- Camera Position 4,627 m above ground level

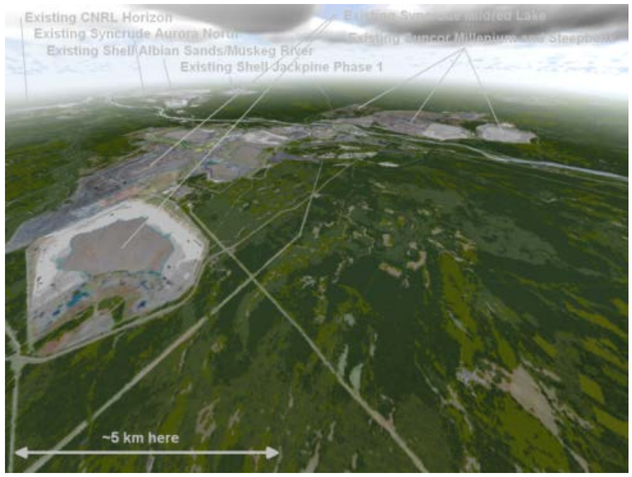


Figure 198 Suncor Voyageur South – Existing

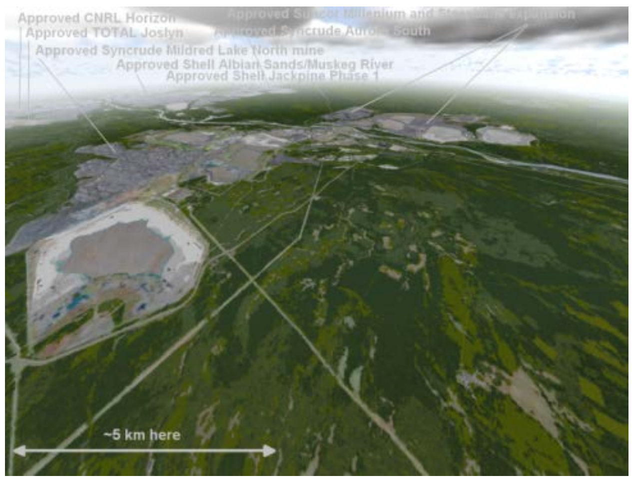


Figure 199 Suncor Voyageur South - Approved and Existing Projects

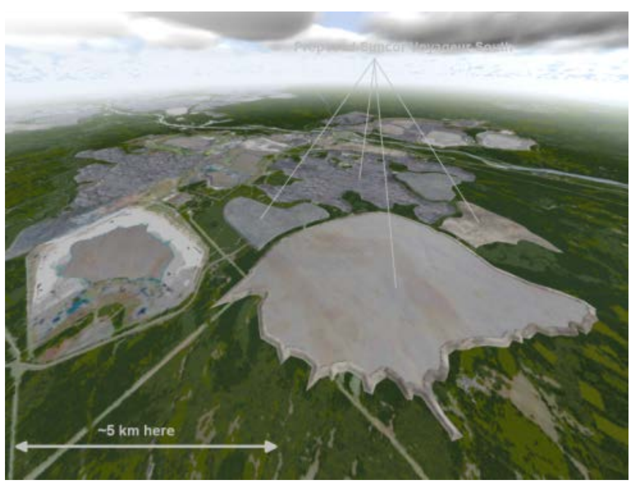


Figure 200 Suncor Voyageur South - Proposed, Approved, and Existing

Mine #14 TOTAL Sinopec Northern Lights – Proposed Project – Camera Position 2,706 m above ground level

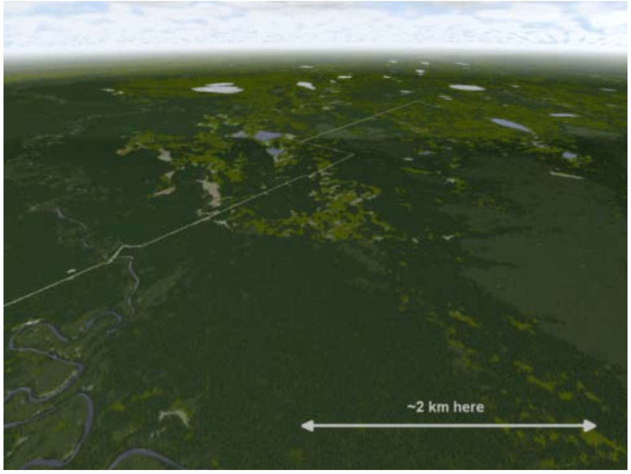


Figure 201 TOTAL Sinipec Northern Lights – Existing

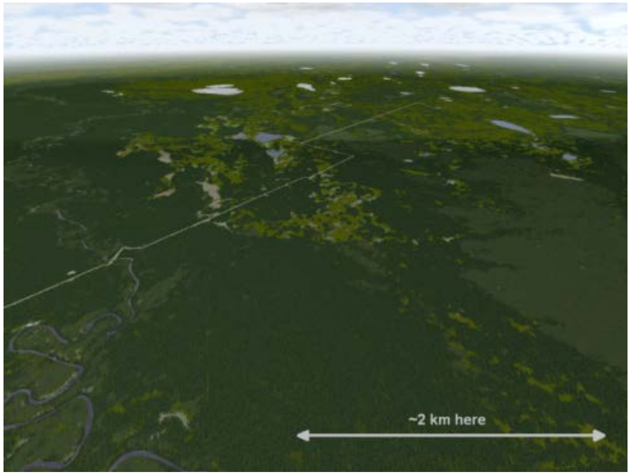


Figure 202 TOTAL Sinopec - Approved and Existing

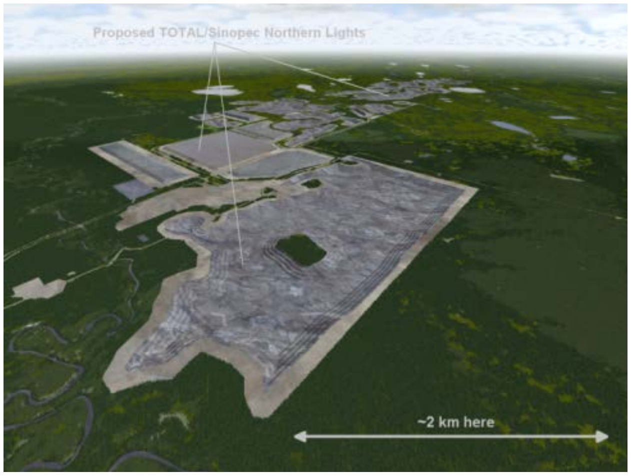


Figure 203 TOTAL Sinopec - Proposed, Approved, and Existing

APPENDIX H: SCREENING CRITERIA QUESTIONS

"This study is looking for members of the general public who do not belong to organizations with pre-defined positions on large energy projects. With your permission, I would like to first ask you some questions to determine if you qualify for this study. Is that alright?

[If potential subjects answer "yes" to any one of the following questions, the researcher would state: "Thank you for your interest in this study, but you do not meet the screening criteria. If you are interested in the results of the study, I can email you the project web-site when the study is completed."]

1) Are you a technical expert in an environmental or natural resource field?
2) Are you a direct employee of oil and gas projects?
3) Are you a staff member of an environmental agency or organization?
4) Are you a student from a faculty associated with mineral/resource extraction or conservation?

I also have some additional questions to determine your eligibility for this study:

[If potential subjects answer "no" to any one of the following questions, the researcher would state: "Thank you for your interest in this study, but you do not meet the screening criteria. If you are interested in the results of the study, I can email you the project web-site when the study is completed."]

1) Are you above the age of 18 and can directly provide consent to participate in this study?
2) Do you have adequate eyesight to be able to operate a computer with a standard screen?
3) This study requires viewing and responding to colour images on a computer screen. Can you see and tell apart all visible colours?
4) This study requires individually navigating Google Earth software on a PC computer. Do you have at least basic computer skills for the typical use of a computer?

[If potential subjects answer "yes" to any one of the following questions, the researcher would state: "Thank you for your interest in this study, but you do not meet the screening criteria. If you are interested in the results of the study, I can email you the project web-site when the study is completed."]

As this study involves group discussion, we are seeking participants who do not belong to organizations with pre-defined positions on large energy projects:

1) To your knowledge, has anyone else from you immediate workplace already been enrolled in this study?
2) To your knowledge, has anyone else from your household already been enrolled in this study?"

APPENDIX I: INFORMATION ABOUT THE STUDY AND CONSENT FORM

Collaborative for Advanced Landscape Planning
Department of Forest Resource Management
Faculty of Forestry, University of British Columbia
2045-2424 Main Mall, Vancouver, BC
Canada, V6T 1Z4

July 19, 2012

RE: Invitation to participate in "Visualizing the Industrial North: Exploring New Ways to Engage and Inform the Public on Very Large Energy Projects"

August 11, 2012, 2pm-4:30pm, University of British Columbia, Vancouver, BC
(3rd and 4th year UBC Students only)

August 13 and 14, 2012, 7pm-9:30pm, Downtown Vancouver, BC
(Vancouver general public)

August 16, 2012, 7pm-9:30pm, University of Alberta, Edmonton, AB
(Edmonton general public)

Dear Potential Research Participant:

This University of British Columbia research project explores the use of new visual tools such as **Google Earth** for explaining extremely large energy projects to the public, using the Tar Sands development in Alberta as a case study. The aim of the study is also to record your understanding of the Tar Sands development.

We are seeking participants from 3rd and 4th year students at the University of British Columbia in Vancouver and the general public in Vancouver and Edmonton (who are not professionals in the oil/gas industry or environmental issues and who are over the age of 18), in order to get a broad cross-section of participants in different geographic areas.

If you meet these criteria and agree to participate, you will be asked to join a small focus group of up to twelve people who will "fly" over the existing, approved, and planned tar sands projects using simple Google Earth software on individual computers in a lab or office setting. You will be shown how to use Google Earth software. You will be asked to fill in two brief questionnaires – one before and one after the hands-on exercise. You will be asked to comment on your reactions to the material and to save screenshots of the views you consider most significant.

Your total time commitment to this study will be two to three hours. You will receive a **$25 honorarium**, regardless of whether you complete the study or not. You will also be given **a portable "jump" drive** containing all the screenshots that you selected.

I have attached two copies of the consent form with a stamped self-addressed envelope. If you wish to participate in the study, please sign one copy of the consent form and return it by mail and keep the second consent form for your records.

If you have any questions, please do not hesitate to contact me or Dr. Sheppard, Director of the Collaborative for Advanced Landscape Planning at UBC (contact details below).

Sincerely yours,

[Signed by]

Petr Cizek, PhD Candidate
[email]
[phone]

Dr. Stephen R.J. Sheppard
[phone]

CONSENT FORM

“Visualizing the Industrial North: Exploring New Ways to Engage and Inform the Public on Very Large Energy Projects”

Principal Investigator:

Dr. Stephen Sheppard, Professor
Collaborative for Advanced Landscape Planning
Department of Forest Resource Management
Faculty of Forestry, University of British Columbia
2045-2424 Main Mall, Vancouver, BC
Canada, V6T 1Z4
[Pnone], [Fax]

Sponsor: *Social Sciences and Humanities Research Council of Canada*

The aims of this study are to help assess the use of mapping and visual tools such as Google Earth for mapping, visualizing, and understanding very large energy projects, using the physical footprint of tar sands development in Alberta as a case study and to record your understanding of the tar sands development.

We are seeking participants from 3rd and 4th year students at the University of British Columbia in Vancouver and the general public in Vancouver and Edmonton who are not professionals in the oil/gas industry or in environmental issues and who are over the age of 18. The reason for these selection criteria is to get a broad cross-section of participants in different geographic areas who do not represent organizations with pre-defined positions on tar sands development.

If you meet these criteria and agree to participate, you will be asked to join a small focus group of up to twelve people who will undertake hands-on navigation and viewing of computer maps and 3D simulations of the tar sands, using simple Google Earth software on individual computers in a computer lab setting. You will be asked to fill in two brief questionnaires – one questionnaire before and one after the hands-on exercise. You will be asked to comment on your reactions to the material and to save screenshots of the views you consider most significant. The computer will also video-record your use of the software. This will be a video-recording of the computer screen only -- no video of actual computer users or anyone else in the focus group will be captured.

Your total time commitment to this study will be two to three hours. You will receive a $25 honorarium, regardless of whether you complete the study or not. You will also be given a portable “jump” drive containing all the screenshots that you selected.

Your participation in this project is entirely voluntary and there will be no negative consequences if you refuse to participate in it, withdraw from it, or refuse to answer certain questions.

Your confidentiality will be maintained by excluding your name from any questionnaire responses, focus group comments, screenshots that you select, or the computer screen video recording of your use of the software. Your name will not appear in any of the results or conclusions in this study.

The focus session will be audio recorded, but only the researchers will hear the tape to help refresh our memory. The audio recording will be destroyed when its review is complete.

We will encourage all participants to refrain from disclosing the contents of the discussion outside of the focus group; however, we cannot control what other participants do with the information discussed.

The results of this study will be published in academic journals and presented at conferences and on the web. The researchers will be happy to provide you with a copy of the results if you desire.

If you have any questions or concerns about the project itself or the methods used, you should contact:

Petr Cizek, PhD Candidate
Collaborative for Advanced Landscape Planning
Department of Forest Resource Management
Faculty of Forestry, University of British Columbia
[phone]
[email]

Please read and sign the following statement:

Having understood the above information and after being given an opportunity to have my questions answered, I agree to participate in this study.

__________________________ _______________

Signature of Participant Date

____

Please print name

APPENDIX J: LAYOUT OF COMPUTER LABORATORIES

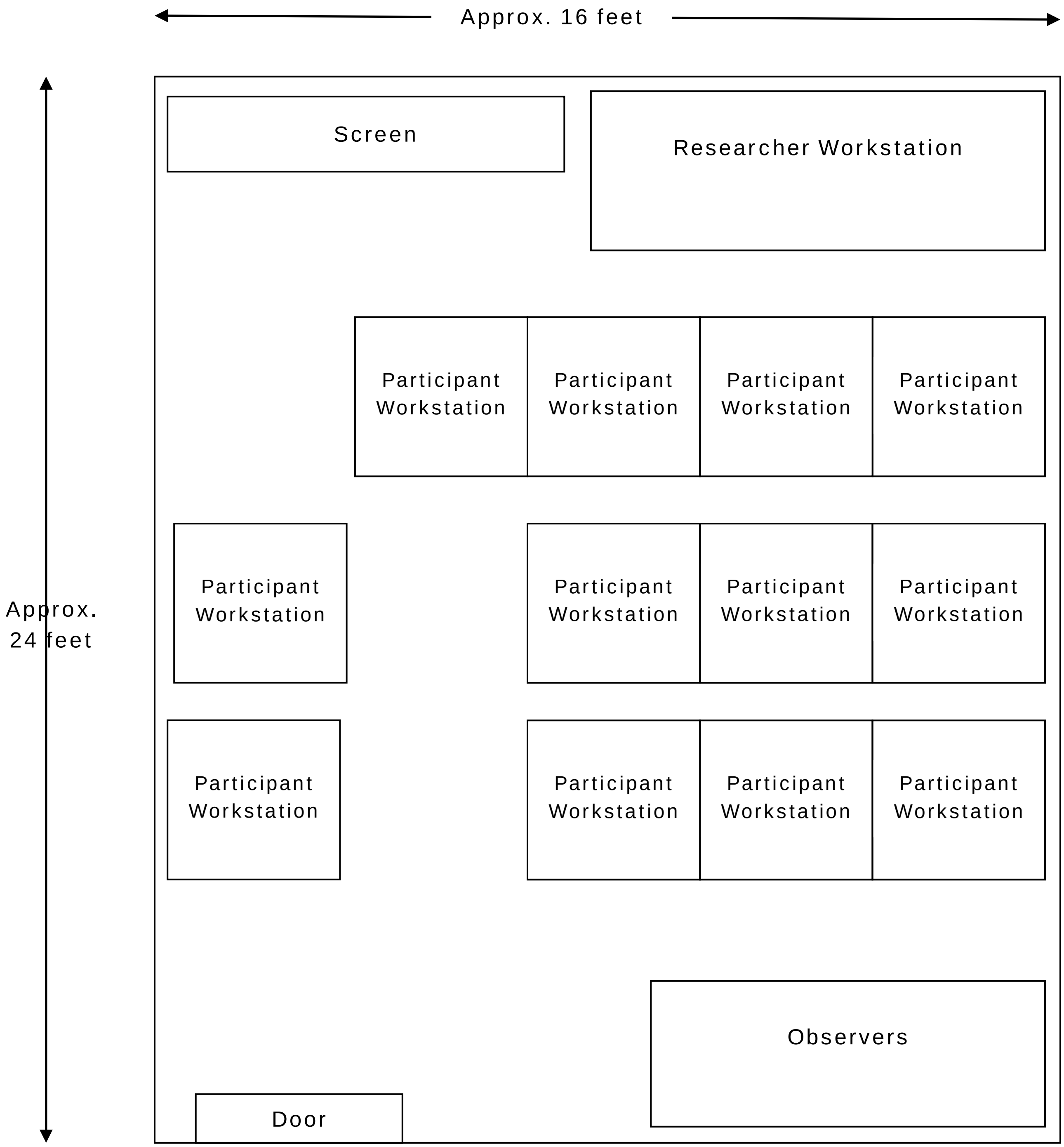


Figure 204 Floor Layout of Computer Lab at University of British Columbia, Robson Square

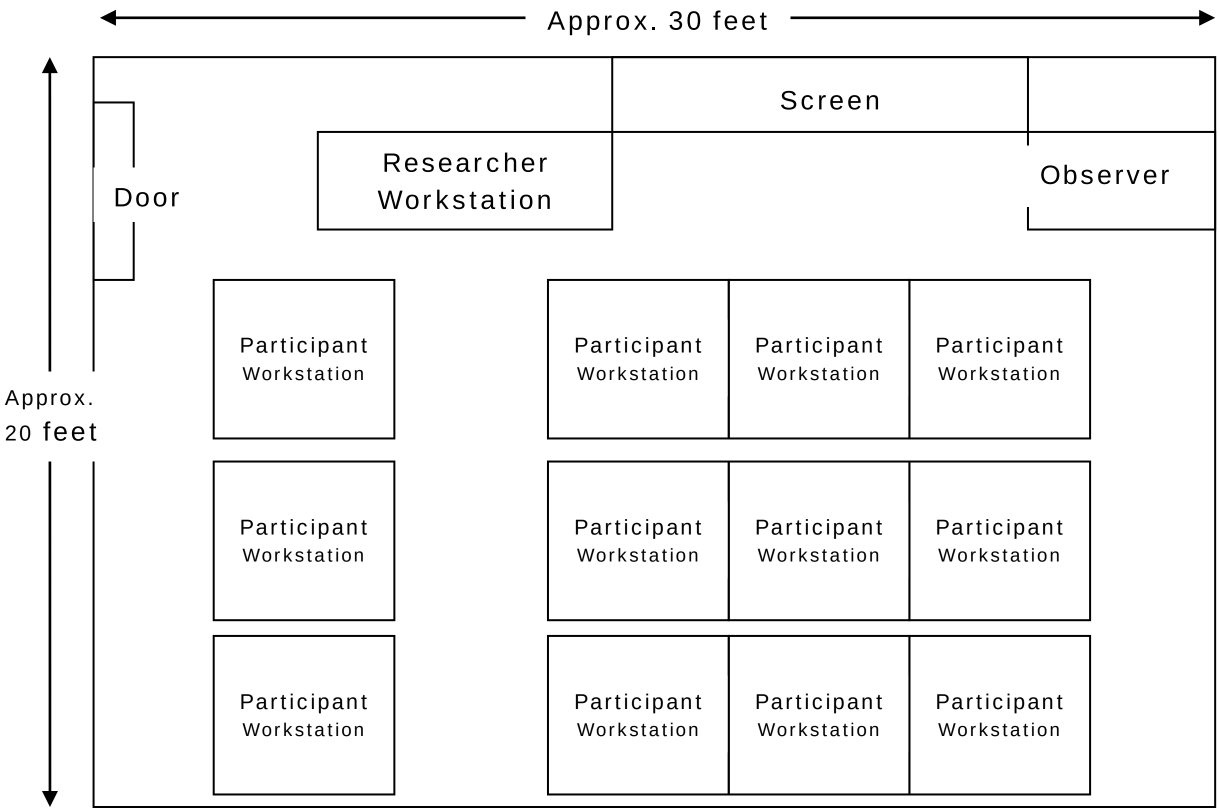


Figure 205 Floor Layout of Computer Lab at University of Alberta, Technology Training Centre

APPENDIX K: RESEARCH PROTOCOL

Exploring New Ways to Engage and Inform the Public on Very Large Projects

RESEARCH PROTOCOL

Focus Group Summary and Timing

(table also distributed as workshop agenda handout)

Activity	**Activity Time (min)**	**Cumulative Time (hrs: min)**
1. Introduction	3	0:03
2. Initial Questionnaires	10	0:13
3. Brief Factual Context	2	0:15
4. Practice Navigation and Screenshots	10	0:25
5. Context of Tar Sands Development	10	0:35
6. Existing Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	30	1:05
7. Break	10	1:15
8. Adding Approved Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	25	1:40
9. Adding Planned Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	35	2:15
10. Follow Up Questionnaires	10	2:25
11. Collect Questionnaires and Copy Individual Screenshots to Jump Drives	10	2:35

1. **Introduction and Questions**

I'd like to welcome you to this focus group and thank you for your participation. Please don't start using the computers until I ask you.

The aims of this study are help us assess the use of mapping and visual tools such as Google Earth for mapping, visualizing, and understanding very large energy projects, using the Alberta tar sands open pit mines as a case study. We are also interested in your opinions on tar sands open pit mines and the scale of development.

We intentionally use the original term "tar sands" because the resource does not contain any crude oil in its natural form. The resource contains a tar-like substance called bitumen, which must be highly processed and upgraded to **convert** it into "synthetic crude oil." **I**ndustry and government now only use the term "oil sands" **to promote the development of the resource.** However, the two terms **are still used** interchangeably.

Before we start, I have a short statement to read:

"*Your participation in this hands-on use of Google Earth for mapping and landscape visualization of the tar sands and the following discussion is completely voluntary. Your participation in this activity will be kept confidential, and your name will not appear in any of the results or conclusions from this session. The session will be tape-recorded, but only the researchers will hear the tape to help refresh our memory. The tape will be destroyed when the study is complete. We also have a second observer who is here to take notes and help out. (Introduce observer by name).We encourage all participants to refrain from disclosing the contents of the discussion outside of the focus group; however, we cannot control what other participants do with the information discussed.*

All the computer screenshots that you select will be copied as part of this research, but no names will be attached to the images. At the end of the session, you will be given a portable jump drive containing your individual screenshot images.

The computer will video-record your use of the software – this is only a recording of the computer screen. No video of you or anyone else in the focus group will be taken. No names will be attached to the video-recording.

You may cease participation in this activity at any time for any reason without prejudice and receive your entire honorarium. This activity has been approved by the University of British Columbia's Behavioural Ethics Review Board."

This session will last about two and a half hours as shown on your agenda handout. We'll begin with a short questionnaire and then practice navigation and screenshots. We'll look at the context of tar sands development at continental and provincial scales. We'll then examine and discuss ***existing*** tar sands open pit mining projects followed by a short break. After the break, we'll examine and discuss approved and proposed tar sands open pit mining projects. We'll conclude with a one more short questionnaire following which you will receive all your screenshots on a jump drive.

Do you have any questions at this stage?

We will now distribute the honoraria.

(Distribute honoraria and collect signed receipts).

The main purpose of inviting you here today is to help us explore the use of new mapping and visual tools such as Google Earth for understanding the physical footprint of large projects such as the Alberta tar sands. Particularly, we are interested in the physical footprint of existing, approved, and proposed tar sands open pit mining projects and your response to this. By physical footprint, we mean the landscape area changed through the removal of vegetation, soils and minerals, construction of roads and buildings, tailings ponds etc. In this project we aren't focusing on the other "footprints" such as greenhouse gases, pollution, or water consumption, although these are also important.

Do you have any questions?

2. **Initial Questionnaire**

And now, I'd like you to take 10 minutes to complete the short questionnaire I am handing out.

(Distribute questionnaires with assigned numbers for each participant)

If you have any questions to clarify the questionnaire at any time, please let me know.

(Take any questions and share answers with all)

(10 minute pause, with 5 minute and 1 minute warning to complete questionnaire).

Please return the questionnaire sheets to me. Thank you.

(Collect questionnaire).

3. Brief Factual Context on Alberta Tar Sands

(Show in bullet powerpoint summary on screen while presenting)

The following information comes from government and industry sources. Canada's tar sands deposits contain as much as 170 billion barrels of proven oil, third only in size to Saudi Arabia and Venezuela.

Tar sands production started in 1967. Current production is about 1.5 million barrels of oil per day. The tar sands account for about 390,000 direct, indirect, and induced jobs across Canada.[56] In 2009, $10 billion was spent on capital projects in the tar sands with an additional $218 billion of capital spending planned during the next twenty-five years. By 2020, production is planned to grow to about 3 million barrels per day.

There are three deposits of tar sands in Alberta. The largest is near Fort McMurray but there are two more near Peace River and Cold Lake. There are currently 91 producing tar sands projects in these three areas.

There are two kinds of tar sands production – open pit mining and in-situ. In-situ production recovers deposits that are deeper underground, using techniques that are similar to conventional oil production. This project only examines tar sands open pit mining projects near Fort McMurray.

Open pit mining is used when tar sands deposits are close to the surface, using truck and shovel technology. In the region of Fort McMurray, twenty per cent of all tar sands deposits are close enough to the surface (i.e. within 75m) to be mined. It takes two tonnes of extracted materials to

[56] http://www.ceri.ca/images/stories/2011-08-24_CERI_Study_125_Section_1.pdf

produce one barrel of oil. The current area disturbed of open pit mining projects is 715 km^2, which is about of the size of the municipal boundaries of Edmonton.

The petroleum in the tar sands is called bitumen. Bitumen does not flow in its natural state – it is as thick as peanut butter. It must be processed and upgraded, using water, steam, and natural gas to create "synthetic crude oil."

Due to all the extra processing required, tar sands extraction and upgrading now produces a total of 45 million tonnes of greenhouse gas emissions per year, or about 7% of Canada's total. By the time the fuels from the tar sands are refined, transported, and consumed, over five times more total greenhouse gases are currently be emitted.

Tar sands mining requires 2 to 4 barrels of fresh water for every barrel of oil produced. Annual tar sands fresh water use is 179 million cubic metres, which is just over 1/3 of the City of Toronto's annual water consumption.

After the tar sands have been mined, oil is separated from the sand and sent for further processing. "Tailings" are the leftover mixture of water, sand, clay and residual oil. Tailings ponds are large engineered dam and dyke systems designed to contain and settle the water, sand, fine clays, silts, residual bitumen and other by-products of the oil sands mining and extraction process. The total area of existing tailings ponds is 170 km^2.

4. Practice Navigation and Screenshots using Standard Google Earth Satellite Image Data

We are now going to practice navigating around the tar sands in Google Earth and practice taking screenshots of the images that you find most interesting or informative, so that you can show them to the group later. Each one of you will be asked to show a screenshot to the rest of the group.

I will give a very brief demonstration about how to navigate in Google Earth (5 minutes). You can now begin using your computers. Please watch me first and then you will try it for yourselves.

The "Places" pane is located in the middle left of your Google Earth window. To zoom into the tar sands open pit mines, double click into the ***text*** of "Tar Sands Cumulative Development Network Link" in the "Places" pane. Do not turn on the check-boxes or round radio buttons. If you have turned on the check-boxes, please click the checkmark to turn it off.

(Demonstration based on:
http://support.google.com/earth/bin/answer.py?hl=en&answer=148186)

Most of the standard satellite imagery in Google Earth around the tar sands is at a very high resolution of about 1 metre, but the images are taken at different dates and have slightly different colours. The colours in the images are not completely realistic but you should be able to distinguish clearly between the different features such as roads, tailings ponds, and mine pits.

You can zoom in and out with any one of the following functions:

1) using the zoom slider bar in the top right of the Google Earth window
2) placing the "hand" cursor in the Google Earth map window and using the scroll wheel on your mouse
3) placing the "hand" cursor in the Google Earth map window and using the "+" and "–" buttons on your numeric keypad

When you zoom in close enough, you can see the date of each image in the bottom left hand corner of the screen and you will see that the imagery is a few years out of date already. Please try this now.

In the bottom left hand corner of the screen, there is also a scale bar which gives you an idea of the size of the image you are looking at.

Further, you can move around in Google Earth with any one of the following functions:

1) using the "move" joystick image with the hand in the top right of the Google Earth map window
2) pressing the left button of the mouse and moving the "hand" cursor in the Google Earth map window
3) using the arrow keys on the keyboard

Please try this now.

You can also tilt and rotate Google Earth with any one of the following functions:

1) using the "look" joystick with the eyeball in the top right of the Google Earth window
2) pressing the "Shift" key on the keyboard, pressing the left button on the mouse, and moving the "hand" cursor in the main Google Earth window
3) pressing "Shift" on the keyboard and using the arrow keys on the keyboard.

Please try this now.

Anytime you want to return to the vertical upright position with "North" at the top of your screen, press "r" on the keyboard.

Please try this now.

Anytime you want to return to a viewpoint in the project, press any of the texts in the "Places" menu.

Please try this now.

By pressing "F10" at any time, the computer will take a screenshot of your view and store the image in your private folder on the shared network drive.

Please try this now.

Now, please practice navigating and taking screenshots for a few minutes. At anytime that you wish to return to the original vertical map viewpoint double-click into the ***text*** of "Tar Sands Cumulative Development." Please let me know if you have any questions or need assistance.

(5 minute pause) (observe, troubleshoot, and help)

5. Context of Tar Sands Development

First we are going to look at the context of tar sands development at continental and provincial scales so that you can see the possible outcomes of existing and future development in a larger geographic area. This information is from industry and government sources. I will first demonstrate and then you can follow along. Please wait for me to ask you to select each round radio button. You can also take screenshots by pressing "F10".

<u>Continental Pipelines</u>

These maps include all the main pipelines that are used to ship tar sands products. Most of these pipelines ship conventional oil products as well. These maps also show the main natural gas pipelines that are needed to supply the additional energy required to extract the bitumen from the sand and to upgrade it into "synthetic crude oil". To make the maps easier to read, these maps do not show all pipelines in North America.

Now, please select the round radio button for "Continental Pipelines" and double-click in the *text* of "Existing Pipelines" and Google Earth will automatically zoom out to the continental scale. If this is not shown on the menu tree, click into the plus "+" signs in the checkboxes until it appears.

The first map shows "Existing Pipelines in 2011**."** In 2011, tar sands bitumen and "synthetic crude oil" production was about 1.5 million barrels per day. About 1 billion cubic feet of natural gas per day from Alberta and north-eastern British Columbia were used to extract and upgrade the bitumen. Extracting and upgrading the bitumen produced about 45 million tonnes per year of greenhouse gas emissions or about 7 percent of Canada's total greenhouse gas emission. By the time the fuels from the tar sands are refined, transported, and consumed, over five times more total greenhouse gases are currently emitted, which is over one-third of all of Canada's current emissions.

Next, please select the round radio button for "Proposed Pipelines", which are specific pipeline routes that have been submitted to regulators ***but not yet*** approved. Double-click in the *text* of "Proposed Pipelines" and Google Earth will automatically zoom to this scenario. This map shows "Existing and Proposed Pipelines circa 2019." By about 2019, tar sands bitumen and "synthetic crude oil" production is forecast to double to about 3 million barrels per day. This would require about 2.1 billion cubic feet of natural gas per day to extract and upgrade the bitumen. It would use the entire capacity of the recently-approved but not yet built Mackenzie

Gas Project pipeline that would ship natural gas from the mainland Northwest Territories and Beaufort Sea to the tar sands. Doubling tar sands production would also result in about 108 million tonnes per year of greenhouse gas emissions to extract and upgrade the bitumen. By the time the fuels from the tar sands were refined, transported, and consumed, over five times more total greenhouse gases would be emitted, which is almost as much as all of Canada's current emissions.

Finally, please select the round radio button for "Conceptual Pipelines", which are pipelines with general routes that have been announced by industry at one time but not yet submitted to regulators. At the moment, industry may not be actively promoting all these pipelines. Double-click in the ***text*** of "Conceptual Pipelines" and Google Earth will automatically zoom into this scenario. This map shows "Existing, Proposed, and Conceptual Pipelines circa 2035." By about 2035, tar sands bitumen and "synthetic crude oil" production is forecast to more than triple from current production levels to about 5 million barrels per day. This would require about 5.9 billion cubic feet of natural gas per day to extract and upgrade the bitumen. In addition to using the entire capacity of the Mackenzie Gas Project natural gas pipeline, most of the capacity of the proposed Alaska pipeline that would ship natural gas from Prudhoe Bay to the tar sands would also be required. As natural gas from the mainland Northwest territories and Beaufort Sea becomes depleted, liquefied natural gas could be shipped by tankers from the Sverdrup Basin in the high arctic islands through the Northwest Passage to a terminal in the Mackenzie Delta where it would be fed into the Mackenzie Gas Project pipeline. This scenario would also result in about 147 million tonnes per year of greenhouse gas emissions to extract and upgrade the bitumen. By the time the fuels from the tar sands were refined, transported, and consumed, over five times more total greenhouse gases would be emitted, which is 125% of all of Canada's current emissions.

(4 minutes)

<u>Tar Sands Leases 2011</u>

Select the round radio button for "Leases 2011" and double-click in the ***text*** of "Leases 2011" to expand the menu tree. Google Earth will automatically zoom to the province of Alberta. This map shows the "Existing Tar Sands Leases 2011" with the total areas available for leasing outlined in purple and the existing leases in orange. The "Surface Mineable Area" where the open pit mines are located north of Fort McMurray is outlined in pink. Outside the "Surface Mineable Area" tar sands development uses "in-situ" methods. Select the round radio button for "Compare to Florida" to show the outline of the State of Florida on top of the leased area.

(3 minutes)

Regulatory Maps

Select the round radio button for "Regulatory Maps Open Pit Mines" and double-click on the ***text*** of "Regulatory Maps Open Pit Mines" to expand the menu tree. Google Earth will automatically zoom into this area and will show the first tar sands mine "Suncor Millenium and Steepbank" with the regulatory map overlaid at the correct scale. Select different round radio buttons to display any one of the other existing, approved, or proposed tar sands open pit mines. These maps show how tar sands projects are managed and regulated one at a time. In most cases, these maps do not show any other adjacent projects owned by other companies

(3 minutes)

6. **Existing Tar Sands Open Pit Mines – Navigation and Discussion**

Please follow along and don't go too far ahead as we work through some exercises together.

The first item we are going to examine in depth are the ***existing*** tar sands open pit mining projects. We used the most recently publicly available satellite images from September 2011 to map out the ***existing*** tar sands open pit mining projects. Turn on the round radio button for "Open Pit Mines" and double click into the ***text*** of "Open Pit Mines" to expand the menu tree. Google Earth will automatically zoom into this scenario and will overlay a map of the "Existing Tar Sands Mines" with labels on top of the standard Google Earth satellite image data.

The 2D map of the "Existing Tar Sands Mines" was created using "landscape visualisation" software and has more realistic colours and textures than the standard Google Earth satellite image data. This map was developed using federal government maps and forest information combined with medium-resolution (30 metre pixel) satellite images of the existing footprints of tar sands open pit mines. Since we only had access to free public data, this map is less detailed compared to the standard Google Earth satellite images, which have a resolution of about 1 metre but are very costly to purchase.

In the map, double-click into any one of the blue "Camera" icons and a "balloon" will pop up showing a real-life oblique aerial photograph of the existing tar sands projects taken in August 2008 next to a computer-generated 3D landscape of the same viewpoint. The 3D landscape was produced with "landscape visualization" software and shows realistic textures, trees, shadows, and the shape/depth of open pit mines. At the same time, Google Earth will zoom into a similar 3D view as the photograph in the "balloon".

To see high resolution images, click into the blue underlined hyperlink at the bottom of the balloon. To return to Google Earth, click into the "Back to Google Earth" button at the top left of the high resolution window. At anytime that you wish to return to the original vertical map viewpoint double-click into the ***text*** of "Existing Tar Sands Mines."

Please remember to press "F10" to take one or more screenshots of views that you find especially interesting or informative.

(3 minute pause)

In the map, double click into any one of the green "Camera" icons and a "balloon" will pop up showing a computer-generated 3D landscape of the "Existing Tar Sands Mines." At the same time, Google Earth will zoom into a similar 3D view as the image in the "balloon".

To see high resolution images, click into the blue underlined hyperlink at the bottom of the balloon. To return to Google Earth, click into the "Back to Google Earth" button at the top left of the high resolution window.

Navigate around the "Existing Tar Sands Mines" area, while zooming in and zooming out and changing the tilt of your map. Please take one to three screenshots of views that you find particularly interesting or informative. At anytime that you wish to return to the original vertical map viewpoint double-click into the ***text*** of "Existing Tar Sands Mines."

Take note of the scale bar in the bottom left of your map window to get an idea of the size of the "Existing Tar Sands Open Pit Mines".

(3 minute pause)

Double-click into the ***text*** of "Existing Tar Sands Mines" to return to the original vertical view point. Turn on the check-box for "Comparison to Major Cities" and double-click into the ***text*** of "Comparison to Major Cities" to expand the menu tree. Select individual round radio buttons to compare the outlines of different cities on top of the tar sands open pit mines. Double-click in the text "Actual Location" to zoom into the outline of each city on top of its actual location. To return to the tar sands open pit mines, double-click into the text of "Tar Sands Overlay". Navigate around this area, while zooming in and out changing the tilt of your map. Please remember to take some screenshots of views that you find especially interesting or informative. When you wish to turn off the "Comparison to Major Cities" uncheck the box by clicking into it and click into the minus "-" sign to collapse the menu tree.

(4 minute pause)

Now I would like this group to address some specific issues. This is a focus group, so we need to focus on specific topics. So please try to focus on the issue at hand. There will be an opportunity later to address points you'd like to make that we didn't get to. Now the first of these issues is…

LET'S START THINKING ABOUT THE ***EXISTING*** TAR SANDS OPEN PIT MINES. IF POSSIBLE, I WOULD LIKE ONE OF YOU TO SHOW THE GROUP A SCREENSHOT THAT YOU SAVED TO ILLUSTRATE YOUR REACTIONS, THOUGHTS, OR COMMENTS. PLEASE TELL ME WHICH SCREENSHOT I SHOULD SHOW ON THE PROJECTOR FOR EVERYONE TO SEE. WHO WOULD LIKE TO GO FIRST?

(Show screenshot to group)

IF POSSIBLE, CAN YOU SHOW ME HOW YOU MOVED THROUGH THE LANDSCAPE IN GOOGLE EARTH BEFORE YOU TOOK THIS SCREENSHOT?

(Recreate movement in Google Earth while showing to group; Note: this will already have been recorded on the participant's computer and the recreated movement would also be recorded on the researcher's computer).

(Repeat above about 3 more times during 20 minutes discussion time)

PROBES (During the discussion of the screenshot)

a) Did you find the information useful in better understanding the size of the ***existing*** tar sands open pit mines? How?

b) Did you find any problems using the visualization tool – e.g. when did you become disoriented at all, and if so, when?

c) Do you find any problems with the information?

d) What kind of new knowledge did you gain? Any key moments or navigation points where you received this new information?

e) How does this information make you feel about the development of tar sands open pit mines?

f) Does anyone feel differently?

g) Any other comments or questions?

8. **Approved Tar Sands Open Pit Mines – Navigation and Discussion**

The second item we are going to examine are the already ***approved*** tar sands open pit mines combined with ***existing*** tar sands open pit mines. In your "Places" pane, turn on "Approved and Existing Tar Sands Mines" and double-click into the ***text*** of "Approved and Existing Tar Sands Mines." Google Earth will automatically zoom into the "Approved and Existing Tar Sands Mines."

Approved tar sands open pit mines have been given legal permission by governments to proceed, but that have not yet been built. As shown earlier, we used regulatory maps from the Alberta Energy Resource and Conservation Board web-site to create the realistic computer simulations of the approved tar sands open pit mines.

The computer simulations show what the landscape would look like if the approved projects were fully constructed during the next 30 years approximately. You should be able to identify:

- Open pit mines, at a depth of 75 metres ***below*** the existing land surface;
- Overburden disposal areas, at a height of as much as 60 metres ***above*** the existing land surface; and
- Tailings ponds dams and dykes 40 metres ***above*** the existing land surface containing a mixture of brownish silt, water, and oily film.

The simulations do not show any restoration, which would take place over a period of about 50 years after the bitumen has been extracted from each mine pit.

In the map, double click into the orange "Camera" icons and a "balloon" will pop up showing a computer-generated visualization of the "Approved and Existing Tar Sands Mines." At the same time, Google Earth will zoom into a similar view as the image in the "balloon".

To see high resolution images, click into the blue underlined hyperlink at the bottom of the balloon. To return to Google Earth, click into the "Back to Google Earth" button at the top left of the high resolution window. Anytime you wish to return to the original map viewpoint double-click into the ***text*** of "Approved and Existing Tar Sands Mines."

Navigate around the "Approved and Existing Tar Sands Mines" area, while zooming in and zooming out and changing the tilt of your map. Don't forget to take one or more screenshots of views by pressing "F10" that you find particularly interesting or informative.

Take note of the scale bar in the bottom left of your map window to get an idea of the size of the "Approved and Existing Tar Sands Mines".

(2.5 minutes pause)

Double-click into the ***text*** of "Approved and Existing Tar Sands Mines" to return to the original vertical view point. In your "Places" pane, turn on the check-box for "Comparison to Major Cities" and double-click into the ***text*** of "Comparison to Major Cities" to expand the menu tree.

Select individual round radio buttons to compare the outlines of different cities on top of the tar sands open pit mines. Double-click in the text "Actual Location" to zoom into the outline of each city on top of its actual location. To return to the tar sands open pit mines, double-click into the text of "Tar Sands Overlay". Navigate around this area, while zooming in and out changing the tilt of your map. Please remember to take some screenshots of views that you find especially interesting or informative. When you wish to turn off the "Comparison to Major Cities" uncheck the box by clicking into it and click into the minus "-" sign to collapse the menu tree.

(2.5 minutes pause)

LET'S START THINKING ABOUT THE ***APPROVED*** TAR SANDS OPEN PIT MINES COMBINED WITH THE ***EXISTING*** TAR SANDS OPEN PIT MINES. IF POSSIBLE, I WOULD LIKE ONE OF YOU TO SHOW THE GROUP A SCREENSHOT THAT YOU SAVED TO ILLUSTRATE YOUR REACTIONS, THOUGHTS, OR COMMENTS. PLEASE TELL ME WHICH SCREENSHOT I SHOULD SHOW ON THE PROJECTOR FOR EVERYONE TO SEE. COULD SOMEONE NEW COME UP?

(Show screenshot to group)

IF POSSIBLE, CAN YOU SHOW ME HOW YOU MOVED THROUGH THE LANDSCAPE IN GOOGLE EARTH BEFORE YOU TOOK THIS SCREENSHOT?

(Recreate movement in Google Earth while showing to group. Note: this will already have been recorded on the participant's computer and the recreated movement would also be recorded on the researcher's computer).

(Repeat above about 3 more times during 20 minutes discussion time)

(20 minutes discussion)

PROBES (During the discussion of the screenshot)

a) Did you find the information useful in better understanding the size of the ***existing and approved*** tar sands open pit mines? How? Is there anything different in your use of the tool this time?

b) Did you find any problems using the visualization tool – e.g. when did you become disoriented at all, and if so, when?

c) Do you find any problems with the information?

d) What kind of new knowledge did you gain? Any key moments or navigation points where you received this new information?

e) How does this information make you feel about tar sands development?

f) Does anyone feel differently?

g) Any other comments or questions?

9. **Proposed Tar Sands Open Pit Mines- Navigation and Discussion**

The final item we are going to examine are the ***proposed*** tar sands open pit mines combined with ***approved*** and ***existing*** tar sands open pit mines. ***Proposed*** tar sands open pit mines are defined as projects that have been disclosed or proposed by industry, but that have not yet obtained legal permission from governments to proceed. As shown earlier, we used maps from industry web-sites to create these computer simulations.

In your "Places" pane, turn on "Proposed, Approved, and Existing Tar Sands Mines" and double-click into the ***text*** of "Proposed, Approved, and Existing Tar Sands Mines." Google Earth will automatically zoom into the "Proposed, Approved, and Existing Tar Sands Mines" on the map.

The computer simulations show what the landscape would look like if the projects are fully constructed during the next 30 years approximately. As before, you should be able to identify

- Open pit mines at a depth of 75 metres ***below*** the existing land surface;
- Overburden disposal areas at a height of as much as 60 metres ***above*** the existing land surface; and
- Tailings ponds dams and dykes 40 metres above the existing land surface containing a mixture of brownish silt and water.

Again, the simulations do not show any restoration, which would take place over a period of about 50 years after the bitumen has been extracted from each mine pit.

In the map, double click into any one of the red "Camera" icons and a "balloon" will pop up showing a computer-generated visualization of the "Proposed, Approved, and Existing Tar Sands Mines." At the same time, Google Earth will zoom into a similar view as the image in the "balloon".

To see high resolution images, click into the blue underlined hyperlink at the bottom of the balloon. Next to the title of the high resolution image, you can also click on blue underlined hyper-links that show the same viewpoint in different scenarios (e.g. Existing, Approved, and Proposed). Please explore the high-resolution images in different scenarios and take screenshots of images that you find interesting or informative by pressing "F10". To return to Google Earth, click into the "Back to Google Earth" button at the top left of the high resolution window. Anytime you wish to return to the original map viewpoint double-click into the ***text*** of "Proposed, Approved, and Existing Tar Sands Mines."

Navigate around the "Proposed, Approved, and Existing Tar Sand Mines" area, while zooming in and zooming out and changing the tilt of your map.

Take note of the scale bar in the bottom left of your map window to get an idea of the size of the "Proposed, Approved, and Existing Tar Sands Mines". Please remember to press "F10" to take one or more screenshots of views that you find especially interesting or informative.

(2.5 minutes pause)

Click into the ***text*** of "Proposed, Approved, and Existing Tar Sands Mines" to return to the original vertical view point. In your "Places" pane, turn on the check-box for "Comparison to Major Cities" and double-click into the ***text*** of "Comparison to Major Cities" to expand the menu tree. Select individual round radio buttons to compare the outlines of different cities on top of the tar sands open pit mines. Double-click in the text "Actual Location" to zoom into outline of each city on top of its actual location. To return to the tar sands open pit mines, double-click into the text of "Tar Sands Overlay". Navigate around this area, while zooming in and out changing the tilt of your map. Please remember to take some screenshots of views that you find especially interesting or informative. When you wish to turn off the "Comparison to Major Cities" uncheck the box by clicking into it and click into the minus "-" sign to collapse the menu tree.

If you have extra time, you may also examine the three scenario maps with no labels by selecting the round radio button "2) No Labels". Also, you may examine the labels only with the all the 3D images in the balloons side-by-side by selecting the round radio button "3) All 3D Images."

(3 minutes pause)

We will now look at different ways of looking at the information. In your "Places" pane, select the round radio button in "4) Sample 3D Projects" and double-click into the text of "3D Open Pit" under the folder named "Shell Pierre River" or "TOTAL/Sinopec Northern Lights". Google Earth will automatically zoom into a viewpoint showing the entire proposed open pit mine in 3D.

Please wait a moment for all the 3D features to load. Navigate around this area, while zooming in and zooming out and changing the tilt of your map. Take note of the scale bar in the bottom left of your map window to get an idea of the size of the "3D Open Pit". Please remember to press "F10" to take one or more screenshots of views that you find especially interesting or informative.

(3 minute pause)

Select the round radio button for "3D Trees" and double-click into the ***text*** of "3D Trees." Google Earth will automatically zoom into a viewpoint showing a sample area of the proposed open pit mine with correctly-scaled 3D trees from the original forest cover on the horizon.

Please wait a moment for the 3D features to load. Navigate around the this area, while zooming in and zooming out and changing the tilt of your map. Take note of the scale bar in the bottom left of your map window to get an idea of the size of the "3D Trees" in relation to the open pit. Please remember to press "F10" to take one or more screenshots of views that you find especially interesting or informative.

(3 minute pause)

Select the round radio button for “3D Mining Equipment” and double-click into the ***text*** of “3D Mining Equipment.” Google Earth will automatically zoom into a ground-based view showing a sample area of the proposed open pit mine with correctly-scaled mining equipment, pickup trucks, and workers.

Please wait a moment for the 3D features to load. Navigate around the this area, while zooming in and zooming out and changing the tilt of your map. Take note of the scale bar in the bottom left of your map window to get an idea of the size of the “3D Mining Equipment” in relation to the open pit. Please remember to press “F10” to take one or more screenshots of views that you find especially interesting or informative.

(3 minute pause)

LET’S START THINKING ABOUT THE ***PROPOSED*** TAR SANDS MINES COMBINED WITH THE ***APPROVED*** AND ***EXISTING*** TAR SANDS MINES. IF POSSIBLE, I WOULD LIKE ONE OF YOU TO SHOW THE GROUP A SCREENSHOT THAT YOU SAVED TO ILLUSTRATE YOUR REACTIONS, THOUGHTS, OR COMMENTS. PLEASE TELL ME WHICH SCREENSHOT I SHOULD SHOW ON THE PROJECTOR FOR EVERYONE TO SEE. COULD SOMEONE NEW COME UP?

(Show screenshot to group)

IF POSSIBLE, CAN YOU SHOW ME HOW YOU MOVED THROUGH THE LANDSCAPE IN GOOGLE EARTH BEFORE YOU TOOK THIS SCREENSHOT?

(Recreate movement in Google Earth while showing to group. Note: this will already have been recorded on the participant’s computer and the recreated movement would also be recorded on the researcher’s computer).

(Repeat above about 3 more times during 20 minutes discussion time)

(20 minutes discussion)

PROBES (During the discussion of the screenshot)

a) Did you find the information useful in better understanding the size of the combined ***existing, approved, and proposed tar sands open pit mines***? How? Is there anything different in your use of the tool this time?

b) Did you find any new problems using the visualization tool – e.g. when did you become disoriented, if at all, and when?

c) Do you find any problems with the information?

d) What kind of new knowledge did you gain? Any key moments or navigation points where you received this new information?

e) How does this information make you feel about tar sands development?

f) Does anyone feel differently?

g) Any other comments or questions?

OK, that's all the time we have on the computers for now. You can write in any additional comments on the follow-up questionnaire.

9. **Follow Up Questionnaire**

And now, I'd like you to take 10 minutes to complete the short follow-up questionnaire I am handing out, which is to record your overall responses now that you have explored the existing, approved, and proposed tar sands open pit mines.

(Distribute questionnaire)

(10 minute pause).

10. **Collect Questionnaires and Copy Individual Screenshots to Jump Drives.**

Please return the questionnaire sheets to me and I will give you jump drives with copies of your selected images. Thank you for participating in this research. Please remember that we encourage all participants to refrain from disclosing the contents of the discussion outside of the focus group to maintain participant anonymity. If you have any follow-up questions, please feel free to contact me.

If you are interested in receiving a copy of the overall results at the completion of the study, please leave your name and contact details on the sheet by the door. Thanks again.

(Collect questionnaire, copy screenshots to jump drives, and distribute jump drives.)

APPENDIX L: INITIAL QUESTIONNAIRE

Participant Code (For Researcher Use Only): | | | |

INITIAL QUESTIONNAIRE:

Exploring New Ways to Engage and Inform the Public on Very Large Projects

Collaborative for Advanced Landscape Planning
Department of Forest Resource Management
Faculty of Forestry, University of British Columbia
2045-2424 Main Mall, Vancouver, BC
Canada, V6T 1Z4
[phone] [fax]

Section I: General Questions

PLEASE CIRCLE ***ONLY ONE*** OF THE NUMBERS OR RESPONSES THAT BEST REFLECTS YOUR ANSWER, TO ***EACH*** OF THE FOLLOWING QUESTIONS. IF YOU CHANGE YOUR MIND, CROSS OUT THE CIRCLE AND MAKE ANOTHER ONE:

1) What level of experience do you have in ***reading or using maps***?

1	2	3	4	5
No Experience	Little Experience	Some Experience	Much Experience	Mapping Expert

2) What level of experience do you have in ***using computers***?

1	2	3	3	4
No Experience	Little Experience	Some Experience	Much Experience	Computer Expert

3) What level of experience do you have in ***using Google Earth or other computer mapping programs*** in your work or leisure time?

1	2	3	4	5
No Experience	Little Experience	Some Experience	Much Experience	Professional Expert

4) How many ***photographs*** have you seen that show the ***open pit*** tar sands projects around Fort McMurray, Alberta?

1	2	3	4	5
None	Few	Some	Many	Very Many

5) How many ***TV broadcasts***, ***films, or videos*** have you seen that show the ***open pit*** tar sands project near Fort McMurray, Alberta?

1	2	3	4	5
None	Few	Some	Many	Very Many

6) How many ***articles or books*** have your read about the ***open pit*** tar sands projects near Fort McMurray, Alberta?

1	2	3	4	5
None	Few	Some	Many	Very Many

7) How many ***maps*** have you seen that show the ***open pit*** tar sands projects near Fort McMurray, Alberta?

1	2	3	4	5
None	Few	Some	Many	Very Many

8) Have you ever seen or been to the ***open pit*** tar sands projects near Fort McMurray? (Please check all that apply)

- ☐ Not seen
- ☐ Seen from a plane or helicopter
- ☐ Seen from the ground
- ☐ Lived nearby for a period of time

Section II: Scale Questions

PLEASE NOTE THAT IN THIS SECTION WE ARE ***ONLY*** ASKING ABOUT THE ***OPEN PIT*** TAR SANDS PROJECTS NEAR FORT MCMURRAY, ALBERTA. WE ARE ***NOT*** ASKING ABOUT THE "IN-SITU" TAR SANDS PROJECTS NEAR FORT MCMURRAY OR ELSEWHERE IN ALBERTA. Surface mining is used when the bitumen deposits are close to the surface, using truck and shovel technology, while "in-situ" production recovers deposits that are deeper underground, using techniques that are similar to conventional oil production.

1) How much knowledge do you have about the ***size or geographic area*** of the ***open pit*** tar sands projects near Fort McMurray, Alberta?

1	2	3	4	5
No Knowledge	Little Knowledge	Some Knowledge	Much Knowledge	In-depth Knowledge

2) How ***large*** do you think is the ***total*** size or geographic area of all the combined ***existing*** open pit tar sands projects that have already been developed in the Fort McMurray region of Alberta?

0	1	2	3	4	5	6
Don't know	As large as a football field (about 100 metres across or 0.1km across)	As large as a neighbourhood (about 1 km across)	As large as a town (about 5 km across)	As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	As large as one of the world's largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	As large as a western province or state (about 500 km across)

3) What is your ***opinion*** about the ***existing*** open pit tar sands projects that have already been built near Fort McMurray, Alberta?

+2	+1	0	-1	-2
Very Supportive	Somewhat Supportive	Neutral	Somewhat Opposed	Very Opposed

4) If you are supportive or opposed, please explain why (briefly). Please write in block letters.

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5) How ***large*** do you think is the ***total*** size or geographic area of all the combined ***approved*** open pit tar sands projects that governments have already permitted but that have not yet been developed near Fort McMurray, Alberta?

0	1	2	3	4	5	6
Don't know	As large as a football field (about 100 metres or 0.1 km across)	As large as a neighbourhood (about 1 km across)	As large as a town (about 5 km across)	As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	As large as one of the world's largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	As large as a western province or state (about 500 km across)

6) If all the ***approved*** open pit tar sands projects were built in addition to ***existing*** open pit tar sands projects, how many times would the ***total*** size or geographic area of the combined open pit tar sands projects increase?

a)	b)	c)	***d)***	e)	f)
Don't know	About 1.5 times the existing size (50% increase)	About 2 times the existing size (100% increase)	***About 3 times the existing size*** (200% increase)	About 5 times the existing size (400% increase)	More than 10 times the existing size (>1,000% increase)

7) How ***large*** do you think is the ***total*** size or geographic area of combined ***planned*** open pit tar sands projects that industry has disclosed or proposed, but that governments have not yet approved and that have not yet been developed near Fort McMurray, Alberta?

0	1	2	3	4	5	6
Don't know	As large as a football field (about 100 metres across or 0.1km across)	As large as a neighbourhood (about 1 km across)	As large as a town (about 5 km across)	As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	As large as one of the world's largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	As large as a western province or state (about 500 km across)

8) If all the ***planned and approved*** open pit tar sands projects were built in addition to ***existing*** open pit tar sands projects, how many times would the ***total*** size or geographic area of the combined open pit tar sands projects increase?

a)	b)	c)	d)	e)	f)
Don't know	About 1.5 times the existing size (50% increase)	About 2 times the existing size (100% increase)	About 3 times the existing size (200% increase)	About 5 times the existing size (400% increase)	More than 10 times the existing size (>1,000% increase)

9) What is your ***opinion*** about the expansion of ***future approved and planned*** open pit tar sands projects near Fort McMurray, Alberta?

+2	+1	0	-1	-2
Very Supportive	Somewhat Supportive	Neutral	Somewhat Opposed	Very Opposed

10) If you are supportive or opposed, please explain why (briefly). Please write in block letters.

____

____

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Section III: Other Questions

1) Residence (City, Town, or Village):______________________Province:__________

2) Gender: ☐ Male ☐ Female

3) Age Group:

☐ 0-19 years old

☐ 20-29 years old

☐ 30-39 years old

☐ 40-49 years old

☐ 50-59 years old

☐ 60-69 years old

☐ 70+ years old

4) Highest Level of Formal Education (Please mark only one):

☐ Elementary School

☐ Some High School

☐ High School Diploma

☐ Some College or Technical School Studies

☐ College or Technical Diploma

☐ Some Bachelor's University Studies

☐ Bachelor's University Degree

☐ Some Graduate University Studies (Master's or Doctorate)

☐ Graduate University Degree (Master's or Doctorate)

5) Occupation (Please mark only one):

☐ Student

☐ Homemaker

☐ Retired

☐ Unemployed

☐ Management, Business, Finance and Administrative

☐ Natural and Applied Sciences, Health, Social Science, Education, Government Service and Religion, Art, Culture, Recreation and Sport

☐ Sales and Service

☐ Tr☐les, Transport and Equipment Operators, Primary Industry, Processing, Manufacturing and Utilities

☐ Other, Please Specify:______________________________

6) How involved are you right now in promoting your opinions about tar sands development in the Fort McMurray region of Alberta to government, industry, or the public?

1	2	3	4	5
Not involved	Slightly involved	Moderately involved	Highly involved	Extremely involved

7) If you wish, please provide any additional comments or concerns about the tar sands projects or this questionnaire. Please write in block letters.

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APPENDIX M: FOLLOW UP QUESTIONNAIRE

Participant Code (For Researcher Use Only): | | | |

FOLLOW-UP QUESTIONNAIRE:

Exploring New Ways to Engage and Inform the Public on Very Large Projects

Collaborative for Advanced Landscape Planning
Department of Forest Resource Management
Faculty of Forestry, University of British Columbia
2045-2424 Main Mall, Vancouver, BC
Canada, V6T 1Z4
[phone] [fax]

PLEASE WRITE IN BLOCK LETTERS.

PLEASE CIRCLE ***ONLY ONE*** OF THE RESPONSES THAT BEST REFLECTS YOUR ANSWER TO ***EACH*** OF THE FOLLOWING QUESTIONS. IF YOU CHANGE YOUR MIND, CROSS OUT THE CIRCLE AND MAKE ANOTHER ONE:

1) How much ***new*** knowledge did you gain about the ***size or geographic area*** of ***open pit*** tar sands projects near Fort McMurray, Alberta?

1	2	3	4	5
No New Knowledge	Little New Knowledge	Some New Knowledge	Much New Knowledge	In-depth New Knowledge

2) How ***large*** do you think is the size or geographic area of ***existing*** open pit tar sands projects that have already been built near Fort McMurray, Alberta?

0	1	2	3	4	5	6
Don't know	As large as a football field (about 100 metres across or 0.1km across)	As large as a neighbourhood (about 1 km across)	As large as a town (about 5 km across)	As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	As large as one of the world's largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	As large as a western province or state (about 500 km across)

3) What is your opinion about the ***existing*** open pit tar sands projects that have already been built near Fort McMurray, Alberta?

+2	+1	0	-1	-2
Very Supportive	Somewhat Supportive	Neutral	Somewhat Opposed	Extremely Opposed

4) If you feel more or less concerned or supportive, please explain why:

5) How ***large*** do you think is the size or geographic area of ***approved*** open pit tar sands projects that governments have already permitted but that have not yet been built near Fort McMurray, Alberta?

0	1	2	3	4	5	6
Don't know	As large as a football field (about 100 metres across or 0.1km across)	As large as a neighbourhood (about 1 km across)	As large as a town (about 5 km across)	As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	As large as one of the world's largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	As large as a western province or state (about 500 km across)

6) If all the ***approved*** open pit tar sands projects were built in addition to ***existing*** open pit tar sands projects, how many times would the ***total*** size or geographic area of open pit tar sands projects increase?

a)	b)	c)	d)	e)
Don't know	About 1.5 times the existing size (50% increase)	About 2 times the existing size (100% increase)	About 3 times the existing size (200% increase)	More than 10 times the existing size (>1,000% increase)

7) How ***large*** do you think is the size or geographic area of ***planned*** open pit tar sands projects that industry has disclosed or proposed, but that governments have not yet approved and that have not yet been built near Fort McMurray, Alberta?

0	1	2	3	4	5	6
Don't know	As large as a football field (about 100 metres across or 0.1km across)	As large as a neighbourhood (about 1 km across)	As large as a town (about 5 km across)	As large as a Canadian metropolitan city such as Edmonton, Calgary, or Vancouver (about 25 km across)	As large as one of the world's largest metropolitan cities such as Los Angeles, New York City, or Mexico City (about 100 km across)	As large as a western province or state (about 500 km across)

8) If all the ***approved*** and ***planned*** open pit tar sands projects were built in addition to ***existing*** open pit tar sands projects, how many times would the ***total*** size or geographic area of open pit tar sands projects increase?

a)	b)	c)	d)	e)
Don't know	About 1.5 times the existing size (50% increase)	About 2 times the existing size (100% increase)	About 3 times the existing size (200% increase)	More than 10 times the existing size (>1,000% increase)

9) What is your opinion about the ***expansion*** of future approved and planned open pit tar sands projects near Fort McMurray, Alberta?

+2	+1	0	-1	-2
Very Supportive	Somewhat Supportive	Neutral	Somewhat Opposed	Extremely Opposed

10) If you feel opposed or supportive, please explain why:

____

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11) Has your opinion about open pit tar sands projects changed as a result of this focus group?

1	2	3	4	5
Not Changed	Changed a Little	Somewhat Changed	Very Changed	Extremely Changed

Please explain why:

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12) Overall, how ***useful*** did you find the **Google Earth** tool in learning about the open pit tar sands projects in the Fort McMurray Region of Alberta?

1	2	3	4	5
Not at all useful	Not very useful	Intermediate	Mostly useful	Very useful

13) What images or features were most helpful in expressing the ***scale*** of the open pit tar sands projects? Please check all that apply.

- ☐ People
- ☐ Mining Machinery
- ☐ Trees
- ☐ Cities
- ☐ Alberta Provincial Boundary
- ☐ Zoom tool
- ☐ Scale tool
- ☐ Images in Popup Balloons

Other please list: ____

14) If you wish, please provide any additional comments about the Google Earth tool's ***weaknesses*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features:

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15) If you wish, please provide any additional comments about the Google Earth tool's ***strengths*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features:

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16) How ***believable*** did you find the ***maps*** shown in the Google Earth tool?

1	2	3	4	5
Highly unbelievable	Mostly unbelievable	Intermediate	Mostly believable	Highly believable

17) Which maps do you find most compelling or informative? Please explain why briefly:

____

18) How might the maps have been improved? Please explain how briefly:

____

19) How ***believable*** did you find the static ***3D computer simulations*** shown in the "balloons" in the Google Earth tool?

1	2	3	4	5
Highly unbelievable	Mostly unbelievable	Intermediate	Mostly believable	Highly believable

20) Which ***3D computer simulations*** shown in the "balloons" in the Google Earth tool did you find most compelling or informative? Please explain why briefly:

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21) How might the ***3D computer simulations*** shown in the "balloons" in the Google Earth tool have been improved? Please explain why briefly:

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22) Did you have any problems understanding the research process or filling out the questionnaire? If so, please briefly specify.

23) If you wish, please provide any additional comments on the tar sands, the Google Earth tool, or the overall research session:

Thank you for completing this questionnaire and participating in the focus group.

Please return the questionnaire.

APPENDIX N: FOCUS GROUP HANDOUT AND PRESENTATION

Exploring New Ways to Engage and Inform the Public on Very Large Energy Projects

1) Workshop Agenda
2) Tar Sands or Oil Sands?
3) Brief Factual Context
4) Deposits and Projects
5) Environmental Issues
6) Terminology
7) Google Earth Navigation Controls

WORKSHOP AGENDA

Activity	Activity Time (min)	Cumulative Time (hrs: min)
1. Introduction	3	0:03
2. Initial Questionnaires	10	0:13
3. Brief Factual Context	2	0:15
4. Practice Navigation and Screenshots	10	0:25
5. Context of Tar Sands Development	10	0:35
6. Existing Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	30	1:05
7. Break	10	1:15
8. Adding Approved Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	25	1:40
9. Adding Planned Tar Sands Open Pit Mines – Navigation, Discussion, and Presentation of Two Screenshots/Session	35	2:15
10. Follow-Up Questionnaires	10	2:25
11. Collect Questionnaires and Copy Individual Screenshots to Jump Drives	10	2:35

Tar Sands or Oil Sands?

- I use the term “tar sands” because there is no naturally-occurring crude oil in the resource
- The tar-like bitumen must be highly processed and upgraded to create “Synthetic Crude Oil”
- Industry and government now only use the term “oil sands” to promote development of the resource

The two terms can be used interchangeably

Athabasca Tar Sands, Canada Post 1978,
Canada Postal Archives Database, www.collectionscanada.gc.ca

Brief Factual Context

- Production started in 1967
- Current production 1.5 million barrels per day
- 390,000 direct, indirect, and induced jobs across Canada
- In 2009, $10 billion spent on capital projects
- $218 billion to be spent in next 25 years
- 3 million barrels per day production planned for year 2020

Deposits and Projects

- Three tar sands deposits: Fort McMurray, Peace River, and Cold Lake; 91 producing projects
- Two kinds of tar sands: open pit mining and "in-situ" (more like conventional drilling)
- This study examines open pit mining only located near Fort McMurray where the resource less than 75m below the surface

Environmental Issues

- Two tonnes of materials extracted to produce one barrel of oil
- Current area disturbed is 715 square km
- Currently, 45 million tonnes of greenhouse gases per year or 7% of Canada's total emissions; five times more emissions when actually used
- 2 to 4 barrels of fresh water per barrel of oil or 179 million cubic metres per year
- Area of current tailings ponds now 170 square km

TERMINOLOGY

Project Scenario	**Definition**
Existing	Fully or partially constructed and producing or delivering petroleum
Approved	Approved by government regulators but not yet constructed
Proposed/Planned	Submitted to government regulators but not yet approved
Conceptual	Publicly disclosed by industry but not yet submitted to government regulators

APPENDIX O: WRITTEN RESPONSES TO OPEN-ENDED QUESTIONS

Table 74 Explanation of Opinion of Existing Tar Sands Open Pit Mines, Before Viewing

4) If you are supportive or opposed, please explain why (briefly). Please write in block letters.
1. Global warming, destruction of water and environment, peoples illness and animal.
2. Worried about my child's future. Termination of our species and planet earth. No future, no chances for survival.
3. I have no knowledge about the tar sands at all.
4. Too much use of clean water in process instead of more "sustainable" possible techniques. Too much pollution involved.
5. I feel neutral because I don't yet know enough about this subject to form an opinion.
6. The amount of energy required to process the bitumen exceeds the energy recoverable/usable and the environmental damage is not justified to facilitate an already depleting resource.
7. Against continued use of fossil fuel prod./services etc.
8. Any open pit work done cannot be good for the environment or local ecology.
9. Inhumane parasitic military industrial ecocidal and social atrocities! (the rest is footnotes)
10. Doesn't seem to negatively affect me and seems to positively affect other Canadians economically. However I don't want permanent environmental damage affecting living beings.
11. It interferes with wildlife habitats.
12. I believe it is one of the greatest deposits in the world. I think we should exploit this resource to the best of our abilities.
13. The animals have been displaced.
14. Seems to be little benefit (few jobs) or benefit is spread thinly (little revenue collected for social programs) for huge risk and encouraged poorly developed economy. Destroys agricultural land and therefore decreases food security.
15. Opposed for the negative and environmental reasons and impacts (irreversible and detrimental to human and forest/land health. Only supportive because of economy.
16. A pox on the landscape which is not recoverable.
17. n/a
18. I believe in alternative energy.
19. Careful consideration about the potential damage to the environment must be taken before a project begins. Usually such project will cause worse environment, such as pollution and unstable land.
20. The inputs required to extract energy as well as the lack of planning to deal with the tailings "ponds" are worrisome, but what other sources of energy are better?
21. The destruction of the surface seems to be more than the industry can correct (back to a natural state).
22. I support it because it employs a lot of people.
23. It’s an environmental disaster.
24. High environmental costs.

Table 75 Explanation of Opinion About Expansion of Planned and Approved Open Pit Tar Sands Mines, Before Viewing

10) If you are supportive or opposed, please explain why (briefly). Please write in block letters.
1. It could be detrimental to ecosystems and water systems in Alberta.
2. Global warming, environment, water, illness.
3. Same as previous/above.
4. More investment will flow through.
5. Corporate profits/royalties undertaxed. Destruction of ecosystems.
6. I don't yet know enough about this to have an opinion.
7. Environmentally destructive. Short term economic gain.
8. Same as #3
9. As in the last section, the larger the site, the more damage done to the environment and local ecology.
10. See above
11. See 4) = same.
12. Its effects on the environment - air quality.
13. I can't think of any other reason to go to Fort McMurray.
14. The animals may never return. Destroys the traditional way of life for natives.
15. Poorly developed culture/resource dependent economy destruction of First Nations land.
16. Need to keep development gradual until less harmful/destructive ways to process the tar sands are discovered.
17. Too much, too fast, too soon.
18. n/a
19. I support alternative energy not gaping holes in the ground.
20. Open pit tar sands project will probably ruin the local environment. Plants and animals living there might suffer.
21. The current sites need to be cleaned up first and I believe they want require a nuclear reactor.
22. Since the existing mines are so far from being restored - question why many more square miles are going to change the level of destruction.
23. Our natural resources are starting to deplete and in order to sustain our resources, projects like the tar sands are necessary.
24. It’s an environmental hazard.
25. High environmental costs.

Table 76 Explanation of Feeling More or Less Concerned or Supportive of Existing Tar Sands Open Pit Mines, After Viewing

4) If you feel more or less concerned or supportive, please explain why:
1. Although I'm somewhat supportive, I'm still a little concerned of the proposed plans and the magnitude.
2. Damage far larger - will it ever be repaired.
3. Enablement of an already finite resource at astronomical environmental cost.
4. Environmental costs.
5. Hard to say without more environmental facts/data.
6. I feel more concerned because I have been able to a bit more (only less than if I used a plane/or ground visit) conceptualize their size.
7. I feel the same way as I did when I came in.
8. I have concerns about taking all that water from the Athabasca River and depleting it.
9. It will never be the same (wild).
10. Less room for wildlife to live.
11. More concerned; had not realised the full scale compared to 1) cities 2) province 3) rest of Canada
12. More concerned as I now know how large the impact is.
13. More concerned. It's growing the mines the pipelines covering everything.
14. Not supportive. Re-forestation/restoration pretexts it will never be the same again (geopathic blight!).
15. Opposed because environment, huge area, trees die. For because employment, resources.
16. Proximity of rivers →risk. Now I realize the scale. Tailing ponds are very disturbing.
17. Supportive because the open pit mines will be generating more revenues comparable to the largest cities in the world.
18. Tailings ponds near river. No reclamation.
19. Tailings too close to river.
20. The pits have already been constructed, so there's not much use in getting upset about that. It would be good if we hadn't needed to build these pits in the first place though.
21. The scale of emissions, excavation → perpetuating the whole increase of consumption. More people buying more vehicles.
22. They need to look at the environment and the cost to protect it.
23. Things seem okay in news except for a few birds landing in tailings ponds.
24. Ugly and stupid way to get energy. Science explains why it is bad and an exponential problem but is not supported by Conservative fed. gov.
25. Worse than I thought - insane!

Table 77 Explanation of Opposition or Support for Future Expansion of Tar Sands Open Pit Mines, After Viewing

10) If you feel opposed or supportive, please explain why:
1. Concerned about the contamination and leakage into the rivers and ground.
2. Destroying so much land when alternatives are available seems senseless.
3. Environmental concerns - poor air quality.
4. Environmental impacts.
5. First it was whale oil lubricants→almost to extinction. Opposed because it undermines planetary geo-bio supportive infrastructures.
6. Huge destruction of environment/First Nations' rights for comparatively little gain.
7. I don't approve of wrecking anything for profit.
8. I don't know of active replanting, refilling of tar sands open pits presently. I am assuming same will happen if more open pit tar sands = environmental disaster (lack of trees in large areas).
9. I feel opposed due to the lack of info that is out there. I don't think the average person realizes what really happen with open pit mine.
10. I think Canada should utilize the resources that it has.
11. I think we depend on oil too much. We shouldn't have to destroy so much nature for our needs. We should all try to live simpler so we don't rely on oil so much.
12. I'm concerned about increased water depletion of the Athabasca River.
13. It is environmental disaster.
14. Kills earth.
15. Opposed - too much environmental disturbance water forest health land and resulting emissions regardless of economic benefit.
16. Opposed because too many areas that will damage the environment.
17. Same - too much too quickly and without baselines.
18. Supportive - more jobs, more revenues better economy but environmental impact should be looked into.
19. The amount of water/energy used in extraction is ridiculous. What are we destroying ecologically for purely economic gain?
20. The planned area occupies large areas of forests, ponds, and natural landscapes causing water amount decreasing.
21. The proposed pipelines are passing through the Rockies.
22. The reclamation must be addressed before they move on. Obtaining natural gas from the arctic will be problematic.
23. Threat to water, enviro, land, people, life.
24. Too many projects side-by-side or adjacent to each other - making it harder for land recovery in the future.
25. Too much oil production causing emissions.
26. What will be the effect on water and natural gas supplies as well as pollution.
27. Why get energy this way? Be smarter. It's wasteful and dirty to the air, environment, and social structure.
28. Worsening an already destructive situation.

Table 78 Explanation Why Opinion Changed, After Viewing

Please explain why:
1. Because it is environmental hazard.
2. Better informed about scope of projects, size, closeness to rivers. I now believe that this is already out of control, a complete disaster area. The city comparisons were important and helpful.
3. Even more concerned.
4. Frightened by how out of control the province and the fuel addicts are. How do we break the cycle when 40% of the populace would become unemployed?
5. I did not know what was happening re: open pit tar sands. I am disappointed that it is not common knowledge and I fear secrecy by our government because it is on crown land and they may not feel they have to be totally and easily accessible re: tar sands activities (development).
6. I had an idea of size before.
7. I had no idea the projects were so large. Without the comparisons to urban cities, the pits seemed like little campgrounds out in the forest. Compared to Vancouver, though, I was shocked at the scale, especially of future projects.
8. I have the same opinion, but it feels more important now that I can grasp (somewhat) the size in comparison to Vancouver, my neighbourhood, and the province of Alberta.
9. I really didn't find out anything more about the impact on environment. Just how 2 google it.
10. I understand what these tar sands are all about.
11. I'm even more concerned now!
12. I've gone from knowing nothing to knowing the full scale of the tar sands impact.
13. It's too big.
14. Little information makes someone naive about the topic "What you don't know won't hurt you!" But with this information and visual effects make it easier to understand the magnitude of the project.
15. Maybe I should do something - although I see no change of making a difference. Look who is stacked up against any real change - government, industry, workers, unions, the USA, China...!!!
16. More negative due to the scale of existing tar sands. Future looks disturbing and frightening.
17. Not enough information to decide.
18. Opposition and anger has been joined by fear of the consequences of continuation, let alone augmentation.
19. Previous to this focus group, I lack knowledge about open pit tar sands projects.
20. Proximity to the population concerns me as the distance between the tailings ponds and the river is minimal in addition to the usage of natural gas required to extract the tar sands from the mines.
21. Situation of industry approved development for processing tar sands.
22. Still unsure about the true environmental impact as in-situ mining impact -- what happens below the surface is uncertain.
23. The focus group has been concerned with the graphic depiction of the images of the proposed sites rather than the effects of the mining.
24. There is very little effort on the companies to protect the environment.
25. The physical maps are only a small part of the larger issue of the relationships to global warming and degradation of environment and use of scarce resources as well as possible/likely pollution through tanker and pipeline spills.
26. The projects would support the BC economy and provide jobs. I didn't realize the scale of these projects.
27. They are very unattractive.
28. Wasn't aware how big the projects are and how close to the rivers.

29.	Would have like more time to learn "the nav system". Would have like more "labels" as to what I was seeing/selecting.
30.	Yes, I am more opposed because I now see greater exploitation and destruction of surrounding water systems, forests, and ecosystems. And also the increased greenhouse gas emissions is very troubling.
31.	It striked me a bit that how large area of trees and waters are ruined by developing open pit tar sands projects.

Table 79 Comments About Weaknesses of Google Earth Tool

14) If you wish, please provide any additional comments about the Google Earth tool's ***weaknesses*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features:	
1.	3D rendering was too slow to be usable. Clearer/sharper imagery would make the maps more realistic.
2.	3D visualization did not seem apparent.
3.	3D visualization excellent. Accuracy good. Realism difficult to emulate as level of detail still dependent on computer technology.
4.	3D visualization is not clear or effective
5.	3d visualization of mining areas is not that real. The tools are not very easy to use when it comes to visualization.
6.	3D was frustrating→too slow to load and too much seizing up!
7.	Clarity is an issue given source images from satellites.
8.	Could always be sharper. Could use a "navigation ikon" showing tool status.
9.	Difficulty with slow processing speed. Lack of detail on the tar sands make it difficult to zoom.
10.	I don't think it can be understood by general population (many may not use computers). It is probably necessary to be taught how to use program (difficult to be self-taught for most people, I believe).
11.	Mine wouldn't load, could not view properly; mine wouldn't load. Couldn't get all images to load. Need side by side comparison of existing/future views. Fairly accurate, yet some people may be cynical/doubtful of accuracy.
12.	Mining machinery looks very artificial.
13.	More potential to combine different "places" on top of each other. Very handy, tho I..
14.	Most modern games look better.
15.	Need more real visual effects or video clips to give better perspective and understanding of actual site.
16.	Need put more labels.
17.	No atmosphere. Textures are flat. Doesn't allow you to experience the reality.
18.	Please add machinery and labour to show the immensity of each project. Real time shots of highway, towns, river during all seasons.
19.	The 3D graphics of mining pits were too slow.
20.	The 3D images of the trees and pits didn't look realistic at all, but gave good insight.
21.	This was great, thank you. Comparison, cumulative impact, larger picture, knowing what's now and projecting a picture of what's potentially coming.

Table 80 Comments About Strengths of Google Earth Tool

15) If you wish, please provide any additional comments about the Google Earth tool's ***strengths*** in terms of clarity, ease of use, accuracy, realism, combination of maps and 3D visualization, or other features:
1. 3D visuals did provide some depth perspective which helps to visualize potential impacts to water sources. The combination of maps were also quite useful in comparing different perspectives.
2. Add comparison of what is river like (water level, fish, temperature) upstream vs. along the tar sands rivers and downstream.
3. Controls seem very simple and easy to use.
4. Easy to use. Effective to see features written on map (ie. labelling mine sites on map of Alberta).
5. Fairly easy - standard windows type menus + map features found on google. Great colouring. I find map 2D info well generalized into 3D. Like tilting function.
6. Gives good sense of scale. Allows you to walk however you like. Lets you explore.
7. Google Earth is amazing for the detail that you can get down to.
8. Google Earth is useful for comparing the size of open pit mines relative to cities. Because it is all visual, it is very easy to understand.
9. Great to be able to move around. Need scale of nearby cities (in side-by-side view and of the same scale). 3D visualization would benefit from some explanatory boxes (?) to say what the terraced land/pits are. Understand process of pit mining. - Approval -Clear trees -Dig/mine - How does it 'grow' - Where do materials mined go?
10. Great tool - needed more practice. N.B. Screen shots were chosen for "graphical interest" rather than informational content" or interest.
11. I liked having access to a variety of info and visuals to compare and explore. The company maps with the fade out was nice. City comparison→brilliant!
12. Interesting, but takes some getting used to.
13. It was fairly user friendly. It doesn't take too much to navigate.
14. It was very interesting to be able to compare the government maps to Google Earth.
15. Strong sense of realism. Very effective combination of maps.
16. The combination of maps is really helpful in realizing which're actually covered in the maps of development from the government. 3D visualization is a good try though not good enough.
17. The shock value of how close the river and the sense of scale.
18. Usefulness and practicality to end users.
19. Very useful. I would think if memory on computer were adequate (acceleration).
20. Zooming and overlays was cool.

Table 81 Most Informative or Compelling Maps

17) Which maps do you find most compelling or informative? Please explain why briefly:
1. "All in 3D images" It help me gain a better idea of what it'll be like throughout the development period. Compare images simultaneously is important.
2. City map overlays.
3. City maps provided good comparison.
4. Comparing with familiar cities.
5. Comparison maps of pipelines and mines existing, approved, planned.
6. Comparisons especially existing, approved, and proposed.
7. Having the maps overlaid on top of the Google Earth globe was very clear.
8. I found the "borders" ie Alberta (Canada provinces etc.) very helpful in conceptualizing areas affected by open pit tar sands. I kind of already understood present pipelines in Canada but proposed USA and Canada refineries and pipelines and gas and oil development made me see with respect to my lifetime.
9. I found the maps that had a comparison to major cities were the most useful.
10. I liked the existing, planned, and future but wished they were in flip motion layering on top of each other as I had to click back and forth several times.
11. Map summarizing all projects because the information has never been presented together. Maps using city boundaries superimposed because it shows the scale effectively.
12. Maps of areas were OK.
13. Maps that start as a country on the globe and can take you down to a street or a building.
14. Maps with cities to show scale. Original maps of existing have more detail so interest more.
15. Most of the maps showed the existing, the approved to the proposed.
16. Overlay of proposed site to actual site proximity was interesting.
17. Overlaying size of area compared to size of city. Overlaying size of area compared to size of province.
18. Overlays of cities gives scale, but so would Sahara desert!
19. Pipeline route - proposed v mentioned?
20. Regulatory maps showed info and were easy 2 use and load.
21. Superimposing the major cities over the existing and proposed open pit mines provided an idea of the overall impact of this project and usefulness of these maps.
22. The most informative are the ones listing the different mines. → helps me to see the land impact that surface mining actually entails.
23. The people and machinery. The pits looked very large.
24. The pipeline maps and comparisons with cities were very informative. City comparisons were very helpful in providing scale.
25. The Vancouver map because I know the city, also the Alberta map because I could see how much the tar sands would change Canada geographically.
26. Those with comparisons to scale - e.g. using Edmonton boundaries.
27. Vancouver city (and other cities)→powerful→conceptual pipelines trees.

Table 82 Improvement of Maps

18) How might the maps have been improved? Please explain how briefly:
1. Add information on wildlife, upstream, along, downstream.
2. Add some real photos to some samples of sites will be better.
3. Better relative comparison to things i.e. Vancouver Island.
4. Clarity/resolution. Historical transitions from forest to pit. I love maps of all kinds. I would also enjoy an "informational aesthetic" beyond the utilitarian; not to underestimate the thought and effort in assembling the data in any form.
5. Combine with Google Maps (for existing open pit tar sands). Also combine with other developments such as diamonds, gold, etc.
6. I wish I knew.
7. Include info./area used by aboriginal bands.
8. Load quicker. More exciting - have animals that are native 2 the area running around. Maybe they can give interesting facts.
9. Maps with existing, approved, and proposed could be combined on 1 map with each area in a different colour.
10. More realistic imagery would help.
11. More snap, more colour, more animations.
12. No comments. I am not a computer technology expert.
13. Overlays in Google Earth tool. Overlay of all developments (approved and proposed) to fully understand the full scope of all projects.
14. Perhaps some cross-reference academic kind of like wikipedia; compare Venezuela heavy oil fields etc. environmental health controversies.
15. Regulatory maps of companies sometimes unclear.
16. Sharper resolution.
17. The regulatory maps are horrible. More details on the appearance of the tailings ponds.
18. To be able to see the tar sands individually outline (as opposed to in satellite image on block-filled in) as navigating may have been easier.
19. To be more clear.
20. Traffic, highway size, infrastructure, reserves, native preserves. The difference between winter and spring summer and fall. Also the effects of seasons on growth, infrastructure, tailings ponds. I've only seen summer shots what are they like in winter.
21. Video overlays of 3D areas would be good. For existing sites to see a video of the area will be helpful. Maps of proposed areas lack detail. Just looks like grey blobs. Boring!
22. Would help to have something of shared identifiable height to identify with depth perception.

Table 83 Most Compelling or Informative 3D Computer Simulations

20) Which ***3D computer simulations*** shown in the "balloons" in the Google Earth tool did you find most compelling or informative? Please explain why briefly:
1. "All in 3D images". It gives me a good idea of what the developing process is like.
2. Already gone - sorry.
3. Attempts to show the size of the pits were believable.
4. Because they weren't interactive, I didn't find them helpful. The regular map was just as good.
5. By the river. Water texture believable. Trees believable.
6. Did not pay attention to this.
7. Few of mine would load...difficult to say what is informative. I liked how one could move around and navigate.
8. I could tell the magnitude of the existing to proposed.
9. I did not like these they were a bit laughable. Seriously a realtime shot is the best and its what we are used to seeing as viewers.
10. I didn't quite understand the images. They didn't quite make sense to me. I wasn't really sure what I was looking at.
11. I don't remember.
12. I found the comparison between the actual and the proposed most compelling.
13. I trust you! Human activity (homes machinery).
14. Links.
15. My computer froze too often to engage with the 3D portion.
16. n/a
17. None - cause I can't recall them. Problems loading distracted me.
18. Simulations of proposed projects and views of river very interesting.
19. The proposed mines really hit home on how gigantic things already are and how deep.
20. The simulations looked just like the photos.
21. Those showing contrast between current undeveloped areas vs changes/proposed/approved footprints.

Table 84 Improvement of 3D Computer Simulations

21) How might the ***3D computer simulations*** shown in the "balloons" in the Google Earth tool have been improved? Please explain why briefly:
1. ?
2. A little more realistic (from what I saw on others' screens).
3. Being able to print proposed and present maps.
4. Can't think of any improvements.
5. Did not pay attention to this.
6. Even higher resolution imagery. More photo-realistic.
7. I don't have an opinion regarding this.
8. Just to be more clear in the picture and text.
9. Make it as close to documentary style as possible then load for the viewer to play with. Powerpoint →Animation.
10. More detail. More depth of field. More atmosphere. Feels like they are empty stages or scenes.
11. n/a
12. n/a

13. Overlay showing each phase in one map.
14. Reality. Add more real data rather than pursuing better resolution.
15. The level just has to be either clearer (more contrast, etc.) or photo realistic.
16. They were believable, but not very compelling. The macro scale is only interesting if the viewer is moving because then I can grasp scale.

Table 85 Problems with Research Process

22) Did you have any problems understanding the research process or filling out the questionnaire? If so, please briefly specify.
1. Difficulty understanding the thrust of the inquiry.
2. I jumped ahead of things. I also fell behind slightly but found it easy to see display screen at front of room to find my place plus help from assistants was quick.
3. I was able to understand the research process.
4. I'm not entirely clear what outcomes are being explored here. Are we researching future methods of informing the public and if so, would government and corporations use these methods to sway and control public opinion?
5. No
6. No - perhaps more explanation of existing technology and the improvements would have caused less confusion.
7. No, not really.
8. No.
9. None.
10. Not really.
11. Since we can't factor in any action "view my maps" is simply non-purposeful to be of any use.
12. Yes.
13. No.

Table 86 Additional Comments

23) If you wish, please provide any additional comments on the tar sands, the Google Earth tool, or the overall research session:
1. Better/faster computers make it a lot smoother. The more detail the better in terms of maps. Hard to know the relevancy of things. We know what we're looking at, but don't really understand what it is or why we should care!
2. Biggest thing I learned: suppression of information is totally effective in a democracy with a "free" press, academic research and political lack of action contributing. (sorry for spelling)
3. Explain the objects clearly and briefly before research session.
4. Glad to participate. Thank you!
5. I know too little about the ramifications of the oil sands to make a meaningful comment.
6. I now have a general idea of how the tar sands are impacting the environment/society.
7. In order to have a productive discussion about development, the facts/maps presented are necessary. The maps shed light on a black box that industry and government don't explain.
8. Interesting implications. Good luck!
9. It wasn't what I was expecting to gain info about. I found it quite boring in the end. Start was informative though.
10. It would be nice if there was a time scale in which I could identify the length of time in which the proposed projects might begin construction.

11. Labels on what is presented on the site.
12. Needed a bit more time. Second questionnaire too long for time allotted.
13. Needs comparative analysis with the other controversial open pit mining for example how about Russia, Venezuela, China, natural gas fracking. Good luck.
14. Tar sands are an environmental disaster. This greed should stop. Canada should explore economy on other sustainable products and projects.
15. Thank you for illustrating the size and scope of the tar sands projects. There are also a lot of ideological positions implicit in the term "oil sands" and "tar sands", and this is very informative because the public is not aware of these subtle changes in the terms.
16. Thank you.
17. The Google Earth applications are quite helpful in understanding the scale of these very large projects.
18. Very interesting to see everything together as the gov't maps create distance and no emotion or any awareness of the implications of the projects.
19. Well done.
20. When mentioning the natural gas used and needed for future, relate to some cities' consumption rates. E.g. if the tar sands use x cu ft/day - how many houses does that heat in winter? Ditto for projected/future consumption rates. I.e. relate to stuff we use.
21. No.

APPENDIX P: ORDINAL CROSS-TABULATIONS AND TEST RESULTS

The following statistical tests of significance and strength of correlations were generated as defined in the SPSS software manual (International Business Machines Corp., n.d.a):

> **Chi Square** measures the discrepancy between observed cell counts and what you would expect if the rows and columns were unrelated. For tables with any number of rows and columns, select Chi-square to calculate the Pearson chi-square and the likelihood-ratio chi-square. When both table variables are quantitative, Chi-square yields the linear-by-linear association test.
>
> **Correlations**. For tables in which both rows and columns contain ordered values, Correlations yields Spearman's correlation coefficient, rho (numeric data only). Spearman's rho is a measure of association between rank orders. When both table variables (factors) are quantitative, Correlations yields the Pearson correlation coefficient, r, a measure of linear association between the variables.
>
> **Ordinal Tests**. For tables in which both rows and columns contain ordered values, select Gamma (zero-order for 2-way tables and conditional for 3-way to 10-way tables), Kendall's tau-b, and Kendall's tau-c. For predicting column categories from row categories, select Somers' d.
>
> > • Gamma. A symmetric measure of association between two ordinal variables that ranges between -1 and 1. Values close to an absolute value of 1 indicate a strong relationship between the two variables. Values close to 0 indicate little or no relationship. For 2-way tables, zero-order gammas are displayed. For 3-way to n-way tables, conditional gammas are displayed.
> >
> > • Somers' d. A measure of association between two ordinal variables that ranges from -1 to 1. Values close to an absolute value of 1 indicate a strong relationship between the two variables, and values close to 0 indicate little or no relationship between the variables. Somers' d is an asymmetric extension of gamma that differs only in the inclusion of the number of pairs not tied on the independent variable. A symmetric version of this statistic is also calculated.
> >
> > • Kendall's tau-b. A nonparametric measure of correlation for ordinal or ranked variables that take ties into account. The sign of the coefficient indicates the direction of the relationship, and its absolute value indicates the strength, with larger absolute values indicating stronger relationships. Possible values range from -1 to 1, but a value of -1 or +1 can be obtained only from square tables.
> >
> > • Kendall's tau-c. A nonparametric measure of association for ordinal variables that ignores ties. The sign of the coefficient indicates the direction of the relationship, and its absolute value indicates the strength, with larger absolute values indicating stronger relationships. Possible values range from -1 to 1, but a value of -1 or +1 can be obtained only from square tables.

The Somers’ d test is the only asymmetric or directional test which assumes that “one of the two variables can be identified as the independent variable and the other variable as the dependent variable” (Bacher, 2004). The remaining tests are all symmetric measures of association that “describe the relationship between two variables X and Y without differentiating if either variable is an antecedent (or independent variable) or a consequent (or dependent variable)” (Chen & Krauss, 2004).

1) Using Computers * New Knowledge

After viewing the Google Earth project, significantly more participants with more experience using computers stated that they gained more new knowledge about geographic area or scale of the open pit mines compared to participants with less experience, as highlighted in green in Table 87.

Table 87 Using Computers * New Knowledge

Crosstab							
			New Knowledge				Total
			2= Little New Knowledge	3= Some New Knowledge	4= Much New Knowledge	5= In-depth New Knowledge	
Using Computers	2= Little Experience	Count	1	1	0	0	2
		% within Using Computers	50.0%	50.0%	0.0%	0.0%	100.0%
	3= Some Experience	Count	0	2	9	0	11
		% within Using Computers	0.0%	18.2%	81.8%	0.0%	100.0%
	4= Much Experience	Count	0	4	11	3	18
		% within Using Computers	0.0%	22.2%	61.1%	16.7%	100.0%
	5= Computer Expert	Count	0	0	0	1	1
		% within Using Computers	0.0%	0.0%	0.0%	100.0%	100.0%
Total		Count	1	7	20	4	32
		% within Using Computers	3.1%	21.9%	62.5%	12.5%	100.0%

As highlighted in red in Table 88, the difference between participants who had more experience using computers compared to participants with less experience using computers are significant (.002) only using the Pearson Chi-Square test. This indicates that there is a discrepancy between the observed cell counts and what one would expect if the rows and column were unrelated. However, none of the other tests show a significant correlation with the Bonferroni correction.

Table 88 Cross-Tab Tests for Using Computers * New Knowledge

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.549[a]	9	.002
Likelihood Ratio	16.823	9	.052
Linear-by-Linear Association	7.293	1	.007
N of Valid Cases	32		

a. 14 cells (87.5%) have expected count less than 5. The minimum expected count is .03.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	.350	.158	1.956	.050
		Using Computers Dependent	.355	.164	1.956	.050
		New Knowledge Dependent	.345	.157	1.956	.050

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.350	.158	1.956	.050
	Kendall's tau-c	.258	.132	1.956	.050
	Gamma	.579	.225	1.956	.050
	Spearman Correlation	.371	.169	2.190	.036[c]
Interval by Interval	Pearson's R	.485	.158	3.038	.005[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

2) Seen Photos * Opinion Existing Before

Before viewing the Google Earth project, a significantly greater percentage of participants who had seen more photos of the open pit mines were more opposed to existing open pit mines compared to participants who had seen fewer photos, as highlighted in green in Table 89.

Table 89 Seen Photos * Opinion Existing Before

Crosstab

			Opinion Existing Before				Total
			-2= Extremely Opposed	-1= Somewhat Opposed	0= Neutral	1= Somewhat Supportive	
Seen Photos	1= None	Count	1	3	7	2	13
		% within Seen Photos	7.7%	23.1%	53.8%	15.4%	100.0%
	2= Few	Count	3	2	4	1	10
		% within Seen Photos	30.0%	20.0%	40.0%	10.0%	100.0%
	3= Some	Count	4	5	0	0	9
		% within Seen Photos	44.4%	55.6%	0.0%	0.0%	100.0%
Total		Count	8	10	11	3	32
		% within Seen Photos	25.0%	31.2%	34.4%	9.4%	100.0%

As highlighted in red in Table 90, all the directional and symmetric measures are significant. The Somers' d test is significant (.000) with moderate negative correlations (-.436 to -.472). The ordinal by ordinal symmetric measures are all significant (.000) with moderate negative correlations (-453. to -.619).

Table 90 Cross-Tab Tests for Seen Photos * Opinion Existing Before

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.371[a]	6	.078
Likelihood Ratio	15.095	6	.020
Linear-by-Linear Association	8.396	1	.004
N of Valid Cases	32		

a. 12 cells (100.0%) have expected count less than 5. The minimum expected count is .84.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.453	.106	-4.241	.000
		Seen Photos Dependent	-.436	.103	-4.241	.000
		Opinion Existing Before Dependent	-.472	.110	-4.241	.000

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.453	.106	-4.241	.000
	Kendall's tau-c	-.466	.110	-4.241	.000
	Gamma	-.619	.133	-4.241	.000
	Spearman Correlation	-.529	.118	-3.413	.002[c]
Interval by Interval	Pearson's R	-.520	.115	-3.338	.002[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

3) Seen Photos * Opinion Future Before

Before viewing the Google Earth project, a significantly greater percentage of participants who had seen more photos of the open pit mines were more opposed to future open pit mines compared to participants who had seen fewer photos, as highlighted in green in Table 91.

Table 91 Seen Photos * Opinion Future Before

Crosstab

			Opinion Future Before				Total
			-2= Extremely Opposed	-1= Somewhat Opposed	0= Neutral	1= Somewhat Supportive	
Seen Photos	1= None	Count	2	2	6	3	13
		% within Seen Photos	15.4%	15.4%	46.2%	23.1%	100.0%
	2= Few	Count	4	3	2	1	10
		% within Seen Photos	40.0%	30.0%	20.0%	10.0%	100.0%
	3= Some	Count	4	5	0	0	9
		% within Seen Photos	44.4%	55.6%	0.0%	0.0%	100.0%
Total		Count	10	10	8	4	32
		% within Seen Photos	31.2%	31.2%	25.0%	12.5%	100.0%

As highlighted in red in Table 92, the Somers' d test is significant (.000) with moderate negative correlations (-.406 to -.448). With the exception of the Spearman correlation, the ordinal by ordinal symmetric measures are also significant (.000) with moderate negative correlations (-426. to -.584).

Table 92 Cross-Tab Tests Seen Photos * Opinion Future Before

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.562[a]	6	.072
Likelihood Ratio	14.329	6	.026
Linear-by-Linear Association	7.700	1	.006
N of Valid Cases	32		

a. 12 cells (100.0%) have expected count less than 5. The minimum expected count is 1.13.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.426	.116	-3.624	.000
		Seen Photos Dependent	-.406	.109	-3.624	.000
		Opinion Future Before Dependent	-.448	.125	-3.624	.000

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.426	.116	-3.624	.000
	Kendall's tau-c	-.442	.122	-3.624	.000
	Gamma	-.583	.147	-3.624	.000
	Spearman Correlation	-.498	.131	-3.145	.004[c]
Interval by Interval	Pearson's R	-.498	.120	-3.149	.004[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

4) Seen Photos * Opinion Existing After

After viewing the Google Earth project, a significantly greater percentage of participants who had seen more photos of the open pit mines were more opposed to existing open pit mines compared to participants who had seen fewer photos, as highlighted in green in Table 93.

Table 93 Seen Photos * Opinion Existing After

Crosstab								
			Opinion Existing After					Total
			-2= Extremely Opposed	-1= Somewhat Opposed	0= Neutral	1= Somewhat Supportive	-2= Extremely Opposed	
Seen Photos	1= None	Count	2	2	5	2	1	12
		% within Seen Photos	16.7%	16.7%	41.7%	16.7%	8.3%	100.0%
	2= Few	Count	4	3	2	1	0	10
		% within Seen Photos	40.0%	30.0%	20.0%	10.0%	0.0%	100.0%
	3= Some	Count	6	3	0	0	0	9
		% within Seen Photos	66.7%	33.3%	0.0%	0.0%	0.0%	100.0%
Total		Count	12	8	7	3	1	31
		% within Seen Photos	38.7%	25.8%	22.6%	9.7%	3.2%	100.0%

As highlighted in red in Table 94 all the directional and symmetric measures are significant. The Somers' d test is significant (.000) with moderate negative correlations (-.458 to -.500). The ordinal by ordinal symmetric measures are all significant (.000 to .001) with moderate negative correlations (-.476 to -.600).

Table 94 Cross-Tab Tests Seen for Photos * Opinion Existing After

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.041[a]	8	.199
Likelihood Ratio	13.884	8	.085
Linear-by-Linear Association	8.943	1	.003
N of Valid Cases	31		

a. 15 cells (100.0%) have expected count less than 5. The minimum expected count is .29.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.478	.113	-4.105	.000
		Seen Photos Dependent	-.458	.108	-4.105	.000
		Opinion Existing After Dependent	-.500	.122	-4.105	.000

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.479	.114	-4.105	.000
	Kendall's tau-c	-.496	.121	-4.105	.000
	Gamma	-.660	.137	-4.105	.000
	Spearman Correlation	-.547	.127	-3.522	.001[c]
Interval by Interval	Pearson's R	-.546	.112	-3.510	.001[c]
N of Valid Cases		31			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

5) Seen Video or Film * Increase Planned After

Only those 30 participants who thought they knew the increase of the open pit mines after viewing can be included to calculate an ordinal correlation. As highlighted in green in Table 95, a significantly greater percentage of participants who had previously seen more TV broadcasts, videos, or films about the open pit mines thought, after viewing the Google Earth project, that the planned open pit mines would be three times the geographic area of the existing open pit mines, which is the spatially correct answer.

Correct Answer

Table 95 Seen Video or Film * Increase Planned After

			Increase Planned After			Total
			2.0 x existing size	3.0 x existing size	10.0x existing size	
Seen Video or Film	1= None	Count	0	5	8	13
		% within Seen Video or Film	0.0%	38.5%	61.5%	100.0%
	2= Few	Count	1	4	2	7
		% within Seen Video or Film	14.3%	57.1%	28.6%	100.0%
	3= Some	Count	1	7	1	9
		% within Seen Video or Film	11.1%	77.8%	11.1%	100.0%
	4= Many	Count	0	1	0	1
		% within Seen Video or Film	0.0%	100.0%	0.0%	100.0%
Total		Count	2	17	11	30
		% within Seen Video or Film	6.7%	56.7%	36.7%	100.0%

As highlighted in red in Table 96, the Somers' d test is significant (.001) with moderate negative correlations (-.387 to -.427). With the exception of the Spearman correlation, the ordinal by ordinal symmetric measures are also significant (.001) with moderate negative correlations (-.430 to -.667).

Table 96 Cross-Tab Tests for Seen Video or Film * Increase Planned After

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.897[a]	6	.246
Likelihood Ratio	9.206	6	.162
Linear-by-Linear Association	6.422	1	.011
N of Valid Cases	30		

a. 10 cells (83.3%) have expected count less than 5. The minimum expected count is .07.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.427	.120	-3.442	.001
		Seen Video or Film Dependent	-.477	.131	-3.442	.001
		Increase Planned After Dependent	-.387	.116	-3.442	.001

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.430	.121	-3.442	.001
	Kendall's tau-c	-.387	.112	-3.442	.001
	Gamma	-.667	.158	-3.442	.001
	Spearman Correlation	-.477	.132	-2.870	.008[c]
Interval by Interval	Pearson's R	-.471	.136	-2.822	.009[c]
N of Valid Cases		32	30		

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

6) Seen Maps * Opinion Existing Before

Before viewing the Google Earth project, a significantly greater percentage of participants who had previously seen more maps showing the open pit mines were more opposed to existing open pit mines compared to participants who had seen fewer maps, as shown highlighted in green in Table 97.

Table 97 Seen Maps * Opinion Existing Before

Crosstab

			Opinion Existing Before				Total
			-2= Extremely Opposed	-1= Somewhat Opposed	0= Neutral	1= Somewhat Supportive	
Seen Maps	1= None	Count	2	5	9	3	19
		% within Seen Maps	10.5%	26.3%	47.4%	15.8%	100.0%
	2= Few	Count	5	5	2	0	12
		% within Seen Maps	41.7%	41.7%	16.7%	0.0%	100.0%
	3= Some	Count	1	0	0	0	1
		% within Seen Maps	100.0%	0.0%	0.0%	0.0%	100.0%
Total		Count	8	10	11	3	32
		% within Seen Maps	25.0%	31.2%	34.4%	9.4%	100.0%

As highlighted in red in Table 98, all the directional and symmetric measures are significant. The Somers' d test is significant (.000) with moderate negative correlations (-.413 to -.583). The ordinal by ordinal symmetric measures are all significant (.000 to .002) with moderate to strong negative correlations (-.442 to -.759).

Table 98 Cross-Tab Tests for Seen Maps * Opinion Existing Before

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.477[a]	6	.106
Likelihood Ratio	11.583	6	.072
Linear-by-Linear Association	8.808	1	.003
N of Valid Cases	32		

a. 10 cells (83.3%) have expected count less than 5. The minimum expected count is .09.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.484	.117	-3.813	.000
		Seen Maps Dependent	-.414	.106	-3.813	.000
		Opinion Existing Before Dependent	-.583	.139	-3.813	.000

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.491	.119	-3.813	.000
	Kendall's tau-c	-.442	.116	-3.813	.000
	Gamma	-.759	.142	-3.813	.000
	Spearman Correlation	-.533	.131	-3.449	.002[c]
Interval by Interval	Pearson's R	-.533	.118	-3.451	.002[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

7) Seen Maps * Opinion Existing After

After viewing the Google Earth project, a significantly greater percentage of participants who had previously seen more maps showing the open pit mines were more opposed to future open pit mines compared to participants who had seen fewer maps, as highlighted in green in Table 99.

Table 99 Seen Maps * Opinion Existing After

Crosstab								
			Opinion Existing After					Total
			-2= Extremely Opposed	-1= Somewhat Opposed	0= Neutral	1= Somewhat Supportive	-2= Extremely Supportive	
Seen Maps	1= None	Count	4	5	5	3	1	18
		% within Seen Maps	22.2%	27.8%	27.8%	16.7%	5.6%	100.0%
	2= Few	Count	7	3	2	0	0	12
		% within Seen Maps	58.3%	25.0%	16.7%	0.0%	0.0%	100.0%
	3= Some	Count	1	0	0	0	0	1
		% within Seen Maps	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Total		Count	12	8	7	3	1	31
		% within Seen Maps	38.7%	25.8%	22.6%	9.7%	3.2%	100.0%

As highlighted in red in Table 100, the Somers' d test is significant (.002) with weak to moderate negative correlations (-.352 to -.496). With the exception of the Spearman Correlation, the ordinal by ordinal symmetric measures are also significant (.002) with weak to strong negative correlations (-.381 to -.670).

Table 100 Cross-Tab Tests for Seen Maps * Opinion Existing After

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.232[a]	8	.512
Likelihood Ratio	8.951	8	.346
Linear-by-Linear Association	6.089	1	.014
N of Valid Cases	31		

a. 14 cells (93.3%) have expected count less than 5. The minimum expected count is .03.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.411	.125	-3.136	.002
		Seen Maps Dependent	-.352	.111	-3.136	.002
		Opinion Existing After Dependent	-.496	.150	-3.136	.002

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.418	.127	-3.136	.002
	Kendall's tau-c	-.381	.121	-3.136	.002
	Gamma	-.670	.174	-3.136	.002
	Spearman Correlation	-.459	.141	-2.779	.009[c]
Interval by Interval	Pearson's R	-.451	.116	-2.718	.011[c]
N of Valid Cases		31			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

8) Seen Maps * Changed Opinion

After viewing the Google Earth project, a significantly greater percentage participants who had previously seen ***fewer*** maps showing the open pit mines thought they had changed their opinions more compared to participants who had previously seen ***more*** maps, as highlighted in green in Table 101.

Table 101 Seen Maps * Changed Opinion

Crosstab								
			Changed Opinion					Total
			1=Not Changed	2=Changed a LIttle	3=Somewhat Changed	4=Very Changed	5=Extremely Changed	
Seen Maps	1= None	Count	1	4	7	6	1	19
		% within Seen Maps	5.3%	21.1%	36.8%	31.6%	5.3%	100.0%
	2= Few	Count	4	5	2	1	0	12
		% within Seen Maps	33.3%	41.7%	16.7%	8.3%	0.0%	100.0%
	3= Some	Count	0	0	1	0	0	1
		% within Seen Maps	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Total		Count	5	9	10	7	1	32
		% within Seen Maps	15.6%	28.1%	31.2%	21.9%	3.1%	100.0%

As highlighted in red in Table 102, the Somers' d test is significant (.002) with weak to moderate negative correlations (-.386 to -.479). With the exception of the Spearman correlation, the ordinal by ordinal symmetric measures are also significant (.002) with moderate to strong negative correlations (-.363 to -.602).

Table 102 Cross-Tab Tests for Seen Maps * Changed Opinion

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.518[a]	8	.231
Likelihood Ratio	11.133	8	.194
Linear-by-Linear Association	4.950	1	.026
N of Valid Cases	32		

a. 13 cells (86.7%) have expected count less than 5. The minimum expected count is .03.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.386	.127	-3.043	.002
		Seen Maps Dependent	-.323	.103	-3.043	.002
		Changed Opinion Dependent	-.479	.165	-3.043	.002

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.393	.129	-3.043	.002
	Kendall's tau-c	-.363	.119	-3.043	.002
	Gamma	-.602	.182	-3.043	.002
	Spearman Correlation	-.443	.143	-2.706	.011[c]
Interval by Interval	Pearson's R	-.400	.143	-2.387	.023[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

9) Knowledge of Area * Area Approved Before

Only those 24 participants who thought they knew the area of the approved open pit mines before viewing can be included to calculate an ordinal correlation. Before viewing the Google Earth project, a significantly greater percentage of participants who stated that they had less previous knowledge about the size or geographic area of the open pit mines thought the approved open pit mines were smaller than participants who stated they had more previous knowledge, as highlighted in green in Table 103. The greatest percentage of participants who had "No Knowledge" thought the geographic area of the approved open pit mines was as large as a "Canadian metropolitan city", which is the spatially correct answer.

Spatially Correct Answer

Table 103 Knowledge of Area * Area Approved Before

Crosstab								
			Area Approved Before					Total
			2= Neighbour hood	3= Town	4= Canadian metropolitan city	5= World metropolitan city	6= Western province or state	
Knowledge of Area	1= No Knowledge	Count	0	0	4	2	0	6
		% within Knowledge of Area	0.0%	0.0%	66.7%	33.3%	0.0%	100.0%
	2=Little Knowledge	Count	1	1	2	3	3	10
		% within Knowledge of Area	10.0%	10.0%	20.0%	30.0%	30.0%	100.0%
	3=Some Knowledge	Count	0	0	0	5	3	8
		% within Knowledge of Area	0.0%	0.0%	0.0%	62.5%	37.5%	100.0%
Total		Count	1	1	6	10	6	24
		% within Knowledge of Area	4.2%	4.2%	25.0%	41.7%	25.0%	100.0%

As highlighted in red in Table 104, the Somers' d test is significant (.000) with moderate positive correlations (.388 to .415). The ordinal by ordinal symmetric measures are all significant (.000 to .000) with moderate to strong positive correlations (.401 to .557).

Table 104 Cross-Tabs for Knowledge of Area * Area Approved Before

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.427[a]	8	.133
Likelihood Ratio	15.174	8	.056
Linear-by-Linear Association	3.817	1	.051
N of Valid Cases	24		

a. 18 cells (100.0%) have expected count less than 5. The minimum expected count is .25.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	.401	.103	3.753	.000
		Knowledge of Area Dependent	.388	.105	3.753	.000
		Area Approved Before Dependent	.415	.104	3.753	.000

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.401	.103	3.753	.000
	Kendall's tau-c	.406	.108	3.753	.000
	Gamma	.557	.133	3.753	.000
	Spearman Correlation	.486	.113	2.610	.016[c]
Interval by Interval	Pearson's R	.407	.111	2.092	.048[c]
N of Valid Cases		32	24		

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

10) Involved * Opinion Existing Before

Before viewing the Google Earth project, a significantly greater percentage of participants who stated that they were more involved in promoting their opinions about tar sands development were more opposed to the existing open pit mines, as highlighted in green in Table 105.

Table 105 Involved * Opinion Existing Before

Crosstab							
			Opinion Existing Before				Total
			-2= Extremely Opposed	-1= Somewhat Opposed	0= Neutral	1= Somewhat Supportive	
Involved	1=Not involved	Count	2	7	11	3	23
		% within Involved	8.7%	30.4%	47.8%	13.0%	100.0%
	2=Slightly involved	Count	4	1	0	0	5
		% within Involved	80.0%	20.0%	0.0%	0.0%	100.0%
	3=Moderately involved	Count	2	2	0	0	4
		% within Involved	50.0%	50.0%	0.0%	0.0%	100.0%
Total		Count	8	10	11	3	32
		% within Involved	25.0%	31.2%	34.4%	9.4%	100.0%

As highlighted in red in Table 106, this difference is significant (.002) using the Linear-by-Linear Association test as well as all the directional and symmetric measures. The Somers' d test is significant (.000) with moderate to strong negative correlations (-.427 to -.687). The ordinal by ordinal symmetric measures are all significant (.000) with weak to strong negative correlations (-.375 to -.605).

Table 106 Cross-Tab Tests, Involved * Opinion Existing Before

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.631[a]	6	.016
Likelihood Ratio	17.718	6	.007
Linear-by-Linear Association	9.412	1	.002
N of Valid Cases	32		

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .38.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.527	.080	-4.708	.000
		Involved Dependent	-.427	.090	-4.708	.000
		Opinion Existing Before Dependent	-.687	.105	-4.708	.000

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.542	.083	-4.708	.000
	Kendall's tau-c	-.457	.097	-4.708	.000
	Gamma	-.848	.091	-4.708	.000
	Spearman Correlation	-.616	.093	-4.288	.000[c]
Interval by Interval	Pearson's R	-.551	.096	-3.617	.001[c]
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

11) **Increase Approved After * Opinion Existing After**:

After viewing the Google Earth project, a significantly greater percentage of participants who thought the growth of the ***approved*** tar sands open pit mines would be greater were more were more opposed to the ***existing*** tar sands open pit mines after viewing the Google Earth project, as highlighted in green in Table 107.

Table 107 Increase Approved After * Opinion Existing After

			Opinion Existing After					Total
			-2= Extremely Opposed	-1= Somewhat Opposed	0= Neutral	1= Somewhat Supportive	-2= Extremely Opposed	
Increase Approved After	1.5 times existing size	Count	0	0	0	1	0	1
		% within Increase Approved After	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
	2.0 times existing size	Count	1	1	3	0	0	5
		% within Increase Approved After	20.0%	20.0%	60.0%	0.0%	0.0%	100.0%
	3.0 times existing size	Count	11	7	3	2	0	23
		% within Increase Approved After	47.8%	30.4%	13.0%	8.7%	0.0%	100.0%
	10.0 times existing size	Count	0	0	0	0	1	1
		% within Increase Approved After	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
Total		Count	12	8	6	3	1	30
		% within Increase Approved After	40.0%	26.7%	20.0%	10.0%	3.3%	100.0%

As shown in Table 108, only the Pearson Chi-square test was significant, demonstrating that there is a discrepancy between observed cell counts and what one would expect if the rows and columns were unrelated.

Table 108 Cross-Tab Tests, Increase Approved After * Opinion Existing After

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	45.087[a]	12	.000
Likelihood Ratio	18.695	12	.096
Linear-by-Linear Association	3.390	1	.066
N of Valid Cases	30		

a. 18 cells (90.0%) have expected count less than 5. The minimum expected count is .03.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Somers' d	Symmetric	-.158	.201	-.780	.435
		Increase Approved After Dependent	-.121	.156	-.780	.435
		Opinion Existing After Dependent	-.227	.288	-.780	.435

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	-.165	.211	-.780	.435
	Kendall's tau-c	-.116	.148	-.780	.435
	Gamma	-.273	.345	-.780	.435
	Spearman Correlation	-.166	.231	-.890	.381[c]
Interval by Interval	Pearson's R	.342	.269	1.925	.064[c]
N of Valid Cases		30			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

APPENDIX Q: NOMINAL CROSS-TABULATIONS AND TEST RESULTS

The following statistical tests of significance and strength of correlations were generated as defined in the SPSS software manual (International Business Machines Corp., n.d.a):

> **Chi Square** measures the discrepancy between observed cell counts and what you would expect if the rows and columns were unrelated. For tables with any number of rows and columns, select Chi-square to calculate the Pearson chi-square and the likelihood-ratio chi-square. When both table variables are quantitative, Chi-square yields the linear-by-linear association test.
>
> **Nominal Tests**. For nominal data, you can select Contingency coefficient, Phi (coefficient) and Cramer's V, Lambda (symmetric and asymmetric lambdas and Goodman and Kruskal's tau), and Uncertainty coefficient.
>
> • Contingency coefficient. A measure of association based on chi-square. The value ranges between 0 and 1, with 0 indicating no association between the row and column variables and values close to 1 indicating a high degree of association between the variables. The maximum value possible depends on the number of rows and columns in a table.
>
> • Phi and Cramer's V. Phi is a chi-square-based measure of association that involves dividing the chi-square statistic by the sample size and taking the square root of the result. Cramer's V is a measure of association based on chi-square.
>
> • Lambda. A measure of association that reflects the proportional reduction in error when values of the independent variable are used to predict values of the dependent variable. A value of 1 means that the independent variable perfectly predicts the dependent variable. A value of 0 means that the independent variable is no help in predicting the dependent variable.
>
> • Uncertainty coefficient. A measure of association that indicates the proportional reduction in error when values of one variable are used to predict values of the other variable. For example, a value of 0.83 indicates that knowledge of one variable reduces error in predicting values of the other variable by 83%. The program calculates both symmetric and asymmetric versions of the uncertainty coefficient.

As shown in Table 109, the significant cross-tabulated pairs are highlighted in red.

Table 109 Cross-Tabulation of Hypothetical Nominal Pairs
N=No Significant Correlation Y=Significant Correlation (Highlighted in Red)

	Independent Variables					
Dependent Variables	1. Seen From Air	2. Lived Nearby	3. Seen From Ground	4. Province	5. Gender	6. Occupation
1. Using Maps	N	N	N	N	N	N
2. Using Computers	N	N	N	N	N	N
3. Using Google Earth or GIS	N	N	N	N	N	N
4. Seen Photos	N	N	N	N	N	N
5. Seen Video or Film	N	N	N	N	N	N
6. Read Articles or Books	N	N	N	N	N	N
7. Seen Maps	N	N	N	N	N	N
8. Knowledge of Area	N	N	N	N	N	N
9. Area Existing Before	N	N	N	N	N	N
10. Opinion Existing Before	N	N	N	N	N	N
11. Area Approved Before	N	Y	N	N	N	N
12. Increase Approved Before	N	N	N	N	N	N
13. Area Planned Before	N	N	N	N	N	N
14. Increase Planned Before	N	N	N	N	N	N
15. Opinion Future Before	N	N	N	N	N	N
16. Gender	N	N	N	N	N	N
17. Age	N	N	N	N	N	Y
18. Education	N	N	N	N	N	N
19. Occupation	N	N	N	N	N	N
20. Involved	N	N	N	N	N	N
21. New Knowledge	N	N	N	N	N	N
22. Area Existing After	N	N	N	N	N	N
23. Area Approved After	N	N	N	N	N	N
24. Increase Approved After	N	N	N	N	N	N
25. Area Planned After	N	N	N	N	N	N
26. Increase Planned After	N	N	N	N	N	N
27. Opinion Future After	N	N	N	N	N	N
28. Changed Opinion	N	N	N	N	N	N
29. Useful Google Earth	N	N	N	N	N	N
30. People	N	N	N	N	N	N
31. Mining Machinery	N	N	N	N	N	N
32. Trees	N	N	N	N	N	N
33. Cities	N	N	N	N	N	N
34. Alberta Provincial Boundary	N	N	N	N	N	N
35. Zoom Tool	N	N	N	N	N	N
36. Scale Tool	N	N	N	N	N	N
37. Images in Balloon	N	N	N	N	N	N
38. Maps Believable	N	Y	N	N	N	N
39. Images Believable	N	N	N	N	N	N
40. Seen From Ground				N		N
41. Province					N	N

1) Lived Nearby * Area Approved Before

Before viewing the Google Earth project, a significantly greater percentage of participants who had ***not*** lived nearby the open pit mines thought the geographic area of the approved open pit mines was larger compared to the one participant who had lived nearby, as highlighted in green in Table 110. The largest number of participants who had ***not*** lived nearby thought the geographic area of the approved open pit mines was as large as a “World metropolitan city”, which is not the spatially correct answer.

Table 110 Lived Nearby * Area Approved Before

Crosstab			Area Approved Before			Correct Answer			Total
			0= Don’t know	2= Neighbour-hood	3= Town	4= Canadian metropolitan city	5= World metropolitan city	6= Western province or state	
Lived Nearby	0= No	Count	8	1	0	6	10	6	31
		% within Lived Nearby	25.8%	3.2%	0.0%	19.4%	32.3%	19.4%	100.0%
	1= Yes	Count	0	0	1	0	0	0	1
		% within Lived Nearby	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
Total		Count	8	1	1	6	10	6	32
		% within Lived Nearby	25.0%	3.1%	3.1%	18.8%	31.2%	18.8%	100.0%

As highlighted in red in Table 111, this difference is significant (.000) using the Pearson Chi-square test. Using the Goodman and Kruskal tau test, the correlation is significant (.000) but with very high error value (1.000) since there was only focus group participant who had lived nearby the open pit mines. The correlation is strong (.700 to 1.000) and significant (.000) using all the symmetrical measures.

Table 111 Cross-Tab Tests for Lived Nearby * Area Approved Before

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32.000[a]	5	.000
Likelihood Ratio	8.900	5	.113
Linear-by-Linear Association	.070	1	.792
N of Valid Cases	32		

a. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .03.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Lambda	Symmetric	.087	.081	1.016	.310
		Lived Nearby Dependent	1.000	.000	1.016	.310
		Area Approved Before Dependent	.045	.044	1.016	.310
	Goodman and Kruskal tau	Lived Nearby Dependent	1.000	.000		.000[c]
		Area Approved Before Dependent	.049	.002		.178[c]
	Uncertainty Coefficient	Symmetric	.164	.109	1.317	.113[d]
		Lived Nearby Dependent	1.000	.000	1.317	.113[d]
		Area Approved Before Dependent	.089	.065	1.317	.113[d]

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on chi-square approximation

d. Likelihood ratio chi-square probability.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	1.000	.000
	Cramer's V	1.000	.000
	Contingency Coefficient	.707	.000
N of Valid Cases		32	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

2) Lived Nearby * Maps Believable

A significantly greater percentage of participants who had ***not*** lived nearby the open pit mines thought the maps were more believable compared to the one participant who had lived nearby, as highlighted in green in Table 112.

Table 112 Lived Nearby * Maps Believable

Crosstab								
			Maps Believable					Total
			1= Highly unbelievable	2= Mostly unbelievable	3= Intermediate	4= Mostly believable	5= Highly believable	
Lived Nearby	0= No	Count	2	0	10	10	9	31
		% within Lived Nearby	6.5%	0.0%	32.3%	32.3%	29.0%	100.0%
	1= Yes	Count	0	1	0	0	0	1
		% within Lived Nearby	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
Total		Count	2	1	10	10	9	32
		% within Lived Nearby	6.2%	3.1%	31.2%	31.2%	28.1%	100.0%

As highlighted in red in Table 113, this difference is significant (.000) using the Pearson Chi-square test. Using the Goodman and Kruskal tau test, the correlation is significant (.000) but with a very high error value (1.000) for "Lived Nearby" as the dependent variable since there was only (1) participant who had lived nearby the open pit mines. The correlation is strong (.707 to 1.000) and significant (.000) using all the symmetrical measures.

Table 113 Cross-Tab Tests for Lived Nearby * Maps Believable

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32.000[a]	4	.000
Likelihood Ratio	8.900	4	.064
Linear-by-Linear Association	2.457	1	.117
N of Valid Cases	32		

a. 7 cells (70.0%) have expected count less than 5. The minimum expected count is .03.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Lambda	Symmetric	.087	.081	1.016	.310
		Lived Nearby Dependent	1.000	.000	1.016	.310
		Maps Believable Dependent	.045	.044	1.016	.310
	Goodman and Kruskal tau	Lived Nearby Dependent	1.000	.000		.000[c]
		Maps Believable Dependent	.054	.003		.150[c]
	Uncertainty Coefficient	Symmetric	.185	.120	1.317	.064[d]
		Lived Nearby Dependent	1.000	.000	1.317	.064[d]
		Maps Believable Dependent	.102	.073	1.317	.064[d]

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on chi-square approximation
d. Likelihood ratio chi-square probability.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	1.000	.000
	Cramer's V	1.000	.000
	Contingency Coefficient	.707	.000
N of Valid Cases		32	

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

3) Occupation * Age

As highlighted in green in Table 114, all participants with occupations listed as “Student” were age 20-29, all “Unemployed” were age 40-49, and both of the two (2) “Sales etc.” were age 30 to 39. All “Retired” were older than 50. All “Management etc.” were younger than 50. All “Science etc.” were between the ages of 30 to 59.

Table 114 Occupation * Age

Crosstab									
			Age						Total
			2= 20-29	3= 30-39	4= 40-49	5= 50-59	6= 60-69	7= 70+	
Occupation	1= Student	Count	4	0	0	0	0	0	4
		% within Occupation	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	2= Homemaker	Count	0	2	0	1	0	0	3
		% within Occupation	0.0%	66.7%	0.0%	33.3%	0.0%	0.0%	100.0%
	3= Retired	Count	0	0	0	1	3	3	7
		% within Occupation	0.0%	0.0%	0.0%	14.3%	42.9%	42.9%	100.0%
	4= Unemployed	Count	0	0	2	0	0	0	2
		% within Occupation	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
	5= Management etc.	Count	2	2	2	0	0	0	6
		% within Occupation	33.3%	33.3%	33.3%	0.0%	0.0%	0.0%	100.0%
	6= Science etc.	Count	0	2	1	2	0	0	5
		% within Occupation	0.0%	40.0%	20.0%	40.0%	0.0%	0.0%	100.0%
	7= Sales etc.	Count	0	2	0	0	0	0	2
		% within Occupation	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	8=Trades etc.	Count	0	0	0	1	0	0	1
		% within Occupation	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
	9=Other	Count	0	0	0	1	1	0	2
		% within Occupation	0.0%	0.0%	0.0%	50.0%	50.0%	0.0%	100.0%
Total		Count	6	8	5	6	4	3	32
		% within Occupation	18.8%	25.0%	15.6%	18.8%	12.5%	9.4%	100.0%

As highlighted in red in Table 115, these differences are significant using the Pearson Chi-square test (.001). With the exception of Lambda with Occupation as the dependent variable, Lambda and Goodman and Kruskal tau are significant (.001) and have moderate correlations (.341 to .472). All symmetric measures are significant (.001) and have high correlations (.677 to 1.513).

Table 115 Cross-Tab Tests for Occupation * Age

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	73.242[a]	40	.001
Likelihood Ratio	67.374	40	.004
Linear-by-Linear Association	.607	1	.436
N of Valid Cases	32		

a. 54 cells (100.0%) have expected count less than 5. The minimum expected count is .09.

Directional Measures

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Lambda	Symmetric	.408	.093	3.961	.000
		Occupation Dependent	.360	.106	3.093	.002
		Age Dependent	.458	.119	3.284	.001
	Goodman and Kruskal tau	Occupation Dependent	.341	.046		.000[c]
		Age Dependent	.472	.032		.001[c]
	Uncertainty Coefficient	Symmetric	.555	.043	10.868	.004[d]
		Occupation Dependent	.514	.043	10.868	.004[d]
		Age Dependent	.603	.051	10.868	.004[d]

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on chi-square approximation

d. Likelihood ratio chi-square probability.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	1.513	.001
	Cramer's V	.677	.001
	Contingency Coefficient	.834	.001
N of Valid Cases		32	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

APPENDIX R: SCREENSHOT DATA STRUCTURE WITH SAMPLE IMAGES

1) Viewpoints

a) Vertical Maps (771 Screenshot Images)

i. Standard Google Earth Imagery (183 Screenshot Images)

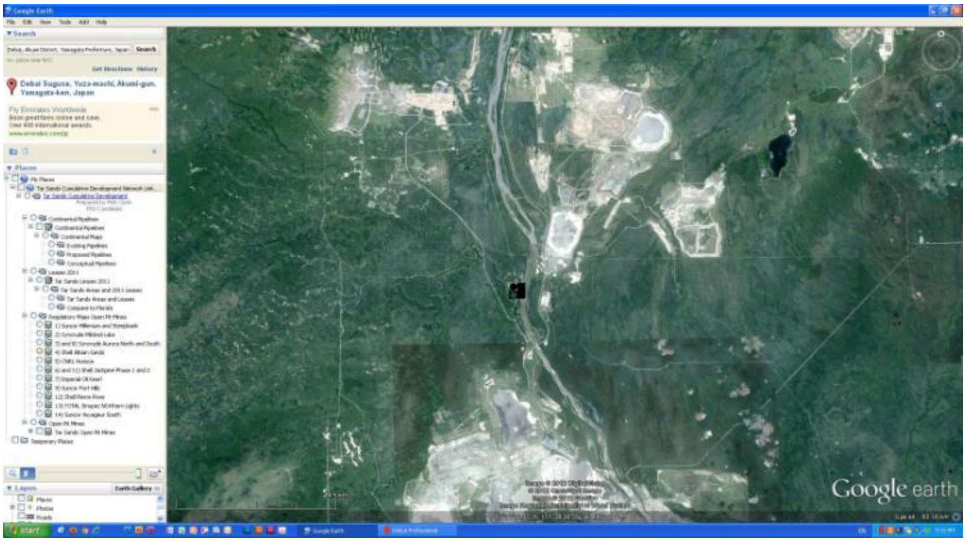


Figure 206 Example Vertical Map, Standard Google Earth Imagery, Focus Group Participant E9

ii. Regulatory Maps (160 Screenshot Images)

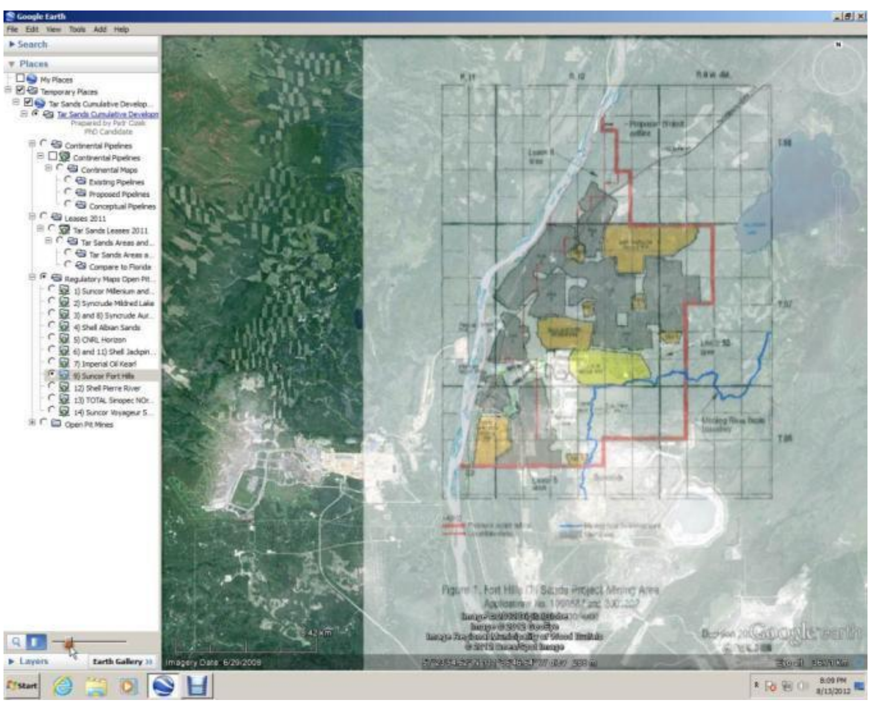


Figure 207 Example Vertical Map, Regulatory Map, Focus Group Participant VB5

iii. Comparison to Cities (143 Screenshot Images)

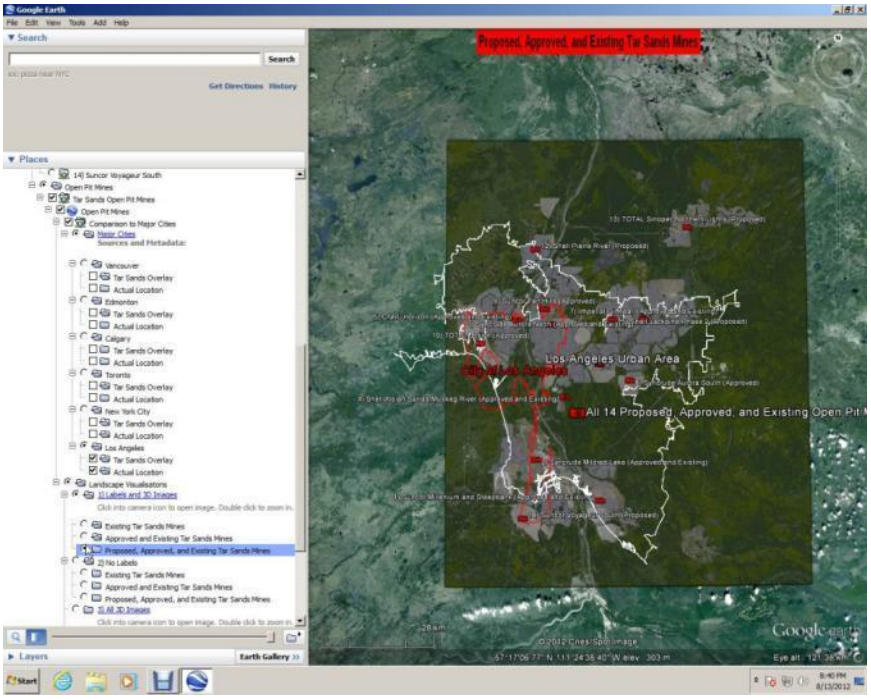


Figure 208 Example Vertical Map, Comparison to Cities, Focus Group Participant VB12

iv. Open Pit Scenarios (119 Screenshot Images)

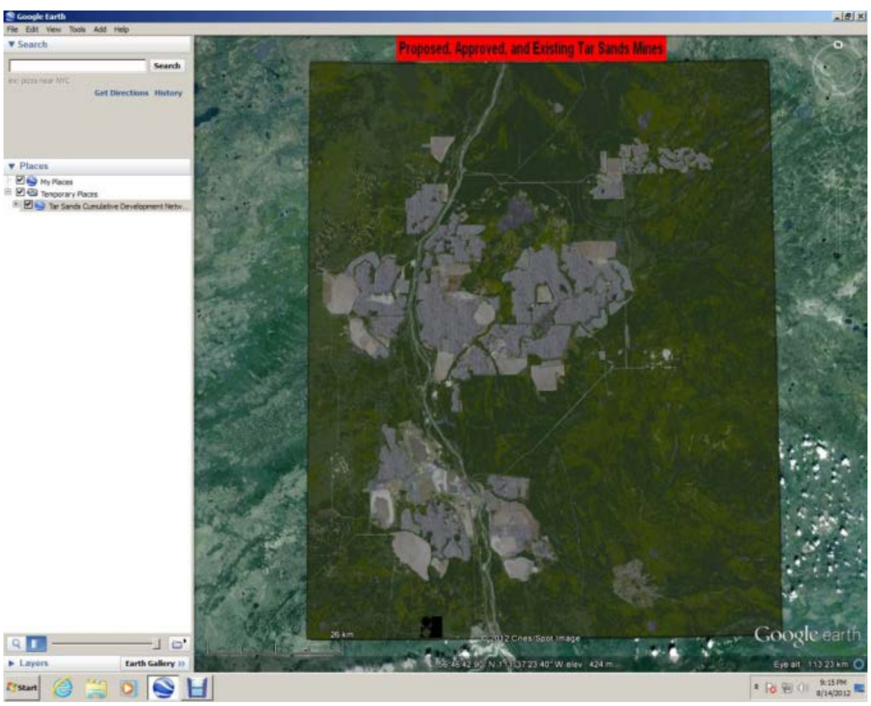


Figure 209 Example Vertical Map, Open Pit Scenario, Focus Group Participant VA5

v. Pipelines (90 Screenshot Images)

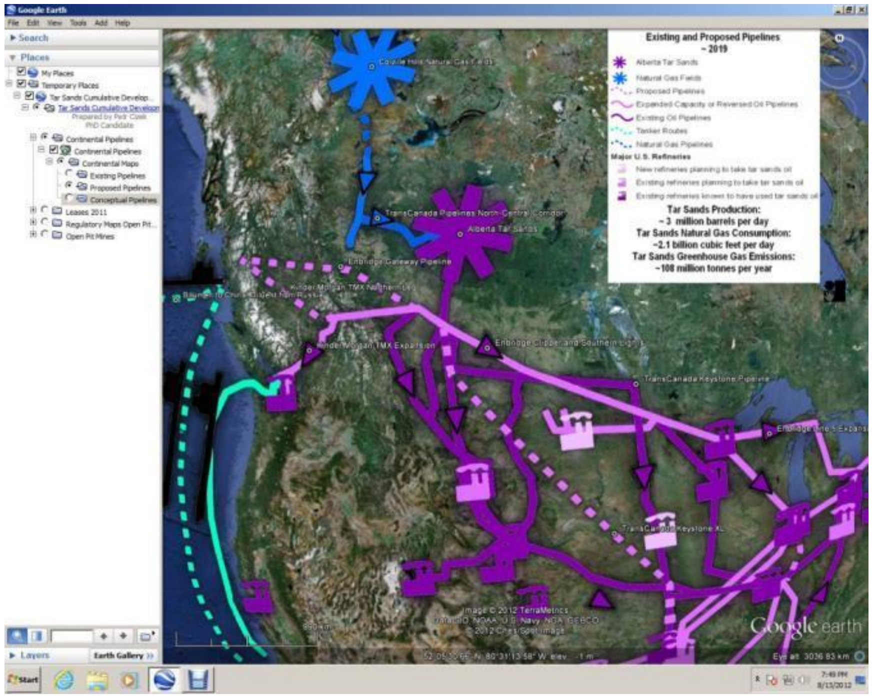


Figure 210 Example Vertical Map, Pipelines, Focus Group Participant VB1

vi. Leases (76 Screenshot Images)

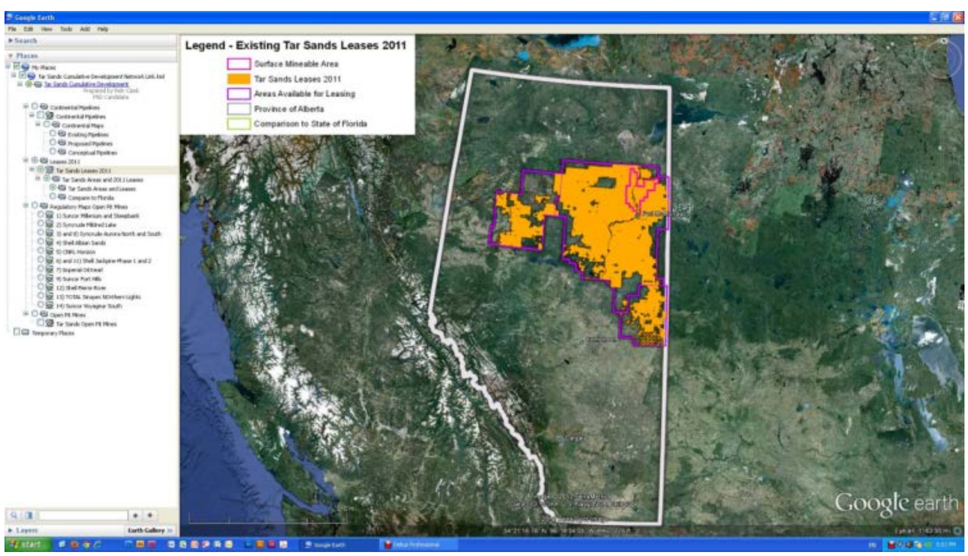


Figure 211 Example Vertical Map, Leases, Focus Group Participant E3

b) Static Landscape Visualisation Formats of Open Pit Mines (206 Screenshot Images)

i. HTML Hyperlinks (110 Screenshot Images)

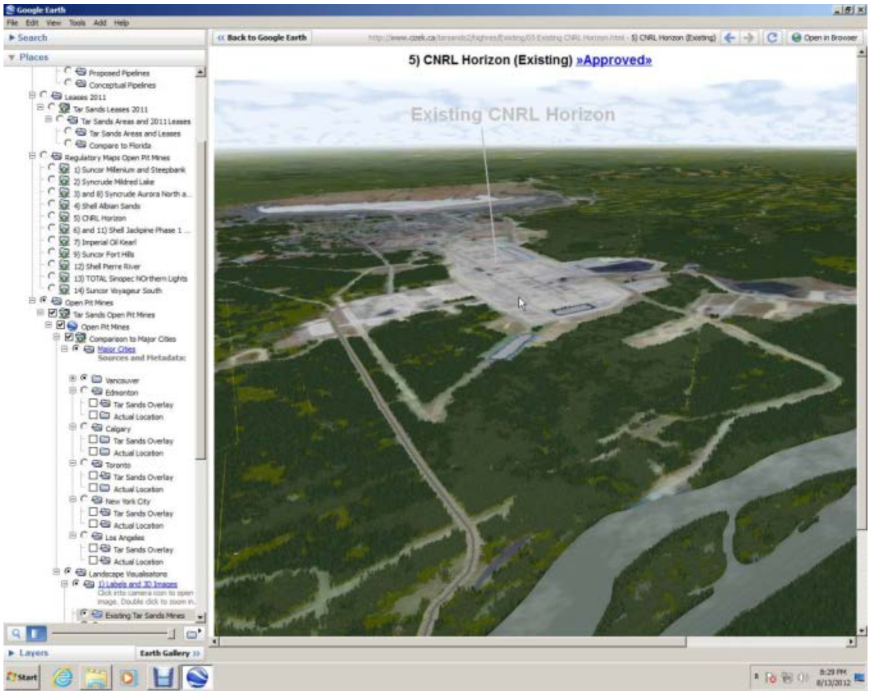


Figure 212 Example Static Visualisation, HTML Hyperlink, Focus Group Participant VB6

ii. Popup Balloons (96 Screenshot Images)

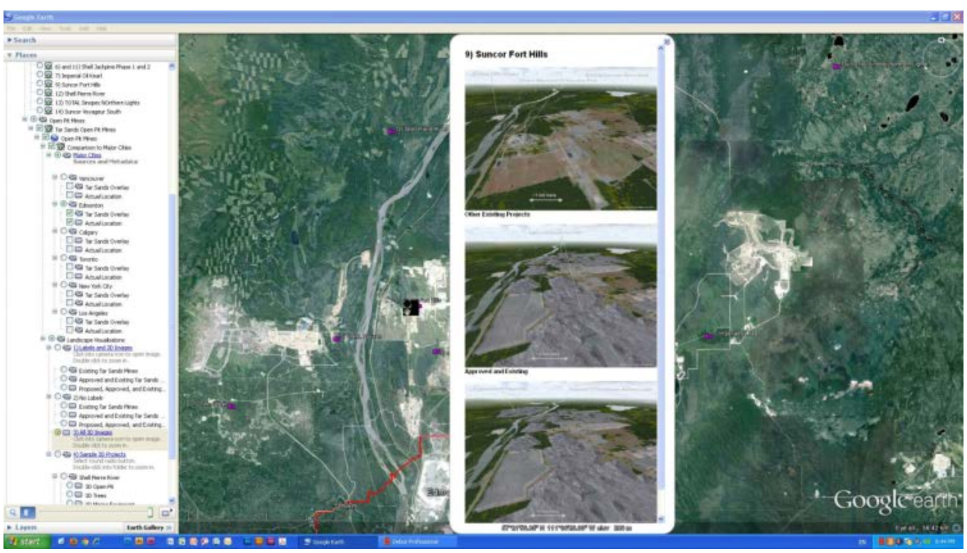


Figure 213 Example Static Landscape Visualisation, Popup Balloons, Focus Group Participant E8

c) Oblique Map (186 Screenshot Images)

i. Standard Google Earth Imagery (102 Screenshot Images)

Figure 214 Example Oblique Map, Standard Google Earth Imagery Focus Group Participant E3

ii. Open Pit Scenarios (35 Screenshot Images)

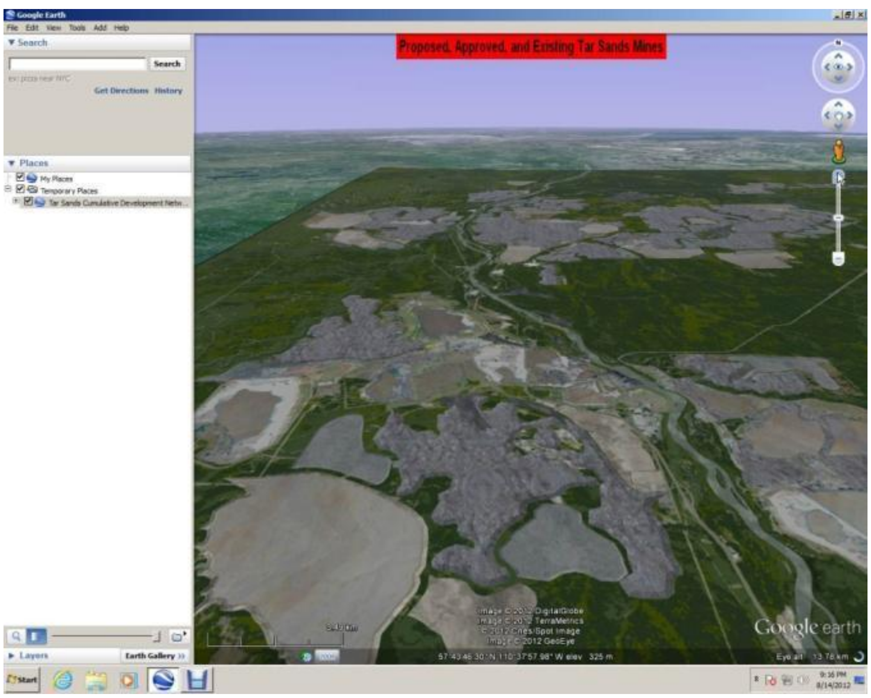


Figure 215 Example Oblique Map, Open Pit Scenarios, Focus Group Participant VA5

iii. Comparison to Cities (19 Screenshot Images)

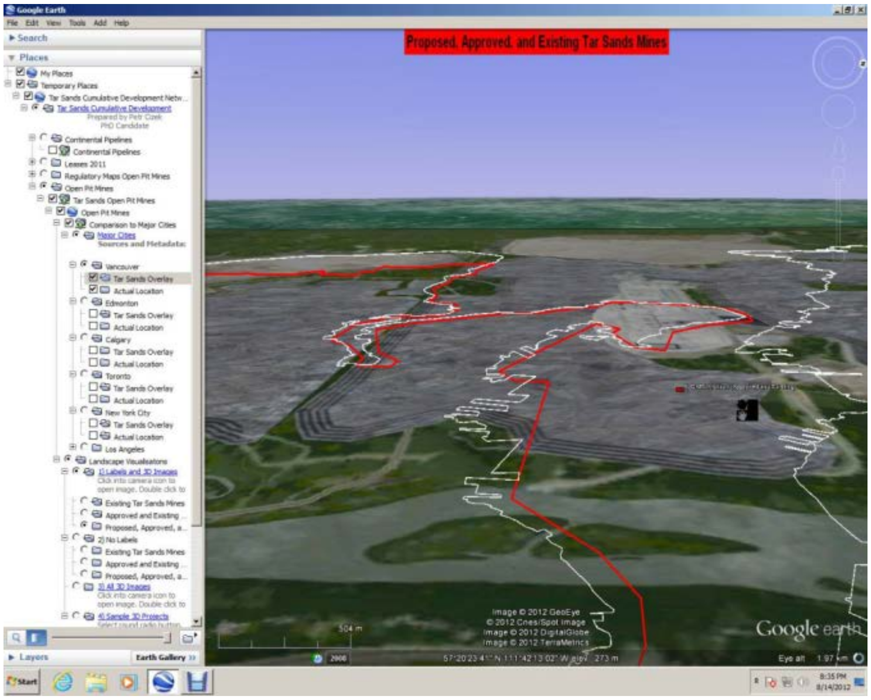


Figure 216 Example Oblique Map, Comparison to Cities, Focus Group Participant VA8

iv. Regulatory Maps (18 Screenshot Images)

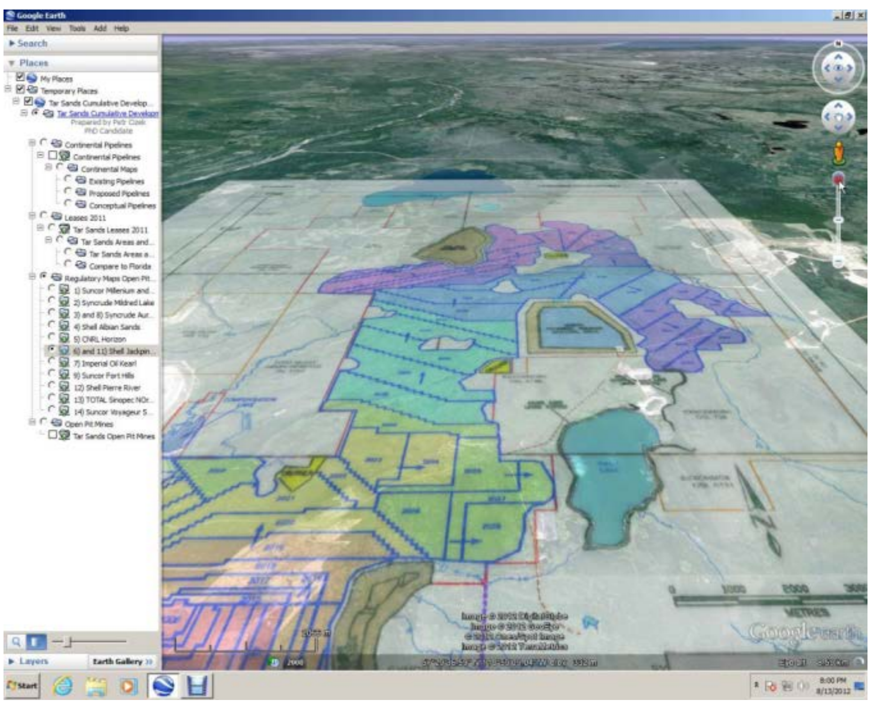


Figure 217 Example Oblique Map, Regulatory Map, Focus Group Participant VB3

v. Leases (9 Screenshot Images)

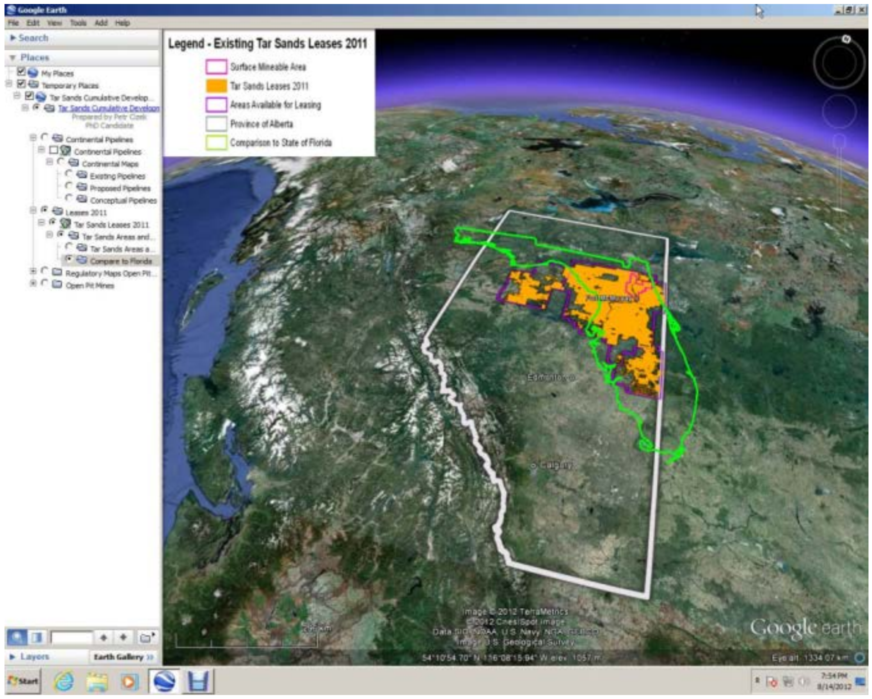


Figure 218 Example Oblique Map, Leases, Focus Group Participant VA3

vi. Pipelines (3 Screenshot Images)

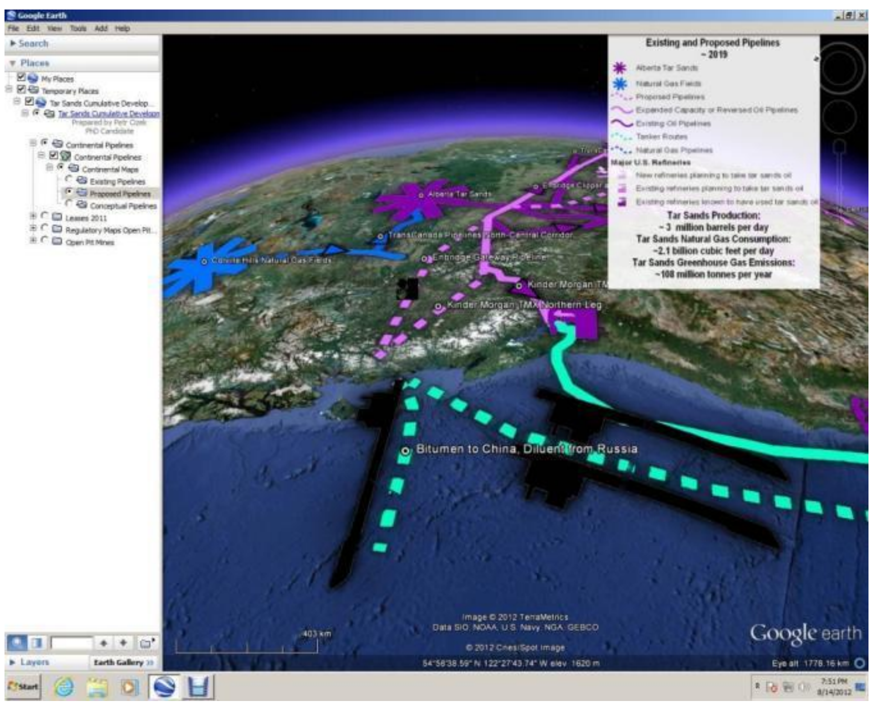


Figure 219 Example Oblique Map, Pipelines, Focus Group Participant VA8

d) Interactive Landscape Visualisations (135 Screenshot Images)

i. Mining Equipment and People in Open Pit Mines (83 Screenshot Images)

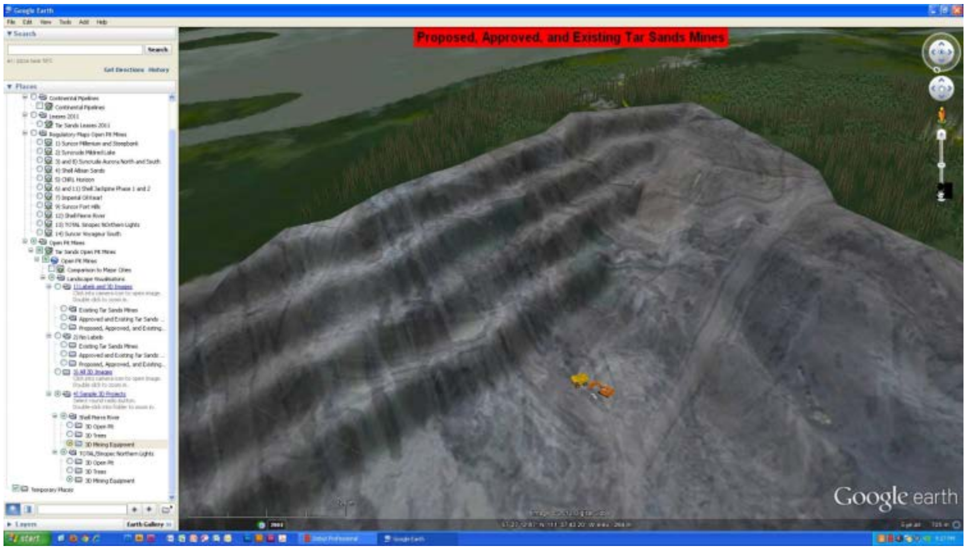


Figure 220 Example Interactive Landscape Visualisation, Mining Equipment and People in Open Pit Mines, Focus Group Participant E12

ii. Open Pit Mines Only (32 Screenshot Images)

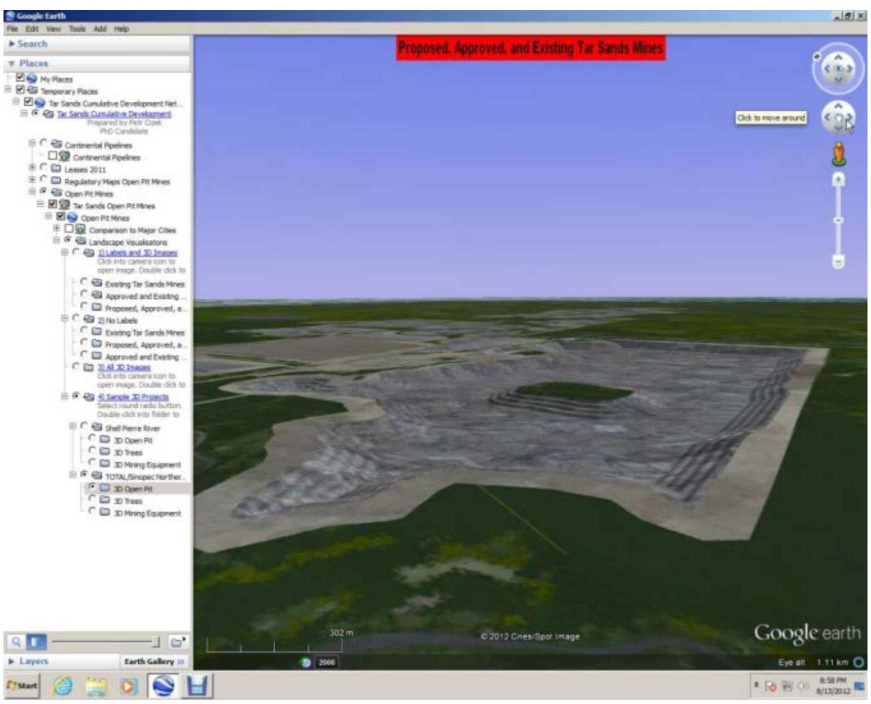


Figure 221 Example Interactive Landscape Visualisation, Open Pit Mine Only, Focus Group Participant VB3

iii. Trees Surrounding Open Pit Mines (16 Screenshot Images)

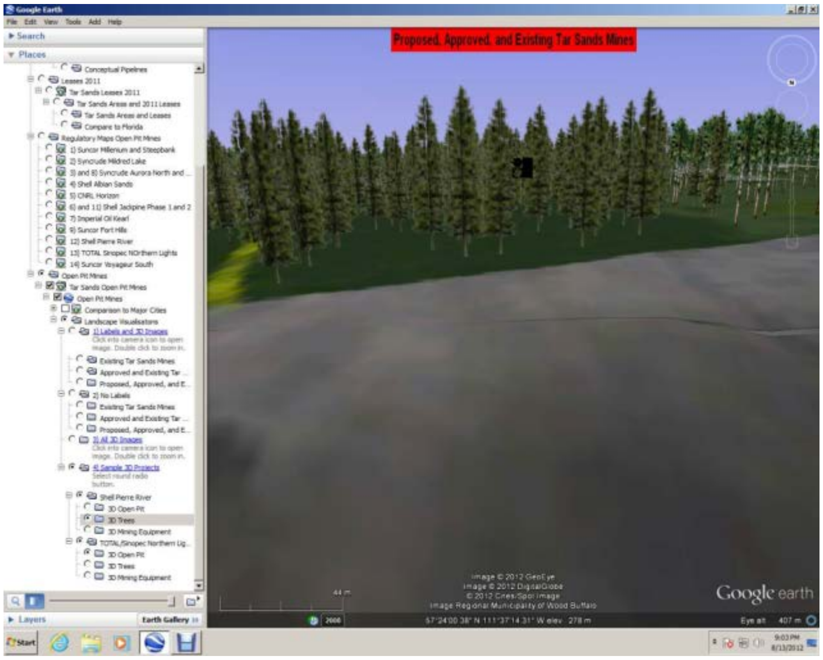


Figure 222 Example Interactive Landscape Visualisation, Trees Surrounding Open Pit Mines, Focus Group Participant VB5

iv. Athabasca River and Open Pit Mines (4 Screenshot Images)

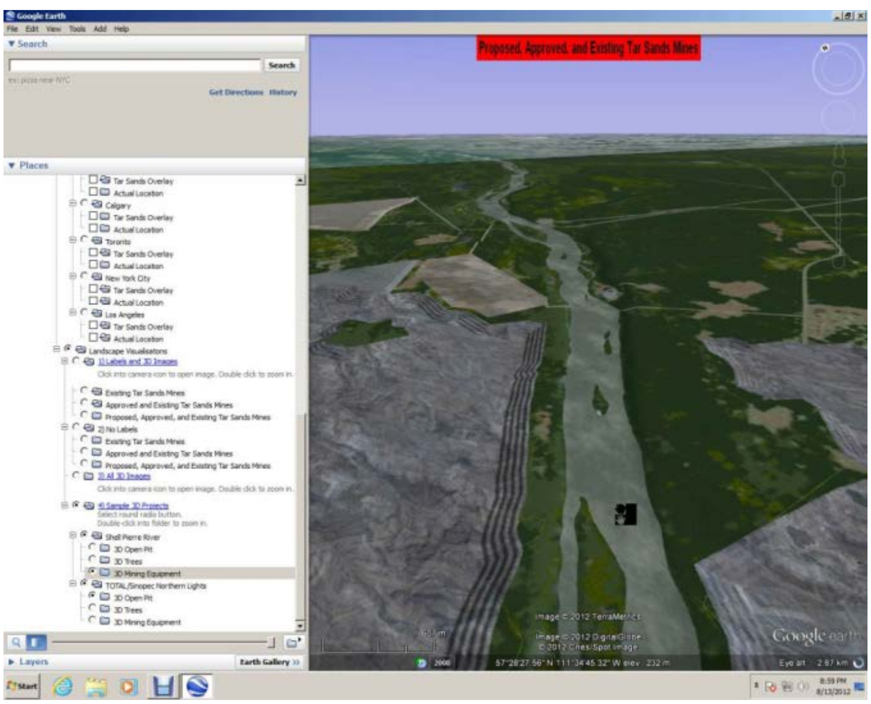


Figure 223 Example Interactive Landscape Visualisation, Athabasca River and Open Pit Mines, Focus Group Participant VB12

e) Metadata Hyperlink (1 Screenshot Image)

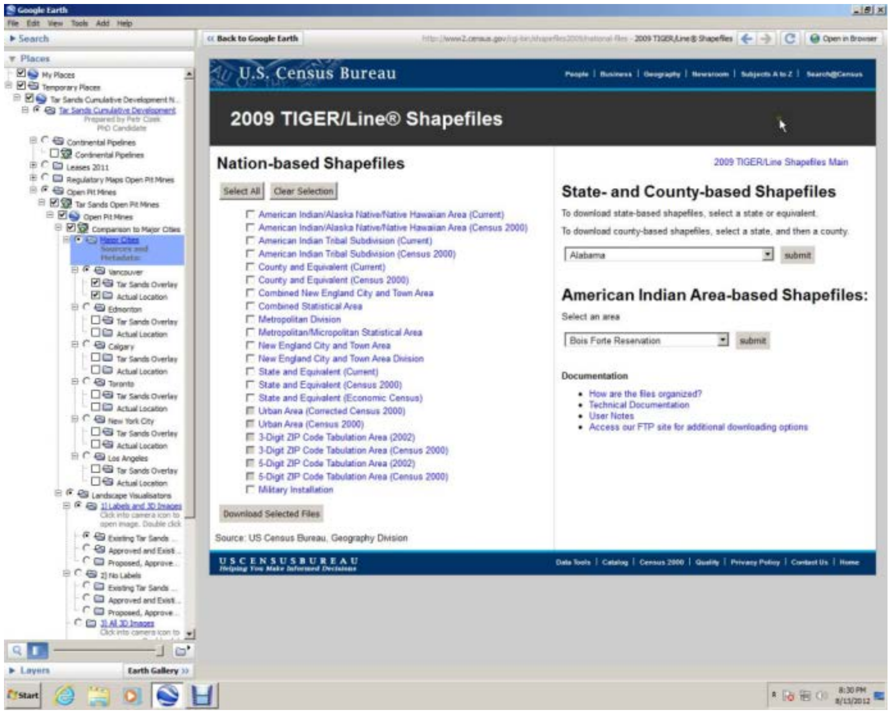


Figure 224 Metadata Hyperlink, Focus Group Participant VB3

2) Topics

a) Open Pit Scenarios (495 Screenshot Images)

i. Static Landscape Visualisations (206 Screenshot Images)

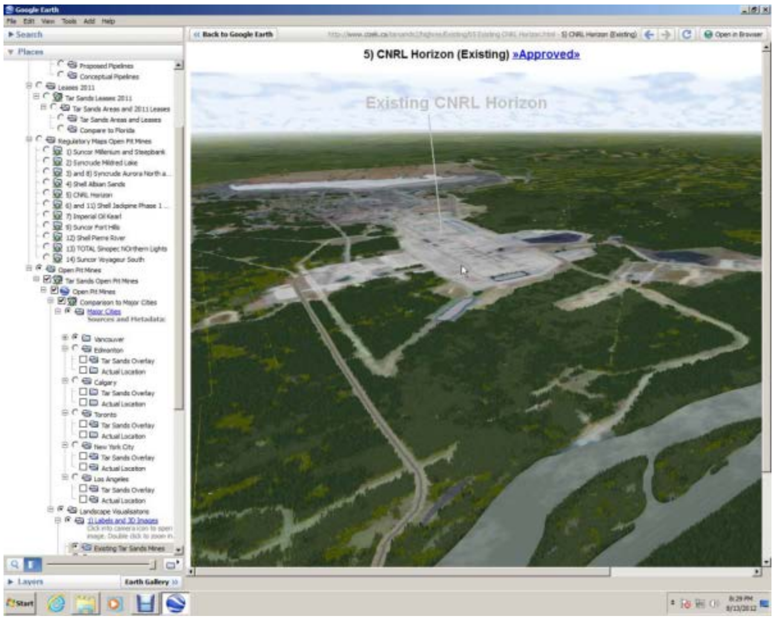


Figure 225 Example Open Pit Scenarios, Static Landscape Visualisation, Focus Group Participant VB6

ii. Interactive Landscape Visualisations (135 Screenshot Images)

Figure 226 Example Open Pit Scenario, Interactive Landscape Visualisation, Focus Group Participant VB3

iii. Vertical Maps (119 Screenshot Images)

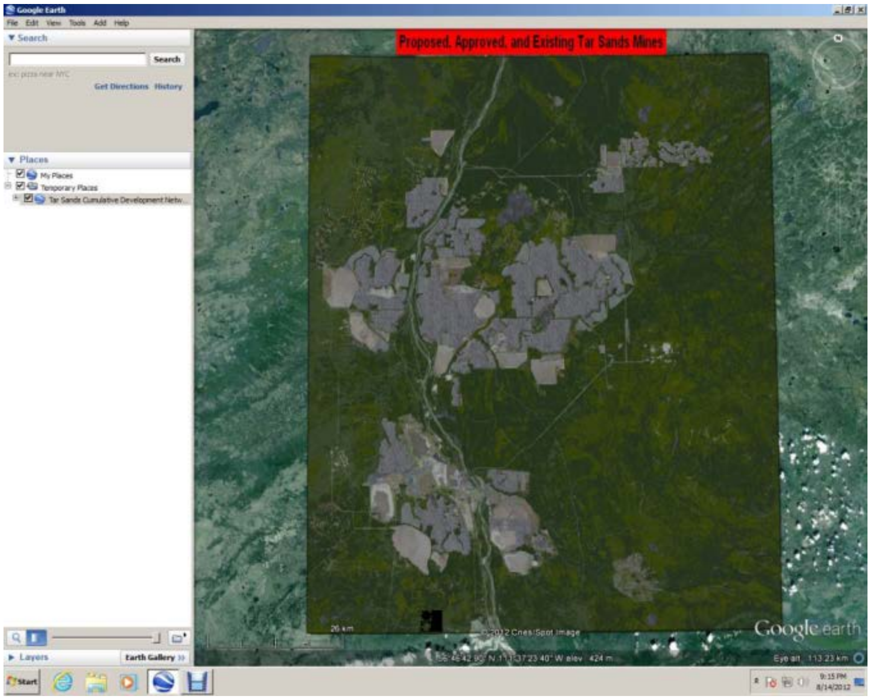


Figure 227 Example Open Pit Scenarios, Vertical Map, Focus Group Participant VA5

iv. Oblique Maps (35 Screenshot Images)

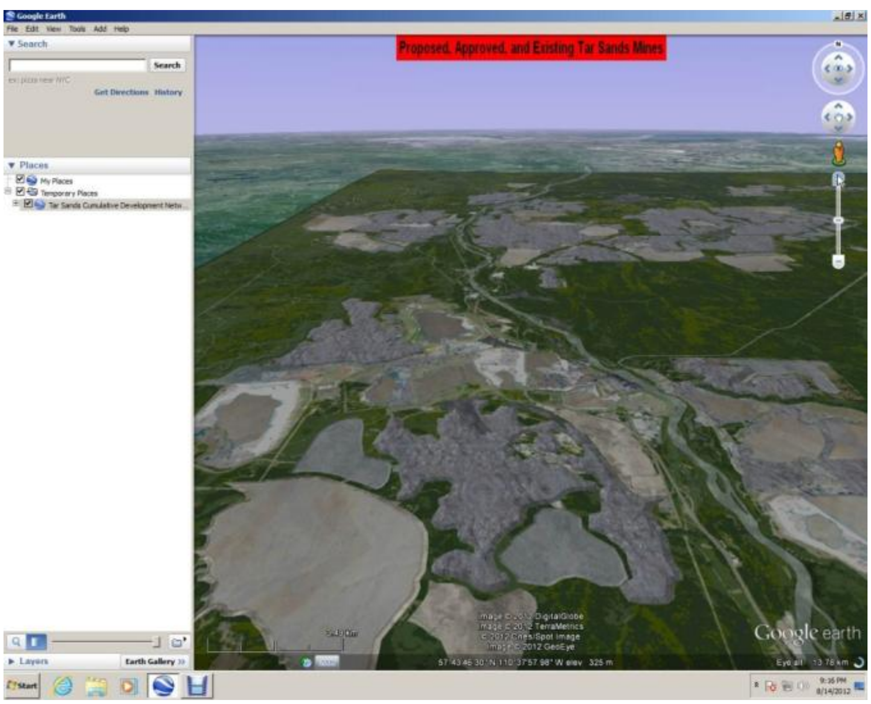


Figure 228 Example Open Pit Scenarios, Oblique Map, Focus Group Participant VA5

b) Standard Google Earth Imagery (285 Screenshot Images)

i. Vertical Maps (183 Screenshot Images)

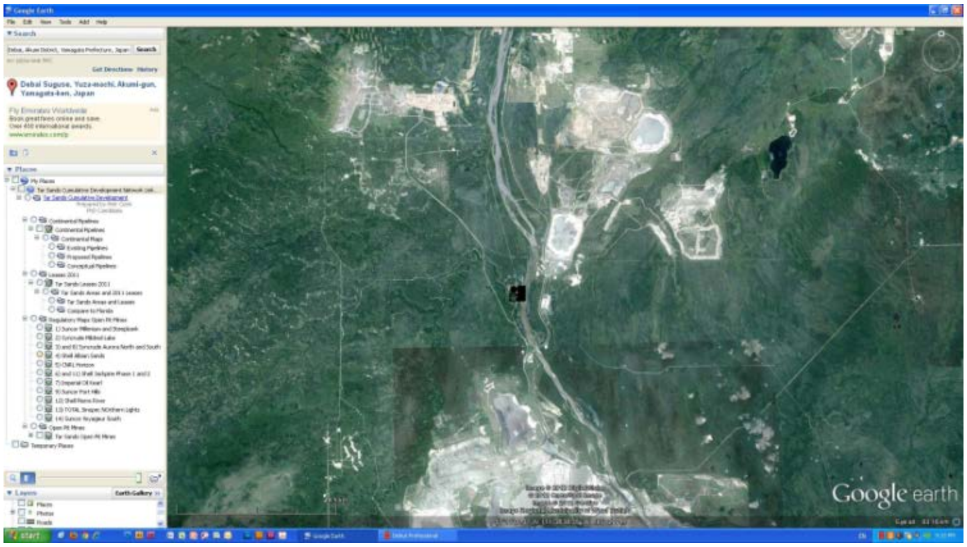


Figure 229 Example Standard Google Earth Imagery, Vertical Map, Focus Group Participant E9

ii. Oblique Maps (102 Screenshot Images)

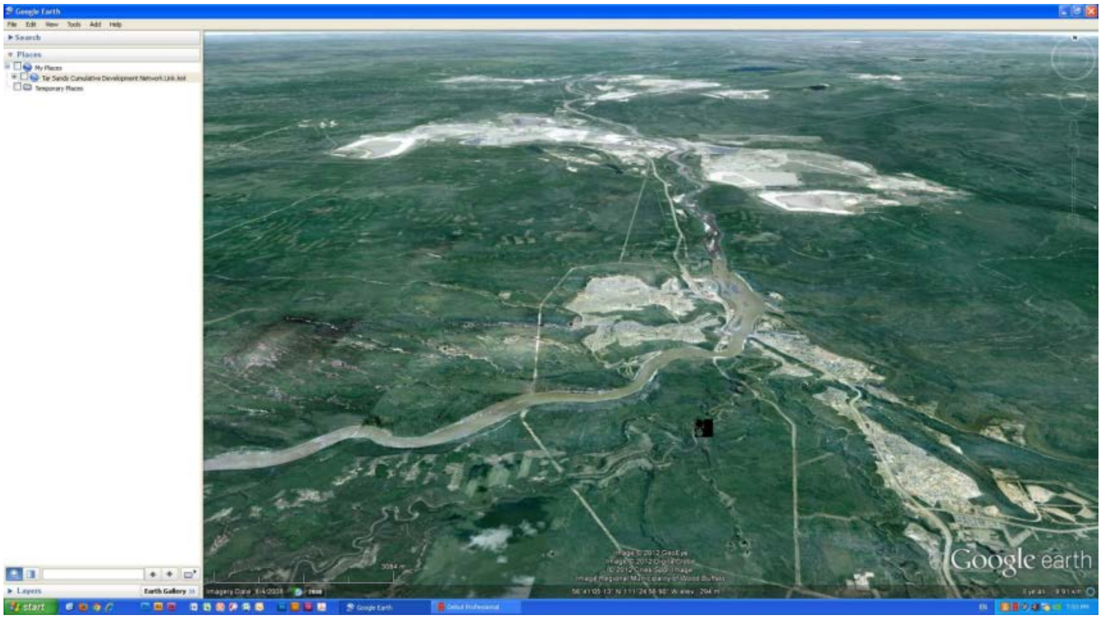


Figure 230 Example Standard Google Earth Imagery, Oblique Map, Focus Group Participant E3

c) Regulatory Maps (178 Screenshot Images)

i. Vertical Maps (160 Screenshot Images)

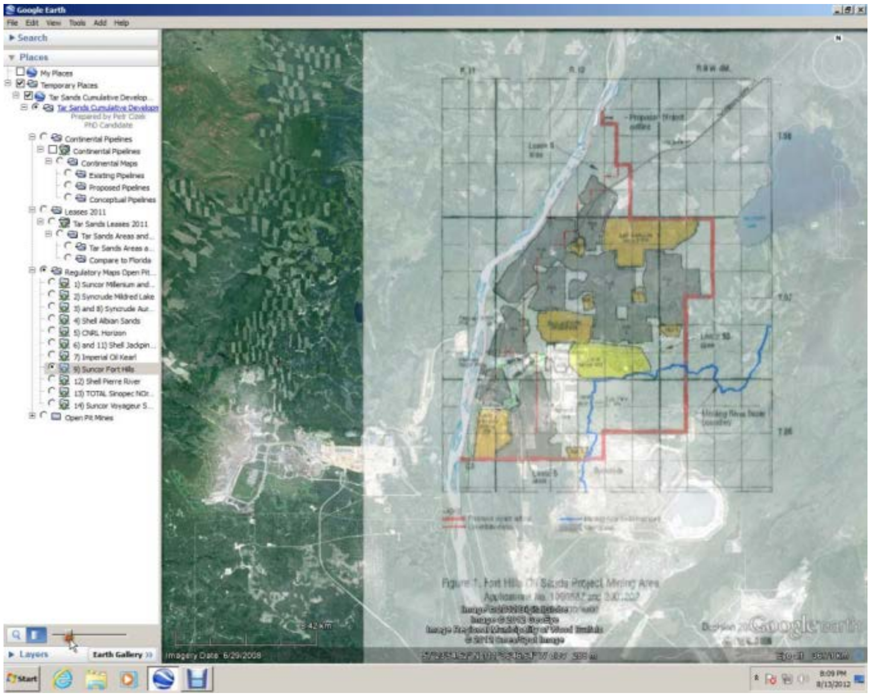


Figure 231 Example Regulatory Map, Vertical Map, Focus Group Participant VB5

ii. Oblique Maps (18 Screenshot Images)

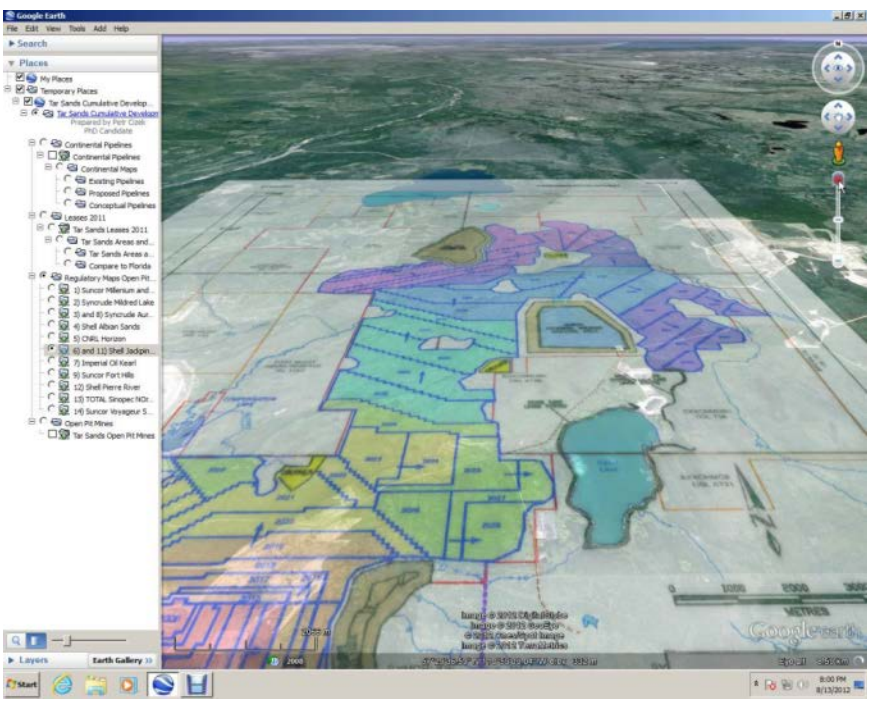


Figure 232 Example Regulatory Map, Oblique Viewpoint, Focus Group Participant VB3

d) Comparison to Cities (162 Screenshot Images)

i. Vertical Maps (143 Screenshot Images)

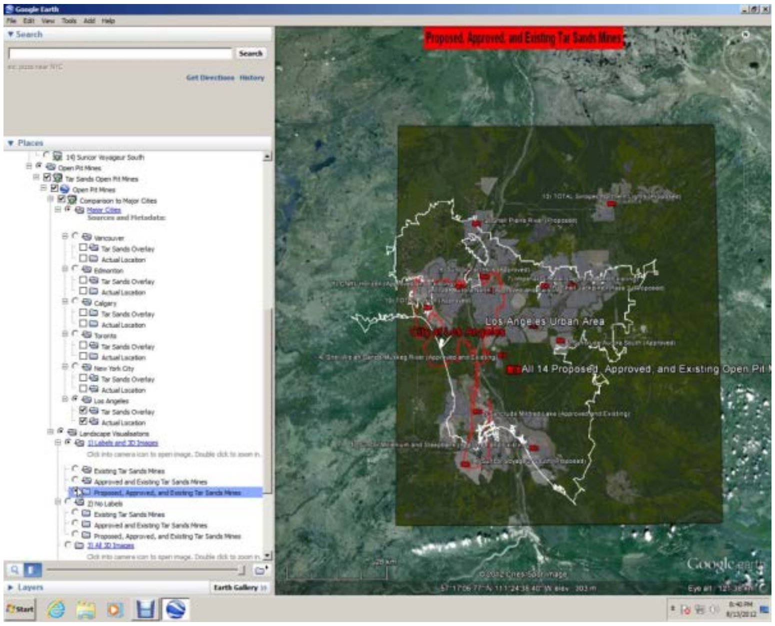


Figure 233 Example Comparison to Cities, Vertical Map, Focus Group Participant VB12

ii. Oblique Maps (19 Screenshot Images)

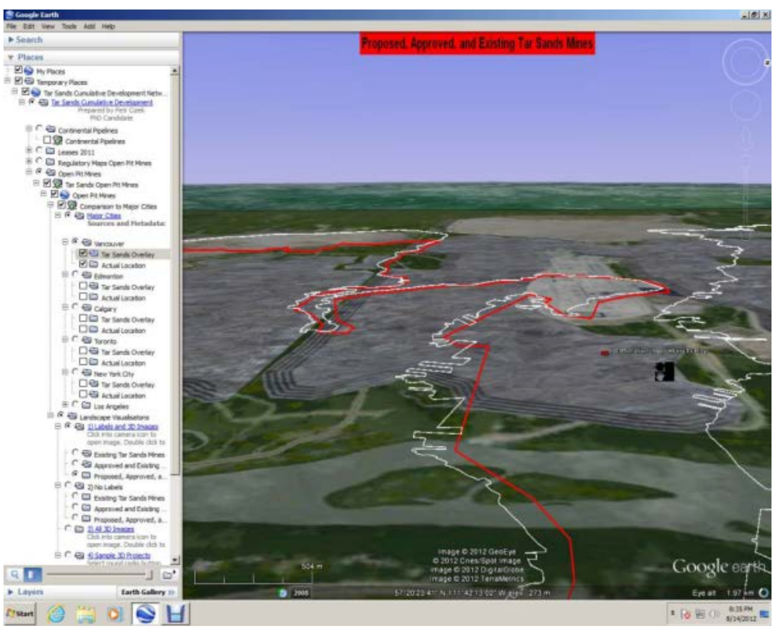


Figure 234 Example Comparison to Cities, Oblique Map Focus Group Participant VA8

e) Pipelines (93 Screenshot Images)

i. Vertical Maps (90 Screenshot Images)

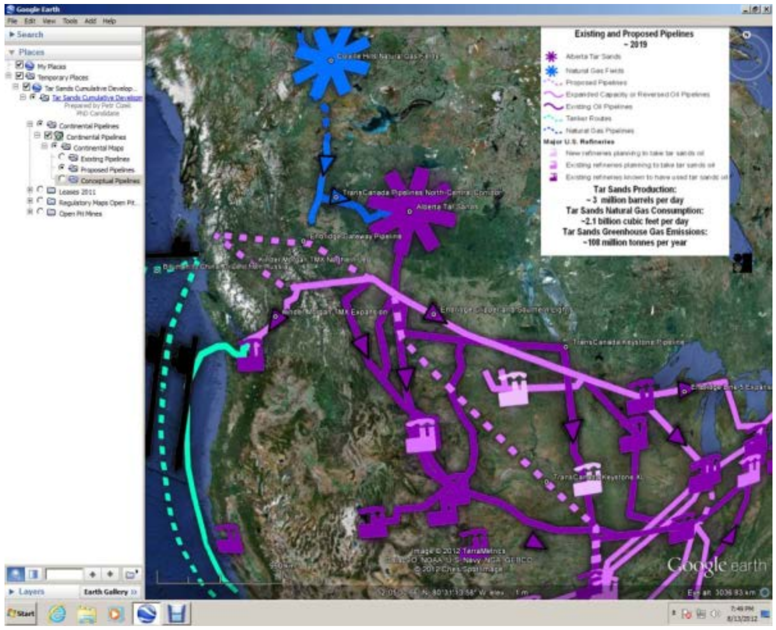


Figure 235 Example Pipelines, Vertical Map, Focus Group Participant VB1

ii. Oblique Maps (3 Screenshot Images)

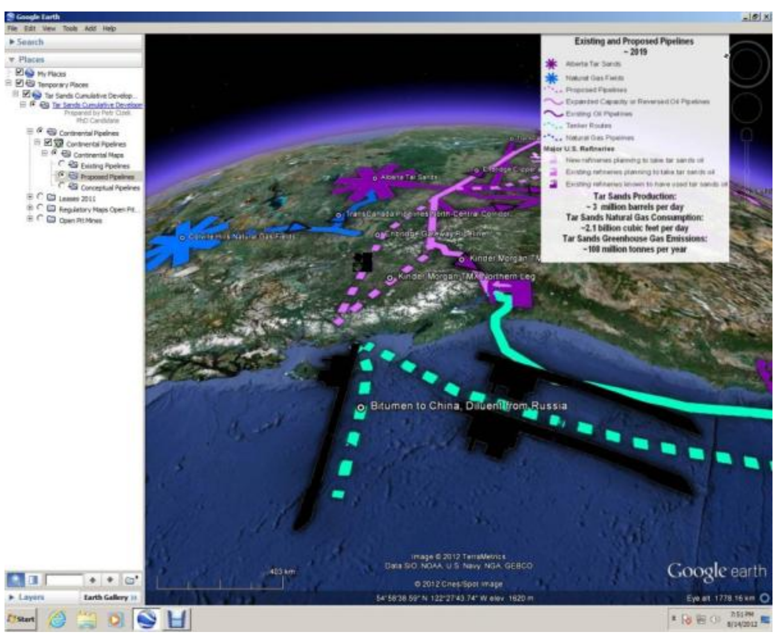


Figure 236 Example Pipelines, Oblique Map, Focus Group Participant, VA8

f) Leases (85 Screenshot Images)

i. Vertical Maps (76 Screenshot Images)

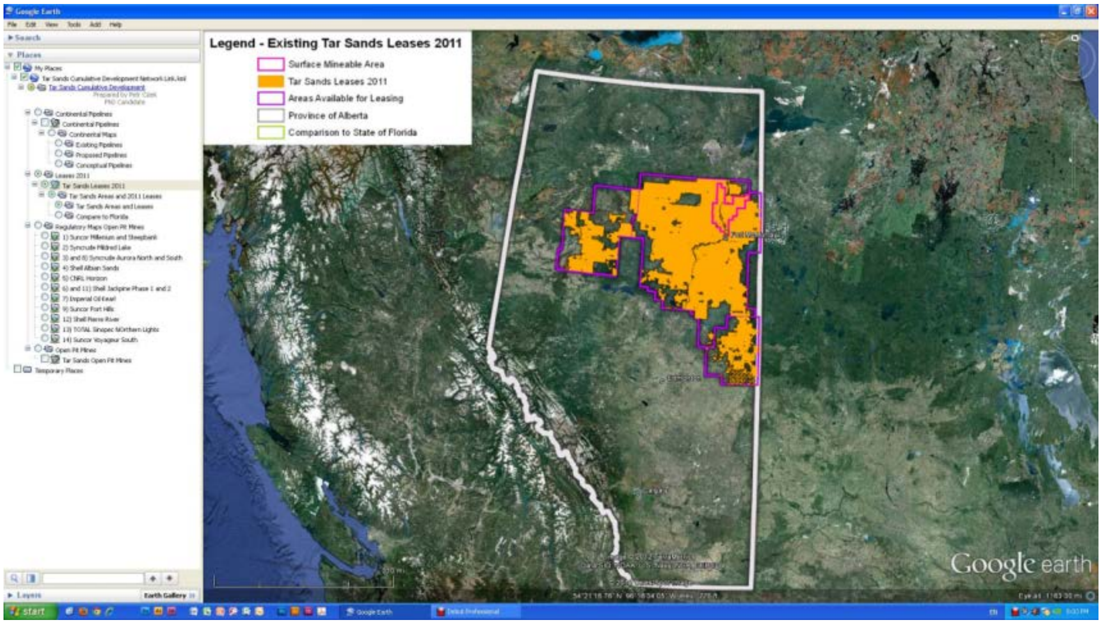


Figure 237 Example Leases, Vertical Map, Focus Group Participant E3

ii. Oblique Maps (8 Screenshot Images)

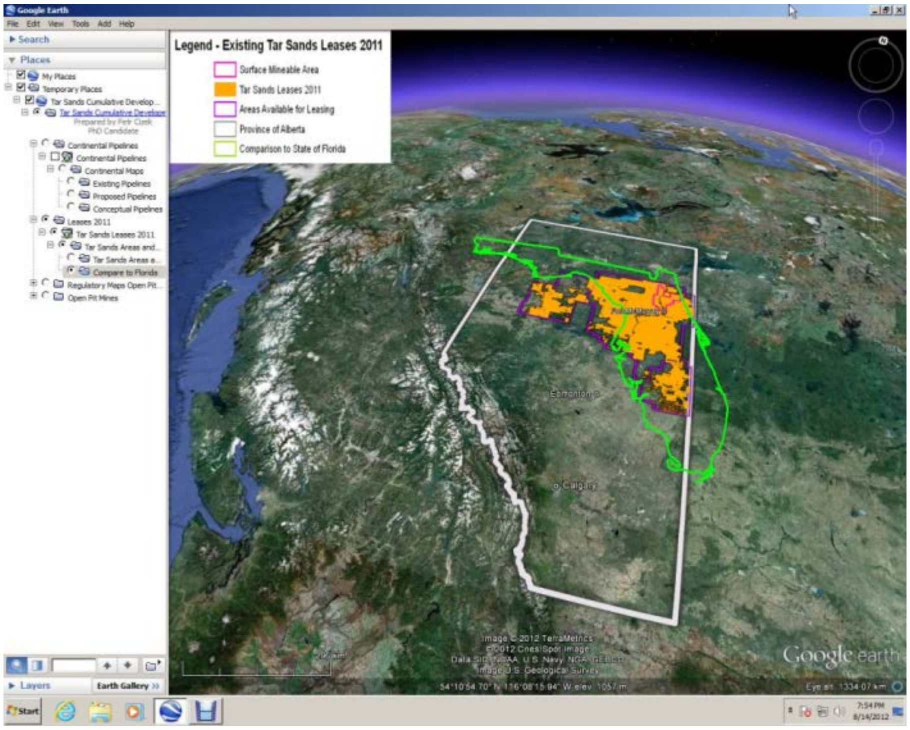


Figure 238 Example Leases, Oblique Map, Focus Group Participant VA3

g) Metadata Hyperlink (1 Screenshot Image)

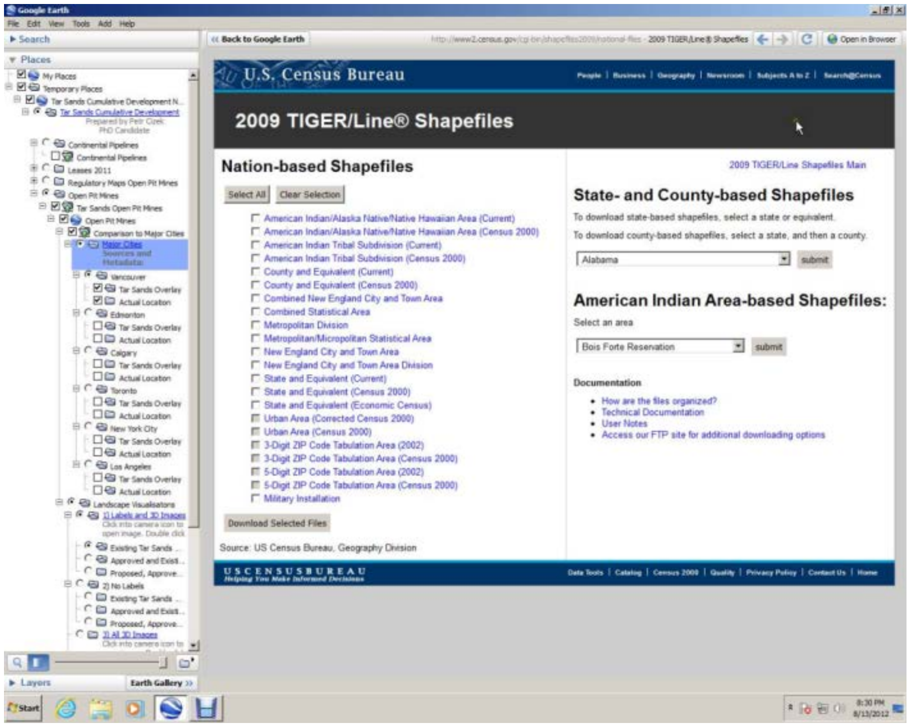


Figure 239 Metadata Hyperlink, Focus Group Participant VB3

APPENDIX S: COMMENTS AND QUESTIONS

Table 116 General Negative Impact Comments

Number	Participant	Source	Comment
1)	E04	Q2	Science explains why it is bad and an exponential problem but is not supported by Conservative fed. gov.
2)	E07	Q2	I don't approved of wrecking anything for profit.
3)	E07	Q2	Maybe I should do something - although I see no chance of making a difference. Look who is stacked up against any real change - government, industry, workers, unions, the USA, China...!!!
4)	E08	Q2	They need to look at the environment and the cost to protect it.
5)	E08	Q2	I feel opposed due to the lack of info that is out there. I don't think the average person realizes what really happen with open pit mine.
6)	E08	Q2	There is very little effort on the companies to protect the environment.
7)	E10	Q1	Its an environmental disaster.
8)	E10	Q1	Its an environmental hazard.
9)	E10	Q1	Man made environmental disasters should stop.
10)	E10	Q2	It is environmental disaster.
11)	E10	Q2	Because it is environmental hazard.
12)	E10	Q2	Tar sands are an environmental disaster. This greed should stop. Canada should explore economy on other sustainable products and projects.
13)	E11	Q1	High environmental costs.
14)	E11	Q1	High environmental costs.
15)	E11	Q2	Environmental costs.
16)	E11	Q2	Environmental impacts.
17)	VA03	Q2	Yes, I am more opposed because I now see greater exploitation and destruction of surrounding water systems, forests, and ecosystems.
18)	VA04	Q1	Global warming, destruction of water and environment, peoples illness and animal.
19)	VA04	Q1	Global warming, environment, water, illness.
20)	VA04	Q2	Worse than I thought - insane!
21)	VA04	Q2	Threat to water, enviro, land, people, life.
22)	VA04	Q2	Even more concerned.
23)	VA05	Q1	Worried about my child's future. Termination of our species and planet earth. No future, no chances for survival.
24)	VA05	Q1	Same as previous/above.
25)	VA05	Q2	More concerned. It's growing the mines the pipelines covering everything.
26)	VA05	Q2	Kills earth.
27)	VA05	Q2	I'm even more concerned now!
28)	VA08	Q1	Destruction of ecosystems.
29)	VA09	Q2	The pits have already been constructed, so there's not much use in getting upset about that. It would be good if we hadn't needed to build these pits in the first place though.
30)	VA10	Q1	Environmentally destructive. Short term economic gain.
31)	VA10	Q2	Enablement of an already finite resource at astronomical environmental cost.
32)	VB01	Q2	Opposed because environment, huge area, trees die.
33)	VB01	Q2	Opposed because too many areas that will damage the environment.
34)	VB02	Q1	Any open pit work done cannot be good for the environment or local ecology.
35)	VB03	Q1	Inhumane parasitic military industrial ecocidal and social atrocities! (the rest is footnotes)
36)	VB03	Q1	See above.
37)	VB03	Q2	First it was whale oil lubricants-->almost to extinction. Opposed because it undermines planetary geo-bio supportive infrastructures.
38)	VB04	Q1	However I don't want permanent environmental damage affecting living beings.

Number	Participant	Source	Comment
39)	VB04	Q1	See 4) = same.
40)	VB06	Q1	I've signed my name to projects that oppose the growth of the tar sands.
41)	VB11	Q2	Huge destruction of environment/First Nations' rights for comparatively little gain.
42)	VB12	Q1	Opposed for the negative and environmental reasons and impacts (irreversible and detrimental to human and forest/land health.
43)	VB12	Q1	Opposed - too much environmental disturbance water forest health land and resulting emissions regardless of economic benefit.

Table 117 Cumulative Negative Impact Comments

Number	Participant	Source	Comment
1)	E02	Q1	Too much, too fast, too soon.
2)	E02	Q2	Same - too much too quickly and without baselines.
3)	E08	Q2	Although I'm somewhat supportive, I'm still a little concerned of the proposed plans and the magnitude.
4)	VA10	Q2	Worsening an already destructive situation.
5)	VA10	Q2	Opposition and anger has been joined by fear of the consequences of continuation, let alone augmentation.
6)	VA12	Q2	Situation of industry approved development for processing tar sands.
7)	VB02	Q1	As in the last section, the larger the site, the more damage done to the environment and local ecology.
8)	VB02	Q2	More concerned as I now know how large the impact is.
9)	VB09	Q2	Too many projects side-by-side or adjacent to each other - making it harder for land recovery in the future.
10)	VB10	Q2	It's too big.
11)	VB11	Q2	I feel more concerned because I have been able to a bit more (only less than if I used a plane/or ground visit) conceptualize their size.
12)	VB11	Q2	I have the same opinion, but it feels more important now that I can grasp (somewhat) the size in comparison to Vancouver, my neighbourhood, and the province of Alberta.
13)	VB12	Q1	Need to keep development gradual until less harmful/destructive ways to process the tar sands are discovered.
14)	VB12	Q2	More negative due to the scale of existing tar sands. Future looks disturbing and frightening.

Table 118 Water Negative Impact Comments

Number	Participant	Source	Comment
1)	E02	Q1	Too many downstream effects insufficient baseline data taken.
2)	E05	Q2	The planned area occupies large areas of forests, ponds, and natural landscapes causing water amount decreasing.
3)	E05	Q2	It striked [sic] me a bit that how large areas of trees and waters are ruined by developing open pit tar sands projects.
4)	E08	Q2	Concerned about the contamination and leakage into the rivers and ground.
5)	E12	Q2	What will be the effect on water and natural gas supplies as well as pollution.
6)	VA03	Q1	It could be detrimental to ecosystems and water systems in Alberta.
7)	VA03	Q2	I have concerns about taking all that water from the Athabasca River and depleting it
8)	VA03	Q2	I'm concerned about increased water depletion of the Athabasca River.
9)	VA05	Q2	Add comparison of what is river like (water level, fish, temperature) upstream vs. along the tar sands rivers and downstream.
10)	VA08	Q1	Too much use of clean water in process instead of more "sustainable" possible techniques. Too much pollution involved.
11)	VA08	Q2	Proximity of rivers --> risk. Now I realize the scale. Tailing ponds are very

Number	Participant	Source	Comment
			disturbing.
12)	VA08	Q2	The amount of water/energy used in extraction is ridiculous. What are we destroying ecologically for purely economic gain?

Table 119 Lack of Reclamation Comments and Questions

Number	Participant	Source	Comment
1)	VB Unknown	FG	Q This sure cuts down a lot of trees. PC Actually they plan to replant them
2)	VB Unknown	FG	Q How long do the open pits last? PC They talk about progressive reclamation. As soon as they're finished with a particular part of a pit they'll start replanting so they won't wait until they're finished with the entire pit, they'll start planting part of the pit.
3)	E06	Q1	The current sites need to be cleaned up first and I believe they want require a nuclear reactor.
4)	E06	Q2	No reclamation.
5)	E06	Q2	The reclamation must be addressed before they move on.
6)	E07	Q1	The destruction of the surface seems to be more than the industry can correct (back to a natural state).
7)	E07	Q1	Since the existing mines are so far from being restored - question why many more square miles are going to change the level of destruction.
8)	E07	Q2	Damage far larger - will it ever be repaired.
9)	VB03	Q2	Not supportive. Re-forestation/restoration pretexts it will never be the same again (geopathic blight!).
10)	VB03	Q2	I don't know of active replanting, refilling of tar sands open pits presently. I am assuming same will happen if more open pit tar sands = environmental disaster (lack of trees in large areas).

Table 120 Land Negative Impact Comments

Number	Participant	Source	Comment
1)	E02	Q1	A pox on the landscape which is not recoverable.
2)	E02	Q2	I had an idea of size before.
3)	E05	Q2	It striked (sic) me a bit that how large areas of trees and waters are ruined by developing open pit tar sands projects.
4)	E07	Q1	The destruction of the surface seems to be more than the industry can correct (back to a natural state).
5)	VB02	Q2	Destroying so much land when alternatives are available seems senseless.
6)	VB10	Q1	Stop the forestry that follows behind using the new in-roads.
7)	VB10	Q2	It will never be the same (wild).
8)	VB11	Q1	Destroys agricultural land and therefore decreases food security.
9)	VB12	Q2	Poorly developed culture/resource dependent economy destruction of First Nations land.

Table 121 Air and Climate Negative Impact Comments

Number	Participant	Source	Comment
1)	VB Unknown	FG	I think it's more to do with GHG's and what burns; very interesting…
2)	VA03	Q2	And also the increased greenhouse gas emissions is very troubling.
3)	VA12	Q2	The scale of emissions, excavation > perpetuating the whole increase of consumption. More people buying more vehicles.

Number	Participant	Source	Comment
4)	VA12	Q2	Too much oil production causing emissions.
5)	VB06	Q1	Its effects on the environment - air quality.
6)	VB06	Q2	Environmental concerns - poor air quality.

Table 122 Animals Negative Impact Comments

Number	Participant	Source	Comment
1)	E05	Q1	Open pit tar sands project will probably ruin the local environment. Plants and animals living there might suffer.
2)	VB04	Q2	Things seem okay in news except for a few birds landing in tailings ponds.
3)	VB06	Q1	It interferes with wildlife habitats.
4)	VB06	Q2	Less room for wildlife to live.
5)	VB10	Q1	The animals have been displaced.
6)	VB10	Q1	The animals may never return. Destroys the traditional way of life for natives.

Table 123 Too Close to River Comments

Number	Participant	Source	Comment
1)	E02	Q2	Tailings too close to river.
2)	E04	Q2	The shock value of how close the river and the sense of scale.
3)	E06	Q2	Tailings ponds near river.
4)	E06	Q2	Wasn't aware how big the projects are and how close to the rivers.
5)	VA08	Q2	Proximity of rivers --> risk. Now I realize the scale. Tailing ponds are very disturbing.

Table 124 Aesthetics Negative Impact Comments

Number	Participant	Source	Comment
1)	E04	Q2	Ugly and stupid way to get energy.
2)	VB06	Q2	They are very unattractive.

Table 125 Economy Negative Impact

Number	Participant	Source	Comment
1)	VA08	Q1	Corporate profits/royalties undertaxed.
2)	VB11	Q1	Seems to be little benefit (few jobs) or benefit is spread thinly (little revenue collected for social programs) for huge risk and encouraged poorly developed economy.

Table 126 Neutral Environmental Impact Comments

Number	Participant	Source	Comment
1)	E05	Q1	Careful consideration about the potential damage to the environment must be taken before a project begins. Usually such project will cause worse environment, such as pollution and unstable land
2)	E05	Q1	Consider environment first.
3)	VA01	Q2	I now have a general idea of how the tar sands are impacting the environment/society
4)	VA07	Q1	I have no knowledge about the tar sands at all.
5)	VA07	Q2	I understand what these tar sands are all about.
6)	VA09	Q1	I feel neutral because I don't yet know enough about this subject to form an opinion.
7)	VA09	Q1	I don't yet know enough about this to have an opinion.
8)	VA11	Q2	I really didn't find out anything more about the impact on environment. Just how 2 google it.
9)	VB09	Q2	Hard to say without more environmental facts/data.
10)	VB09	Q2	Still unsure about the true environmental impact as in-situ mining impact --

Number	Participant	Source	Comment
			what happens below the surface is uncertain.

Table 127 Positive Impact on Socio-Economic Environment Comments

Number	Participant	Source	Comment
1)	E08	Q1	I support it because it employs a lot of people.
2)	VA01	Q2	The projects would support the BC economy and provide jobs. I didn't realize the scale of these projects.
3)	VA07	Q1	More investment will flow through.
4)	VA07	Q2	Supportive because the open pit mines will be generating more revenues comparable to the largest cities in the world.
5)	VA07	Q2	Supportive - more jobs, more revenues better economy but environmental impact should be looked into.
6)	VB01	Q2	For because employment, resources.
7)	VB04	Q1	Doesn't seem to negatively affect me and seems to positively affect other Canadians economically.
8)	VB04	Q1	See 4) = same.
9)	VB12	Q1	Only supportive because of economy.

Table 128 Natural Gas Use Comments

Number	Participant	Source	Comment
1)	E02	Q2	When mentioning the natural gas used and needed for future, relate to some cities' consumption rates. E.g. if the tar sands use x cu ft/day - how many houses does that heat in winter? Ditto for projected/future consumption rates. I.e. relate to stuff we use.
2)	E03	Q2	Proximity to the population concerns me as the distance between the tailings ponds and the river is minimal in addition to the usage of natural gas required to extract the tar sands from the mines.
3)	E06	Q1	The inputs required to extract energy as well as the lack of planning to deal with the tailings "ponds" are worrisome, but what other sources of energy are better?
4)	E06	Q2	Obtaining natural gas from the arctic will be problematic.
5)	E12	Q2	What will be the effect on water and natural gas supplies as well as pollution.
6)	VA08	Q2	The amount of water/energy used in extraction is ridiculous. What are we destroying ecologically for purely economic gain?
7)	VA10	Q1	The amount of energy required to process the bitumen exceeds the energy recoverable/usable and the environmental damage is not justified to facilitate an already depleting resource.

Table 129 Need for Alternative Energy Comments

Number	Participant	Source	Comment
1)	E04	Q1	I believe in alternative energy.
2)	E04	Q1	I support alternative energy not gaping holes in the ground.
3)	E04	Q2	Why get energy this way? Be smarter. It's wasteful and dirty to the air, environment, and social structure.
4)	E04	Q2	Frightened by how out of control the province and the fuel addicts are. How do we break the cycle when 40% of the populace would become unemployed?
5)	VA09	Q2	I think we depend on oil too much. We shouldn't have to destroy so much nature for our needs. We should all try to live simpler so we don't rely on oil so much.
6)	VA12	Q1	Against continued use of fossil fuel prod./services etc.

Table 130 Need for Tar Sands Comments

Number	Participant	Source	Comment
1)	E06	Q1	The inputs required to extract energy as well as the lack of planning to deal with

Number	Participant	Source	Comment
			the tailings "ponds" are worrisome, but what other sources of energy are better?
2)	E09	Q1	Our natural resources are starting to deplete and in order to sustain our resources, projects like the tar sands are necessary .
3)	VB08	Q1	I believe it is one of the greatest deposits in the world. I think we should exploit this resource to the best of our abilities.
4)	VB08	Q1	I can't think of any other reason to go to Fort McMurray.
5)	VB08	Q2	I think Canada should utilize the resources that it has.

Table 131 Questions About Surrounding Communities

Number	Participant	Source	Comment
1)	VB Unknown	FG	Q Where's Fort McMurray in comparison to these? PC Fort McMurray is always at the bottom of these projects; at the bottom center of this area. We're not studying Fort McMurray itself. Q So this is all houses right here? PC Yeah. So these are all the new subdivisions
2)	VB Unknown	FG	PC Most of the land is Crown land. The people in the middle at Fort McKay seem to really like what's going on Q Further north where is Fort Chip? What's this body of water there? PC Some of them are working there; that's Lake Athabasca; and some are very concerned about what's going downstream.
3)	E Unknown	FG	Q Can you indicate on the map where Fort McMurray is? PC Right, I totally forgot. On the base map, the town of Fort McMurray is down here. You can zoom in on it if you want. There's the Athabasca River flowing north. And here are the existing open pit mines. The in-situ projects are off to the side, but we're not going to worry about those. Q Can you make Fort McMurray bigger on the map? PC Just zoom down if you want to look at it. There it is. Any other questions? You'll have lots of time to practice this in the other scenarios.
4)	E Unknown	FG	Q Can you show us where Fort Chipewyan is? PC Sure I'll show you where Fort Chip is. PC SHOWS FORT CHIP IN RELATION TO FORT MCMURRAY AND ATHABASCA RIVER Q So it's like a 100 km down from Fort McMurray? PC DIDN'T HEAR/ANSWER QUESTION

Number	Participant	Source	Comment
5)	E02	FG	E02 I was thinking about the native reserves and I'm wondering if you could have an overlay showing…I don't even know what groups there are besides the ones at Fort Chip and what their area of, I don't know what, operations of community compared to these regions on the map how much they overlap with the in-situ stuff down in Cold Lake or the other place.. PC Peace River? E02 Peace River yeah. Of all these things, one or two percent of the land doesn't mean anything because we're in the city but for the natives it's a big deal and that's the kind of thing I was thinking of. I don't know if it makes any difference to anybody else, I'm just saying that. Maybe a hunter cares. I don't know, but I'm sure the natives care. PC OK, do you know that there's a community right in the middle of the tar sands? E02 I didn't know that. PC It's not a reserve, it's like.. E02 Right in the middle of the tar sands? I knew only about the ones downriver at Fort Chip. PC Right in the middle there's a place called Fort McKay, which is right here. Can't see it very well on my simulation. There right there, do you see that. (PC SHOWS FORT MCKAY IN ORIGINAL GOOGLE EARTH IMAGERY). It's considered a settlement, they don't have a reserve there. Basically they support the development. There are many people who work in the area. The political leadership is behind it. Right now they have a lot of business ventures. Fort Chip, which is further away and downstream has a more mixed reaction. Some people work in it, some people are concerned about the downstream.

Table 132 Questions About Waterbodies

Number	Participant	Source	Comment/Question
1)	VB Unknown	FG	PC You can see the Athabasca River in the middle of everything. CHATTER; <u>KEY MOMENT #2</u>: LOTS OF DISCUSSION AND INTEREST
2)	VA Unknown	FG	Q What is the river? PC The river that's flowing through the middle is the Athabasca River that flows from Fort McMurray in between all these projects and eventually it flows north into Lake Athabasca, which then flows into the Slave River that flows into Great Slave Lake into the Mackenzie River and into the Arctic Ocean. Q They have to take water from that river? PC That's right they have to take water to create the steam and for the various industrial processes to convert the bitumen into synthetic crude oil.

Number	Participant	Source	Comment/Question
3)	VA Unknown	FG	Q I'm just wondering if they're using an open pit mine, how much water are they using versus the "in-situ"? PC Both are going on simultaneously, the ones that are still not built might have a 30 to 40 year lifespan.
4)	VA Unknown	FG	Q A comment about that tailings pond. I heard that some are vulnerable to leakages PC Yeah David Schindler who's a professor at the University of Alberta has done a series of scientific studies that state that there's some leakage but there's a debate between him and industry and government about whether or not those contaminants in the water are natural or caused by the actual disturbances. So there's some natural seepage from the natural deposits that are right next to the river but the question is whether the mining has increased that or not. You can look that up, those studies are public at this point. Any other comments about the images? Q All the tar sands mines are along the river? PC Yes, Q How far from the river. The position along the river? Where does it start or where does it stop? PC Here's Fort McMurray at the bottom of the map, here's your scale bar. About 75 km. There's also a feature here that I haven't shown you (MEASURING BAR) 72 km. And when you add all the proposed projects you can measure it…about 100km.

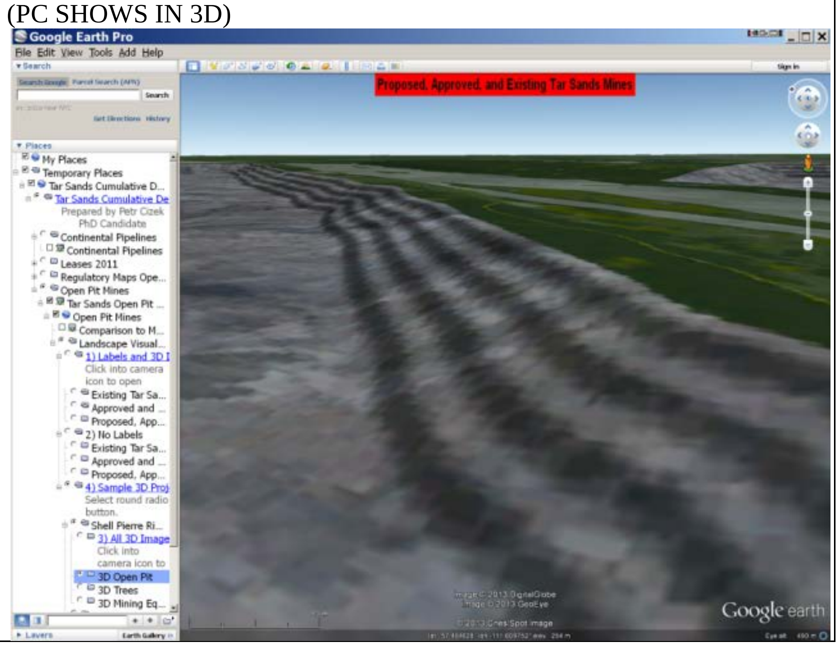
Number	Participant	Source	Comment/Question
5)	VA Unknown	FG	Q They draw the water from the river? PC Yes, they’re close to the river. We can probably zoom in and get an idea of how close to the river they are Q But they’re not mining under the river? PC No, they’re not mining under the river, they’re within 50 to 100 metres. Here they seem to be within about 250 metres of the river. We might be able to see how that looks in 3D, because I said they’re not mining under the river, but they’re mining lower than the river. (PC SHOWS IN 3D) 

Table 133 Questions About Open Pit Mines

Number	Participant	Source	Comment/Question
1)	VB Unknown	FG	Q The process of making the pit? PC Yeah, it won’t suddenly appear like that. It will take many many years.
2)	VA Unknown	FG	Q How deep is the deepest pit? PC They all seem to be about 75 metres; so that would be almost the size of a football field deep. If you’re lost with trees in the air, just double-click into the text to take you back to the original viewpoint.

Number	Participant	Source	Comment/Question
3)	VA Unknown	FG	Q Is there any sense of the productive lifespan of these mines? You know with an oil well you can say that it will run dry in x number of years or decades before its dry. But with bitumen and with its methods for all the trouble it takes them how long are they going to have something to dig up. When will it run out? PC Different people have different estimates. Depends how hard they go at it. Industry thinks that they can keep mining for 50 years. An independent geologist who's retired from Natural Resources Canada said that industry is overestimating quite a bit. It's not that the bitumen isn't there, it's what's economically recoverable. As you get lower and lower grades you have to spend more money excavating or using more natural gas. He thinks that industry is wildly overestimating this stuff.

Table 134 Questions About Tailings Ponds

Number	Participant	Source	Comment/Question
1)	E01 and E02	FG	E01 INDISTINCT COMMENTS ON TAILINGS PONDS. E02 You had mentioned that there were 170 square km of tailings ponds. I have a hard time visualizing where these are and I don't know where 170 square km is with respect to some lake that I know about. KEY MOMENT #9: INSDISTINCT MUTTERING FROM SEVERAL PEOPLE. COMMENT SPARKS SOME INTEREST. DIFFERENT PEOPLE PROVIDING THEIR OWN ESTIMATES OF SIZE. PC OK, this is the simulation that I've created. This thing here is actually the original tailings pond called tar island. It issued to be an island and this channel was closed off. This is actually under advanced reclamation by Suncor where they've started to plant a few trees here PC SHOWS GOOGLE EARTH EXAMPLE TO GROUP E01 What's the dark area above it? PC That's another waste pond. Let's have a look in the native Google Earth imagery, from back in 2010. This doesn't look like a tailings pond, it looks like it might be a water holding tank. You can see the darker water, the lighter water has sediment. E01 So the tailings ponds are the lighter ones? KW The tailings ponds are the white? PC The problem with the imagery in Google Earth is that the satellite images don't capture the colours realistically. You're actually looking at things with bandwidths that we don't see. They're using combinations of infrared and ultraviolet and then the technicians try to make it realistic. So what I tried to do is to make it more realistic by using textures from actual photographs kind of blending them in. The resolution isn't the same. This is a tailings pond where I simulated the texture based on the photograph that reflects it and there's my effort to get that as accurate as possible.
2)	E1 and E2	FG	PC In any case, before you looked at this set of maps did you know the tailings ponds were that close to the river?

Number	Participant	Source	Comment/Question
			E1 No Other Q I'd heard about it but I didn't know, this is a whole new level of understanding… PC How close do you think they are to the river? Can you guess at it based on that scale bar? E1 About 100 to 200 metres E2 Doesn't matter because all the tailings ponds leak anyway! (SARCASM) NO RESPONSE TO SARCASTIC COMMENT FROM PARTICIPANTS PC Tar island, the other way to look at it is tilted too so that you can get a sense of how high it is. Do you see the river and then do you see the height that's coming up? At this angle it doesn't look that big 1500 feet above.  PC Pretend that you were on the river in a boat it would give you a whole other sense of the height.

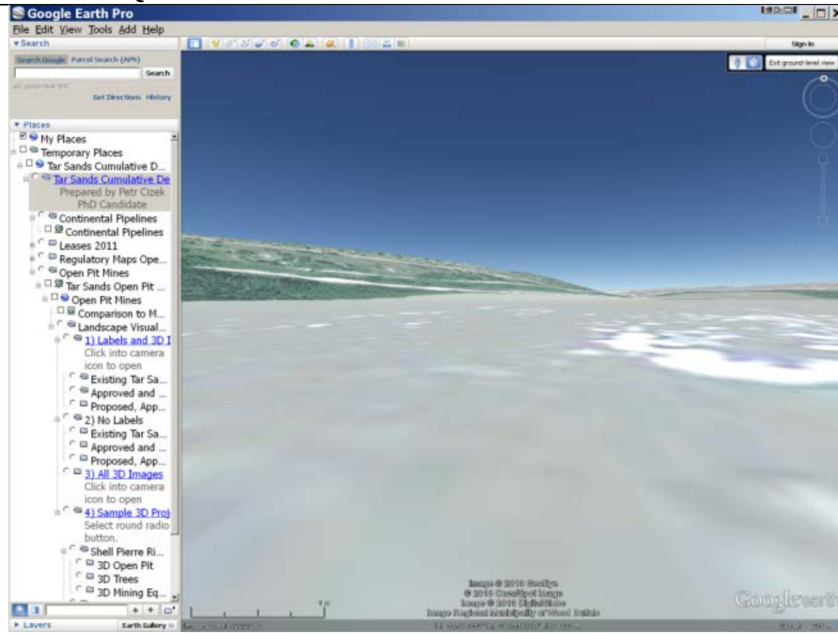
Number	Participant	Source	Comment/Question
			 PC SHOWS TAR ISLAND TAILINGS POND FROM RIVER LEVEL VIEWPOINT (WITHOUT ANY VERTICAL EXAGGERATION) NO AUDIBLE RESPONSE FROM FOCUS GROUP PARTICIPANTS TO THIS VIEWPOINT

Table 135 Negative Opinion of Pipelines Comments

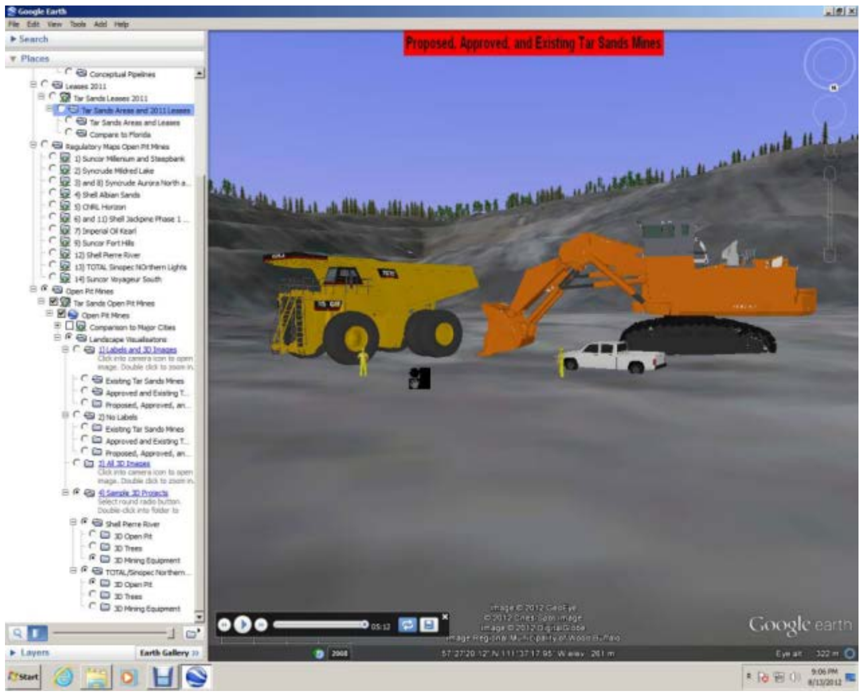
Number	Participant	Source	Comment
1)	VA05	Q2	More concerned. It's growing the mines the pipelines covering everything.
2)	VB10	Q2	The proposed pipelines are passing through the Rockies.

Table 136 Questions About Pipelines

Number	Participant	Source	Question
1)	VB Unknown	FG	Q Solid green line is the Kinder-Morgan pipeline? PC Yes Q So the green line is sending it down to Vancouver? Q You don’t show all the pipelines and refineries in Canada PC Yeah

Table 137 Critical Comments About Interactive 3D Visualisation

Number	Participant	Source	Comment
1)	VB Unknown	FG	VB Unknown It’s slowing down now. PC It may take its time loading all that stuff up. VB Unknown I see people going into that pit wall?? PC Well some of you are going into the side of the pit and going through it. What

Number	Participant	Source	Comment
			we had to do in Google Earth you can't excavate into Google Earth so we had to create a fake pit above the existing landscape and unlike most computer games that you might be used to when you hit a wall in a computer game it's called a collision and the wall in the computer game prevents you from going through the wall and Google Earth doesn't have anything to prevent you from going through wall so some of you may be going into the side of the pit and going through it But if you want to return to the original viewpoint all you need to do is click into the text "3D Mining Equipment" and it will take you back where you started into the original viewpoint.
2)	VB6 several VB unknown	FG	 VB06 What I found interesting was the texture like it looks like very soft earth there at the forefront and then in the background… it looks very barren in the front and then in the back you got all the trees so in a way it's kind of a sad picture because you don't see the trees anymore in the forefront…at least that's my take on it. PC So you're thinking about the comparison between the disturbed ground and the trees on the edge? VB06 Yeah that's right PC Do you think that the background texture that you see in this image looks realistic? VB6 No it doesn't, it looks almost like parts of it is paved. It doesn't look realistic to me at all. PC Have you seen real pictures of these open pits? VB06 No I haven't. PC Anybody else, has anyone see pictures of the open pits? Does that look realistic to you?

Number	Participant	Source	Comment
			VB Unknown (Someone else) Not at all. PC Why doesn't it look realistic? VB06 It's fuzzy and the colour's wrong and it's too clean. PC It's too clean so what I actually did with these textures it's fuzzy close up further away like that. What this texture is actually a sample of a photograph of an open mine that's been duplicated and rotated and overlaid so it doesn't look like the sample is a tile it's been done with a simulation software. You're right, I think the colour is realistic, it just looks too clean. The real open pit mines look very, very dirty I guess if you've seen them. VB Unknown And grittier. It's grittier. VB Unknown (Another Participant). This is just a conceptualization isn't it to show you the stark differences. It's not like a painting where you're going to get texture and feeling from it. It's basically saying this has been raped and this is natural. PC That's your interpretation… VB Unknown You're not trying to create an emotional feeling from the colours and texture. PC I'm trying to make it as realistic as possible. VB Unknown Why don't you use photographs then? PC Whatever photographs I could sample. So how does this image in Google Earth compare to images that you've seen in the popups or the high resolution images in the browser? Is it better or worse or about the same? Let's have a look at the same mine in the actual popup image not in Google Earth. Here is the same open pit that is done in the 3D simulation software. You can zoom in to see the trees, and it shows you the texture. Is it any different to you than seeing it in Google Earth? Or is it about the same? (Indistinct chattering) PC Are you saying when you get too close it's too fuzzy? The foreground, like water almost? OK, I think Google Earth is doing some kind of distortion in the foreground there. SS I think there was another question there about why didn't you just use photographs? PC Why didn't we just use photographs of the proposed? VB Unknown Thinking of looking to get realistic, the question is what the pits look like. PC The point is we're trying to show you pits that don't exist yet. VB Unknown But there are pits that do exist and they're going to look like pits that will exist. They're not going to be nice and clean like the pits that you display here, they're going to be like the dirty old pits that everyone's showing you. FEMALE GIGGLES IN BACKGROUND PC Sure there's all sorts of photographs of the ones that are there.

Number	Participant	Source	Comment
			VB Unknown This lady didn't like the look of the pits the way they are now. If you show the pits the way they really were, she'll like them even less. LOTS OF GIGGLES IN BACKGROUND PC Ok, but the point is we're trying to simulate something that isn't there. We're trying to show what this scene would look like in the future. We're showing it as accurately as possible. You can look at it and see it here. This is what it looks like now. The reason we didn't take a photograph of that is we couldn't spend that much time flying around. It would cost a huge amount of money flying around to get a picture of this from this angle at this location. It would have cost us thousands and thousands of dollars of flying time. So we took a few pictures and based on those textures we tried to make the simulations as accurate as possible.
3)	VB Unknown	FG	VB Unknown The location there, it doesn't have the air filled with dirt, like all you have is the pit. The experience of being there doesn't really come through. VB Unknown (Other) It looks too clean! PC Yes, if you're actually there, there's all sorts of steam and dust and the textures look dirtier than what I've done them, I've done them as close as I could VB Unknown Like the trees, like they might be covered in dirt, like the dust probably travels to the trees. PC Probably, not all those trees would actually necessarily be left at the edge of the pit because there would be all sorts of roads going back and forth. You can see on the existing how much disturbance there is on the edge of the pits.
4)	VA none PC comment only	FG	TREE SIMULATION NEXT 1:51:46 PC NOTES LACK OF COLLISION DETECTION WITH EDGE OF PIT IN 3D SIMULATION 1:52:42 FINAL LEVEL OF DETAIL GROUND LEVEL; TRUCK AND SHOVEL COMBINATION PC SAYS QUITE A BIT OF DATA STREAMING INTO YOUR COMPUTER SO IT MAY TAKE A MOMENT TO LOAD;
5)	VA unknown	FG	PC Are you having trouble getting it loading? These things don't have any graphic acceleration. MUTTERING If you're lost, click into one of the texts and it will take you to a standard viewpoint. KEY MOMENT #7; LOTS OF MUTTERING DUE TO DIFFICULTY OF LOADING 3D SIMULATION; "Double-click into the text to take you back" "Did you get anything here? The other solution is to ?? the internet, to get it out again?? LOTS OF MUTTERING; ONE MALE PERSON LAUGHS
6)	VA unknown	FG	PC Were you moving around while it was sending you data? If you had more powerful computers with video cards it would be a lot smoother than what you're getting here.

Number	Participant	Source	Comment
			It looks like you're here in the pit of Sinopec and you don't see the trees on the horizon because there's a buffer around this. 1:59 MUTTERING; Background (KW?) "Refresh this" PC You can see there's a buffer around this. SS Can you fly around in this? VA Unknown Yeah PC OK, we can see some of the limitations in showing the 3D landscape LOTS OF MUTTERING; SS COMMENTING A LOT
7)	VA unknown	FG	PC Did you see the mine from different viewpoints? VA Unknown I haven't touched it. PC Oh I see you're afraid to touch it? VA Unknown No, I'm not afraid I just haven't PC In principle, if you double-click into the text you should zoom in…some of the machines for whatever reason keep seizing up quite a bit…
8)	E01	FG	PC I'm going to have to cut this discussion off right here because I still want to show you one more way of looking at this in 3D within Google Earth what an open pit mine might look like. SHOWS 3D OF SHELL PIERRE RIVER WITH FULL 3D EFFECT SHOWING ENTIRE PIT WITH 3D TREES; FINAL VIEWPOINT AT GROUND LEVEL OF PIT; Is that working for everybody? Any screenshots you'd like to share or any comment you'd like to make? E01 When I look at this, A simple 3D program or video is sooooo much more accurate to give you an idea of what this would look like than this. PC A simple 3D…? E01 I think the graphics are still extremely flat and rudimentary…a video would give you a much better idea of what this looks like. PC OK, now you're talking about existing? E01 Yeah. You can put this kind of stuff on YouTube. It looks so fake that it… PC OK, but you can't interact with a TV program E01 That's true. PC That's what we're trying to figure out. There's a couple of things here. The graphics are limited because this is all streaming through the internet so you don't have to buy a computer game and load it up. Anybody in the world can look at this. And in comparison to let's say a film even that's simulating these

Number	Participant	Source	Comment
			things…by interacting with it zooming in and out does that overcome the limitations of the graphics. What do you think? What does anybody else think? E01 I believe the problem is the graphics…are so fake that I feel it detaches the emotions it doesn't feel real. It doesn't give you a visual sense of what it looks like. PC Alright, anybody else?
9)	E04	FG	E04 I agree in some ways but the infrastructure is missing. Like if I look at the existing tar sands I would want to know how many of those trucks and diggers existed in the existing plant, how many are going to be added once it goes to the next phase. How much more of the INDISTINCT infrastructure will be there? PC OK, that's quite a bit of detail. E04 Yeah! I don't know if you could just put a photo of the CAT and then say 40 of those are going to be on site at this location. This CNRL Horizon that's existing how many have on site on average. PC So you want more information? E04 The infrastructure that's going to be required, the roads that are going to go in there, the people that are going to go in there. The amount of roads, yeah.
10)	E05	FG	PC OK, any other comments about whether this 3D approach is at all helpful. E05 I think it would be better if you provided some real photos…. PC Of existing projects? You understand that of what you see there I can't provide you a photo. E05 I mean not everywhere, but sometimes to give you an idea…INDISTINCT
11)	E09 AND E04	FG	E09 Well, like a little video clip of an existing excavation site to give you a visual idea of what's there right now. I'm not saying every place, right. So if you have a little video of what's currently going on there to give you a visual perspective of it… PC Have you seen any other media material of what's out there now? E04 No, not a lot. Very narrowly focussed and generally only one company out six will actually tell you what's going on behind the gate. So I would say they are standard, they certainly would be guarding their privacy. PC Have you seen any video or pictures put out by environmental organizations? E04 No just the standard ones that…during the tail ponds that were uh..for Syncrude or Suncor they showed those on TV and a lot of film footage from that and that's about it. But that was recent..sure in the past just small little pieces.
12)	E03	Q2	Would help to have something of shared identifiable height to identify with depth perception.
13)	E04	Q2	Please add machinery and labour to show the immensity of each project.
14)	E04	Q2	Real time shots of highway, towns, river during all seasons

Number	Participant	Source	Comment
15)	E05	Q2	3d visualization of mining areas is not that real. The tools are not very easy to use when it comes to visualization.
16)	E05	Q2	3D visualization is a good try though not good enough.
17)	E06	Q2	3D visualization is not clear or effective
18)	E07	Q2	Most modern games look better.
19)	E09	Q2	Need more real visual effects or video clips to give better perspective and understanding of actual site.
20)	E10	Q2	Mining machinery looks very artificial.
21)	VA01	Q2	The 3D images of the trees and pits didn't look realistic at all, but gave good insight.
22)	VA04	Q2	The 3D graphics of mining pits were too slow.
23)	VA09	Q2	3D rendering was too slow to be usable.
24)	VA10	Q2	3D was frustrating-->too slow to load and too much seizing up!
25)	VA10	Q2	My computer froze too often to engage with the 3D portion.
26)	VB02	Q2	No atmosphere. Textures are flat. Doesn't allow you to experience the reality.
27)	VB02	Q2	Better/faster computers make it a lot smoother
28)	VB08	Q2	The focus group has been concerned with the graphic depiction of the images of the proposed sites rather than the effects of the mining.
29)	VB08	Q2	3D visualization did not seem apparent.
30)	VB09	Q2	Realism difficult to emulate as level of detail still dependent on computer technology.
31)	VB11	Q2	Difficulty with slow processing speed. Lack of detail on the tar sands make it difficult to zoom.
32)	VB12	Q2	People, mining machinery, trees: mine wouldn't load, could not view properly. Couldn't get all images to load. Need side by side comparison of existing/future views. Fairly accurate, yet some people may be cynical/doubtful of accuracy.
33)	VB12	Q2	3D visualisation would benefit from some explanatory boxes (?) to say what the terraced land/pits are. Understand process of pit mining. - Approval -Clear trees -Dig/mine - How does it 'grow' - Where do materials mined go?

Table 138 Complimentary Comments About Interactive 3D Visualisation

Number	Participant	Source	Comment
1)	VB unknown	FG	LOTS OF CHATTERING DURING 3D EXPLORATION VB Unknown What kind of forest is this? PC This is the boreal forest so it’s a very simple forest it’s not like here it’s basically three kinds of trees but there’s many different kinds of trees. I’ve shown it’s poplar which is kind of similar to alder here there’s white spruce and there’s black spruce that I’ve shown. I’ve only shown a selection of trees because it would seize up your computer if I did everything. You might be able to move closer to trees KEY MOMENT #3: “OOOOH” RESPONSE TO 3D TREES APPEARING ON SCREEN
2)	VB11 and VB unknown	FG	KEY MOMENT #4 VB11 Just a comment, just having seen pictures of the tar sands it always struck me how enormous the vehicles are. I feel like the scale and how huge the wheels are and that kind of thing. Whereas if you look into the pit, the vehicles look so tiny (VB11 GASPS!) and so insignificant…to keep in my head the photograph and like the… PC Which angle are you looking at it? Do you think at this point of view the vehicles look tiny and toy like? I just selected one point of view, of course you

Number	Participant	Source	Comment
			can navigate wherever you like. VB11 Hmmmm. Hmmm. PC And the people were put there for the sense of scale. Do they still look tiny and toy like? VB11 Yeah, because we've been spending so much time above, like, looking at it from such an unnatural scale that zooming in it's sort of hard for me to reconcile how big these machines look to me seriously you know what I mean? PC OK what if I zoom closer in? Does it still look toy-like to you? It might look too clean. Very easy to go interactive. (pause) How about this, does it still look toy-like? VB Unknown (Male interrupts) The scale is lost now. PC You don't have the person there now. VB Unknown (Male) That's right. VB11 What I'm trying to say is that I find it hard to like think of the entire map of the tar sands…like when I see these people I can imagine myself as one of them right, I can imagine ???INDISTINCT, but it's almost impossible standing in a tarpit and to think about the whole map. Does that make sense? PC Yes, I understand what you're getting at, this is the kind of feedback we're really looking for. What if you went from this position, maybe it's going too fast, let's go slow (PC DOES THE GREAT ZOOM BETWEEN REGIONAL AND LOCAL SCALE). Is that too fast? VB11 I think going from that scale? Maybe a bit slower. PC Theoretically, this is the benefit of Google Earth, is to be able to move between these scales at the click of a button. VB11 Yeah PC Maybe the zoom feature is going too fast maybe we need to go more slowly? You can change the speed at which Google Earth zooms. VB Unknown Indistinct comment from A2 PC We are just using the default settings. It's zooming out. VB Unknown It's zooming out? GIGGLES VB Unknown If you could see the orange truck as a reference.
3)	VB unknown	FG	VB Unknown Like my question before, how deep are the actual pits made me think about lots of things and looking at the little person and I know the size of the trucks used in BC mining made me see how huge it is that's what that image said to me made me think how big they are. That's pretty much it.

Number	Participant	Source	Comment
			LAUGHTER FROM OTHER FEMALE “The mines….”
4)	E03	Q2	3D visuals did provide some depth perspective which helps to visualize potential impacts to water sources. The combination of maps were also quite useful in comparing different perspectives.
5)	E09	Q2	Little information makes someone naive about the topic "What you don't know won't hurt you!" But with this information and visual effects make it easier to understand the magnitude of the project.
6)	E11	Q2	The Google Earth applications are quite helpful in understanding the scale of these very large projects.
7)	VA04	Q2	Very useful. I would think if memory on computer were adequate (acceleration).
8)	VB04	Q2	Great colouring. I find map 2D info well generalized into 3D. Like tilting function.
9)	VB04	Q2	I trust you! Human activity (homes machinery).
10)	VB06	Q2	The people and machinery. The pits looked very large.
11)	VB09	Q2	3D visualization excellent. Accuracy good.

Table 139 Questions About Interactive 3D Visualisation

Number	Participant	Source	Comment
1)	VB unknown	FG	VB Unknown If you’re in the space station I’ve heard that you can see the tar sands, they’re one of the major disturbances? PC Yes, if you’re in the international space station you can see them as a little blob, but you won’t see them like that. You’ll see them like that if you’re in a low flying aircraft at about maybe 10,000 feet. We’re trying to simulate these viewpoints as accurately as possible and then what we’re trying to do is simulate what this open pit mine would look like if it’s actually built using the most accurate information that we have.
2)	VA Unknown	FG	VA Unknown INDISTINCT PC Can you distinguish the open pits from the overburden mounds? That’s the material taken out of the pit that’s piled up.
3)	VA Unknown	FG	VA Unknown Can we go into these 3D images? (WANTS TO GO INTERACTIVE WITH STATIC 3D VISUALISATION IMAGES IN POPUP OR WINDOWS EXPLORER) PC Unfortunately, that doesn’t work yet but we have a sample at the end of the focus group where in Google Earth you’ll go into a 3D landscape. It’s kind of experimental because it requires a lot of digital resources so you might see it going a bit slow.
4)	VA Unknown	FG	VA Unknown You can navigate around? PC Of course you can navigate around. There’s the 3D open pit to get a sense of the size and scale. OK it’s taking it’s time loading here I see. The question is about these “islands” in this pit and why are these areas left behind. They would have done some exploratory drilling before excavating this area so they might notice some areas may not be worth excavating the pit because the pools of the bitumen aren’t there so they’re leaving it behind because it’s not worth it.

Number	Participant	Source	Comment
			I should also mention that these areas don't show any reclamation or rehabilitation they just show what's proposed. The restoration and rehabilitation might take place once certain areas are excavated and no longer needed but to become a forest again might take 40 or 50 more years, but to map that out is quite a bit beyond the scope of this project.
5)	VA Unknown	FG	VA Unknown Do your images allow the environmental scientists to measure the environmental impact of the open mine pits? Would they be able to determine the environmental impact using the scales you know? PC The accuracy of these images is fairly limited using the information. One of the things that they'd be able to see is the total footprint of the area that's proposed to be excavated in the future. The reason this is important is because no one else has shown all the projects that are there now with all the projects that are proposed. No one has shown all those projects in one map. This is the first time all of it has been combined into one map. They look at the projects individually so it might be useful for them.

Table 140 Critical Comments About Static 3D Visualisations

Number	Participant	Source	Comment
1)	E04	Q2	I did not like these they were a bit laughable. Seriously a realtime shot is the best and its (*sic*) what we are used to seeing as viewers.
2)	E04	Q2	Make it as close to documentary style as possible then load for the viewer to play with. Powerpoint --> Animation.
3)	E05	Q2	Reality. Add more real data rather than pursuing better resolution.
4)	E07	Q2	Already gone - sorry.
5)	E07	Q2	The level just has to be either clearer (more contrast, etc.) or photo realistic.
6)	E08	Q2	I don't remember.
7)	E08	Q2	Just to be more clear in the picture and text.
8)	E09	Q2	Overlay showing each phase in one map.
9)	VA01	Q2	I didn't quite understand the images. They didn't quite make sense to me. I wasn't really sure what I was looking at.
10)	VA01	Q2	I don't have an opinion regarding this.
11)	VA09	Q2	Because they weren't interactive, I didn't find them helpful. The regular map was just as good.
12)	VA09	Q2	Even higher resolution imagery. More photo-realistic.
13)	VA11	Q2	None - cause I can't recall them. Problems loading distracted me.
14)	VB02	Q2	More detail. More depth of field. More atmosphere. Feels like they are empty stages or scenes.
15)	VB04	Q2	Being able to print proposed and present maps.
16)	VB11	Q2	They were believable, but not very compelling. The macro scale is only interesting if the viewer is moving because then I can grasp scale.
17)	VB12	Q2	Few of mine would load...difficult to say what is informative. I liked how one could move around and navigate.
18)	VB12	Q2	A little more realistic (from what I saw on others' screens).

Table 141 Complimentary Comments About Static 3D Visualisations

Number	Participant	Source	Comment
1)	E02	Q2	Those showing contrast between current undeveloped areas vs changes/proposed/approved footprints.
2)	E05	Q2	"All in 3D images". It gives me a good idea of what the developing process is like.

Number	Participant	Source	Comment
3)	E05	Q2	"All in 3D images" It help me gain a better idea of what it'll be like throughout the development period. Compare images simultaneously is important.
4)	E06	Q2	The simulations looked just like the photos.
5)	E09	Q2	I could tell the magnitude of the existing to proposed.
6)	VA03	Q2	Simulations of proposed projects and views of river very interesting.
7)	VA08	Q2	The proposed mines really hit home on how gigantic things already are and how deep.
8)	VB01	Q2	Links.
9)	VB02	Q2	By the river. Water texture believable. Trees believable.
10)	VB08	Q2	Attempts to show the size of the pits were believable.
11)	VB11	Q2	I found the comparison between the actual and the proposed most compelling.

Table 142 Complimentary Comments About Maps

Number	Participant	Source	Comment
1)	VA Unknown	FG	PC …by checking the checkbox, out will popup an outline of Vancouver to compare these projects to that urban area. KEY MOMENT #5: WOMAN SQUEALS AT COMPARISON
2)	E09	FG	E09 I didn't realize how big it was in comparison to the cities and the location close to the river. I didn't know that before. It gave me a good visual awareness. PC How big did you think it was? E09 I knew it was big, I knew it was going to get bigger, but I didn't think it was going to get that big! PC Well, how big is big? A football field? E09 No, I knew it was bigger than Fort McMurray but I had no idea of the total land mass in comparison to Fort McMurray. PC OK, does the area of disturbance concern you? E09 Yeaaaah, it does but I mean it's still a small part of what's not being used right now to get natural resources out. PC Do you think that's the only area that's being are used to extract natural resources? E09 Well, in this area ???INDISTINCT. PC That's where the open pit mines are but there's natural resources being extracted elsewhere. E09. Oh yeah, I know I'm just talking about this particular area.
3)	E02	FG	PC Anybody else have any comments on this topic? Is this anything new to you? E02 The real strength of what you've done here is to make the comparisons. I mean putting the city image on any map or any figure or anything by itself so that you can compare it to. And you've done a nice job of making something we can understand that we can compare it to…
4)	E02	Q2	Those with comparisons to scale - e.g. using Edmonton boundaries.

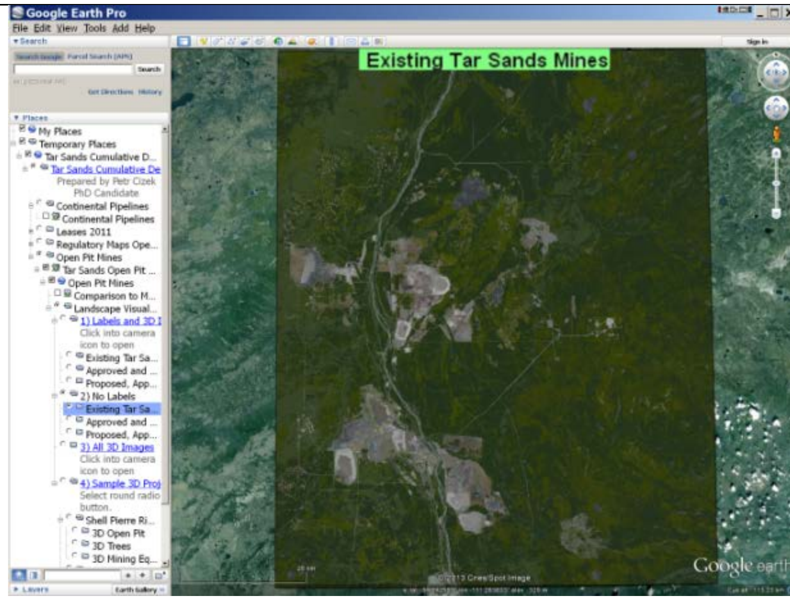
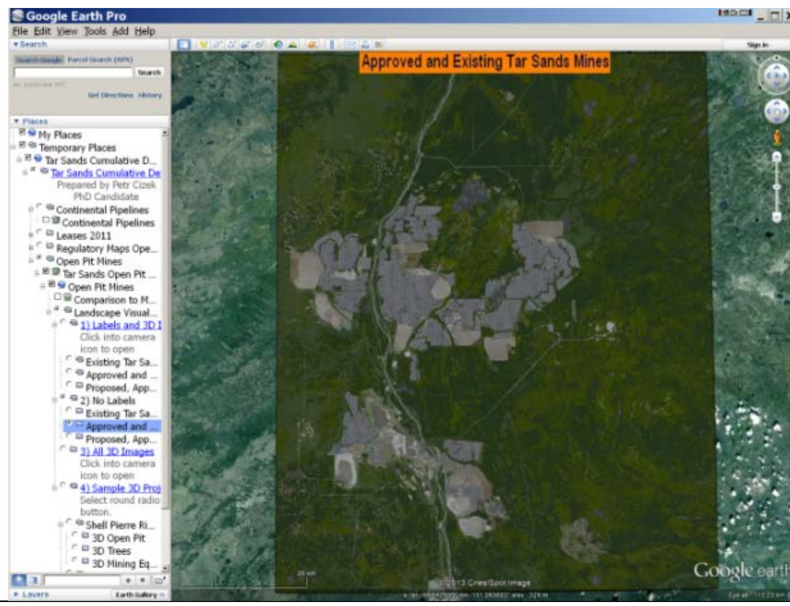
Number	Participant	Source	Comment
5)	E02	Q2	The most informative are the ones listing the different mines. --> helps me to see the land impact that surface mining actually entails.
6)	E05	Q2	The combination of maps is really helpful in realizing which're actually covered in the maps of development from the government.
7)	E06	Q2	Map summarizing all projects because the information has never been presented together. Maps using city boundaries superimposed because it shows the scale effectively.
8)	E06	Q2	Easy to use. Effective to see features written on map (ie. labelling mine sites on map of Alberta).
9)	E06	Q2	In order to have a productive discussion about development, the facts/maps presented are necessary. The maps shed light on a black box that industry and government don't explain.
10)	E07	Q2	Overlays of cities gives scale, but so would Sahara desert!
11)	E08	Q2	Most of the maps showed the existing, the approved to the proposed.
12)	E09	Q2	Overlay of proposed site to actual site proximity was interesting.
13)	E10	Q2	Maps of areas were OK.
14)	E11	Q2	The Google Earth applications are quite helpful in understanding the scale of these very large projects.
15)	E12	Q2	Comparisons especially existing, approved, and proposed.
16)	VA01	Q2	I found the maps that had a comparison to major cities were the most useful.
17)	VA03	Q2	The pipeline maps and comparisons with cities were very informative. City comparisons were very helpful in providing scale.
18)	VA04	Q2	Pipeline route - proposed v. mentioned
19)	VA05	Q2	Comparison maps of pipelines and mines existing, approved, planned.
20)	VA07	Q2	Superimposing the major cities over the existing and proposed open pit mines provided an idea of the overall impact of this project and usefulness of these maps.
21)	VA08	Q2	Vancouver city (and other cities)--> powerful-->conceptual pipelines trees.
22)	VA08	Q2	Better informed about scope of projects, size, closeness to rivers. I now believe that this is already out of control, a complete disaster area. The city comparisons were important and helpful.
23)	VA08	Q2	I liked having access to a variety of info and visuals to compare and explore. The company maps with the fade out was nice. City comparison -> brilliant!
24)	VA09	Q2	Having the maps overlaid on top of the Google Earth globe was very clear.
25)	VA09	Q2	I had no idea the projects were so large. Without the comparisons to urban cities, the pits seemed like little campgrounds out in the forest. Compared to Vancouver, though, I was shocked at the scale, especially of future projects.
26)	VA09	Q2	Google Earth is useful for comparing the size of open pit mines relative to cities. Because it is all visual, it is very easy to understand.
27)	VA10	Q2	City map overlays.
28)	VA10	Q2	Strong sense of realism. Very effective combination of maps.
29)	VA11	Q2	Regulatory maps showed info and were easy 2 use and load.
30)	VA12	Q2	Overlaying size of area compared to size of city. Overlaying size of area compared to size of province.
31)	VB01	Q2	Comparing with familiar cities.
32)	VB02	Q2	Maps with cities to show scale. Original maps of existing have more detail so interest more.
33)	VB04	Q2	I found the "borders" ie Alberta (Canada provinces etc.) very helpful in conceptualizing areas affected by open pit tar sands. I kind of already understood present pipelines in Canada but proposed USA and Canada refineries and pipelines and gas and oil development made me see with respect to my lifetime.
34)	VB04	Q2	I did not know what was happening re: open pit tar sands. I am disappointed

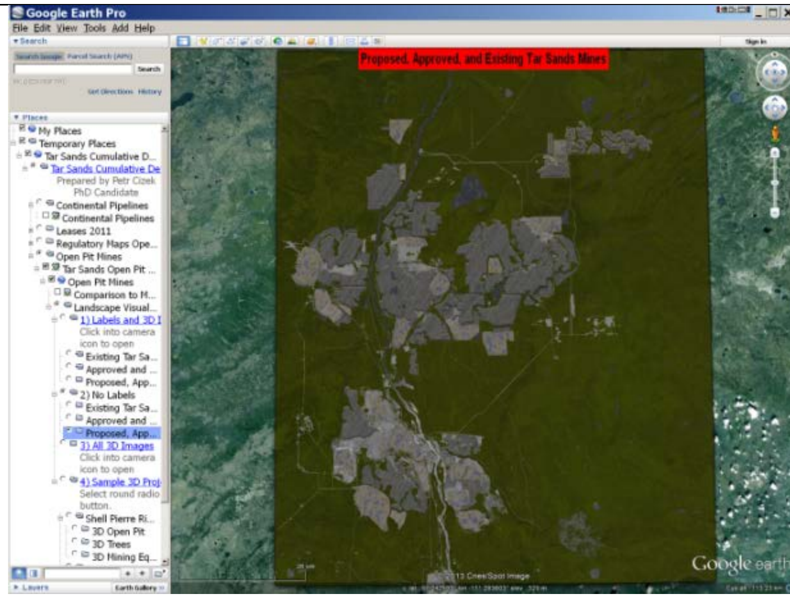
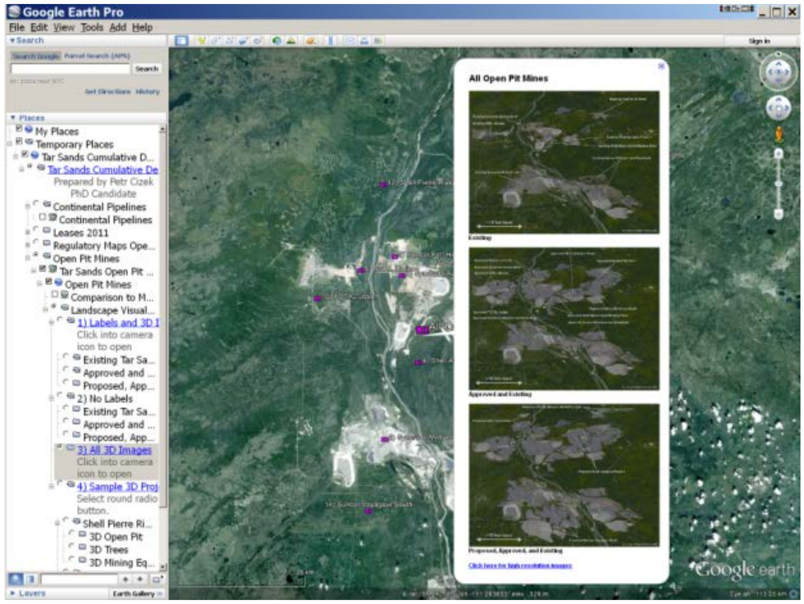
Number	Participant	Source	Comment
			that it is not common knowledge and I fear secrecy by our government because it is on crown land and they may not feel they have to be totally and easily accessible re: tar sands activities (development).
35)	VB08	Q2	Maps that start as a country on the globe and can take you down to a street or a building.
36)	VB08	Q2	Google Earth is amazing for the detail that you can get down to.
37)	VB09	Q2	City maps provided good comparison.
38)	VB11	Q2	The Vancouver map because I know the city, also the Alberta map because I could see how much the tar sands would change Canada geographically.
39)	VB11	Q2	It was very interesting to be able to compare the government maps to Google Earth.
40)	VB11	Q2	Very interesting to see everything together as the gov't maps create distance and no emotion or any awareness of the implications of the projects.
41)	VB12	Q2	More concerned; had not realised the full scale compared to 1) cities 2) province 3) rest of Canada.

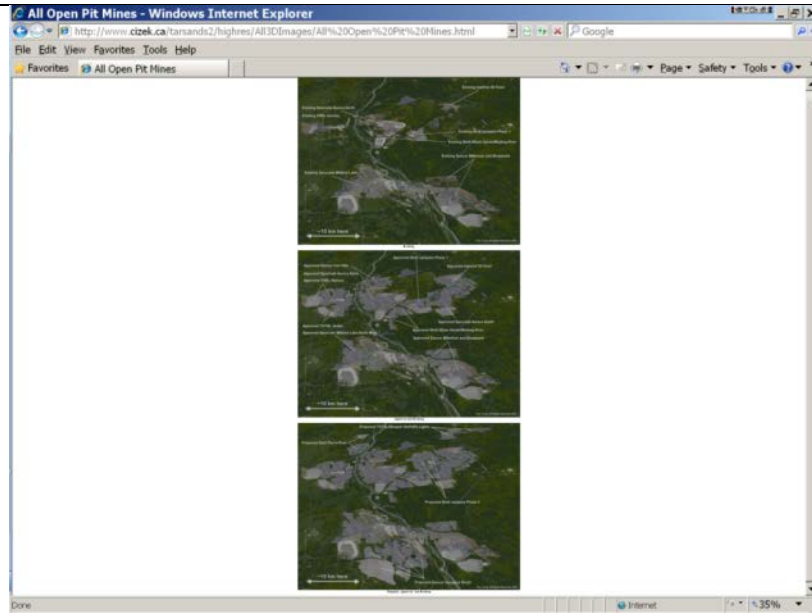
Table 143 Critical Comments About Maps

Number	Participant	Source	Comment
1)	E07, E11, and E Unknown	FG	KEY MOMENT #10: PARTICIPANT E07 IS SITTING WITH LOOK OF FRUSTRATION AND NOT USING COMPUTER PC Are you OK? E07 I just don’t see the point. PC You don’t see the point…OK? E07 We’re being shown this, we’re being told it’s 1%, we’re being shown the rivers here. What does this mean? PC I’m not telling you. E07 ANGER AND SARCASM IN VOICE I know. PC I’m being neutral. E07 INCREASED ANGER AND SARCASM Good for you.. PC Part of this session…. E07 ALMOST YELLING To heck with this session! PC The purpose of this to improve on these technologies to find better ways to present this material. E07 To whom? PC To the public. E07 Ok, I’m the public, PC OK, so you’re looking at the screen… E7 So I can show you three dimensions, and I can see overlays of the cities and

Number	Participant	Source	Comment
			that’s it. PC Have you ever seen a map showing all these combined projects? E07 No. PC So? E07 So. Exactly. PC So you don’t think it’s significant to show the combined projects when government and industry don’t provide that information? E07 VERY ANNOYED TONE IN VOICE. That’s what I would expect from the government whether I lean politically one way or the other. Like, I’ve been over the Syncrude site in a helicopter. You haven’t shown that the tailings pond behind the main processing area is tall enough that if the bank failed it would wipe out the entire processing area and block the river. You haven’t shown me that. You haven’t even discussed it as a possibility. PC I just showed it to you. E07 No, you showed me a perspective, but you didn’t draw any conclusions. What these people here have seen a wall rising but they don’t have any conclusions. E11 There’s no indication of the height of the tailings pond and how high it is above the river for example. PC OK. KEY MOMENT #11: LOTS OF EXCITEMENT AND SEVERAL PEOPLE TRYING TO SPEAK AT ONCE. PC OK, this is very good. E11 I think it would be very useful if you showed the proposed, approved, and existing and if it is possible to get the differences between them. So then you have the proposed and then you have the have a separate map showing how much that is more than the existing. Rather than showing the two of them so that we can at least subtract. PC You’d like to see a calculated area? E11 That would be nice too, but I don’t know if you’re able to do it to subtract one map from another. E Unknown It’s not very helpful because when you when you click on one and then the other proposed, it’s very hard to remember one from the other. KEY MOMENT #12: LOTS OF CHATTER INTERRUPTING EACH OTHER E Unknown And when you’re on the periphery you don’t have a feeling…. PC OK, is this helpful what I just showed you where you can look at it in a number of different ways, you turn off the labels…and here’s the existing, approved, and proposed. I know it’s a bit jerky when you use your mouse…

Number	Participant	Source	Comment
			 

Number	Participant	Source	Comment
			 E Unknown It's helpful, but I'd like to see all three of them at the same time. PC OK, how about this?....this one's kind of at an angle where you see the side by side?  E Unknown I find that better…yeah PC Part of the issue is how to fit these maps into the window of the screen…here we have the maps at higher resolution (IN WINDOWS EXPLORER). This is an aerial oblique very high above. You could just as well do a flat map. You can also zoom it out to fit it into the screen. Would it be more helpful to be able to shift your eye from one map to another like that?

Number	Participant	Source	Comment
			 E Unknown You could just scroll from one map to the next if you wanted. KEY MOMENT #13 E07 (AGAIN VERY EMOTIONAL) Who cares!!? If you show me a lot of Sahara desert if you show me a little Sahara desert, you show me a larger Sahara desert, you show me a great big Sahara desert. That's great from a map point of view but it's not telling me anything. We're going to permit the Sahara desert to be small or to be large or we're going to permit the oil sands to be small or to be large. PC I'm not permitting anything. E07 I'm just saying that's all that I'm being shown. Smaller or bigger. PC OK, but you've never been shown that before. E07 No, I knew it was coming. You don't have to show me to know that they're leasing more oil sands that more people are building these kind of sites. I don't need to necessarily see it to understand it. PC You want to do anything about it? E07 VERY EMOTIONAL I would like to see the reclamation and why they're not cleaning it up as they're going. Why they're tearing up the entire face of the moon and then placing the sticks back when they've got all the money out it. Which strikes me as insane. That's like saying we'll keep creating Sahara desert until we just take all Africa out. But you can disregard all that…like all we're seeing are these maps. Like maps by themselves like whether something is close to a river or not, that river's probably dead anyway it looks like they probably poured the stuff into the tailings ponds and oozed into the river…whereas I see a map…I want more context. This by itself is a waste of time!
2)	E03	Q2	Clarity is an issue given source images from satellites.
3)	E03	Q2	It would be nice if there was a time scale in which I could identify the length of time in which the proposed projects might begin construction.
4)	E04	Q2	I liked the existing, planned, and future but wished they were in flip motion

Number	Participant	Source	Comment
			layering on top of each other as I had to click back and forth several times.
5)	E04	Q2	Traffic, highway size, infrastructure, reserves, native preserves. The difference between winter and spring summer and fall. Also the effects of seasons on growth, infrastructure, tailings ponds. I've only seen summer shots what are they like in winter.
6)	E05	Q2	Add some real photos to some samples of sites will be better.
7)	E06	Q2	Maps with existing, approved, and proposed could be combined on 1 map with each area in a different colour.
8)	E07	Q2	More snap, more colour, more animations.
9)	E07	Q2	Since we can't factor in any action "view my maps" is simply non-purposeful to be of any use.
10)	E08	Q2	To be more clear.
11)	E10	Q2	No comments. I am not a computer technology expert.
12)	E12	Q2	The physical maps are only a small part of the larger issue of the relationships to global warming and degradation of environment and use of scarce resources as well as possible/likely pollution through tanker and pipeline spills.
13)	VA04	Q2	Perhaps some cross-reference academic kind of like wikipedia; compare Venezuela heavy oil fields etc. environmental health controversies.
14)	VA05	Q2	Add information on wildlife, upstream, along, downstream.
15)	VA07	Q2	Sharper resolution.
16)	VA07	Q2	Need put more labels.
17)	VA08	Q2	The regulatory maps are horrible. More details on the appearance of the tailings ponds.
18)	VA08	Q2	More potential to combine different "places" on top of each other. Very handy, tho I..
19)	VA09	Q2	More realistic imagery would help.
20)	VA09	Q2	Clearer/sharper imagery would make the maps more realistic.
21)	VA11	Q2	Load quicker. More exciting - have animals that are native 2 the area running around. Maybe they can give interesting facts.
22)	VB02	Q2	Video overlays of 3D areas would be good. For existing sites to see a video of the area will be helpful. Maps of proposed areas lack detail. Just looks like grey blobs. Boring!
23)	VB02	Q2	The more detail the better in terms of maps.
24)	VB03	Q2	Clarity/resolution. Historical transitions from forest to pit. I love maps of all kinds. I would also enjoy an "informational aesthetic" beyond the utilitarian; not to underestimate the thought and effort in assembling the data in any form.
25)	VB03	Q2	Would have like more "labels" as to what I was seeing/selecting.
26)	VB03	Q2	Could always be sharper.
27)	VB03	Q2	Combine with Google Maps (for existing open pit tar sands). Also combine with other developments such as diamonds, gold, etc.
28)	VB04	Q2	Labels on what is presented on the site.
29)	VB05	Q2	Better relative comparison to things i.e. Vancouver Island.
30)	VB09	Q2	Regulatory maps of companies sometimes unclear.
31)	VB11	Q2	To be able to see the tar sands individually outlined (as opposed to in satellite image on block-filled in) as navigating may have been easier.
32)	VB12	Q2	Overlays in Google Earth tool. Overlay of all developments (approved and proposed) to fully understand the full scope of all projects.
33)	VB12	Q2	Need scale of nearby cities (in side-by-side view and of the same scale).

Table 144 Questions About Maps

Number	Participant	Source	Question
1)	VB Unknown	FG	VB Unknown So the whole world hasn't been mapped from satellite? PC The whole thing is mapped by satellite, but we're trying show you something even more accurate than the satellite. The satellite doesn't show you the accurate colours nor is the satellite able to show you trees actually 3D trees.
2)	VA Unknown	FG	VA Unknown When are those maps made? PC The map is issued at the end of the hearings or the various processes that companies have to go through. The outlines that you see in the map are the areas where the companies have been given permission to excavate.
3)	VA Unknown	FG	VA Unknown Are the maps to scale to the satellite map? PC The maps as you can see have a grid. I used that grid to put them in the accurate position. There's an additional feature that you can use to check the accuracy of the map about how well they're placed. If you click down here in your places bar you can see this slider bar that says "Adjust opacity" that allows you to make the map transparent. LOTS OF CHATTER FOR TRANSPARENCY FEATURE
4)	VA Unknown	FG	PC Oh look at that, you're using the slider on that as well. I hope that you share that with the group. I just found something very interesting. She's using the slider on this. I just thought that you could use it on the regulatory maps but you can also show how proposed compares to the existing underneath on the raw Google Earth imagery. Click into here the slider make sure the "Proposed" is selected and then it will fade this out just like it fades the "Regulatory" maps. Put the slider back in the overlay otherwise you won't see what you were looking at before.
5)	VA Unknown	FG	VA Unknown It was a question about the line around the city how many people are in each?? census? PC Yes, which city did you use?

Table 145 Questions About Navigation

Number	Participant	Source	Comment/Question
1)	VB Unknown	FG	VB Unknown How do I return to the original position? PC Yeah, the letter "r" Forgot to mention, to return to the "tar sands" click into the text.
2)	VB Unknown	FG	VB Unknown Where's Florida? PC We're not there yet
3)	VB Unknown	FG	VB Unknown Will we see what they look like? PC Absolutely, we have georeferenced them on Google Earth.

Number	Participant	Source	Comment/Question
4)	VB Unknown	FG	VB Unknown Do you have Nexen on here? PC Nexen is an in-situ project.
5)	VB Unknown	FG	VB Unknown Do you have all these [regulatory maps] in one shot? A No we don't because it would be a mess.
6)	VB Unknown	FG	SS There's a few that don't popup PC So you need to get in the text.
7)	VB Unknown	FG	VB Unknown How do I get back to the existing tar sands? PC Are you lost? Close the web-browser.
8)	VB Unknown	FG	VB Unknown How do I get back to that shot? PC Turn off the comparison.
9)	VB Unknown	FG	PC turns on overlay of outlines of cities on existing tar sands open pit mines. KEY MOMENT #1 – LOTS OF GROUP DISCUSSION ON NAVIGATION PC NEED TO REFRESH IMAGES Anytime you want to turn something off turn off the check-mark box.
10)	VB Unknown	FG	PC Already in proposed?
11)	VB Unknown	FG	VB Unknown I lost my screen. PC We can bring you back.
12)	VA Unknown	FG	PC So you're in Africa there... VA Unknown I know how to get back. PC You know how to get back. You were just looking at Africa?
13)	E Unknown	FG	E Unknown It all seems very fuzzy all of a sudden. PC That's because you're on another layer. Turn on this radio button.
14)	E Unknown	FG	PARTICIPANT IS LOOKING AT SOMETHING ELSE IN GOOGLE EARTH PC Are you there on purpose? E Unknown Yes. (Giggle) PC In case you're lost, you know how to get back? E Unknown Yes.

Number	Participant	Source	Comment/Question
15)	E09	FG	1:43:15 ONE PARTICIPANT IS IN STREETVIEW LOOKING AT HER HOUSE IN SUBURBAN EDMONTON PC When you go to Edmonton, do you feel like going home? Are you looking where your house is? LAUGHTER

Table 146 Complimentary Comments About Navigation

Number	Participant	Source	Comment
1)	E Unknown	FG	PC He’s zooming in so far that he can see individual trees. In all depends what you’re looking at. Some places do not have such detailed stuff. These computers are running fairly fast.
2)	E07	Q2	Controls seem very simple and easy to use.
3)	E09	Q2	Zooming and overlays was cool.
4)	E11	Q2	The Google Earth applications are quite helpful in understanding the scale of these very large projects.
5)	VA01	Q2	It was fairly user friendly. I doesn't take too much to navigate.
6)	VA07	Q2	Usefulness and practicality to end users.
7)	VB02	Q2	Gives good sense of scale. Allows you to walk however you like. Lets you explore.
8)	VB03	Q2	Great tool - needed more practice.
9)	VB04	Q2	Fairly easy - standard windows type menus + map features found on google.
10)	VB12	Q2	Great to be able to move around.

Table 147 Critical Comments About Navigation

Number	Participant	Source	Comment
1)	E02	Q2	Interesting, but takes some getting used to.
2)	VB03	Q2	Would have like more time to learn "the nav system".
3)	VB03	Q2	Could use a "navigation ikon" showing tool status.
4)	VB04	Q2	I don't think it can be understood by general population (many may not use computers). It is probably necessary to be taught how to use program (difficult to be self-taught for most people, I believe).

Table 148 Neutral Comments About Research Process

Number	Participant	Source	Comment
1)	E02	Q2	No.
2)	E03	Q2	No.
3)	E04	Q2	No.
4)	E04	Q2	No.
5)	E05	Q2	No.
6)	E08	Q2	No.
7)	E09	Q2	No.
8)	E10	Q2	Not really.
9)	VA01	Q2	No, not really.
10)	VA03	Q2	None.
11)	VA04	Q2	No.
12)	VA05	Q2	No.
13)	VB01	Q2	No.
14)	VB02	Q1	I recently emigrated to Vancouver from England, so have very little knowledge of the tar sands, other than they are a place that exists!
15)	VB02	Q2	No.

Number	Participant	Source	Comment
16)	VB03	Q1	No time at the moment but I will consider a submission at a later date.
17)	VB03	Q2	N.B. Screen shots were chosen for "graphical interest" rather than “informational content" or interest.
18)	VB04	Q1	I am hopeful that this session will improve my factual knowledge of the affects (*sic*) of the tar sands.
19)	VB05	Q2	No, not really.
20)	VB09	Q2	No.
21)	VB12	Q1	I simply want to learn more; to make a more informed decision on whether to support the tar sands or not. My general inclination is that these initiatives are poor for Canada.
22)	VB12	Q2	No

Table 149 Complimentary Comments About Research Process

Number	Participant	Source	Comment
1)	VB Unknown	FG	LOTS OF CHATTERING SHARING LAUGHTER EVERYBODY LOOKING AT ALL SCENARIOS INDISTINCT CHATTER “I think this is very interesting”
2)	E09	Q2	Thank you.
3)	VA03	Q2	Thank you for illustrating the size and scope of the tar sands projects. There are also a lot of ideological positions implicit in the term "oil sands" and "tar sands", and this is very informative because the public is not aware of these subtle changes in the terms.
4)	VA04	Q1	Will engage people in conversation if asked.
5)	VA04	Q2	Needs comparative analysis with the other controversial open pit mining for example how about Russia, Venezuela, China, natural gas fracking. Good luck.
6)	VA05	Q2	This was great, thank you. Comparison, cumulative impact, larger picture, knowing what's now and projecting a picture of what's potentially coming.
7)	VA08	Q1	Very curious to see final results of our group.
8)	VA08	Q2	Glad to participate. Thank you!
9)	VA10	Q2	Interesting implications. Good luck!
10)	VB01	Q2	Previous to this focus group, I lack knowledge about open pit tar sands projects.
11)	VB02	Q2	I've gone from knowing nothing to knowing the full scale of the tar sands impact.
12)	VB04	Q2	I jumped ahead of things. I also fell behind slightly but found it easy to see display screen at front of room to find my place plus help from assistants was quick.
13)	VB06	Q2	I was able to understand the research process.
14)	VB09	Q2	Well done.
15)	VB11	Q1	Government needs to be transparent about the expected outcomes, positive and negative, of the tar sands.

Table 150 Critical Comments About Research Process

Number	Participant	Source	Comment
1)	E05	Q2	Explain the objects clearly and briefly before research session.
2)	E07	Q2	Biggest thing I learned: suppression of information is totally effective in a democracy with a "free" press, academic research and political lack of action contributing. (sorry for spelling)
3)	VA07	Q2	Yes.
4)	VA10	Q2	I'm not entirely clear what outcomes are being explored here. Are we researching future methods of informing the public and if so, would government and corporations use these methods to sway and control public opinion?
5)	VA11	Q2	It wasn't what I was expecting to gain info about. I found it quite boring in the end. Start was informative though.

Number	Participant	Source	Comment
6)	VB02	Q2	Hard to know the relevancy of things. We know what we're looking at, but don't really understand what it is or why we should care!
7)	VB04	Q2	Needed a bit more time. Second questionnaire too long for time allotted.
8)	VB05	Q2	Not enough information to decide.
9)	VB08	Q2	Can't see where this is going.
10)	VB08	Q2	I feel the same way as I did when I came in.
11)	VB08	Q2	Difficulty understanding the thrust of the inquiry.
12)	VB08	Q2	I know too little about the ramifications of the oil sands to make a meaningful comment.
13)	VB11	Q2	No - perhaps more explanation of existing technology and the improvements would have caused less confusion.

Table 151 Questions About Research Process

Number	Participant	Source	Question
1)	VB Unknown	FG	VB Unknown You don't really have an agenda as to whether you approve or disapprove of the tar sands operations itself; it's just to do with the google mapping technique isn't it? PC What do you mean the agenda? VB Unknown You don't have an agenda to try and find whether there's lots of people against the tar sands. It's not really approval or disapproval of the tar sands? PC We'll ask you in the initial questionnaire what your point of view is and you may raise your point of view in this discussion as you wish. VB Unknown Who's funding this? PC This is funded by SSHRC a federal academic funding organization. VB Unknown So they told you to study Google Earth? PC To these research funders, you apply with your idea of what you want to study, so does that make sense? VB Unknown Yes VB Unknown So this is independently funded. It's not funded by environmental groups and it's not funded by oil companies.
2)	VB Unknown and VB10	FG	VB Unknown How do we get see the screenshots? VB10 I'll just look at the last one I took. PC You want to look at them on your own screen. It's easier for me to show you here. VB Unknown So will we all learn how to review our screenshots when you do it up on the screen? PC I'll give them to you on your jump drive. VB Unknown For the purpose of discussion, if we could all review our screenshots so that we

Number	Participant	Source	Question
			can propose which ones to talk about. PC Unfortunately we didn’t… VB Unknown Ok next time.
3)	VA Unknown	FG	VA Unknown The terms used by industry and government, why are they using the term oil sands and not tar sands? PC You’re wondering why they’ve chosen to do that? I’ve looked into the historical documents about that and have had trouble finding where that came from. But for example as you may have heard if anybody uses the term “tar sands” in parliament, the government of the day will chant “oil sands, oil sands, oil sands”. So that’s been reported in the news and it seems to be a controversial thing yet they were calling it “tar sands” sometime in the past not too long ago. Any other questions?
4)	VA Unknown	FG	SS Could you repeat how we do a screenshot and why? PC The F10 button allows you to collect images that you thought were interesting but also for you to share with the group on the screen later on where you can go up and tell the group why you thought something was interesting you can ask questions about it and you can have a discussion about it as well.
5)	VA Unknown	FG	VA Unknown We don’t have any indication about when we took screenshots? PC Yeah, it doesn’t tell you that you took it but hopefully you remember.
6)	VA Unknown	FG	VA Unknown Any interesting shots you mentioned? PC Don’t forget to press F10, for anything that you find particularly interesting. VERY QUIET WHILE PARTICIPANTS GOING THROUGH CONTINENTAL SCALE AND PROVINCIAL SCALE
7)	VA Unknown	FG	VA Unknown The screenshots are a couple of megabytes? PC No they’re just very small. They’re a few hundred kilobytes.
8)	E Unknown	FG	KW You’re not going to get any flashing or anything, you just have to trust that the computer is taking the screenshot when you press F10. I’m just explaining that they won’t get any feedback. PC They won’t see anything. I just want you to take a few minutes practicing. I’m already seeing some screenshots being taken here.
9)	E10	FG	E10 How much has the government committed for the cost of this project? PC How much is the cost of this project? E10 Yes. PC We had a grant from the research council was $70,000. E10

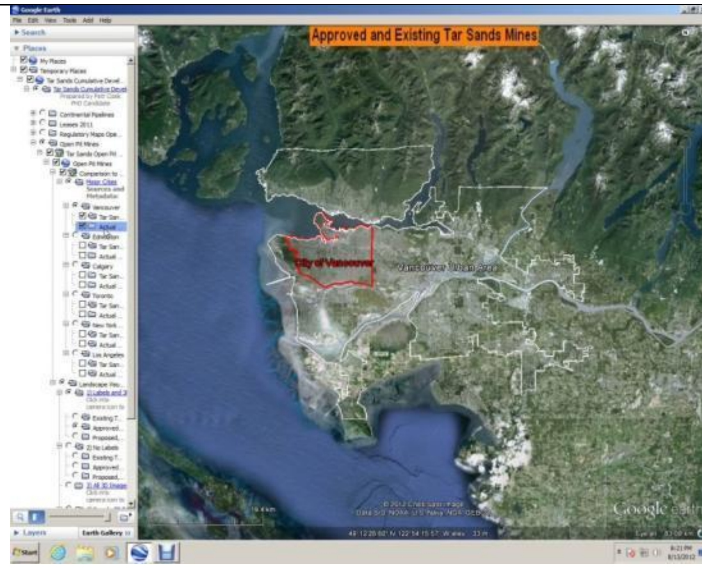
Number	Participant	Source	Question
			That's it? PC I spent the last four years preparing these data and I had to work with the data that I told you about because the province of Alberta does not release these data to the public and certainly industry doesn't either. Part of that grant was a small stipend during my studies and the rest went to your honoraria and cookies! LAUGHTER

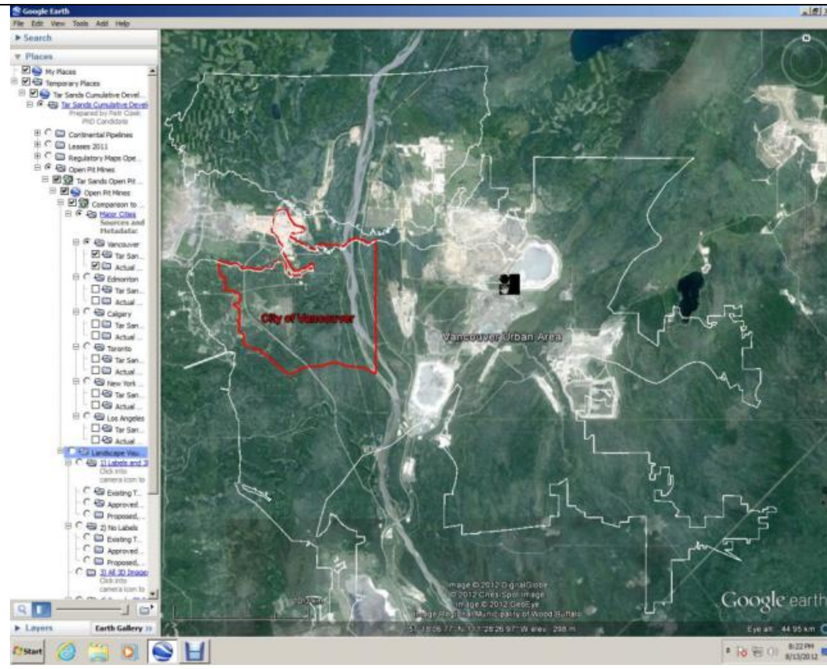
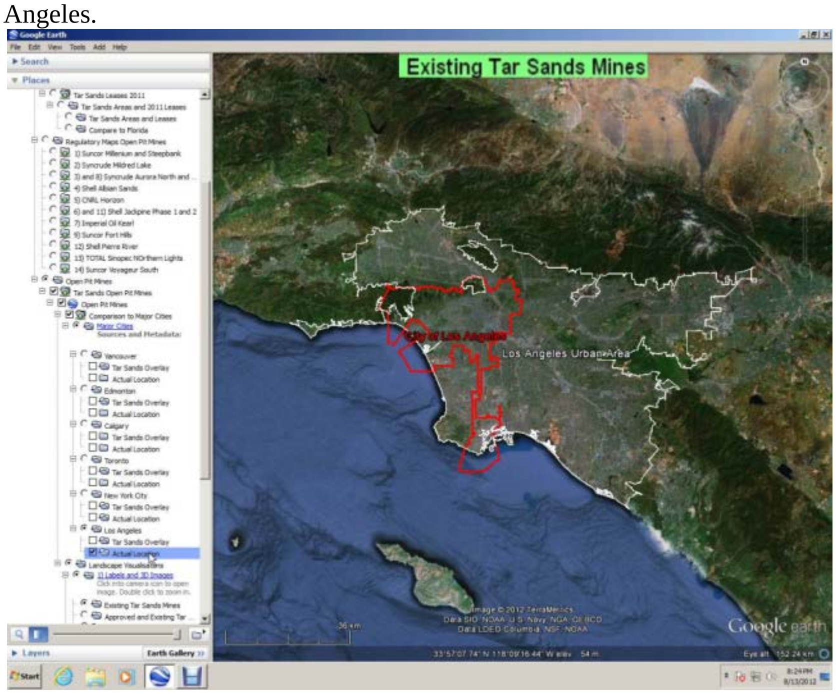
Table 152 Computer Malfunctions

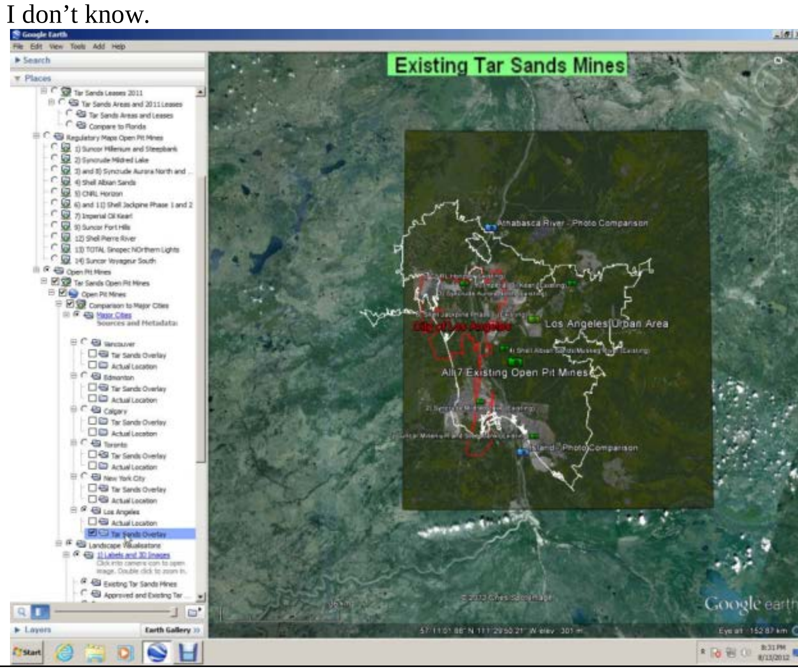
Number	Participant	Source	Comment
1)	VB Unknown	FG	KW IS SPENDING LOTS OF TIME WITH SOMEONE WHO IS COMPLETELY FROZEN; PC REFRESHES THE GOOGLE EARTH PROJECT PC There you go you're all refreshed! Do you need refreshing? There you go! VERY QUIET Anybody else hung up? (No answer)
2)	VA Unknown	FG	1:46:31 PC Holy Moly Crash! It'll come back. Give me a shout when it re-boots. The 3D crashed the computer.
3)	VA Unknown	FG	1:49:04 PC OK, you're back! (FROM PREVIOUS RE-BOOT OF COMPUTER).
4)	E11	FG	PARTICIPANT INDICATES PROBLEM WITH MONITOR The monitor is dying? Take the paper off the back. Contrast? Figure out how to get into this windows…ok you're back. PROBLEM WITH MONITOR ON COMPUTER; CONTRAST? PC SOLVED PROBLEM QUICKLY
5)	E Unknown	FG	PC Can you tell me what this does on your computer? Does it open it in Windows explorer for you? E Unknown No, it's opening it in Google Earth. PC That's just my setting. It shouldn't go directly to Explorer. Bear with me for a second while you go through those images. E Unknown Should we go through all of them? KW Petr, the question was should they go through all of them? All the camera shots? PC Of those camera icons? You can start going through the other camera icons if you wish. They show my efforts to simulate the existing open pit mines from a variety of elevations and heights. You could do that with photographs but you would blow the budget flying around to all those different viewpoints. (LAUGHTER) So you can go through the camera icons. I'm just trying to figure out why this browser is doing something different than yours. PC It's always a surprise when you do these projects!

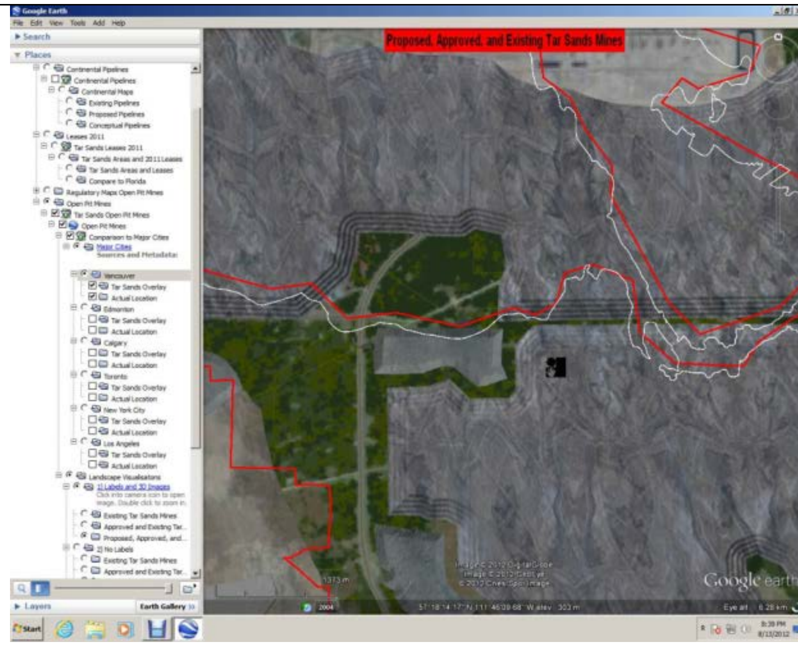
Number	Participant	Source	Comment
			PC NEEDS TO RESET DEFAULT GOOGLE EARTH OPTIONS ON HIS LAB COMPUTER OPTIONS→GENERAL→SHOW WEB RESULTS IN EXTERNAL BROWSER (UNCHECK) FIXING THIS PROBLEM TOOK 30 SECONDS OF DELAY

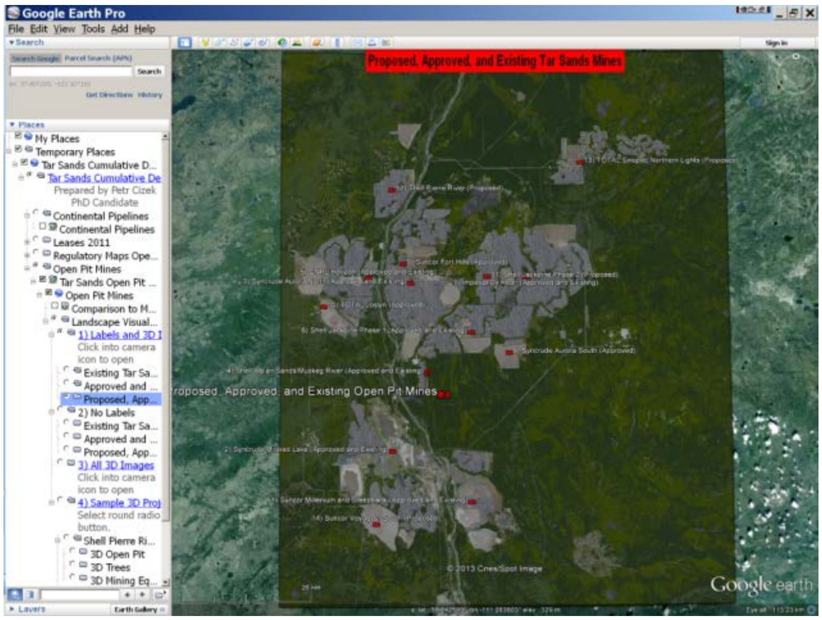
Table 153 Comparison to Cities

Number	Participant	Source	Comment
1)	VB2	FG	 PC Tell us what you think about that screenshot. VB02 I overlaid Vancouver over the tar sands to get the effect of scale but I didn't know whereabouts in Vancouver that was so I went back to Vancouver to know how big the area actually was; I could actually make a comparison to the tar sands. 1PC what did you do after that? VB02 I went back to the tar sands to have another look to actually see the rest of it. PC Did you take a screenshot going back? VB02 Have a look PC Yeah it actually looks like you did.

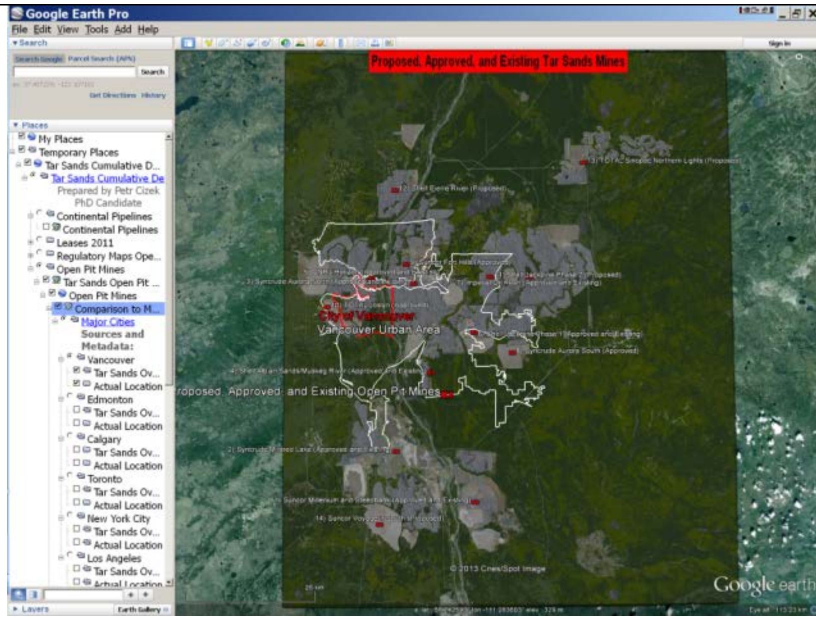
Number	Participant	Source	Comment
			 VB02 To find out what size the area actually is and go back PC Did you have any trouble jumping back and forth? VB02 No PC You just have to double-click to go back and forth. Is there anything else you want to show us while you're up?
2)	VB05		VB05 I found fascinating the amount of area the tar sands encompasses all of Los Angeles.  PC

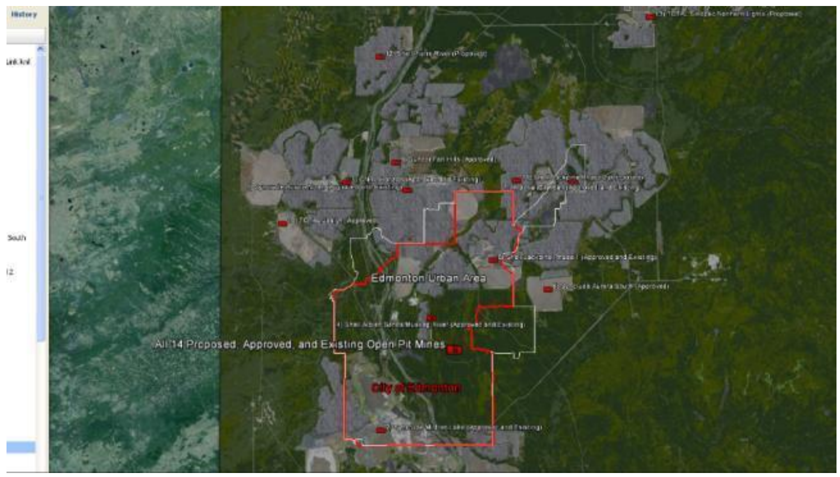
Number	Participant	Source	Comment
			Have you ever been to Los Angeles? VB05 No I never have PC Does it look big to you on there? How big do you think it is? VB05 I've heard it takes two hours from when you're entering the Los Angeles sign until you're actually in downtown Los Angeles so I think it's quite large. It's very large. PC Did you look at it with the overlay over the tar sands? VB05 I don't really know. PC Yes you did. It seems to me like VB02 said that it is helpful to look at the outline in Google Earth to know what that outline actually represents. Is there anything else you looked at that you found fascinating? VB05 I don't know. 
3)	VB11	FG	PC It seems that you're all very excited and interested. You look like you're excited about something. What number are you? VB 11 I felt like even with the cities it was sort of still a bit hard being able to really conceptualize how big they were so I zoomed in on the, this the arm on the right is downtown Vancouver and then that's my neighbourhood Kitsilano right in the middle; so I just sort of thought about if you are walking on that street how long would it take me to take to walk for a couple of hours.

Number	Participant	Source	Comment
			 PC S So you live in Kits right; so where would that be on this street; so where would downtown be? So that’s English bay? This is Stanley Park and we’re here? VB11 So for me to walk over would be like two hours. PC Fascinating. So that’s what you imagine if you were dropped into one of those open pits. VB11 It would take me a lot longer than two hours easily [to walk out]. PC Did you have trouble conceptualizing that or did you go back and forth to the real satellite image of Vancouver? VB11 No, I thought the shape was easy enough. PC The shape made sense. VB11 It would be weird to zoom in on that and think about the different places. PC It took me a while to figure out what you were looking at. VB11 Yeah, starting from the larger area of Vancouver looking at that it was easier PC Oh, so before you looked at this image you were looking at the big picture? VB11 Yeah PC Let’s try to recreate what you did; turn on Vancouver and Kits is here. Did you use the scale bar at all? The scale bar is here showing 1200 metres almost a mile VB11 Yeah and then zooming back out PC

<table>
<tr><th>Number</th><th>Participant</th><th>Source</th><th>Comment</th></tr>
<tr><td></td><td></td><td></td><td>Wow interesting. Anything else you want to show us? Is there someone else who did something equally fascinating?</td></tr>
<tr><td>4)</td><td>VA12</td><td>FG</td><td>VA12
(CAN’T FIND SCREENSHOT BUT WILL RE-CREATE)
PC
You want to go between the proposed and the existing?
VA12
I want to see all 14 proposed
PC
Why don’t I recreate it myself for you? Easy enough to do. Is this what you had in mind?


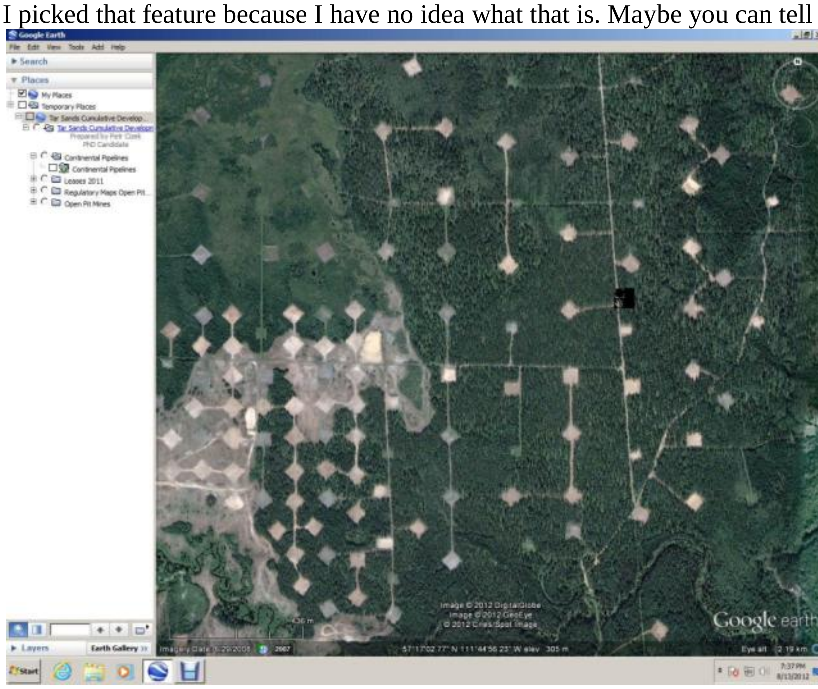
V12
Something like that. Yes I was also wanting to show the scale.
PC
Yes, how did you measure the scale?
V12
Well I compared it to Vancouver
PC
Like that? Is that legible for you. Would you prefer the labels turned off?</td></tr>
</table>

Number	Participant	Source	Comment
			 VA12 No you can leave them on. PC Did you think they were that big? VA12 No. Perhaps I was just thinking the city proper of Vancouver, but not the metro. So I do think it was two times, perhaps three times bigger than I thought KEY MOMENT #6: WOMAN IN BACKGROUND ALSO GASPS "NO!!" POSSIBLY REACTING TO SIZE OF OPEN PIT MINES PC Where did you hear that information? VA12 No, I was only speculating. PC Does anybody else have anything to add about this comparison?
5)	VA Unknown	FG	VA Unknown Well Vancouver was kind of ??? INDISTINCT to that, but then I did New York and that's the poster child for sprawl and I went "Wow!" PC Did you find that New York City metro outline complicated to see or? VA Unknown It had to look several times to see what I should looking at it but I could see it pretty good PC Have you ever been to New York? VA Unknown Yes I have, Yeah. I was thinking about the time it took to go to the boroughs.
6)	VA Unknown	FG	PC Does anybody else have anything else to add? VA Unknown I tried different cities. First I tried smaller cities like Edmonton and Calgary; I realized that I had to move up to bigger cities like Los Angeles sprawling cities and that was able to really encompass the size of proposed and approved

Number	Participant	Source	Comment
			projects as well; you need to go up to bigger cities as well like Los Angeles which is hell on earth. The other thing I noticed too looking at the oil sands site and comparing to where the nearest ports and oceans were like you know the west coast of Vancouver.
7)	E11 and E12	FG	E11 I'm just looking at the proposed tar sand mines is compared to the city of Edmonton very interesting to see that at that scale. I had no idea the tar sand areas may be three or four times larger than they are now. PC We'll just turn on the image that you selected. We can also look at your images directly in Google Earth. You're already into proposed in this image. You leaped ahead into this? E11 Yes.  PC You're comparing to Edmonton, right? E11 Yes. PC You're estimating that it will grow to three or four times the size? E11 Yes. INDISTINCT PC Is that what other people think too? E12 It strikes me that this is actually a very small bit of an incredible amount of northern forest covering northern Alberta…it's a very small part, but what shatters me is the amount of natural gas production from northern Canada and the amount of water that this is going to consume ….and to what extent are these companies going to be told by the Alberta government that they are going to have to re-use and conserve water in order to create the next generation of bitumen in the oil sands…in other words, how do you change the path that we're on terms the process? It's not the amount of land, it's relatively underused land, it's actually a relatively small chunk of land relative to northern Alberta, it's an incredible resource we have the bitumen but we're exporting it in its raw form to other countries to get the jobs …. PC Everything you say is a valid opinion, but we're trying to focus on the physical footprint these projects. I did mention the natural gas requirements and what

Number	Participant	Source	Comment
			you say about the physical footprint is what industry says in their communication material. They say that it's a relatively small piece of the boreal forest, less than 1% of Alberta for the open pit mines. Anybody else have an opinion on that based on what you've seen so far, whether you think this just a small underused landscape or do you think the size is significant?

Table 154 Deforestation

Number	Participant	Source	Question
1)	VB09	FG	VB09 I picked that feature because I have no idea what that is. Maybe you can tell me.  PC What happens way before companies apply to build an open pit mine they go to a very intensive drilling in their lease area you can see the drilling is following a grid and what they do is take core samples in the grid and that will tell them how much bitumen how much tar is underground and that at this spot we have a lot to a certain distance and we take all these samples that are fed into a 3D model that will actually allow them to show the deposit as a blob, a kind of blob underground and based on that they develop their mine plans. What this image is telling us is actually the landscape somewhat disturbed even before an open pit mine is actually proposed or even approved simply through the exploratory drilling. That's a very interesting shot that you took.

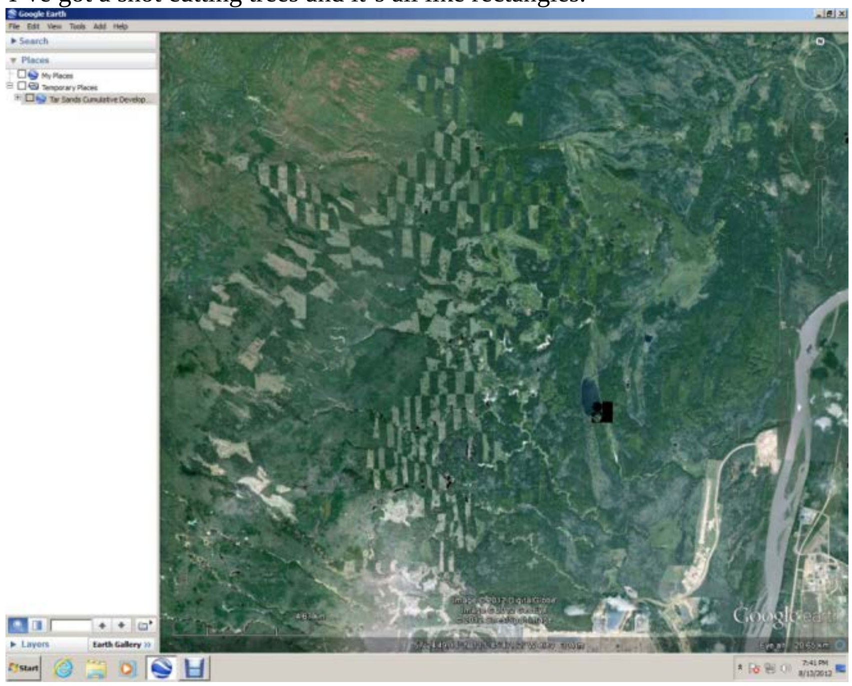
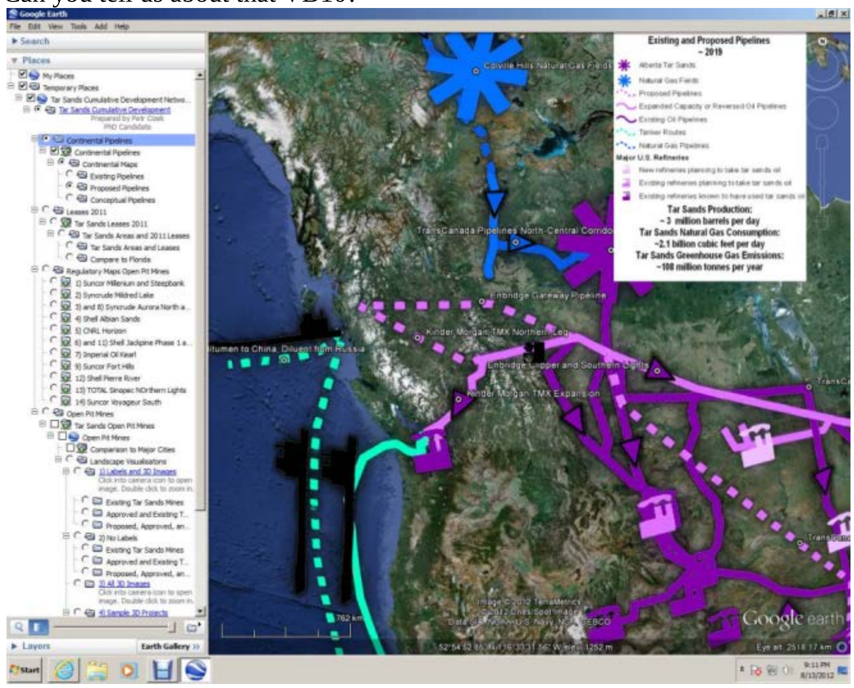
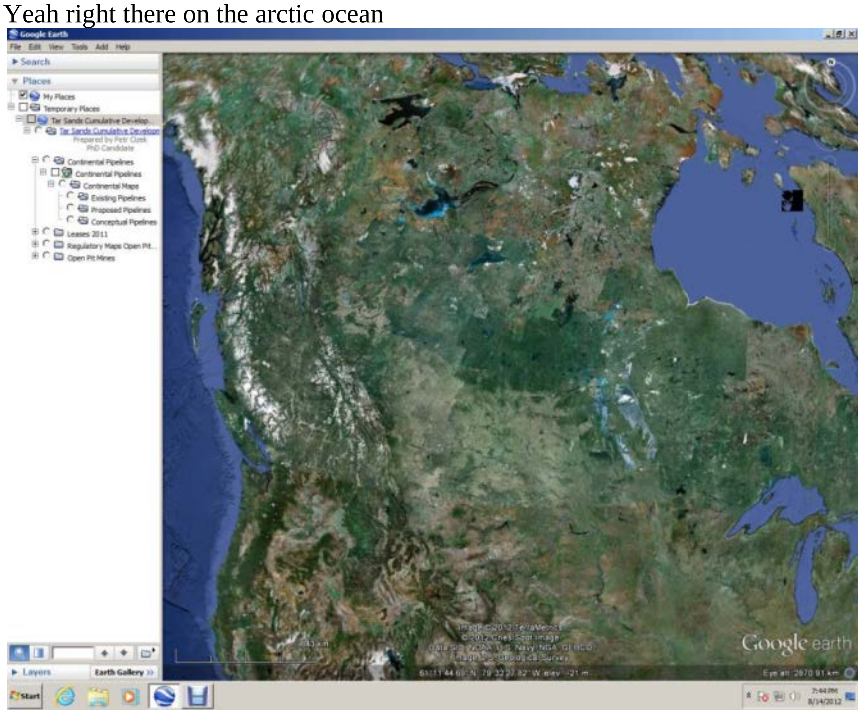
Number	Participant	Source	Question
2)	VB06	FG	VB06 I’ve got a shot cutting trees and it’s all like rectangles.  PC OK, that’s something else that’s going on the landscape before mines are approved. There’s a company there named Alberta Pacific that holds timber licenses there and you can see in my simulation what they’re doing is that even before some of these projects are approved they start cutting out most of the timber. This is what it looks like with the colours hat I tried to simulate and that’s what it looks like in the raw Google Earth image. This is what’s called an alternating block cut and that’s logging that’s going on. You can also see how the land is cleared further to the east even before the projects are built, well before they’re built, so for example this light green area and all these roads is land that’s cleared of timber even before the open pit mining is actually carried out so the timber is harvested over very large areas first. VB06 Why do they block it? Is it like a farmer with a field? PC They call it salvage logging they want to use the timber before the open pit mines go in.

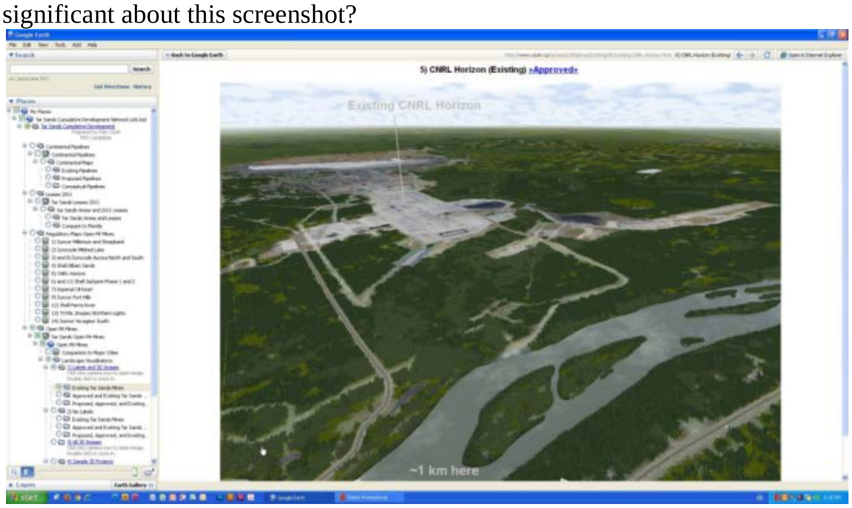
Table 155 Continental Pipelines

Number	Participant	Source	Question
1)	VB10	FG	PC Can you tell us about that VB10?  VB10 As far as I know, there's caribou that runs through this area? And I thought these pipelines can't be built because of the environmental impact they will have on the caribou herds, now the caribou they run, they travel hundreds of miles to the birthing grounds and the pipelines will cut right through their migration pattern PC The Alaska or the Mackenzie? VB10 The ones up there. PC The blue lines? VB10 They're all in that area. PC Those are all the natural gas pipelines? VB10 The Alaska Gas Pipeline, Colville Hills, these are all in the caribou herd. PC Some of them are. I was personally involved in the environmental assessment of the Mackenzie Gas Project and I can assure you that a year or two ago it was formally approved. All the approvals are in place the companies are just trying to figure out whether or not to go ahead with it because the price of natural gas is quite low. The Alaska pipeline is still being proposed and the northern part of it will follow the existing oil pipeline from Prudhoe Bay and then will follow the Alaska highway so there's already a corridor there. What you may have heard about that's still being discussed and there's quite a bit of controversy is whether or not there should be drilling allowed in the Arctic National Wildlife Refuge, which is I'll show you in Google Earth, to the east of Prudhoe Bay, it's not drilling for natural gas it's kind of in between these things (Prudhoe Bay

Number	Participant	Source	Question
			and Mackenzie Delta) it's drilling for oil. The natural gas in Prudhoe Bay has already been discovered. It's a big pool that they discovered when they discovered the original oil in the 1970's. So there's controversy now about drilling for oil in the calving grounds of the Porcupine caribou herd. So that's what you may have heard about.
2)	VA Unknown and VA04	FG	PC You're looking at the pipeline map? VA Unknown I noticed it was equidistant between the west coast and Hudson's Bay. I took a snapshot. PC Any screenshot that you'd like to share? VA Unknown Can you place a dot right in the middle between Hudson's Bay and Kitimat and try to find the nearest ocean you have to go the same distance either west or east to Hudson's Bay or to the Pacific Ocean. PC OK and you can recognize the open pit mines at this scale? Can you see them at this scale? VA Unknown Yeah I can. It's kind of like a grey area. Back in Google Earth, you show a dot and it's right in the middle. Like you have to travel quite a bit PC Do you know the Port of Churchill? VA Unknown Yeah right there on the arctic ocean  PC What do you think might be the problem shipping out of Hudson's Bay? VA4 Well there's no export market from Hudson's Bay right, they have to go out west to the Pacific Ocean they want to ship it to Asia; so to go to Asia you have

Number	Participant	Source	Question
			to go to the Pacific ocean there's no point . PC Have you heard about the Premier of the NWT offering to the Premier of Alberta that because of the problems in BC they could ship it along the Mackenzie Valley to the Beaufort Sea? VA4 No I didn't hear about that? PC This is the beauty of Google Earth that you can see (PC SHOWS MACKENZIE VALLEY TO BEAUFORT SEA AND AROUND ALASKA AND SIBERIA). Offered in case BC was causing trouble. SS There's another question back here. PC Does anybody see a problem shipping through the arctic ocean? VA Unknown Treacherous isn't it. You have to cross between Alaska and Siberia. VA Unknown It brings to mind Exxon Valdez right of way been there before. PC Well actually Exxon Valdez was shipping oil from Prudhoe Bay, Exxon Valdez was down here. Anyway the shipping season is a little short in the arctic ocean! LOTS OF LAUGHTER

Table 156 Proximity to River

Number	Participant	Source	Question
1)	E06	FG	E06 COMES UP PC OPENS SCREENSHOTS. Look at all this. Is it something recent you looked at? OK, what was most significant about this screenshot?  E06 I was surprised how close it was to the river. The source of life…it's pretty close. PC OK, I have trouble seeing that [THE SCALE BAR] in that image. We'll go right to where you were. (PC DISPLAYS IT IN HIS OWN GOOGLE EARTH SOFTWARE TO SEE

Number	Participant	Source	Question
			SCALE BAR). There’s your scale marker. How close do you think that mine will be to the river? Can you get a sense from this? E06 A kilometre. PC Yeah, about that. You looked at just the existing do you realize that? This mine has not yet been fully constructed. E06 Hmmm. PC If you want to have a look. We go to this popup. Let’s use Explorer to see it better. Click approved. KEY MOMENT #8: E06 EXCLAIMS “WOW!” That’s the actual full footprint of the mine that’s been approved PC So how close to the river do you think it is now?  1:42:06 E6 INDISTINCT. The river could flood here. That’s awfully narrow!

Table 157 Comparison to Florida

Number	Participant	Source	Question
1)	E06	FG	PC OK, anything else that you found or anyone else that thought this was an issue? E06 INDISTINCT SOMETHING ABOUT THE SIZE OF FLORIDA (Also found comparison to area of Florida interesting). PC OK, do you think the open pit mines are going to be the size of Florida? E06 No, but that's a gigantic area. PC Yes, did you know that before you looked at this? E06 No, I had no idea. PC OK, thank you E06. Is there anyone else who wants to come up at this stage?