Intent to create a Quantification Protocol for the

Ridership in Trains

An Overview

Carbon Offset in the Ridership in Trains

Greenhouse gas reductions

in construction

of Rail Transit

in the trade-off between passenger vehicles

and train ridership

First draft

April 2011

Intent to Develop Alberta Offset System Quantification Protocol: *{Ridership in Trains}*

Please contact Climate Change Central with any questions or clarification of requirements at contact@climatechangecentral.com.

This Intent to Develop an Alberta Offset System Quantification Protocol document is intended to provide Alberta Environment with an overview of the proposed protocol idea to demonstrate how this protocol will meet the requirements of the Alberta Offset System. The protocol developer is required to present this information to Alberta Environment and **must** receive approval in concept for the protocol before the protocol idea will be considered for development in the Alberta Offset System.

Familiarity with and general knowledge of the Alberta Offset System is required prior to initiating a protocol. Information on the Alberta Offset System is available on the Carbon Offset Solution website (http://carbonoffsetsolutions.climatechangecentral.com) and on the Alberta Environment website (http://environment.alberta.ca/02275.html).

Alberta Environment will review the submitted information in order to assess and provide feedback on the following elements:

- How the proposed protocol meets the eligibility criteria in section 7 of the *Specified Gas Emitters Regulation;*
- Applicability of the proposed protocol against purpose and intent of the Alberta Offset System;
- Baseline adoption levels and credit potential for Alberta;

- Baseline, project condition, and key assumptions for the proposed protocol;
- Key stakeholders and technical experts in the field; and
- Relevant science and technical information

General Description of the Proposed Protocol[1]

[Provide a written overview on the intent, purpose and relevant background information on the protocol.]

The purpose of this protocol is to seek to generate an income stream for Light Trains through carbon trading. Building trains in a city is expensive. The intention here will build on the foundation of transportation planning by the city to reduce overall emissions. This protocol will allow the city to add emission reductions to its assets.

Commuting by passenger vehicle is the business as usual and preferred method of travel in cities in North America. The commuter who travels by public transportation is reducing their emissions. That is their carbon footprint is much smaller than traveling by passenger vehicle.

When cities plan for and construct public transportation systems they are also planning to reduce the overall emissions generated by travel in the city. When urban administrations improve their transportation infrastructure they can reduce bottlenecks and traffic congestion and improve public transit. Cities will be able to profit on a trade-off between passenger vehicles and Light Trains.

According to a chemical engineer, overall emissions reduction for 5 000 riders is 2 497 t-CO_2e per year in Edmonton on the Northeast line.[2] The credit potential for 25 000 riders utilizing a machine installation date of January 2002 and a credit duration period through 2010, in Edmonton is approximately 100 000t-CO_2e

Regulated firms can buy verified emission reductions and/or removals of greenhouse gases (i.e. offsets) from voluntary actions arising from

[1] **Some important notes to consider:**
- *Protocols should be based on best available science.*
- *Follow the ISO 14064:2 standard processes – specifically addressing principles of conservativeness, completeness, relevant, consistent with others, accuracy and be completely transparent in development and descriptive processes.*
- *Be very clear with respect to the Measurement, Monitoring and Verification requirements to allow little interpretation.*

[2] Ahmed Hussein, Ridership in Trains Calculations Analysis, 2007

unregulated activities (i.e. offset projects) in Alberta.[i]

Further, the ability to sell offsets provides an incentive for Albertans, from all sectors of the economy, to innovate and invest in activities that will reduce greenhouse gas emissions beyond regulated activities.[ii]

Intent [Describe the protocol activity and reduction opportunity.]

Trains are carbon reservoirs, they are like trees. Theoretically they store the greenhouse gas (GHG) reductions, of the riders, when they park their cars.

Trains store their riders' carbon reductions in the ties and rails of the track bed and in the train-cars themselves. These reductions may be traded to emissions producers to help meet their emission limits.

Each vehicle while operating emits certain greenhouse gases. In a city which is encouraging a shift in modality (Ottawa), the commuter may park their vehicle to use public transportation.

The city must invest in the construction of more environmentally friendly transportation to meet this growing need and to reduce the burden on our planet's atmosphere.

When you look at the construction of trains in a city you can see the carbon footprint is much smaller than traveling by passenger vehicle. The value of the storage of these greenhouse gases in trains is very much like a tree and may be measured in decades. That is, the expected life cycle of the transit equipment, the train cars, tracks and propulsion.

When a city builds new rail lines it grows like a tree expanding throughout the four quadrants of the city, storing the greenhouse reductions of its riders. In Calgary, with more than 200 000 riders of the C-train per weekday afternoon, the value over decades in its ridership and the trains' carbon footprint is significant.

The city of Edmonton has retired their Siemens U2 rail cars after more than three decades of service. When emissions producers are looking for carbon reductions to help them meet their limits this trade-off will offer a measurable & usable alternative.

The new SD-160 rail cars feature brakes which passively regenerate power back into the city's electrical lines. At some point this will positively impact the light rail emissions factor.

Riders traveling by Light trains reduce passenger vehicle emissions of Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x), Carbon Dioxide (CO_2), Carbon monoxide and Volatile Organic Compounds (VOC's).

Accuracy {Please determine the associated level of accuracy for verifying reductions in this project}

There are differing methods utilized in measuring and verifying the reductions (of greenhouse gases).[iii] The more accurate the data measurement, the better; however, this must take into consideration costs and other practicalities of measurement.

Measurements can be categorized as follows where tier 1 is the most accurate and tier 5, the least accurate:

Emissions factor calculations and associated levels of accuracy

Five tiers for GHG information types or sources[iv]	
Tier	GHG information type or source
Tier One	Continuous direct measurement
Tier Two	Site-specific correlations
Tier Three	Intermittent (periodic) direct measurement
Tier Four	Use of models
Tier Five	Use of default emissions factors

At a glance, it seems like the emission factors in the formula supporting the Ridership in Trains, are to be found in Tier 5. It is unclear where this project stands here.

However, there is a corelation between the two factors: the baseline emissions factor for cars Ef_{car} and the rail transport equivalent emission factor Ef_{rail}, and the formula calculating the emission reductions. That is, the two terms are beneficially related.

$$ER_{low} = (EF_{car} - EF_{rail}) * D_{com,low} * NC$$

EF_{car} is the Emission factor for cars

EF_{rail} is the Emission factor for rail travel

Juxtaposing the two factors and utilizing the calculations supported by the emission reduction formula, presented in the *analysis,* creates a relationship between the two factors. When verifying the weekday boarding figures for the train this **may** qualify the project for tier 2 Site-specific accuracy. The sites being between Clareview and Churchill stations of the City of Edmonton Light Rail Transit.
Utilizing the emission factors will ease the administrative burden for reporting and verification of a portion of ridership numbers.

Baseline [Explain the project baseline condition, adoption levels for the province, business as usual activity, general baseline assumptions, credit potential in Alberta, other relevant information.]

The baseline for this protocol is the amount of emission reductions produced by 5 000 riders in t-CO_2e/year in Edmonton. The baseline is calculated to be 2 497 t-CO_2e/year.

$$ER_{low} = (EF_{car} - EF_{rail}) * D_{com,low} * NC$$

Calculating the gasoline emissions factor per passenger kilometer utilizes the following assumptions: according to the US EPA, the 2007 average fuel economy for light-duty vehicles is 11.65 L/100km; the emissions factor for gasoline internal combustion engines is calculated to be 2.446 kg-CO_2e/L; and the average passenger load is 1.15 passengers per vehicle.

The baseline emission factor (EF_{car}) for passenger vehicles is calculated as follows:

$$Ef_{car}=11.65[L/100km]*2.446[kgCO_2e/L]/1.15[passengers/vehicle]$$

= 0.2478[kg-CO_2e/passenger-km]

The commute distance is estimated as follows:

$D_{com,low}$=7.2[km/way] *2 [ways] * [days/week] * 48 [week/year]
=3 456[km/year]

The emissions factor for light trains is estimated to be

0.1033 kg-CO2e/passenger-km

The credit potential for 25 000 riders based on an emissions reduction of 2 497 t-CO_2e/year for 5 000 riders, utilizing a machine installation date of January 2002 and a credit duration period through 2010, is calculated to be 99 880 t-CO_2e.

Project Condition [Explain the project condition, activity creating the emission reduction or removal, other relevant information.]

One way of looking at greenhouse gas reductions is by "Biological Sequestration,"[v] typically like a forest, which acts like a reservoir for carbon" (Alberta Environment). Each rider of public transportation is reducing their greenhouse gas emissions. Theoretically the light rail transit acts like a reservoir storing these GHG reductions in the ties, rails, and train cars.

Vessels like light rail transit store these reductions. They expand their service and grow their routes in branches. The more convenient the commuter finds the transit service the more ridership it will see.

Forests are vulnerable to disturbances where their "emissions and removals are not determined only by natural processes-forest management activities such as harvesting, tree planting, and efforts to fight fires and insects also have an impact."[vi] Forests are "considered a sink when it removes more CO_2 than it emits."[vii]

Trains are not subject to these disturbances.

Applicability [Who is the intended user(s) for this protocol?]

The urban administrations of Calgary, Edmonton, Ottawa and Vancouver.

Regulatory Requirements [Describe all relevant regulations that apply to this activity and explain how the activity is going beyond regulatory requirements.]

According to the Alberta Regulation 139/2007 the Specified Gas Emitters Regulation under the Climate Change and Emissions Management Act, Part 2 under section 7:

(a) the emission reductions occur in the cities of Calgary, Edmonton and in the province of Alberta

(b) no law requires a commuter to travel by light train or by public transportation, however administrations have constructed and continue to expand public transit systems

(c) the emission reductions caused by commuters traveling on the Edmonton Light Rail Transit began in 1978

(d) The emission reductions are real and demonstrable.

We can demonstrate real emission reductions using the formula:

$$ER_{low} = (EF_{car} - EF_{rail}) * D_{com,low} * NC$$

Where

ER_{low} is the Emission Reductions in Edmonton

EF_{car} is the Emission factor for cars

EF_{rail} is the Emission factor for rail travel

$D_{com,low}$ is the commute distance

NC is the number of commuters (riders)

This project goes beyond regularity requirements. Utilizing the light train emission reductions in a municipality are as yet an untapped trade-able resource and unmanaged waste product.

Simply put the reductions may be purchased by the supplier of the fuels or any emissions producer who, in a fair market cap and trade system, may adjust their input costs accordingly.

Additionality [Explain how this activity result in real, quantifiable, and verifiable reductions beyond business as usual activity and government regulations. How does this protocol result in new, incremental greenhouse gas emission reductions and/or removals that would not otherwise have occurred?]

It is clear that the preferred method of travel in North America is by passenger vehicle. In the City of Edmonton travel by public transportation makes up just 9% (1999) of daily trips. Travel by car is the business as usual condition.

> While a city may be defined by its population, all it takes is a quick look at a map to recognize that its transportation system is a fundamental organizing principle behind its urban form. Transport is essential to the functioning of a city in all aspects of daily life and commerce. As a result, the planning, design, construction, and operation of the transportation system have a broad range of impacts on environmental sustainability, including: air, water, and soil quality; habitat and biodiversity; **climate change**; and arable land.[viii]

The Edmonton LRT started with 6.9 kilometers of track in 1978 and with the expansion to Southgate and on to Century Park the train will travel 20.5 kilometers through the City.

> The LRT Network Plan balances the long term transportation needs with a commitment to grow green and create a compact, more integrated urban environment where roads move goods and transit moves people.[ix]

Several circumstances become apparent while speculating on why the commuter travels by rail. Maybe the stations are convenient to his home. Maybe he

enjoys a beverage, partakes in a multi-media event or reads the paper while making the 20 minute trip to work each weekday. Maybe he chooses to reduce his carbon foot print by parking the passenger vehicle at a point of exchange.

Maybe the nearest rail station to home has a convenient connection by bus, or travel by bicycle or on foot. There is also the trains' priority at intersections thereby maintaining its relatively high speed and reducing the overall time spent commuting.

The more convenient the transit system becomes the more ridership it will see:

> Expanding the LRT system is a key priority for the City of Edmonton. The Downtown to NAIT(Northern Alberta Institute of Technology) line is the next priority for LRT expansion. Anticipated to be complete by 2014, the line would feature a 3.1km expansion that would connect the Churchill Station in downtown Edmonton to new LRT stations at Grant MacEwan University, the Royal Alexandra Hospital and NAIT.[x]

Yesterday, the idea that vehicles off the road and train ridership was perpetually bound together changed when we began to count our carbon footprint. According to Stephen R. Covey "almost every significant breakthrough...is first a break with tradition...with old paradigms(models)."[xi] To see this protocol move forward one needs to look at rail transit in a new way, as a carbon reservoir. And that the reductions are additional.

The ability of the city to reduce congestion and automobile emissions rests on its ability to manage its commuters' needs.
One can teach the imagination to see, "our perceptions to evolve."[xii] (Zoppa)

It is clear that urban administrations are planning to better manage the emissions of their citizens and improve the air quality of its air sheds.

> Performance measures have been established by the City that seek to document citizen access to transit, and alternative modes of transportation (i.e. a cycling network). The combined outcomes of these initiatives can be improved air quality as well as healthier communities."[xiii]

Thomas Kuhne has stated, "Yet even in cases like these the range of

anticipated, and thus of assimilable, results is always small compared with the range that imagination can conceive." [xiv]

> ...convenient transportation options can improve social sustainability. Similarly, building a compact city makes more efficient use of infrastructure, which can reduce the financial burden of maintenance.[xv]

Transportation by automobile is the business as usual condition of the urban traveler. Any crisis commonly results in change. Ridership in trains is a new paradigm. The market share of public transit must become more equitable to reduce overall emissions by the cities' commuter.

> Light trains help reduce air pollution from vehicle emissions and greenhouse gases. A transit rider creates 65% fewer greenhouse gas emissions than an auto user for the same trip.[xvi]

Light Rail Transit Ridership Projections in Canada

Train	City	Track	Population	*Average Number of Boarding Passengers per weekday*	Projected Rides per km
Canada Line	Richmond, Airport, Vancouver	19.5 km	753,613	105,000 (2010)	4,700 (5 400)
C-Train	Calgary	42.1 km	956,078	205,298	4,900
O-Train	Ottawa	8 km	800,000	10,000	5,700
LRT	Edmonton	12.3 (20.5) km	1,014,000	42,000 (93,600, 2011)	5,500 (4,600)

Projected rides per km was calculated with Calgary C-train as a baseline. Ridership on the line also known as the RAV line (for Richmond, Airport, and Vancouver) has exceeded all expectations.

Public transit riders are reducing their carbon emissions. These reductions are additional to the business as usual travel by passenger vehicle.

Barriers [Identify barriers that would, in absence of the Offset protocol, disincent or prevent this activity or project from taking place.]

People will balk at servicing the baseline condition, a social barrier of sorts. Some may not recognize Trains, as a conveyance for emission reductions.

Emission reductions have occurred since the machine installation dates and embedded in the ties, rails and train cars. The city of Edmonton has year-by-year records of ridership on its public transit system as well as the Light Rail Transit.

Permanence [Are emission reductions and/or removals reversible. If so, how does the protocol developer propose to address permanence of Offset Credits associated with this activity?]

Permanence, that is carbon stored in the train ties, rails, the track bed and the train cars themselves "must be maintained for a pre-determined period of time." [xvii] This will be a function of the machine installation dates, the dates when the train-cars and propulsion were commissioned and put into service.

> "Under current carbon accounting mechanisms, carbon permanence is typically defined as 100 years (e.g. California Climate Action Registry, Forest Project Protocol 2007)..." [xviii]

Unlike a forest, which is subject to fire, harvest and insect outbreaks, trains in Edmonton are not subject to disturbance. Therefore the carbon stored in it is seen to be permanent and not reversible. Edmonton and Calgary continue to expand and improve their light rail transit, increasing ridership and storing or sequestering further reductions in the train reservoir.

Leakage [Will this protocol result in or threaten leakage of greenhouse gas emissions, and if so, how will these risks be mitigated? Include a discussion on possible scenarios that may occur.]

Leakage is the shifting of emissions up or downstream of the project condition. And beyond the scope of this project. Leakage may be managed by

monitoring tools and conservative emission factors.[xix]

This project is only concerned with the emission reductions created by the reduced carbon footprint of the light train rider. Verification carried out by the City of Edmonton in Park 'n Ride surveys. And determined by placing side-by-side the two emission factors, EF_{car} and EF_{rail} as demonstrated in Regularity Requirements and the Baseline condition.

$$ER_{low} = (EF_{car} - EF_{rail}) * D_{com,low} * NC$$

This plan for mining the embedded emission reductions in the historical expansion of light trains in Alberta goes well beyond regularity requirements. It goes well beyond business as usual rhetoric. Sometimes it is hard to see that this paradigm, this idea, is simply one more way the city is evolving to begin to tidy up another one of it's citizens wastes.

Alternatively this project may be seen in the light of life cycle management. Correcting any wastage in the conservation of energy from producer to distributer to user. In the case of the C-Train, using wind turbine contracts reduces the embodied energy required in commuting.

Conservativeness [How does the proposed protocol idea address conservativeness in emission reduction quantifications?]

The conservativeness principle is used where there is a possible overestimation of the reductions or where there is a risk of overestimation.

> To address the potential incompleteness and high uncertainties of REDD (Reductions of emissions by forest degradation or deforestation) estimates, and thus to increase their credibility, it has been proposed to use the principle of *conservativeness* (e.g., Grassi 2007, Mollicone *et al* 2007b): when completeness or accuracy of estimates cannot be achieved the reduction of emissions should not be overestimated, or at least the risk of overestimation should be minimized.[xx]

Richard Lindezen says we can make adjustments to affect the amount of greenhouse emissions emitted into the atmosphere: that "If we truly believe in warming, then we've already decided we're going to adjust."[xxi]

Public transportation is one technology which is reducing greenhouse gases. Expanding these transit systems can create a more equitable distribution of the daily commute. If you can see this then we can begin to make the adjustments.

Ridership in trains, an emission reduction quantification can be developed based on "A sensible climate policy (which) emphasize(s) building resilience into our capacity to adapt to climate changes." Steven F. Hayward believes we can build resilience into our policy making.[xxii]

Global warming and the Precautionary Principle {Describe the Precautionary principle}

Many people have utilized the precautionary principle to galvanize the debate on global warming and climate change," ...The principle stems out of the debate on whether or not governments should adopt the precautionary principle and act to reduce emissions even in the absence of (absolute) certainty regarding warming." [xxiii]

The theory gambles," that it is a better "bet" to act as if global warming exists than otherwise, because the expected value of acting -that is, the fact that the impending crisis due to global warming will have been averted- is always greater than the expected value of inaction." [xxiv]

Writing in the New Yorker, in the Climate of Man series, Elizabeth Kolbert says,

> "A few years ago, Dutch chemist Paul Crutzen claimed that, starting in the 1780s, industrialization created a new age-the Anthropocene. In the last 200 years, industrialization has driven up carbon-dioxide emissions.[xxv]

French scientist Joseph Fourier, in 1824, formed the theory of the Greenhouse effect, "by which gases such as Carbon Dioxide absorb heat, setting a warming blanket around the world.[xxvi]

> If current trends continue, atmospheric carbon dioxide will reach 500 parts per million; the last time concentrations were that high was during the period known as the Eocene, 50 million years ago. For all practical purposes, the recent "carbonation" of the atmosphere is irreversible.[xxvii]

There is value in public transportation utilized as a conveyance for greenhouse gas reductions. Conveyance can be seen as a mode of transportation and as transmission of an idea. It is a better bet that the protocol Ridership in trains, can be used as an emission reduction quantification.

The idea has merit. It is up to climate scientists, administrators, government, and people to act in our best interests. It is up to us all to look beyond business as usual practices and take advantage of any opportunities to reduce emissions.

Aggregation [Is this protocol likely to result in aggregated projects? If so, are there risks associated with aggregated projects, and how does the protocol propose to handle these risks?]

Verification [What types of records are available to support implementation and verification of the proposed activity or project?]

The machine installation dates are crucial to the going forward of this project. The City of Edmonton keeps track of its daily boarding figures year-by-year.

According to a Park 'n Ride survey conducted by the City of Edmonton, daily boarding ridership of the 12 km North-East branch of the Edmonton Light Rail transit reaches 44 070 commuters[xxviii]

Ownership [Identify issues around ownership that pertain to this activity or project.]

The urban administration in its role to handle another one of the wastes of its citizens has to see the successful evolution of these emission reductions.

The reductions may be realized by the service provider and returning the bulk of the consideration to the administration to be used for the planning, construction and expansion of Light trains and public transit.

The city of Edmonton has taken control of its micro-climate by bringing into law its airshed. Therefore it may begin to trade these reductions in an exchange.

Related Protocols and/or Methodologies [Do other jurisdictions, programs or offset systems have similar or related protocols available, and if so, discuss similarities and differences between the proposed protocol idea for Alberta relative to other jurisdictions.]

Managing emission reductions through the Reduced Tillage Practices quantification protocol has a similar paradigm.

Reducing the preparation and seeding of the acreage soils by eliminating a number of passes by internal combustion engine motive vehicles reduces greenhouse gases.

Other Benefits [List all associated benefits that will result from this activity. These other benefits can include environmental benefits, economic benefits, etc.]

1. Constructing and expanding light trains will result in reduced smog in the cities air sheds

2. Public Transportation reduces the load on arteries in both urban & rural settings

3. Riders of higher density high velocity systems may enjoy a beverage, participate in a multimedia event, read the paper, partake in conversation, work with an electronic device or view the scenery in comfort shepherded by a professional driver

4. These reductions may be traded in whole or part on behalf of both urban & rural administrations to emission producers, and help them meet their limits

5. The bulk of these sales to directly fund planning and construction for branches of Light Trains

More benefits:

Efficient LRT
is one of the fastest and safest ways to travel in Edmonton.
Trains operate at a maximum speed of 70 km per hour and run every six

minutes during peak hours.

Safe

LRT security is constantly reviewed and upgraded, using state of the art technology to maximize customer and employee safety on the system.

Affordable

The LRT can help you save money on fuel, parking and vehicle maintenance. ETS transit pass customers also benefit from the federal transit pass tax credit.

Accessible

LRT offers special accessibility features for customers with mobility difficulties, including elevators, escalators, automatic doors, downtown pedway, hands free emergency phones, and wheelchair accessible washrooms.

Environmentally Friendly

Light trains help reduce air pollution from vehicle emissions and greenhouse gases. A transit rider creates 65% fewer greenhouse gas emissions than an auto user for the same trip.[xxix]

Adverse Effects [List any adverse effects that may result from implementing this activity or project.]

There are some contributions by a transit system to global warming when you look at the life cycle of the materials involved in its construction.

The transportation system is a built artefact. Aggregate, asphalt, concrete, and steel are required for the construction of infrastructure such as roads, bridges, and railways. Materials such as plastic, rubber, and metals are required for the manufacturing of everything from buses, trains, streetlights, and traffic signals, to cars, bicycles, and shoes as well. All of these materials require resource extraction and then processing and/or manufacturing which can pollute the air, water, and soil, destroy habitat, reduce biodiversity, and can contribute to climate change.[xxx]

Aryn Machell, in his paper "Towards a Sustainable Transportation System", discusses the concept of embodied energy in final products like the trains.

> Additionally, all steps of the process - resource extraction, processing, and manufacturing or construction require energy, which is referred to as the "embodied energy" of the final product.
>
> At present, this embodied energy is primarily derived either directly or indirectly from hydrocarbon fuels such as oil or coal. These fuels not only have extraction and processing impacts themselves, but also contribute to climate change through the emission of greenhouse gases. [xxxi]

It is beyond the scope of this project to further define these contributions to emissions of greenhouse gases in the components of the transit system.

However, the City of Calgary in operating the C-Train has taken the step to purchase Wind Turbine contracts from the grid. Reducing the greenhouse gases needed to operate the train.

References [Provide a list of relevant references.]

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Proposed Timing for Submission into the Offset System Review Process [Please identify the anticipated submission date for this protocol to be considered for Stakeholder review (formerly 2nd Round Stakeholder Review). Note: the Stakeholder review is held once per year in fall.]

- Fall 2011

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viii Aryn Machell, Towards a Sustainable Transportation System, City of Edmonton, June 2010, p. 2
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xvii Matthew D Hurteau, Bruce A Hungate and George W Koch, "Accounting for risk in valuing forest carbon offsets", Carbon Balance and Management, 16 January 2009, p. 1
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xxviii Edmonton Monitoring Services, LRT Ridership and Park 'n Ride Report, City of Edmonton, 2008, p. 8
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xxxi Ibid, Aryn Machell, p. 3