ALBERTA GHG OFFSET SYSTEM

Draft Quantification Protocol for Freight Modal Shifting

REVISED DRAFT

Introductory Note

The following draft GHG protocol document has been developed for submission to the Alberta Offset System for ultimate approval as an official GHG Offset Quantification Protocol. As such, this document has been designed to reflect the specific requirements of the Alberta system and the general format of and precedents set by protocols that have already been approved in the system.

This document represents a revised version of the protocol prepared following an expert technical review teleconference held on November 5, 2007.

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1 PROJECT AND METHODOLOGY SCOPE AND DESCRIPTION

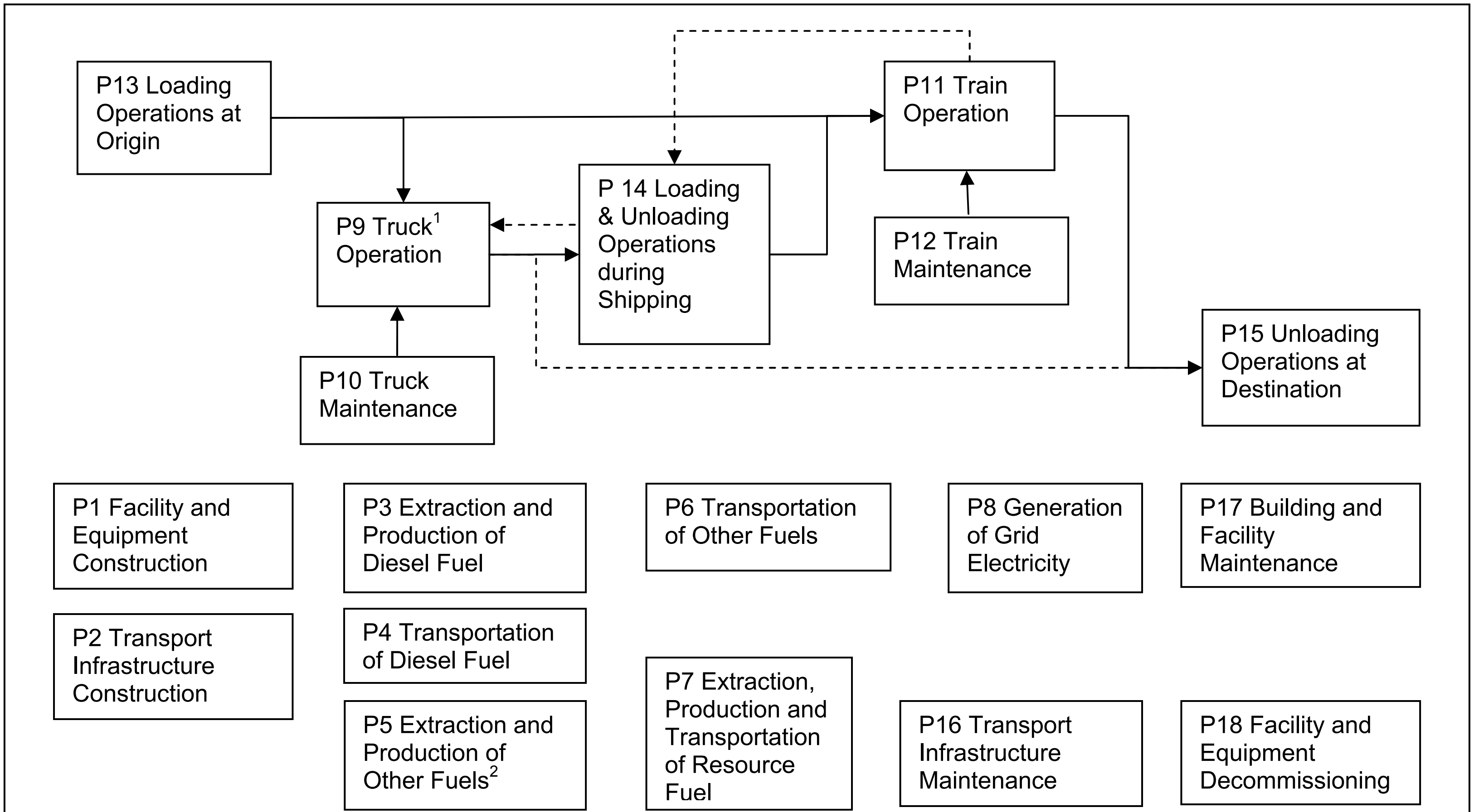
1.1 Protocol Scope and Description

Companies that produce or aggregate goods requiring transport in or through Alberta ship to and from a variety of locations (herein referred to as “Origins” and “Destinations”) primarily by either truck or rail, and in a small percentage of cases also by marine and air. Where greenhouse gas emissions associated with the various potential transportation modes differ, shifting freight transportation from a more GHG-intensive mode to a less GHG-intensive mode will result in GHG emission reductions.

This protocol provides a method for calculating the GHG emission reductions that occur from shifting baseline truck freight transport to project rail freight transport in the Alberta context. This activity results in emission reductions given the significantly higher fuel consumption and associated GHG emission rates of trucks as compared to rail per amount and distance of freight shipped. The opportunity for shifting from truck to rail is considered strongest in the Alberta context for larger shipments traveling longer distances (e.g. east / west movements passing through Alberta; large bulk good, commodity and equipment movements into or out of the Alberta; etc.), versus smaller, more regional/local shipping. However, this protocol is not restricted to these types of shipments, and may be applied to all types of shipping that meet the applicability criteria presented in Section 1.1.2.

Transport modes other than truck and rail, such as air or marine, are not considered within the scope of this protocol (and as such, shifting to or from these other modes is excluded from consideration).

A process flow diagram for a typical project case is provided in Figure 1-1, and for a typical comparison baseline case in Figure 1-2.



Notes
[1]Truck transport, as well as unloading and loading at sites other than the Origin and Destination, may not be necessary, depending on the specific details of a project.
[2]Energy types and sources required depend on the equipment and facilities used for loading and unloading

Figure 1-1: Process Flow Diagram for Project Condition

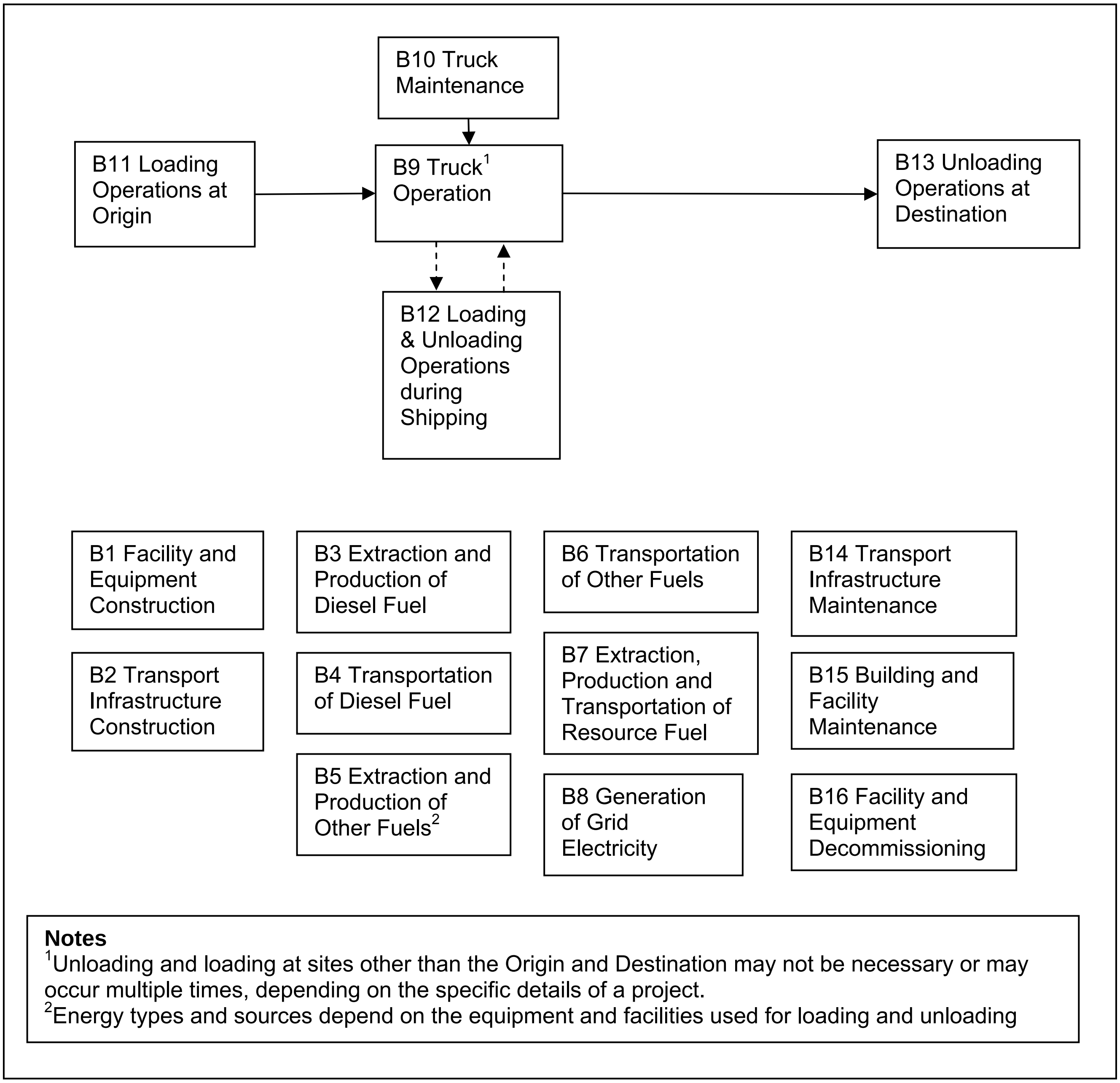


Figure 1-2: Process Flow Diagram for Baseline Condition

1.1.1 Protocol Approach

Determining the GHG emissions resulting from freight transportation, and in particular truck transportation, can be quite complicated due to numerous factors influencing emissions (see Note 1 below Table 2.6 for details). Matters are further complicated where goods are shipped by a particular company to various Origins and Destinations using a number of different routes and associated truck and rail configurations, as some companies may not have detailed route distance, tonnage and transport mode data for each shipment.

Therefore, a simplified approach presented in this protocol for quantifying the GHG benefits of shifting from truck to rail freight transportation in the Alberta context (suitable for only some forms of shipping) relies on the use of average and conservative emission factors and assumptions to allow for the recognition of emission reducing modal shifting even when detailed, per-shipment project data is not available. Where a project involves shipments that do not qualify for the simplified approach, a more detailed approach involving tracking of individual tonnage and distance data for each shipment is provided.

Additionally, since emission reductions from a single shipment of goods will be very small, this protocol is intended to be used for the aggregation of emission reductions from all shipments initiated by a particular producer or aggregator of goods such that the total emission reductions calculated and resulting offset credits that might be generated would justify the costs associated with quantifying the reductions.

In order to accurately compare GHG emissions of rail transport to truck transport, this protocol assumes a common project and baseline function of freight transportation, and a functional unit of revenue tonne-kilometers (RTK) shipped, representing the product of the mass of freight shipped and the distance the freight is shipped.

1.1.2 Protocol Applicability

This protocol applies where:

- the most likely situation in the absence of the project for rail freight shipments being included as part of the project would be the shipping of the same freight by truck (i.e. only freight shipped by rail that would have otherwise been shipped by truck is considered a part of the project, which means that some rail freight transportation used by a proponent may be excluded from the project).

- the goods being shipped as part of the project originate from a single producer or aggregator of goods (not necessarily a single location, but a single company), with this producer or aggregator being considered the project proponent. Note that this protocol cannot be used to quantify the modal shifting benefits of goods being shipped by multiple companies – such freight shipments from each individual company would need to be considered separately.

- the project proponent has shipped goods for at least three years (and thus has sufficient information with which to construct a baseline).

- the project meets the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System. Of particular note, emission reductions must:
    - Result from actions taken on or after January 1, 2002
    - Have clearly established ownership (see note below)
    - Have occurred in Alberta (which in the context of this protocol means that freight shipments included as part of the project must originate, terminate, and/or pass through Alberta, and only the portion of the journey occurring in Alberta can be counted).

With respect to ownership, while the primary emission sources associated with this protocol (truck and rail combustion emissions) will be related to, and not directly owned or controlled by the project proponent (i.e. the producer/aggregator), the potential for ownership issues arises. However, it is the understanding of the protocol development team that, based on discussions with Karen Haugen-Kozyra of Climate Change Central (Haugen-Kozyra, pers. comm., Oct 2007), within the Alberta system, the project proponent must only demonstrate that they have control over the data necessary for emission calculations for project and baseline sources in order to claim benefit for emission reductions quantified using this protocol, and not show that they have contractual agreements establishing ownership of these emission sources. In the case of this protocol, this is interpreted to mean that since proponents decide what is shipped and by which mode, and track associated tonnage and/or distances as appropriate, that this is sufficient to meet the ownership requirements of the system.

Users of this protocol should clearly describe how their project meets these eligibility requirements in their Offset Project Plan.

1.1.3 Protocol Flexibility

Flexibility in applying the quantification protocol is provided to project developers in three ways:

1) <u>Determining Project Rail Revenue Tonne-Kilometers (RTK)</u>

Project developers may use one of two approaches for determining the amount of project rail RTK that resulted from a shift away from trucking in the baseline.

Option 1 – Simplified Approach

This option is for use where the proponent does not have access to detailed distance data for each shipment carried out during the project and baseline timeframes, and is only suitable for freight shipments that pass through Alberta east to west or west to east but that do not: originate, terminate, and/or switch modes within Alberta; or pass through Alberta to or from the North West Territories or the United States. For this option, a standard assumption has been made regarding transportation distances for truck and rail.

Option 2 – Detailed Approach

This option should be used where the proponent has access to detailed size (tonnage) and distance data for each freight shipment conducted during the project and baseline timeframes, and must be used for freight shipments that: originate, terminate, and/or switch modes within Alberta, or pass through Alberta to or from the North West Territories or the United States.

2) <u>Trucking GHG Emission Factor</u>

This protocol provides a default trucking emission factor for use. However, where the proponent has access to truck transport emission factors specific to the fleet of baseline trucks and/or types of routes being used, or otherwise has trucking emission factors that are more suitable for the project, these factors may be used instead of the single default factor provided in this protocol. Alternative emission factors could include a single emission factor or a number of emission factors corresponding to different truck configurations, routes, etc. being used. Where the proponent decides to use their own factors, the appropriateness of these factors must be justified.

1.2 Glossary of New Terms and Definitions

Table 1-1: Glossary of Terms

Term	Acronym	Definition
Destinations	D	The ultimate destination for freight being shipped by the project. This is the location where the freight would be unloaded from a truck or train after having been shipped from project Origins.
Origins	O	Starting points for freight being shipped by the project. This is the location where the freight would be loaded onto a truck or train for ultimate delivery to Destinations.
Revenue tonne – kilometer	RTK	The product of the mass of freight shipped and the distance the freight is shipped. RTK excludes any non-revenue transportation movement (e.g. moving railway or other non-revenue materials, empty rail cars and truck trailers, etc.), and does not include the weight of the rail cars or truck trailers themselves.
Intermodal Terminal		A location where truck containers can be transferred to trains or containers on trains can be transferred to trucks.
Rail Hub		A more general term than intermodal terminal specifying a location where freight can be transferred between truck and rail.
Rail Spur		A rail line that is brought directly into a facility (origin or destination) such that transport by truck to or from an intermodal terminal is not required to ship by rail.
Producer		Refers to the company that manufactures the goods to be shipped.
Aggregator		For the purposes of this protocol, 'aggregator' refers to a company or organization that collects the same kind of good (e.g. wheat, lumber, etc.) from a number of small producers, and acts on their behalf to ship the goods from a centralized location. For the purposes of this protocol, 'aggregator' excludes shipping companies and third party logistics companies that handle a wide variety of goods from many different producers and aggregators.

2 QUANTIFICATION DEVELOPMENT AND JUSTIFICATION

2.1 Identification of Sources, Sinks and Reservoirs (SSRs) for the Project

Approach

A systematic approach was used to identify GHG sources, sinks, and reservoirs (SSRs) that could be controlled, related or affected by the project and that could fall within the project scope described in Section 1.1.

The steps of the systematic approach used are outlined below:

1) Identify the project model based on the activities included in the project by:
   a. identifying main project activities that immediately provide for project function (i.e. physical transporting of freight from Origins to Destinations);
   b. identifying inputs and outputs (materials and energy) associated with these main activities; and
   c. identifying additional project activities by tracking identified material and energy inputs/outputs upstream to origins in natural resources and downstream along life-cycle; and
   d. review all activities and material and energy flows to ensure that all relevant activities have been identified
2) Based on the project model developed in Step 1), identify all SSRs and classify these SSRs as either controlled, related, or affected by the project.

Result

As illustrated previously in Figure 1-1, shipping of freight by rail from Origins to Destinations generally involves the following main activities:
1) Transporting the freight by truck from Origin to intermodal terminals or rail hubs (except where freight is loaded directly onto a train at an Origin rail spur)
2) Transporting the freight by train to intermodal terminals or rail hubs close to Destinations, or rail spurs at Destinations
3) Transporting the freight by truck from intermodal terminals or rail hubs to Destinations (except where freight is unloaded directly from a train at a Destination rail spur)

As part of the above steps, it may be necessary to load and unload the freight multiple times, including at Origins and Destinations and when transferring freight from truck to rail and vice-versa (if required). However, where multiple trains are required to complete the shipping of freight, it should be noted that freight would not be unloaded and loaded each time, but instead freight rail cars would be simply uncoupled from one train and coupled to the next.

SSRs associated with these activities, and related inputs, outputs and other activities identified using the systematic approach described above, are illustrated in Figure 2-1.

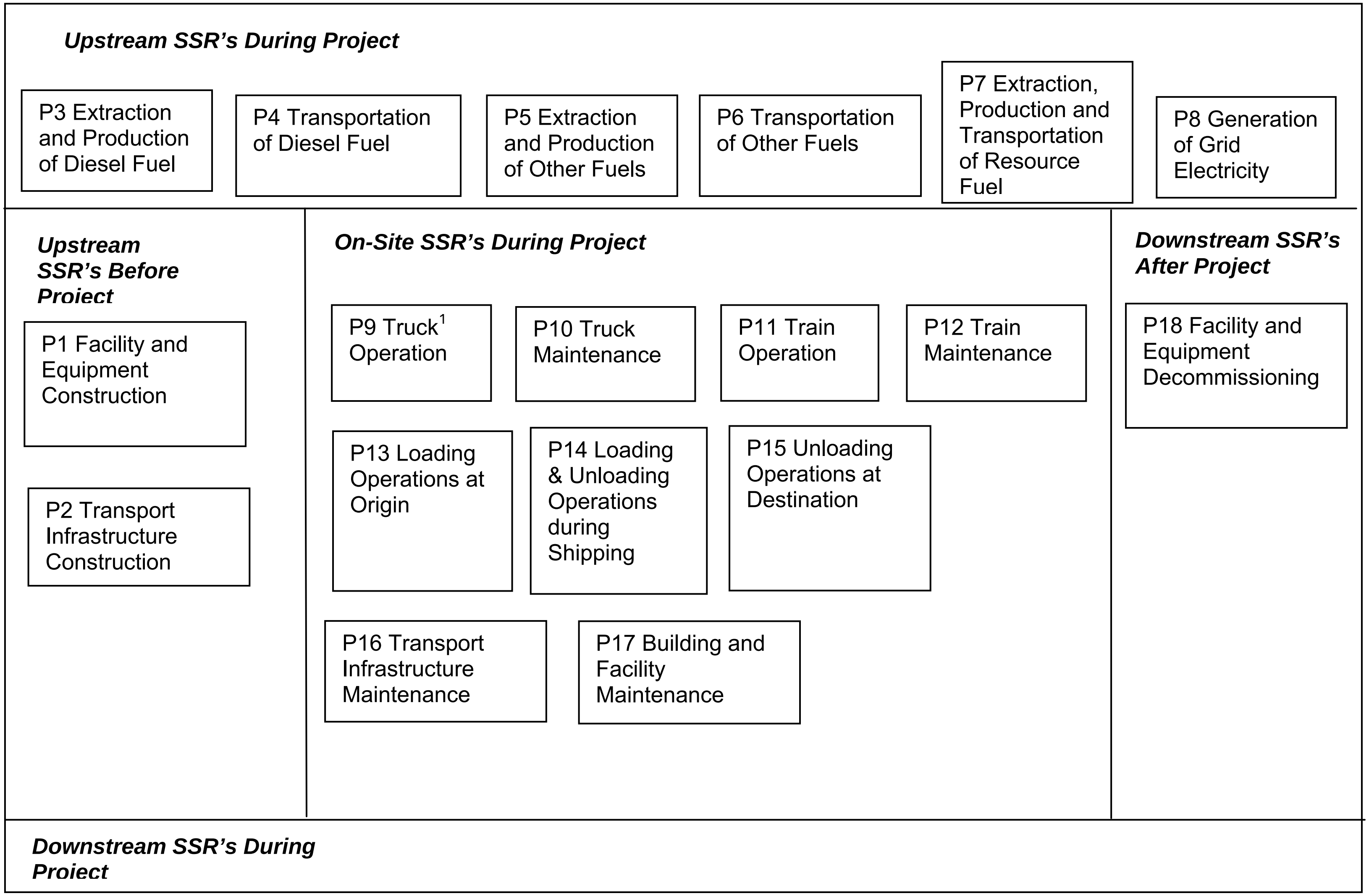


Figure 2-1: Project SSR Life Cycle Chart

SSRs presented in Figure 2-1 are described in Table 2-1. Note that in classifying SSRs as controlled, related, or affected from the perspective of the project proponent, it is assumed that the project proponent is the producer or aggregator of the freight to be shipped, and that, with the exception of loading equipment at Origins, they do not own or directly control any of the activities identified for the project.

Table 2-1: Identification of Controlled, Affected or Related SSRs for the Project

1. SSR	2. Description	3. Controlled, Related or Affected
Upstream SSRs		
P1 – Facility and Equipment Construction	All activities associated with the construction of facilities and equipment (such as shipping hubs, warehouses, rail cars and locomotives, etc.) that would be required in order to facilitate an increase in rail transport due to the project.	Controlled / Related
P2 – Transport Infrastructure Construction	All activities associated with building new roads, rail track, and related infrastructure necessary for truck and rail freight transportation.	Related
P3 - Extraction and Production of Diesel Fuel	All activities associated with the extraction and production of diesel fuel from crude oil or other feedstocks (such as biomass in the case of biodiesel blends). This diesel fuel would be used as fuel for truck and rail transportation, as well as for loading and unloading operations, where applicable.	Related
P4 - Transportation of Diesel Fuel	Transport of diesel fuel from the production facility to the end use location. Transportation typically conducted by truck.	Related
P5 - Extraction and Production of Other Fuels	All activities associated with the extraction and processing of fuels other than diesel. These fuels would be used as fuel for loading and unloading equipment (e.g. cranes, forklifts) and facilities, where applicable.	Related
P6 - Transportation of Other Fuels	Transport of fuel from the production facility to the end use location. Transportation typically conducted by various means, including truck (e.g. propane) and pipeline (e.g. natural gas).	Related
P7 - Extraction, Production and Transportation of Resource Fuel for Grid Electricity Generation	All activities associated with the extraction, processing, and transportation of various resource fuels for use in grid electricity generation. Fuel sources could include coal, refined petroleum, natural gas, uranium, etc., depending on the source of grid electricity.	Related
P8 - Generation of Grid Electricity	Generation of electricity from resource fuel. Generated electricity would be used as an energy source for loading and unloading equipment (e.g. cranes, forklifts) and facilities, where applicable.	Related

1. SSR	2. Description	3. Controlled, Related or Affected
On-site SSRs		
P9 - Truck Operation	All activities associated with operation of trucks transporting project freight. These activities include: • Combustion of diesel fuel during transport of the freight • Combustion of diesel fuel while idling, for example during loading and unloading, or when drivers are resting • Combustion of diesel fuel while driving with an empty trailer, where such driving is a direct result / requirement of transporting the project freight	Related
P10 – Truck Maintenance	All activities associated with maintaining trucks in operational condition. These activities include: • Minor repairs • Major repairs / overhauls • Fluid, filter and minor component replacement	Related
P11 - Train Operation	All activities associated with operation of trains transporting project freight. These activities include: • Combustion of diesel fuel during transport of the freight • Combustion of diesel fuel during idling, for example during loading and unloading or when trains are sitting empty in the yard • Combustion of diesel fuel while moving locomotives without cargo, where such movement is a direct result / requirement of transporting the project freight	Related
P12 – Train Maintenance	All activities associated with maintaining trains in operational condition. These activities include: • Minor repairs • Major repairs / overhauls • Fluid, filter and minor component replacement	Related
P13 – Loading Operations at Origin	All activities associated with loading freight onto trucks or rail cars at Origins, including operation of loading equipment (cranes, forklifts, etc.)	Controlled
P14 - Loading & Unloading Operations during Shipping	All activities associated with loading and unloading freight onto / off of trucks or rail cars, including operation of loading and unloading equipment (cranes, forklifts, etc.)	Related

1. SSR	2. Description	3. Controlled, Related or Affected
P15 – Unloading Operations at Destination	All activities associated with unloading freight from trucks or rail cars at Destinations, including operation of unloading equipment (cranes, forklifts, etc.)	Related
P16 – Transport Infrastructure Maintenance	All activities associated with maintenance of road and rail infrastructure necessary for truck and rail freight transportation. This would also include periodic replacement of key infrastructure components (e.g. bridges, etc.) as required.	Related
P17 – Building and Facility Maintenance	All activities associated with the maintenance of buildings and facilities involved in the project (e.g. rail hubs and warehouses)	Controlled / Related
Downstream SSRs		
P18 – Facility and Equipment Decommissioning	All activities associated with the end-of-life decommissioning, recycling and disposal of facilities and equipment (such as shipping hubs, warehouses, rail cars and locomotives, etc.) that would be required in order to facilitate an increase in rail transport due to the project.	Related

2.2 Identification of the Baseline

To determine the amount of freight transportation shifted from truck to rail by the project and ultimately calculate associated GHG emission reductions, it is necessary to identify the most appropriate baseline scenario. While it is assumed (as part of the protocol scope) that the baseline scenario will involve transportation of freight using at minimum truck transportation, options exist with respect to how this baseline is determined.

Five specific types of potential baseline scenarios have been considered, as described in Table 2-2. These potential baseline types are taken from draft GHG quantification guidance prepared by Environment Canada in 2006 (Environment Canada, 2006a). Please note that this discussion is focused on determining the most appropriate baseline freight transportation activity data (i.e. RTK shipped by various modes), versus identifying the most appropriate baseline emission factor data, which is discussed in Section 2.5.

Table 2-2: Possible Baseline Scenarios for Estimating GHG Emissions without the Project

Baseline Option	
Historic baseline	
• Description	Amounts of baseline freight transportation by truck and rail would be determined based on past transportation practices of the project proponent. For instance, freight transportation data over the three years preceding registration of the project could be tallied, and the percentage of RTK provided by truck and rail could be calculated. This baseline could

Baseline Option	
	also include more detailed information about truck configuration and type if available.
• Static or Dynamic	Amounts of baseline freight transportation (i.e. RTK) by mode would be static (since based on historic practices that have already occurred).
• Accept or Reject and Justify	**Accept, Static** Because transportation practices of individual companies can be highly varied, depending on the goods being shipped, geographic location, and individual decisions made by each company, an historic, project proponent-specific baseline offers the greatest combined level of transparency and accuracy for the baseline. To avoid the impact of year-to-year business fluctuations on determination of baseline data, baseline data should be compiled over a minimum 3-year historic period (versus over a single year) immediately prior to commencement of the project, or the 3-year period immediately prior to the Alberta Offset System project eligibility date of January 1, 2002, (i.e. 1999 – 2001) whichever is later.
Performance standard / Normalized baseline	
• Description	Industry statistics for percentage of goods shipped by truck and rail for specific regions and types of goods would be used as a proxy for project proponent-specific data. Industry regional average transportation distance, load data and truck configuration could also be included.
• Static or Dynamic	Static or Dynamic (could be set once at the beginning of the project or updated periodically)
• Accept or Reject and Justify	**Reject** While in theory this approach would be quite attractive, and could be applied to new companies (currently excluded from the scope of this protocol) as well as companies with an historic track record, it is currently impractical from a cost and data perspective to develop a performance standard that would be suitable for the project. Any performance standard would have to include data from across Canada to account for Origins and Destinations outside of the province of Alberta. It is unlikely that a single performance standard would be an accurate measure of shipping habits for comparison with individual proponents due to the dependence of shipping habits on both region and type of good. Multiple performance standards would require disaggregated freight data that are not readily available and would require significant effort to obtain. In some cases, an insufficient quantity of data may be available for certain regions and/or goods.
Comparison	
• Description	Operations of the project proponent during the project would be compared to the activities of other similar firms not undertaking project activities (i.e. a control group).

Baseline Option	
• Static or Dynamic	Dynamic
• Accept or Reject and Justify	**Reject** This approach is infeasible as it is not clear how an appropriate control group would be chosen or monitored, and how it could be ensured that the control group would follow business-as-usual practices relevant to the project proponent's specific situation and business reality.
Projection-based	
• Description	Use of truck and rail in the business-as-usual case would be projected into the future, based on various assumptions including: historical activities; project proponent-specific circumstances; and industry, economic, and other expectations.
• Static or Dynamic	Static (make projection once at beginning of the project) or Dynamic (update projection regularly throughout the project)
• Accept or Reject and Justify	**Reject** This approach is the least transparent and accurate, particularly given the uncertain nature of projections and the hypothetical nature of the baseline in this case. Development of convincing justification for a particular project-specific projection is expected to be exceedingly difficult and impractical for expected users of this protocol. Additionally, it is expected that any projection of a future baseline would draw heavily on typical industry approaches or historic data, which forms the basis of other baseline approaches described above.
Already approved	
• Description	**Not applicable**
• Static or Dynamic	N/A
• Accept or Reject and Justify	No baselines already registered and approved were identified for this project type

Therefore, the Historic baseline has been selected as the most appropriate baseline scenario for this protocol. As such, this protocol is limited to proponents who have been in business for more than three years, and that should therefore have sufficient data to craft a 3-year average historic baseline.

2.3 Identification of SSRs for the Baseline

Approach

A systematic approach equivalent to the approach outlined for the project in Section 2.1 was also used to identify SSRs for the baseline, using the baseline process flow diagram provided in Figure 1-2.

Result

Shipping of freight by truck from Origins to Destinations generally involves only one main activity: transporting the freight by truck from Origins to Destinations.

As part of this main activity, it will be necessary to load and unload the freight at least once (i.e. load at Origins and unload at Destinations), and possibly multiple times if multiple trucks are required to complete the journey. SSRs associated with these activities, and related inputs, outputs and other activities identified using the systematic approach described above, are illustrated in Figure 2-2.

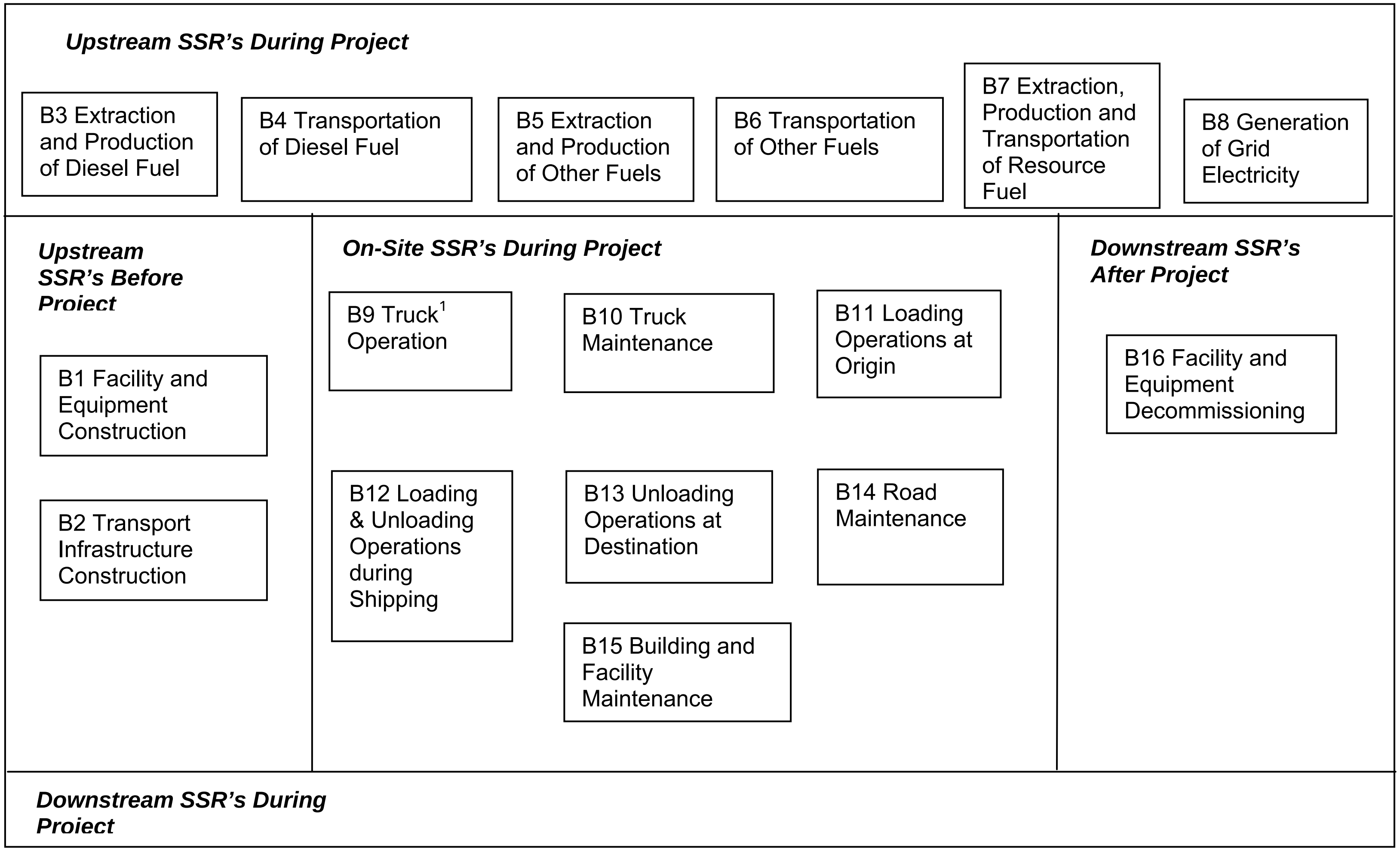


Figure 2-2: Baseline SSR Life Cycle Chart

SSRs presented in Figure 2-2 are described in Table 2-3 Note that in classifying SSRs as controlled, related, or affected from the perspective of the project proponent, it is assumed that the project proponent is the producer or aggregator of the freight to be shipped, and that, with the exception of loading equipment at Origins, they do not own or directly control any of the activities identified for the project.

Table 2-3: Identification of Controlled, Affected or Related SSRs for the Baseline

1. SSR	2. Description	3. Controlled, Related or Affected
Upstream SSRs		
B1 – Facility and Equipment Construction	All activities associated with the construction of facilities and equipment (such as shipping hubs, warehouses, trucks, etc.) that would be required for truck freight transportation.	Related
B2 – Transport Infrastructure Construction	All activities associated with building new roads and related infrastructure necessary for truck freight transportation.	Related
B3 - Extraction and Production of Diesel Fuel	All activities associated with the extraction and production of diesel fuel from crude oil or other feedstocks (such as biomass in the case of biodiesel blends). This diesel fuel would be used as fuel for truck and rail transportation, as well as for loading and unloading operations, where applicable.	Related
B4 - Transportation of Diesel Fuel	Transport of diesel fuel from the production facility to the end use location. Transportation typically conducted by truck.	Related
B5 - Extraction and Production of Other Fuels	All activities associated with the extraction and processing of fuels other than diesel. These fuels would be used as fuel for loading and unloading equipment (e.g. cranes, forklifts) and facilities, where applicable.	Related
B6 - Transportation of Other Fuels	Transport of fuel from the production facility to the end use location. Transportation typically conducted by various means, including truck (e.g. propane) and pipeline (e.g. natural gas).	Related
B7 - Extraction, Production and Transportation of Resource Fuel for Grid Electricity Generation	All activities associated with the extraction, processing, and transportation of various resource fuels for use in grid electricity generation. Fuel sources could include coal, refined petroleum, natural gas, uranium, etc., depending on the source of grid electricity.	Related
B8 - Generation of Grid Electricity	Generation of electricity from resource fuel. Generated electricity would be used as an energy source for loading and unloading equipment (e.g. cranes, forklifts) and facilities, where applicable.	Related

1. SSR	2. Description	3. Controlled, Related or Affected
On-site SSRs		
B9 - Truck Operation	All activities associated with operation of trucks transporting project freight. These activities include: • Combustion of diesel fuel during transport of the freight • Combustion of diesel fuel while idling, for example during loading and unloading, or when drivers are resting • Combustion of diesel fuel while driving with an empty trailer, where such driving is a direct result / requirement of transporting the project freight	Related
B10 – Truck Maintenance	All activities associated with maintaining trucks in operational condition. These activities include: • Minor repairs • Major repairs / overhauls • Fluid, filter and minor component replacement	Related
B11 – Loading Operations at Origins	All activities associated with loading freight onto trucks at Origins, including loading equipment (cranes, forklifts, etc.)	Controlled / Related
B12 - Loading & Unloading Operations during Shipping	All activities associated with loading and unloading freight onto / off of trucks, including operation of loading and unloading equipment (cranes, forklifts, etc.)	Related
B13 – Unloading Operations at Destinations	All activities associated with unloading freight from trucks at Destinations, including operation of unloading equipment (cranes, forklifts, etc.)	Controlled / Related
B14 – Transport Infrastructure Maintenance	All activities associated with construction and maintenance of roads and related truck freight transportation infrastructure. This would also include periodic replacement of key infrastructure components (e.g. bridges, etc.) as required.	Related
B15 – Building and Facility Maintenance	All activities associated with the maintenance of buildings and facilities involved in the project (e.g. warehouses)	Controlled / Related
Downstream SSRs		
B16 – Facility and Equipment Decommissioning	All activities associated with the end-of-life decommissioning, recycling and disposal of facilities and equipment (such as shipping hubs, warehouses, trucks, etc.) that would be required in for truck freight transportation.	Related
Other		

1. SSR	2. Description	3. Controlled, Related or Affected
None identified		

2.4 Selection of Relevant Project and Baseline SSRs

Project and baseline SSRs identified in Sections 2.1 and 2.3 were screened for relevance. An SSR was not considered relevant, and thus excluded from quantification, if any of the following criteria applied:

- Emissions/removals for the SSR unchanged between project and baseline
- Emissions/removals for the SSR less for the project than the baseline and quantification of the emissions/removals not considered cost-effective
- Project emissions/removals for the SSR expected to be less than 1% of total emission reductions / removal enhancements for the project as a whole, making the quantification of the SSR not cost effective given the its limited impact on overall results
- It is determined that the SSR is not actually an emission source for the project/baseline

Results of this screening are presented in Table 2-4, with SSRs included for quantification highlighted in bold text.

Table 2-4: Compare Controlled, Affected or Related Baseline and Project SSRs

1. Identified SSR	2. Baseline Attribution	3. Project Attribution	4. Include or Exclude from Quantification	5. Justification for Exclusion / Notes
Upstream SSRs during Project / Baseline Operation				
P1 / B1 – Facility and Equipment Construction	Controlled / Related	Controlled / Related	Exclude	Emissions associated with construction of facilities and equipment necessary to allow for an increase in project rail transportation are expected to be mostly offset by decreases in emissions associated with truck-related facilities and equipment that will no longer be required. As a result, the change in emissions for this SSR between project and baseline is expected to represent < 1% of total emission reductions.
P2 / B2 – Transport Infrastructure Construction	Related	Related	Exclude	In the near term, project activities are not expected to influence the amount of transportation infrastructure (e.g. road, rails) constructed to any appreciable extent. Over longer terms, if sufficient modal shifting occurs, it would be expected that any increase in rail transport infrastructure construction would be offset by decreases in road construction and/or maintenance (maintenance covered separately in SSR P16/B14). Thus, emissions are expected to be unchanged between project and baseline.

1. Identified SSR	2. Baseline Attribution	3. Project Attribution	4. Include or Exclude from Quantification	5. Justification for Exclusion / Notes
P3 / B3 - Extraction and Production of Diesel Fuel	**Related**	**Related**	**Include**	**n/a**
P4 / B4 - Transportation of Diesel Fuel	Related	Related	Exclude	Where fuel consumption per revenue tonne-km is less for the project than baseline, as is the case for shifting from truck to rail transportation, less fuel will need to be transported in the project case than in the baseline case. Thus, it is conservative to exclude this SSR from quantification since associated baseline emissions will exceed project emissions.
P5 / B5 - Extraction and Production of Other Fuels	Related	Related	Exclude	Diesel-powered cranes are expected to be the primary equipment used for intermodal loading and unloading (CN Rail, 1999). Therefore, extraction and production of other fuels is not expected to be required.
P6 / B6 - Transportation of Other Fuels	Related	Related	Exclude	Diesel-powered cranes are expected to be the primary equipment used for intermodal loading and unloading (CN Rail, 1999). Therefore, transportation of other fuels is not expected to be required.
P7 / B7 - Extraction, Production and Transportation of Resource Fuel for Grid Electricity Generation	Related	Related	Exclude	Since grid electricity is not required (as discussed below as part of SSR P8/B8), emissions from extraction, production and transportation of resource fuel for grid electricity generation do not need to be quantified.
P8 / B8 - Generation of Grid Electricity	Related	Related	Exclude	It is expected that loading and unloading of container-sized loads at intermodal terminals will be conducted using diesel-powered equipment versus smaller electric forklifts or other electric equipment, as assumed for SSR P14/B12 (CN Rail, 1999). Therefore, quantification of emissions from grid electricity generation will not be required.

1. Identified SSR	2. Baseline Attribution	3. Project Attribution	4. Include or Exclude from Quantification	5. Justification for Exclusion / Notes
On-site SSRs during Project / Baseline Operation				
P9 - Truck Operation	Related	Related	Exclude	In the case of shipments passing through but neither originating or terminating in Alberta, no truck emissions associated with transporting goods from origins to intermodal terminals or from intermodal terminals to destinations will occur within Alberta. In the case of shipments either originating or terminating in Alberta, emissions would result where truck transportation is required in the project case to bring freight to and from intermodal terminals. However, the approach described in Section 2.5 for determining the total amount of eligible project rail RTK automatically accounts for these emissions without the need to explicitly quantify them. This is because the project proponent is required to track any truck RTK to and from intermodal terminals separately from rail RTK, and include this truck RTK within the total amount of truck RTK shipped during the project timeframe. Since increasing the project truck RTK decreases %RTK rail during the project timeframe, this will reduce the amount of eligible project rail RTK that can be used to calculate emission reductions.
B9 - Truck Operation	**Related**	**Related**	**Include**	**n/a**
P10 / B10 – Truck Maintenance	Related	Related	Exclude	Since the project involves shifting from truck to rail freight transport, emissions associated with truck maintenance, if any, would be larger in the baseline than in the project. Therefore, this SSR can be conservatively excluded.
P11 - Train Operation	**N/A**	**Related**	**Include**	**n/a**

1. Identified SSR	2. Baseline Attribution	3. Project Attribution	4. Include or Exclude from Quantification	5. Justification for Exclusion / Notes
P12 – Train Maintenance	N/A	Related	Exclude	Locomotives are typically transported to maintenance shops under their own power, so maintenance emissions related to moving trains to maintenance facilities are already covered under P11 – Train Operation. With respect to activities occurring once trains arrive at maintenance facilities, train maintenance activities are performed on average every 92 days (US Gov, 2003; CN Rail, date unknown). Maintenance requires the use of electric overhead cranes and electric or propane forklifts. Due to the infrequency of maintenance compared to the frequency of normal operation, the emissions from maintenance are expected to be less than 1% of total emission reductions, particularly when considering that a decrease in truck use as part of the project would be expected to result in decreased truck related maintenance emissions (discussed as part of SSR P10/B10).
P13 / B11 - Loading Operations at Origins	Controlled	Controlled	Exclude	Emission sources and activity levels are the same for the project and baseline, since in both cases the same load is loaded at the same location (Origin) by the same equipment. Thus, emissions are unchanged between project and baseline.
P14 / B12 - Loading & Unloading Operations during Shipping	**Related**	**Related**	**Include P14**, Exclude B12	To make quantification of this SSR cost effective, only the increase in emissions due to project activities will be assessed, versus quantifying emissions separately for all project and baseline loading and unloading emissions. As such, baseline emissions for this SSR will be assumed to be zero. See the quantification method for SSR P14 in Table 2-5 for further details.
P15 / B13 - Unloading Operations at Destinations	Related	Related	Exclude	Emission sources and activity levels are the same for the project and baseline, since in both cases the same load is unloaded at the same location (Destination) by the same equipment. Thus, emissions are unchanged between project and baseline.
P16 / B14 – Transport Infrastructure Maintenance	Related	Related	Exclude	It is expected that emissions from project transportation infrastructure maintenance would be less than for baseline transportation infrastructure maintenance given that any increase in rail-related maintenance would be expected to be at minimum offset by corresponding decreases in road-related maintenance.

1. Identified SSR	2. Baseline Attribution	3. Project Attribution	4. Include or Exclude from Quantification	5. Justification for Exclusion / Notes
P17 / B15 – Building and Facility Maintenance	Related	Related	Exclude	Emissions associated with maintenance of buildings and facilities necessary to allow for an increase in project rail transportation are expected to be mostly offset by decreases in emissions associated with maintenance of truck-related buildings and facilities that will be used to a lesser extent. As a result, the change in emissions for this SSR between project and baseline is expected to represent < 1% of total emission reductions.
Downstream SSRs during Project / Baseline Operation				
P18 / B16 – Facility and Equipment Decommissioning	Related	Related	Exclude	Emissions associated with decommissioning of facilities and equipment necessary to allow for an increase in project rail transportation are expected to be mostly offset by decreases in emissions associated with decommissioning truck-related facilities and equipment that will no longer need to be constructed. As a result, the change in emissions for this SSR between project and baseline is expected to represent < 1% of total emission reductions.

2.5 Quantification of Reductions / Removals / Reversals of Relevant SSRs

2.5.1 Primary Procedures

Procedures for quantifying emissions associated with relevant SSRs, including associated data measurement and estimation procedures, are described in Table 2-5 and Table 2-6 for project and baseline SSRs, respectively. SSRs are listed in order of expect magnitude of emissions, from greatest to least.

1 **Table 2-5: Procedures for Measuring/Estimating Parameters for Calculating Project SSRs**

1. Project SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
P11 – Train Operation	= (Eligible Project Rail RTK) X (Rail Fuel Consumption Factor) X (Rail Diesel Combustion Emission Factor)					
	Eligible Project Rail RTK	tonne-km	See Appendix I			
	Rail Fuel Consumption Factor	L diesel per Revenue Tonne km	Estimated	Use the most recent 3-year average, from data published in Locomotive Emission Monitoring Program annual reports (www.railcan.ca). See Appendix II for details.	Check for updated data annually	See Appendix III. Average rail fuel consumption for the years 2004 – 2006 was 6.002 L / 1,000 RTK.
	Rail Diesel Combustion Emission Factor	tonne CO_2e per L diesel	Estimated	Use data from Canada's GHG Inventory	Check for updated data annually	It is impractical to measure actual fuel combustion emissions for every locomotive used to haul project freight. Therefore, this parameter is estimated. Canada's GHG Inventory, prepared by Environment Canada, is an accepted reference for a wide variety of GHG emission factors, including rail diesel combustion emission factors. The GHG Inventory is updated on an annual basis. 2004 value for rail is 3074.15 g

1. Project SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
						CO_2e / L Diesel.
P3 - Extraction and Production of Diesel Fuel	= (Volume Diesel Consumed by Train) X (1+ Correction Factor for Loading and Unloading) X (Diesel Extraction and Production Emission Factor), where (Volume Diesel Consumed by Train) = (Train Operation Emissions) / (Rail Diesel Combustion Emission Factor)					
	Train Operation Emissions	tonne CO_2e	Estimated	Taken directly from the result of emission calculations for SSR P11 – Train Operation		
	Correction Factor for Loading and Unloading	unitless	Estimated	Based on a comparison of emissions from loading and unloading versus train operation (see SSR P14 for details).	Whenever the methodology for SSR P14 is updated	It is impractical to measure the actual ratio of diesel fuel consumed by loading and unloading versus train operation for every project shipment. Therefore, this parameter is estimated. Amount of diesel fuel requiring extraction and production is directly proportional to emissions from the same amount of diesel fuel when combusted. Therefore, applying a correction factor to account for loading and unloading emissions based on the ratio of fuel consumption for loading and unloading emissions as compared to train operation emissions is appropriate. A correction factor of 14% is to be used (see SSR P14 for details).
	Rail Diesel Combustion Emission Factor	tonne CO_2e per L diesel	Estimated	Use data from Canada's GHG Inventory for Rail	Check for updated data annually	It is impractical to measure actual fuel combustion emissions for every locomotive used to haul project

1. Project SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
				mobile source emissions		freight. Therefore, this parameter is estimated. Canada's GHG Inventory, prepared by Environment Canada, is an accepted reference for a wide variety of GHG emission factors, including rail diesel combustion emission factors. The GHG Inventory is updated on an annual basis. 2004 value for rail is 3074.15 g CO_2e / L Diesel.
	Diesel Extraction and Production Emission Factor	tonne CO_2e per Litre diesel	Estimated	Use data available from Environment Canada	Check for updated data on an annual basis.	It is impractical to measure actual emissions associated with extracting and producing diesel fuel used in the project. Therefore, this parameter is estimated. Environment Canada data is representative of Canadian average emissions, and is based National GHG Inventory data and data collected by Statistics Canada. Data will likely not be updated more frequently than annually. 2002 value is 562.82 g CO_2e / L Diesel.

1. Project SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
P14 - Loading & Unloading Operations during Shipping	= (Train Operation Emissions) X (Correction Factor for Loading and Unloading)					
	Train Operation Emissions	tonne CO_2e	Estimated	Taken directly from the result of emission calculations for SSR P11 – Train Operation		
	Correction Factor for Loading and Unloading	unitless	Estimated	Based on a comparison of emissions from loading and unloading versus train operation (see Appendix IV).	n/a	See Appendix IV A correction factor of 14% is to be used.

Table 2-6: Procedures for Measuring/Estimating Parameters for Calculating Baseline SSRs

1. Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
B9 – Truck Operation	= (Eligible Baseline Truck RTK) X (Truck Emission Factor)					
	Eligible Baseline Truck RTK	Revenue tonne km	Estimated	Equals the eligible project rail RTK (defined as the amount of baseline truck RTK shifted to project rail), determined as per Appendix I		
	Truck Emission Factor	tonne CO_2e per Revenue tonne km	Estimated	See Appendix V		

1. Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
B3 - Extraction and Production of Diesel Fuel	= (Volume Diesel Consumed by Truck) X (Diesel Extraction and Production Emission Factor), where (Volume Diesel Consumed by Truck) = (Baseline Truck Emissions) / (Truck Diesel Combustion Emission Factor)					
	Baseline Truck Emissions	tonne CO_2e	Estimated	Taken directly from emissions calculated for SSR B9 – Truck Operation		
	Truck Diesel Combustion Emission Factor	tonne CO_2e per L diesel	Estimated	Use data from Canada's GHG Inventory for Heavy Duty Diesel Vehicle, Moderate Controls, mobile source emissions	Check for updated data annually	It is impractical to measure actual fuel combustion emissions for every truck used to haul baseline freight. Therefore, this parameter is estimated. Canada's GHG Inventory, prepared by Environment Canada, is an accepted reference for a wide variety of GHG emission factors, including truck diesel combustion emission factors. The GHG Inventory is updated on an annual basis. 2004 value for a Heavy Duty Diesel Vehicle (HDDV) with moderate controls is 2757.53 g CO_2e / L diesel.
	Diesel Extraction and Production Emission Factor	tonne CO_2e per Litre diesel	Estimated	Use data available from Environment Canada	Check for updated data on an annual basis.	It is impractical to measure actual emissions associated with extracting and producing diesel fuel used in the baseline. Therefore, this parameter is estimated. Environment Canada data is representative of Canadian

1. Baseline SSR	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
						average emissions, and is based National GHG Inventory data and data collected by Statistics Canada. Data will likely not be updated more frequently than annually. 2002 value is 562.82 g CO_2e / L Diesel.

2.5.2 Contingency Procedures

Contingency procedures for data collection, where the methods described in Table 2-5 and Table 2-6 are not available, are described in Table 2-7 and Table 2-8 for project and baseline SSRs, respectively.

Table 2-7: Contingency Procedures for Measuring/Estimating Parameters for Calculating Relevant Project SSRs

1. Project / Baseline SSR (list key SSRs first)	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Contingency Method	6. Frequency	7. Justify measurement or estimation and frequency
P11 – Train Operation						
	Project Rail RTK	Tonne-km	Alternative methods already described as part of Table 2-5			
	Rail Fuel Consumption Factor	L Diesel per Revenue Tonne km	Contingency procedure not required as Locomotive Emissions Monitoring reports are readily available public documents. Should this data source become unavailable in future years, project proponents should consult with their rail provider to identify an alternative data source.			
	Rail Diesel Combustion Emission Factor	Tonne CO_2e per L Diesel	Contingency procedure not required as Canada's GHG Inventory is a readily available public document, and diesel combustion emission factors are not expected to change significantly from year to year.			

1. Project / Baseline SSR (list key SSRs first)	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Contingency Method	6. Frequency	7. Justify measurement or estimation and frequency
P3 - Extraction and Production of Diesel Fuel						
	Project Rail Emissions	Tonne CO_2e	Contingency procedure not required – data taken directly from emissions calculated for SSR P11 – Train Operation			
	Rail Diesel Combustion Emission Factor	Tonne CO_2e per L Diesel	Contingency procedure not required as Canada's GHG Inventory is a readily available public document, and diesel combustion emission factors are not expected to change significantly from year to year.			
	Diesel Extraction and Production Emission Factor	Tonne CO_2e per Litre diesel	If the primary data source is not available, the following sources could be consulted: 1) Clearstone Engineering Ltd. (2004). *A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry Volume 1, Overview of the GHG Emissions Inventory*. Prepared for the Canadian Association of Petroleum Producers. 2) Natural Resources Canada. (1999). *Canada's Emissions Outlook: An Update*.			
P14 - Loading & Unloading Operations during Shipping						
	Train Operation Emissions	tonne CO_2e	Contingency procedure not required – data taken directly from emissions calculated for SSR P11 – Train Operation			
	Correction Factor for Loading and Unloading	unitless	Contingency procedure not required – this is a constant value that does not required monitoring			

Table 2-8: Contingency Procedures for Measuring/Estimating Parameters for Calculating Relevant Baseline SSRs

1. Project / Baseline SSR (list key SSRs first)	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Contingency Method	6. Frequency	7. Justify measurement or estimation and frequency
B9 – Truck Operation						
	Baseline Truck RTK	Revenue Tonne km	Contingency procedure not required – data taken directly from values calculated for SSR P11 – Train Operation			
	Truck Emission Factor	Tonne CO_2e per Revenue Tonne km	Alternative methods already described as part of Table 2-6			
B3 - Extraction and Production of Diesel Fuel						
	Baseline Truck Emissions	Tonne CO_2e	Contingency procedure not required – data taken directly from emissions calculated for SSR B9 – Truck Operation			
	Truck Diesel Combustion Emission Factor	Tonne CO_2e per L Diesel	Contingency procedure not required as Canada's GHG Inventory is a readily available public document, and diesel combustion emission factors are not expected to change significantly from year to year.			
	Diesel Extraction and Production Emission Factor	Tonne CO_2e per Litre diesel	If the primary data source is not available, the following sources could be consulted: 1) Clearstone Engineering Ltd. (2004). *A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry Volume 1, Overview of the GHG Emissions Inventory*. Prepared for the Canadian Association of Petroleum Producers. 2) Natural Resources Canada. (1999). *Canada's Emissions Outlook: An Update*.			

2.6 Management of Data Quality

Procedures for managing data quality for each project and baseline SSR are described in Table 2-9 and Table 2-10, respectively. Note that only parameters that involve data measurement and / or collection are discussed in the tables. Other parameters that involve either checking a published emission factor or assumption, or using data collected as part of another SSR are assumed to require no specific QA/QC procedures.

Table 2-9: Project SSR Parameters, Data Quality Management

Relevant SSRs	Parameters	Data Quality Management Procedure	Explanation for how Procedures meet 'Verifiable' requirement
P11 – Train Operation			
	Project Rail RTK	Since data tracking systems and procedures are expected to vary considerably between different proponents (depending on the goods being shipped, company size, etc.), specific data quality management procedures will not be described here. However, proponents should demonstrate in their Offset Project Plan that their activities include the following data quality procedures: • Data collection, analysis, and quality management processes are clearly documented and made available to all staff with a role in the processes. • Staff responsible for data collection, analysis, and quality management are clearly documented, and responsibilities are clearly communicated to relevant staff. • Appropriate staff training is conducted based on designated responsibilities. • A data management system is established, preferably involving the use of a protected electronic database to store and perform basic calculations on monitored data, and to ensure data integrity and security. If an electronic database is not available, an alternative secure and authenticated hardcopy data management system could/should be implemented. • Data collection records are maintained for seven years, either electronically or in hard-copy, that identify <u>for each data set collected</u>: – Date of the shipment; – Date and time the data was recorded or modified; and	These data quality management procedures, if followed, will ensure that 3rd-party verifiers are able to: • Assess the control risk presented by the proponent's data collection and analysis procedures; • Conduct detailed review of collected data and data quality management procedures as required; and • Ultimately assess the validity of the proponent's GHG assertion

Relevant SSRs	Parameters	Data Quality Management Procedure	Explanation for how Procedures meet 'Verifiable' requirement
		– Identity of staff member recording or modifying the data • A data back-up system is in place to ensure that, in the event of a computer failure, fire, etc., project data will not be lost. • Some form of periodic data assessment / error-checking is performed, possibly on a sub-set of the collected data. • An internal data quality management system is in place to periodically: – Confirm that data quality procedures are being followed; and – Identify, correct, and record where data quality procedures have not been followed. • A competent staff member should be made responsible for the data quality management system, and required to sign-off on data quality on a periodic basis.	

Table 2-10: Baseline SSR Parameters, Data Quality Management

Relevant SSRs	Parameters	Data Quality Management Procedure	Explanation for how Procedures meet 'Verifiable' requirement
Data quality management procedures related to measured baseline data (which is restricted to data used to determine the percentage of baseline freight transportation conducted by truck and rail on a percent of total RTK basis), have already been discussed as part of P11 – Train Operation in Table 2-9.			

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Appendix I: Determining Eligible Project Rail RTK

Eligible Project Rail RTK represents the net amount of baseline truck transportation that has been shifted to rail as part of the project. To determine Eligible Project Rail RTK, the project proponent must determine the amount of rail transportation that they have used during the project time period, in units of RTK, that is due to a shift away from truck freight transportation in the baseline. Eligible project rail RTK will be smaller than or equal to total rail RTK during the project time period since the proponent may have already been using a certain portion of rail transportation prior to the start of the project that would be considered part of the baseline and thus would not count as a project activity. This determination can be complicated because the amount of freight transportation conducted by a project proponent can vary from year to year due to various factors, including growth or down-sizing of business activity and associated freight transportation. As such, it is possible to observe, relative to a baseline case, a decrease in total truck transportation RTK without a shift to rail if total company shipping activity decreases, and conversely also an increase in total rail transportation RTK without a shift away from truck transportation if total company shipping activity increases.

Given the above, the following general approach is to be used for determining the amount of baseline truck transportation shifted to rail in the project (note that baseline data used below is selected based on the most appropriate baseline scenario, as identified in Section 2.2):

A) Compare the <u>percentage</u> of rail RTK during the project time period (as a percentage of total RTK shipped by rail and truck combined) to baseline rail RTK. If the project rail RTK percentage is smaller than the baseline rail RTK percentage, then the project data does <u>not</u> show a shift from truck to rail (i.e. no relative increase in rail use has been observed).

B) Otherwise, if percentage rail RTK is increased and percentage truck RTK is decreased for the project relative to the baseline, then the data reflects a shift from truck to rail. In this case, the percentage shift is then calculated by subtracting the project percentage of transport by truck from the baseline percentage of transport by truck, as shown in the following equation:

$$\%\text{Shift to Rail} = \%RTK_{\text{Truck, Baseline}} - \%RTK_{\text{Truck, Project}}$$

Where,

%Shift to Rail = percent of project RTK that represents a shift from truck to rail
$\%RTK_{\text{Truck, Baseline}}$ = percent of total baseline RTK shipped by truck
$\%RTK_{\text{Truck, Project}}$ = percent of total RTK shipped by truck during the project timeframe

C) To determine the total RTK of baseline truck transportation that has shifted to rail in the project, multiply the total RTK shipped by the proponent by both truck and rail combined during the project timeframe by the percentage shift from truck to rail determined in B), above, as shown in the following equation:

$$\text{RTK Shift to Rail} = RTK_{\text{Total, Project}} \text{ X } \%\text{Shift to Rail}$$

Where,

RTK Shift to Rail = the amount of RTK, in units of tonne-kilometers, that has shifted from truck to rail as part of the project
$RTK_{\text{Total, Project}}$ = total RTK shipped during the project timeframe, by both truck and rail
%Shift to Rail = percent of project RTK that represents a shift from truck to rail (determined above)

Two options have been identified for determining the percentage of total RTK freight transportation conducted by the proponent by rail and truck for the project and baseline.

OPTION 1 – SIMPLIFIED APPROACH

The simplified option is available only for freight shipments that pass through Alberta east to west or west to east using a single mode of transport (truck or rail), with both origin and destination outside Alberta.

Note: if the proponent wishes to seek credit for modal shifting for other types of freight shipments (e.g. shipments that originate, terminate, and/or switch modes within Alberta; or that pass through Alberta to or from the North West Territories or the United States), Option 2 – Detailed Approach must be used.

This simplified approach relies on the key assumption that it is reasonable, based on an analysis of the road and rail network in Alberta, to assume that the most direct (and thus typically the most economical) route for freight to travel through Alberta is similar for both rail and truck. Since there are two primary east-west rail corridors in Alberta: one across southern Alberta via Calgary (approximate distance of 540 km) and a more northerly route via Edmonton (approximate distance of 650 km)[1], and these routes correspond generally with the most direct road routes across the province, this assumption is considered appropriate. Assuming that the two routes are used equally, the average distance across Alberta is 595 km. However, since this assumption cannot be easily validated, a conservative estimate of 540 km (the lower value) will be used.

Using this average distance for both truck and rail shipments, project proponents need only track the tonnes of freight transportation by rail and truck (separately) across the province for both the project and baseline timeframe, and then multiply the total tonnage and average distance together to calculate total RTK shipped by each mode. Percentage RTK shipped by each mode for both the project and baseline is then easily calculated. For instance, in the case of rail RTK during the project timeframe, the following equation would be used:

$$\%RTK_{Rail,\ Project} = RTK_{Rail,\ Project} / RTK_{Total,\ Project} \times 100\%$$

Where,

$\%RTK_{Rail,\ Project}$ = percent of total RTK shipped by rail during the project timeframe
$RTK_{Rail,\ Project}$ = total RTK shipped by rail during the project timeframe
$RTK_{Total,\ Project}$ = total RTK shipped during the project timeframe, by both truck and rail

Resulting percentages are then used in the procedure described at the beginning of this note to determine total RTK shifted from truck to rail (i.e. Eligible Project Rail RTK).

For monitoring the total tonnage shipped by each mode, the proponent may use either the detailed tonnage monitoring approach outlined in the Detailed Approach, below, or use any other form of record that will be able to verifiably demonstrate during an audit that a given tonnage of freight was shipped by each mode across Alberta in the project and baseline case.

A project proponent must be able to verifiably demonstrate during an audit that the method selected for determining freight tonnage values results in accurate tonnage data, and that the approach gathers data from all freight shipments conducted during the project and baseline timeframes that fall within the scope of this protocol. All records of tonnage shipped must be permanent records that are company-approved or approved by a legislative authority.

[1] Distances estimated by measured road distances that followed the same route as the rail lines. All road distances were taken from google maps (http://maps.google.com)

OPTION 2 – DETAILED APPROACH

The detailed approach must be used when a proponent wishes to seek credit for modal shifting for shipments that originate, terminate, and/or switch modes within Alberta (given the range of actual shipping distances that could result from origins and destinations potentially located all over the province, an appropriate simplified approach was not identified for these types of shipments). A proponent may still choose to use the simplified approach for shipments passing through Alberta while using the detailed approach for all other shipments, or may use the detailed approach for all shipments.

The most accurate and transparent way to determine the percentage of total RTK freight transportation conducted by the proponent by rail for the project and baseline is through the use of detailed tonnage and distance data for each shipment made by the proponent, broken down by mode of shipment. For shipments that involve both truck and rail (e.g. shipping goods by truck to the nearest intermodal terminal, where they are then loaded onto a train), the distances for the truck and rail portions of the journey must be tracked separately.

For each shipment, monitored tonnage and distance values are then multiplied together, and then individual RTK values for each shipment made using a particular mode are summed together to give total RTK shipped by each mode. Total RTK shipped by both truck and rail combined can then be determined for the project and baseline by summing these mode-specific RTK values. Percentage RTK shipped by each mode for both the project and baseline is then easily calculated. For instance, in the case of baseline truck RTK, the following equation would be used:

$$\%RTK_{Truck,\ Baseline} = RTK_{Truck,\ Baseline} / RTK_{Total,\ Baseline} \times 100\%$$

Where,

$\%RTK_{Truck,\ Baseline}$ = percent of total baseline RTK shipped by truck
$RTK_{Truck,\ Baseline}$ = total baseline RTK shipped by truck
$RTK_{Total,\ Baseline}$ = total baseline RTK shipped, by both truck and rail

Resulting percentages are then used in the procedure described at the beginning of this note to determine total RTK shifted from truck to rail (i.e. Eligible Project Rail RTK).

Availability of the above detailed data, however, depends on project proponents collecting tonnage (or other load size) data and distance data for each shipment.

Detailed freight tonnage values can be determined in a variety of ways, including:

- Direct measurement using weigh-scales; or
- Estimation using a combination of other measures of load size (e.g. volume, number of units, linear measures such as board-feet for lumber, etc.) and average densities for the freight being shipped (e.g. tonnes per pallet, tonnes per 1000 board-feet, tonnes per box car, etc.).

Distances could be estimated using map distance tables, internet-based mapping programs (e.g. http://maps.yahoo.ca, http://maps.google.ca, http://www.mapquest.ca, etc.), or other distance databases (direct measurement of distances, e.g. using odometer readings, is not currently considered feasible unless the project involves a very limited number of routes). For project rail distances, estimates of distance would ideally be based on rail distances versus road distances. However, since the majority of distance data available to proponents will likely be in the form of road distance data, and road distances will both be less than and greater than rail distances depending upon the specific routes, use of either road or rail distance data is deemed acceptable for these estimates. Note that only distances within Alberta are to be considered. For shipments that enter or leave the province, only the Alberta portion of the journey is to be counted.

This tonnage and distance data could be tracked and recorded in a variety of ways, most easily as part of a proponent's invoicing or logistics system, either as part of invoicing for the shipping (e.g. where cost of shipping is based on load size and transportation distance), or invoicing for the sale of the freight itself (which would typically involve a quantity of goods sold and a delivery address, from which a shipping distance could be determined). Use of electronic invoicing or logistics systems would make the processing of monitored data easier, and, for ease of subsequent verification, it is highly recommended that a database of some sort be used to store and perform RTK calculations on all monitored data.

A project proponent must be able to verifiably demonstrate during an audit that the methods selected for determining freight tonnage values and distance values result in accurate data, and that the approaches gather data from all freight shipments conducted during the project and baseline timeframes that fall within the scope of this protocol. All records of tonnage shipped and distances (or proxies for distances used for distance estimates, such as the location of origins and destinations) for each shipment must be permanent records that are company-approved or approved by a legislative authority.

Appendix II: Determining Rail Fuel Consumption Factor

The average of fuel consumption factors (fuel consumption per RTK) for the three most recently available years, as published in the Railway Association of Canada's Locomotive Emission Monitoring Program annual report (www.railcan.ca), is to be recalculated by the proponent on an annual basis as the latest year's data becomes available.

To determine a single year's fuel consumption factor using RAC data, the following equation should be used:

$$FC = (\text{Total Freight RTK in billions of RTK}) / (\text{Diesel Fuel Consumption from Total Freight Operations in millions of L})$$

Where,

FC = Fuel Consumption Factor in units of L diesel per 1,000 RTK.

Both Total Freight RTK and Diesel Fuel Consumption from Total Freight Operations can be found in separate tables in the Locomotive Emission Monitoring Program annual report. The 'Rail Reference Data' worksheet within the spreadsheet calculator provides a location to enter RTK and fuel consumption data up to the year 2010, and will calculate the fuel consumption factor automatically based on the above equation.

Once fuel consumption factors for the three most recent years have been determined, the following equation should be used to calculate the average fuel consumption factor:

$$FC_{Average} = (FC_{year1} + FC_{year2} + FC_{year3}) / 3$$

Where,

$FC_{Average}$ = equals the three-year average fuel consumption factor
FC_{year1} , FC_{year2} , and FC_{year3} = the three most recent years' fuel consumption factors

The 'Assumptions' worksheet of the spreadsheet calculator provides a convenient place to calculate the average fuel consumption factor based on the above equation, and individual annual fuel consumption factors determined as per the above.

Note: where a proponent is quantifying emissions for historic modal shifting activity back to 2002, an historic 3-year average fuel consumption factor for the three years immediately prior to the year being quantified should be used (e.g., if emissions are being quantified for 2005, then a 3-year average for the years 2002 – 2004 would be used).

Appendix III: Justification for Use of Annual RAC Rail Fuel Consumption Factor Data

It is impractical to measure the actual fuel consumption of every locomotive used to haul project freight. Therefore, this parameter is to be estimated.

Locomotive Emission Monitoring Program annual reports are prepared by the Railway Association of Canada (RAC) and submitted to Environment Canada. These reports include data on total RTK shipped by all Canadian Railways and total freight-related fuel consumption, used according to the method described in Note 2, above, to calculate rail fuel consumption factors. As such, they are considered the premier source for fuel consumption and emissions data for the Canadian rail industry.

Annual fuel consumption data used to determine the fuel consumption factor as described in Note 2, above, represents fuel consumed by all freight-related rail operations (including during actual freight movements as well as during movement of rail materials and other non-revenue materials, yard idling, transport to maintenance facilities, etc., but excluding passenger train-related emissions), and is not limited to the smaller amount of fuel consumed only during actual revenue freight movements. This approach ensures that all rail fuel consumption and emissions due, either directly or indirectly, to the shipment of freight is considered.

To calculate the fuel consumption factor in units of L diesel per 1,000 RTK, fuel consumed is then divided by annual revenue tonne-kilometers shipped by the rail industry, versus the larger value of gross tonne-kilometers moved (which includes the weight of both loaded and unloaded railcars in addition to revenue and non-revenue materials being moved). The net result of this approach is that a larger fuel consumption number is divided by a smaller tonne-km number, resulting in a higher, and thus more conservative, overall fuel consumption factor for rail freight transportation.

Appendix IV: Estimating Emissions from SSR P14 - Loading & Unloading Operations during Shipping

As noted in Table 2-4, emissions for SSR P14 are to be quantified only for the net increase in loading and unloading operations expected during the project as compared to the baseline. Increases in project loading and unloading relative to the baseline would only be expected to occur for shipments involving intermodal terminals where goods must be transferred from truck to rail or from rail to truck, since this would not be expected to occur in a truck-only baseline shipment case.

Since it is impractical for project proponents to measure actual loading and unloading emissions occurring at intermodal terminals for each shipment, emissions for this SSR will be estimated, as described below.

At each intermodal terminal, it is assumed in the worst case (from an emissions perspective) that goods would need to be transferred by crane twice: once to unload from the first transport mode and move to a storage area; and a second time to move from the storage area and load onto the second transport mode. The number of crane transfers (or lifts) required for a particular shipment (with a shipment in this case considered to be one standard shipping container) would therefore typically range from zero to four, depending on if a rail spur, versus intermodal terminal, is used at one or both ends of the journey (wherever a rail spur is used, no incremental transfers would be required as compared to the baseline since loading onto rail occurs at the origin/destination). Interestingly, in the Alberta context, no crane transfers would occur within Alberta for shipments passing through the province, and at maximum only two transfers would occur within the province where the origin or destination is outside of Alberta. However, the worst case of four transfers being needed still applies, and is considered further, below.

Considering the case of four crane transfers, associated emissions can be estimated. Diesel cranes are typically used for intermodal terminal loading and unloading operations (versus electrical or other fuel-powered equipment), and these cranes are have been estimated to consume on average 21.6 L diesel/hr and perform 12.6 lifts/hr according to a CN Rail study (CN Rail, 1999). Using these values, fuel consumption per lift can be estimated as:

$$(21.6 \text{ L/hr}) / (12.6 \text{ lifts/hr}) = 1.7 \text{ L diesel per lift}$$

Using a diesel combustion emission factor for a heavy diesel truck with moderate controls of 2757.53 g CO_2e /L diesel (Environment Canada, 2006b) as a proxy for a crane emission factor, associated emissions can be estimated as:

$$(1.7 \text{ L/lift}) \times (2757.53 \text{ g } CO_2e \text{ /L}) = 4.7 \text{ kg } CO_2e \text{ /lift}$$

In comparison, fuel combustion emissions expected from a train transporting a 15-tonne load 500 km, based on a 2004-2006 average train fuel consumption factor of 6.002 L diesel / 1,000 RTK (RAC, 2007; RAC, 2006) and a train emission factor of 3074.15 g CO_2e / L Diesel (Environment Canada, 2006b), would equal:

$$(6.002 \text{ L diesel / 1,000 RTK}) \times (15 \text{ tonnes}) \times (500 \text{ km}) \times (3074.15 \text{ g } CO_2e \text{ / L Diesel})$$

$$= 138 \text{ kg } CO_2e \text{ / shipment}$$

Therefore, the worst-case estimate of incremental loading and unloading emissions for a single 15 tonne, 500 km intermodal shipment can be determined as:

$$(4.7 \text{ kg } CO_2e \text{ / lift}) \times (4 \text{ lifts / shipment}) / (138 \text{ kg } CO_2e \text{ / shipment}) = 13.6\%$$

While this represents a relatively large percentage of train operation emissions, this is equal to only 2.6% of the net difference between train and truck operation emissions, assuming a trucking emission factor of 114 g CO_2e / t-km (as determined in Appendix V) and rail fuel consumption and emission factors noted above. See below for this calculation:

Worst-case loading and unloading emissions as a percentage of the difference between truck and train operation emissions

= 13.6% X (Rail Emission Factor) / (Truck Emission Factor – Rail Emission Factor)

= 13.6% X (6.002 L diesel / 1,000 RTK) X (3074.15 g CO_2e / L Diesel) / [(114 g CO_2e / RTK) – (6.002 L diesel / 1,000 RTK) X (3074.15 g CO_2e / L Diesel)]

= 2.6%

Of course, some shipments may be less than 15 tonnes and less than 500 km, which would increase the relative significance of loading and unloading emissions as compared to train operation emissions. However, on the other hand, lighter shipments would be expected to require less energy for lifts, and the potential for modal shifting is generally considered to be greater for longer routes. This bias to longer routes for modal shifting means that the worst case of four additional lifts, which would apply only to shipments with both an origin and destination in Alberta, is expected to occur only in the minority of shipments likely to be quantified using this protocol.

Therefore, emissions for SSR P14 will be calculated as 14% of emissions associated with SSR P11 – Train Operation, considered a conservative value in this case. This simplified approach is considered appropriate given that in the worst case presented above loading and unload emissions represent only a modest 2.6% of the difference between truck and train operation emissions.

Appendix V: Determining a Truck Emission Factor for the Baseline

Fuel economy, and thus GHG emissions, of freight transport trucks, is influenced by a wide variety of factors, including:

- Mass of Load
- Configuration (e.g. tractor with single trailer, two trailers – also known as B-Trains, etc., with fuel efficiency per tonne-km improving with additional trailers)
- Technology (including cab heaters, auxiliary power units, limiters, hybrids, etc.)
- Type, age and condition of vehicle
- Driver driving habits, including average speed, idling and breaking / acceleration habits (a significant factor)
- Route planning and optimization
- Topography of the route
- Weather and temperature
- Amount of stop-and-go traffic
- Whether or not the truck returns empty or loaded

As a result, the most accurate truck emission factors would be determined by directly measuring fuel consumption by trucks on the specific routes that will be driven in the baseline scenario, and would include both emissions during actual freight movement as well as emissions from idling, empty returns, etc appropriately allocated on a RTK basis. However, this approach is impractical for all but the least complicated of baseline shipping operations (e.g. where there are only a handful of routes and trucks being driven). Instead, it is necessary to determine appropriate industry average truck emission factors that can be applied to baseline quantifications in general.

Unfortunately, data on freight truck GHG emission factors, whether aggregated (e.g. a single average number) or disaggregated (e.g. broken down by vehicle type, etc.) are limited in their availability and reliability. This lack of data is generally recognized, and has recently prompted Transport Canada to commission a study (Request for Proposal No. T8080-05-0601) to update road transportation emissions data last reviewed in detail by the department in 1995 and 1997. Data from this study should be able to support both the refinement of a single average emission factor and the use of multiple emission factors by vehicle type, provided that the project proponent has sufficiently detailed shipping records or related information.

Various sources of truck emissions data in units of grams CO_2e / tonne-km do exist, but they are often not in agreement, and it is not always clear how the numbers are derived. Table V-1 summarizes emission factors examined during development of this protocol:

Table V-1: Truck emission factors examined during the development of the protocol

Data Source	Data Year	Applicability	Emission Factor (g CO_2e / tonne-km)	Explanation / Derivation
1. Transportation Table, National Climate Change Process, "Foundation Paper on Climate Change – Transportation Section –"	1995	Diesel trucks, for-hire	114	Calculated by the Authors using: • Diesel fuel consumption data from Statistics Canada's Trucking in Canada 1995 survey for for-hire trucking companies with revenues greater the $1M; and • Tonne-km data from Statistics Canada's For-Hire Trucking Commodity Origin / Destination Survey 1995 that was modified by Transport Canada to include an estimated tonne-km amount for smaller freight carriers. The above statistical data is gathered through voluntary surveying of the industry.
2. Statistics Canada and Environment Canada, analyzed by The Delphi Group	2003 2002 2001 2000	Diesel trucks, for-hire, greater than 15 tonne gross vehicle weight (Class 8)	153 159 148 164	Calculated by The Delphi Group using: • Diesel fuel consumption and associated vehicle kilometer data for trucks greater than 15 tonne gross vehicle weight (Class 8) from Statistics Canada's Canadian Vehicle Survey annual reports (Catalogue# 53-223) • Average weight per shipment data for domestic (vs. cross-border) for-hire truck transport of all vehicle sizes from Statistics Canada's Trucking in Canada reports (Catalogue# 53-222), which surveyed for-hire trucking companies with revenues greater the $1M (note, the report indicates that the majority of for-hire trucking is long-distance, suggesting that it would also involve larger loads). Average load ranged from 7.0 to 7.3 tonnes over the 2000 – 2003 period. • Diesel fuel combustion GHG emission factor for Heavy Duty Diesel Vehicles with moderate controls from Canada's GHG Inventory 1990 – 2003, produced by Environment Canada The above statistical data (with the exception of the diesel emission factor) is gathered through voluntary surveying of the industry. Total diesel fuel consumption was multiplied by the diesel fuel emission factor from Environment Canada, and divided by total vehicle kilometers and average shipment weight to give a results in units of g CO_2e / tonne-km for the years 2000 – 2003

Data Source	Data Year	Applicability	Emission Factor (g CO_2e / tonne-km)	Explanation / Derivation
3. Statistics Canada and Environment Canada, analyzed by The Delphi Group	2003 2002 2001 2000	Diesel trucks, for-hire, greater than 15 tonne gross vehicle weight (Class 8)	71.0 73.7 73.1 79.5	Calculated by The Delphi Group using the same assumptions as for 3., except assuming 15 tonnes average shipment load

A fourth data source was also initially consulted (Environment Canada, “Factsheet 3 - Transportation: 1990-2000”, which indicated a trucking emission factor of 264.7g CO_2e/t-km), but it was subsequently learned that this emission factor was in error. Therefore, this emission factor has not been considered.

The emission factors presented in Table V-1 cover a relatively wide range, with the upper end of the range roughly double that of the lower end. Of the three sources, data source 1 represents the most comprehensive reference (though dated), and is very close to the average of all emission factors presented in the table. As well, emission factors from sources 2 and 3 were determined by combining data and assumptions multiple sources since all requisite data was not available in a single source, decreasing their reliability. Therefore, based on the above emission factors, it is recommended that an average trucking emission factor of 114 g CO_2e / tonne-km (Transport Canada value based on 1995 data) be used for baseline truck transportation as an interim measure until updated data are made available by Transport Canada or other sources. The extent to which non-revenue emissions reasonably associated with movement of revenue freight (e.g. from idling, empty returns) are incorporated into this emission factor is not clear; however, if these emissions are not included, the emission factor would be underestimated, which would be conservative for calculating emission reductions from switching from truck to rail. Ideally, a three-year average trucking emission factor based on annually updated trucking emissions data would be used to be consistent with the approach taken for determining rail emissions; however, availability of such data is not foreseen in the near future.

A project proponent is free to use alternative trucking emission factors as long as the appropriateness of the alternative data, in terms of accuracy based on project-specific truck configurations, routes and/or other factors as identified at the beginning of this note, is clearly justified.