Generating Carbon Offset Credits in Canada Using Weigh-in-Motion

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ABSTRACT

Canada has committed to reducing its greenhouse gas emissions (GHGs) by six percent from 1990 levels by 2012 through the Kyoto Protocol. Currently Canada is struggling to meet this target and it is unlikely that it will be met for 2012. Canada's Offset System for Greenhouse Gases is one initiative being pursued to encourage industry to develop methods of reducing GHGs and was formed to encourage the development of technology and procedures that can reduce or store GHGs. It qualifies to be within the compliance market for carbon credits. To earn offset credits that can be sold within the Offset System, specific procedures for quantification, data management and verification by a third party must be followed and maintained.

Weigh-in-motion (WIM) and other intelligent transportation systems (ITS) have been shown to improve efficiencies in trucking while still being able to enforce weights and dimension legislation to protect roadway infrastructure. With these improvements the amount of GHG emissions generated may be reduced, particularly on a per tonne basis to improve transport efficiency. With Canada's commitment to the reduction of GHGs it is important to be able to account for all projects that are reducing carbon within Canada.

This paper reviews the applicability of Canada's Offset System for Greenhouse Gases to the implementation of WIM and other ITS as a method to reduce GHG generation. The findings of this paper indicate that offset credits may be generated through the implementation of systems to improve transport efficiency. The technology now available reduces the GHGs but also specifically accounts for each individual truck.

The case study used the emissions model for truck transport emissions developed at the University of Saskatchewan using 150,000 trucks over a one year period and shows that 228,000 tonnes of carbon dioxide emissions, 0.32% of the Canada's Kyoto target, can be reduced with the implementation of weigh-in-motion and other ITS technologies at weigh stations . This reduction results in 228,000 offset credits that may be sold for revenue by an agency.

1.0 INTRODUCTION AND BACKGROUND

In 1992, world leaders met in Rio de Janeiro for the Earth Summit where the United Nations Framework Convention on Climate Change (UNFCCC) was established to stop the increase of greenhouse gases (GHGs) in the atmosphere (1). In 1997 the UNFCCC established the Kyoto Protocol which demonstrated a commitment by those parties that ratified it to decrease the amount of a country's GHG emissions. In 2002 Canada ratified the Kyoto Protocol and committed to reduce its GHG emissions by six percent from 1990 levels between 2008 and 2012 (2). In March 2008, the Government of Canada reported that GHG emissions were more than 25% greater than 1990 levels – 32% above the Kyoto target (3).

It is estimated that if immediate action is not taken within Canada that by 2020 GHG emissions will be approximately 940 mega tonnes which is 58% higher than 1990 emission levels in Canada (4). The Government of Canada is actively pursuing a number of ways in which GHG emissions can be reduced including instituting requirements within industry to reduce emissions, setting up a carbon trading market and creating a market price for carbon (4).

Emissions are generated by the roadway sector as fossil fuels are required to run the vehicles that transport people and goods. The World Resources Institute reports that 14% of global GHG emissions come from the transportation sector and of that 72% is generated from travel on the roadway networks. Canada is responsible for three percent of the world's GHG emissions from the transportation sector (5). As a society we are dependent on our road transportation systems for personal and commercial goods transportation. Roadways are a critical component to our society's economic health and stability. Reducing the amount of goods that are transported is not an option resulting in the need to become more efficient in the way that vehicles and goods are managed to transport more goods with fewer emissions being generated (6).

With society's dependence upon the trucking industry to deliver goods, it was quickly observed that heavily loaded trucks cause significant damage to the roadway network (7). In efforts to protect the roadway network, weight restrictions on trucks have been imposed by most jurisdictions. To enforce weight restrictions static weigh stations were constructed to monitor weights of trucks (7). Traditional static weigh stations during peak hours can become overwhelmed with trucks coming off the highway causing significant delays and trucks to queue on the highways resulting in safety concerns, long wait times for trucks, mainline congestion results in the generation of additional GHG emissions. Additional GHG emissions occur from the idling of the trucks while they wait and the starting and stopping required. The implementation of Intelligent Transportation Systems (ITS) such as Weigh-in-motion (WIM), vehicle identification and vehicle tracking have assisted the trucking industry to become more efficient and reducing the amount of GHG emissions that are generated (7).

The implementation of carbon markets can assist in the overall reduction of GHGs by encouraging cost-effective reductions in activities that are not regulated by federal regulations (3). A number of carbon markets have been developed around the world and they can be divided into two groups – the Voluntary Carbon Market and the Compliance Carbon Market (8). The Voluntary Carbon Market includes parties that on a voluntary basis choose to purchase carbon credits. One of the issues with the Voluntary Carbon Market is the quality of the credits that are being purchased and as such it is important to verify the quality of the credits (8). The Compliance Carbon Market is utilized by parties involved in government regulated programs. Because these programs are government regulated a strict review process must be implemented to determine if a project may generate carbon offset credits (8).

2.0 STUDY OBJECTIVE

The objective of this project is to investigate the use of ITS technologies such as weigh in motion, automatic vehicle identification, and vehicle tracking to generate carbon offset credits within Canada's Offset System for Greenhouse Gases (Offset System).

3.0 SCOPE

The scope of this project includes a review of the requirements of Canada's Offset System for Greenhouse Gases. The values that are used for increased efficiencies and GHG generation trucking applications when WIM and other ITS systems are implemented will be collected from an emissions model developed at the University of Saskatchewan. This model is used to quantify various applications of WIM at a typical weigh station (14).

4.0 CANADA'S CARBON OFFSET SYSTEM

Lingt and Carlson define a carbon credit offset as "a reduction in GHG emissions created by one party that can be purchased and used to balance emissions of another party" (9). Canada's Offset System for Greenhouse Gases falls within the Compliance Carbon Market and it is regulated through Environment Canada under the Environmental Protection Act 1999, section 322 as a voluntary program and it is the market in which carbon credit offsets may be bought and sold in Canada at a national level (10). The Offset System may be implemented for any size project and small projects may be banded together to achieve more credits under one project. Environment Canada has detailed five steps that are required under the Offset System as shown in the following figure to achieve offset credits and they are summarized below.

Step 1: Creation of a Quantification Protocol

Step 2: Registration of the Project

Step 3: Implementation of the Registered Project and Monitoring of Data

Step 4: Reporting and Verification of Reductions from the Registered Project

Step 5: Certification of Reductions and Issuance of Offset Credits

Figure 1: Steps for Achieving Canada's Offset Credits (10)

Step 1: Creation of a Quantification Protocol

Environment Canada indicates that, "[a]n Offset System Quantification Protocol is an approved approach to quantifying [GHG] reductions from a particular project type" (10). This protocol is very important as it clearly indicates how a Project Proponent will implement and report the GHG quantification for a project. The purpose of this first step is to maintain a level of environmental integrity with the Offset System and to ensure a consistent approach to the quantification of reductions for a specific type of project (10).

There are two key components to the Offset System Quantification Protocol (OSQP) which are the core and background sections. The core section details how a Proponent will approach quantification, monitoring and data management for the issuance of credits. The background section provides the data that justifies the decisions made in the first section. Protocols are developed for a particular type of project and they are available to the public for use during and after development without charge. When a OSQP has already been developed for a specific type of project the project can be fast tracked which will reduce the time it will take for a project to get approved (10).

The review of the OSQP will be preformed based on the international standard ISO 14064-2: *Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.* This standard has six principles which include Relevance, Completeness, Consistency, Accuracy, Transparency and Conservativeness (10). Refer to the ISO standard for more details on these principles.

For the development of the OSQP the first requirement is to develop and submit the Base Protocol Plan which shows the intent of the developer to develop a Base Plan for a specific project type, if one has not already been completed. The Base Protocol Plan allows Environment Canada to provide feedback and for other interested parties to collaborate on the effort to minimize duplication of work (10).

The second requirement is to develop the Base Protocols which are the building blocks of the OSQP. Environment Canada indicates specific information that is required for the Base Protocols. Refer to Environment Canada documents for all of the details that are required. The case study included in Section 6.0 will review some but not all of them.

Step 2: Registration of the Project
If the project is registered, this will indicate to the Proponent that if the project is implemented as detailed in the Project Application Form and the OSQP, it will most likely receive offset credits. A preliminary review is also conducted which reduces the risk for the Proponent in working on a project that may not be eligible to receive credits. Assistance and advice may also be provided to the Proponent to enhance their project (10).

For the registration of Offset Projects in Canada there are six eligibility criteria that must be reviewed for a project. Many of these eligibility criteria are addressed during the development of the OSQP.
These criteria are (10):

1. Scope – The project must take place in Canada and reduce one or more of the six GHGs.
2. Real – After accounting for all of the GHG sources, sinks and reservoirs within a project, the Proponent must show specific and identifiable action for which the reduction occurs.
3. Incremental – Any credits that are applied for must be addition to the regulatory requirements and other climate change incentives.
4. Quantifiable – GHGs must be able to be quantified.
5. Verifiable – A third party verifier must review the GHG reduction claims of the project.
6. Unique – The GHG reduction can only be used once for offset credits.

Step 3: Implementation of the Registered Project and Monitoring of Data
As implementation of the project moves forward it must be implemented as detailed in the OSQP. The third party that will conduct the verification of the implementation of the project will use the OSQP as a reference.

Step 4: Reporting and Verification of Reductions from the Registered Project
This step is important to the Offset System as it ensures that the environmental integrity of the system is maintained. The Proponent must show that a third party verifier has reviewed the reductions that are being claimed and that the verifier has a reasonable level of satisfaction that the values are being monitored, estimated and quantified as detailed in the OSQP. The verifier must also indicate if the values that are being claimed are reasonable. The third party verification is conducted as stated in the international standards ISO 14064-3 *Specification with guidance for the validation and verification of greenhouse gas assertions* and in accordance with the *Program Rules for Verification* as detailed in the Offset System-specific requirements. Verification bodies must also be accredited by the Standards Council of Canada (10).

One of three outcomes will result from the third party review and are a positive, qualified or adverse conclusion. A positive outcome indicates that there no major discrepancies in the quantification system in place. A qualified result indicates that there are issues that are beyond the control of the Proponent and third party and a result of adverse is that there are discrepancies within the system. A project must submit its Greenhouse Gas Assertion (report with project details) and Verification Statement (report from verification party) after a full calendar year or after 100,000 tonnes of GHG reduction has occurred, which ever has occurred first (10).

Step 5: Certification of Reductions and Issuance of Offset Credits
Prior to the issuance of offset credits, a final review is conducted to ensure that all requirements are met to protect the integrity of the Offset System. First, the Offset System checks the Greenhouse Gas Assertion, the Project Monitoring Report and the Verification Statement. If a positive response is received from the third party verification body, a final check is completed to confirm that all of the requirements within the Offset System have been met. Once this is complete, the reported number of offset credits will be placed in the Proponents account with a serial number. These credits may then be traded, banked or used for compliance purposes with any party that will accept them. Audits may be conducted on the information that has been submitted by the Proponents and third party verifiers. As such, all relevant information and forms that were used in the application process must be retained for eight years. Through an audit if a party is found to be in noncompliance with the requirements set forth, the government may take action against the party at fault (10).

5.0 TRUCKING EMISSION REDUCTIONS AND FRAMEWORK FOR QUANTIFYING CARBON CREDITS WITH ITS

In 2005, the trucking industry in Canada contributed over $14.2 billion into the economy resulting in it being a key component of the transportation of Gross Domestic Product in Canada (10). From 1989 to 2006 the tonnes of freight carried by for-hire trucks increased by 59% and the tonne-kilometre transported goods in Canada increased by 144% mainly due to the concept of 'just-in-time' delivery (12). With the increase in usage of trucks for freight the amount of emissions that are being created are also increasing.

With an increase in the amount of goods transported, additional damage has been observed on the highways. To reduce the damage occurring on highways, it is critical to have proper enforcement to protect the roadway infrastructure that is in place. Various ITS technologies with different purposes are implemented to facilitate the use of WIM to measure the weight of a truck while it is on the highway, traveling at highway speed to enforce weight and dimension restrictions. If that truck is determine to be overweight it can be signalled through the use of a variable message board to direct trucks into the weigh station for further inspection. Those trucks that are in compliance with the weight limits may continue on their route without stopping (7). WIM solved many of the issues with the delay of drivers associated with the static weigh stations. WIM technologies that can be implemented include piezoelectric sensors, bending plates and load cells. Vehicle identification allows a weigh station to have information about a truck as it goes by such as owner, cargo, travel plan, safety and other information that may be pertinent making weigh stations also truck inspection stations. Vehicle identification can be achieved through transponders, imaging and/or automatic vehicle identification (AVI). Finally software is required to translate the information that is collected from the WIM sensors, transponders or imaging sensors to a format that can be understood in the office.

Because of the implementation of WIM in combination with other ITS technologies, trucking efficiencies have increased resulting in less fuel consumption and as a result fewer emissions have also been generated (7). For example, the Oregon Department of Transportation implemented WIM and has determined that each vehicle that is able to by-pass the weigh scale saves 1.47 minutes in travel time. With an estimated 1.5 million vehicles by-passed in 2008 this resulted in savings of over $600,000 in fuel for the trucking companies and the annual reduction of carbon dioxide (CO_2) is estimated to be 1300 metric tonnes annually (13).

To specifically quantify the emission savings that can be achieved through the use of WIM a framework as detailed in Figure 2 is proposed to be implemented. This framework uses the ITS technologies that are already utilized to facilitate the use of WIM and other methods of collecting information from trucks while they are in motion. This framework extends the existing use of WIM to calculate the specific amount of GHG emissions that can be reduced based on each truck that is able to by-pass the weigh station.

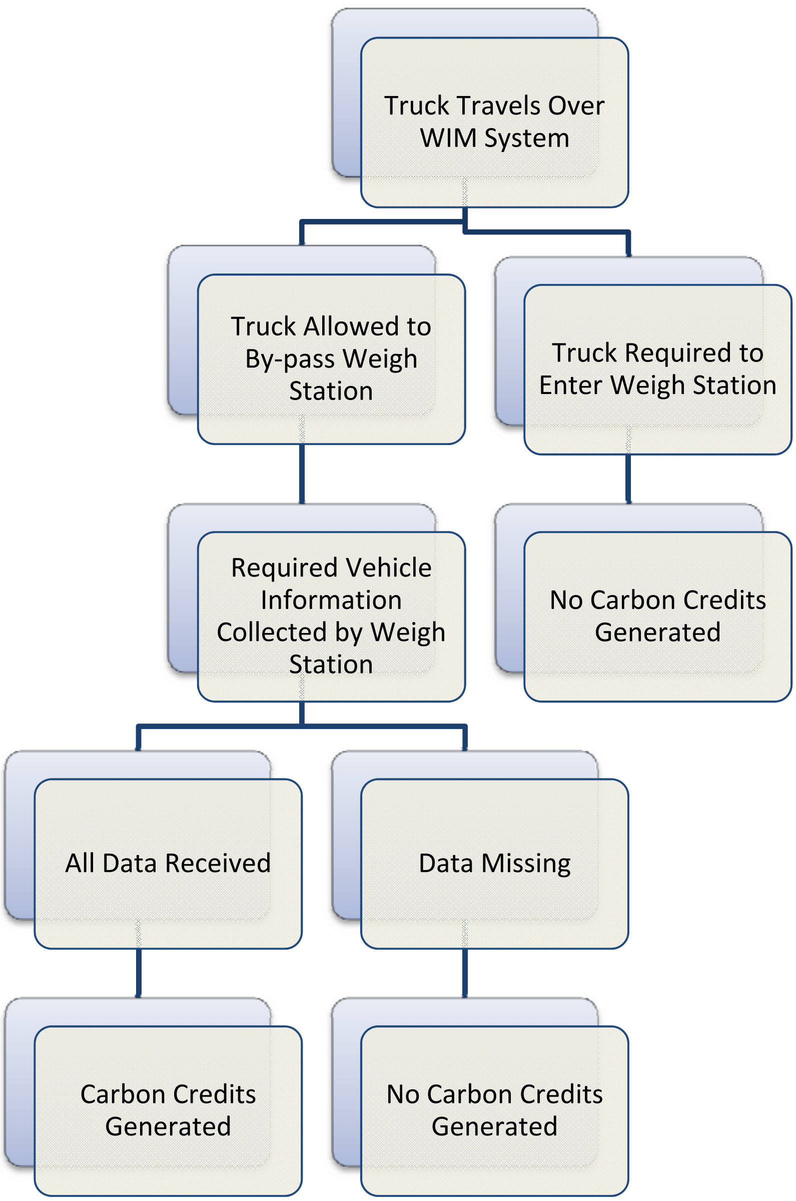

Figure 2: Framework for Quantifying Carbon Credits with the Implementation of WIM

With the framework outlined in Figure 2, only those trucks that are not required to enter the weigh station will be eligible to generate carbon credits. The key requirement with this framework is the collection of specific vehicle information which will be unique to each vehicle that is able to by-pass the weigh station. To collect this information transponders, imaging and AVI can be used to identify the truck or to collect all of the unique information. If the truck is preregistered within a database then the specific vehicle information can be determined with simply identifying the truck.

6.0 CASE STUDY: APPLYING THE OFFSET SYSTEM AND FRAMEWORK FOR QUANTIFYING CARBON CREDITS TO WEIGH STATIONS WITH ITS

This case study reviews the application of Canada's Offset System for Greenhouse Gases and the proposed quantification framework as shown in Figure 2 to a weigh station that wants to implement ITS technologies to decrease the amount of emissions that are generated and to increase the efficiency of trucks. Only the first two steps of the Offset System will be discussed in some detail in this case study as these are the steps that will indicate if a project may accumulate carbon credit offsets. The remaining steps are discussed briefly. The emissions model for truck transport emissions developed by Amélie Couraud at the University of Saskatchewan will be used to quantify the emissions of the trucks that will enter or by-pass a weigh station (14).

A case study with the implementation of WIM at a weigh station was included as part of the work completed by Couraud. This case study quantified the amount of CO_2 for a fleet of 150,000 trucks ranging in weights from 32,500 to 50,000 kg. Each truck was assumed to travel approximately 1000 kilometres in one day for 250 days/year with an average of three stops a day at weight enforcement locations. The range of time that a truck is stopped at a weigh station may range from 5 to 30 minutes. Numerous other assumptions were also included for the number of times the vehicle would stop and start and the duration of idling that occurred during a typical day or trip as well as assumptions with road and engine characteristics (14). A schematic of a ramp sorter WIM system used in the case study is included in Figure 3.

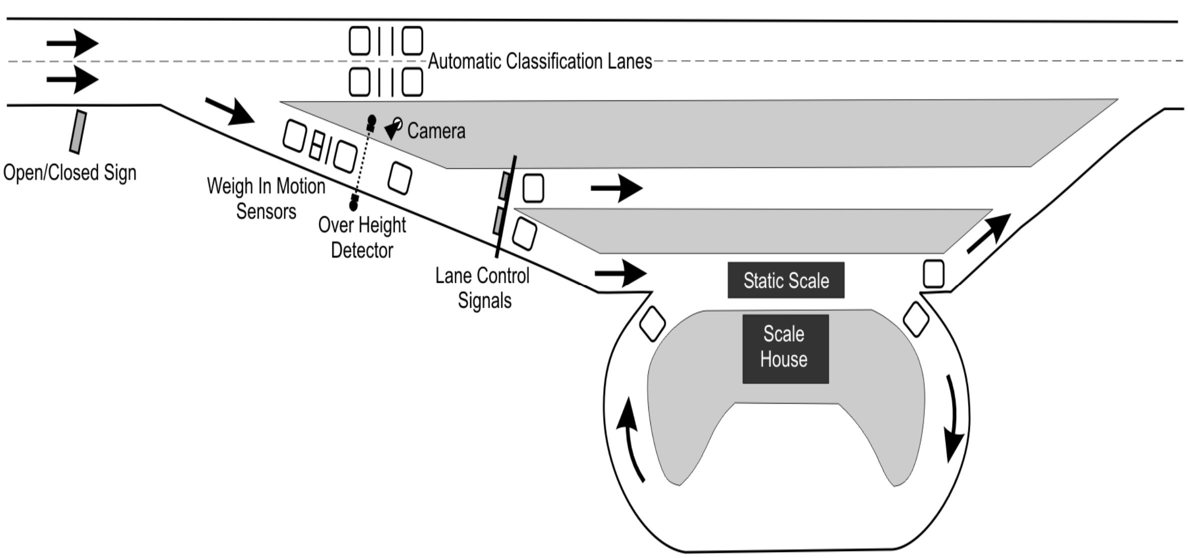

Figure 3: Ramp Sorter WIM System (15)

The results of the case study indicated that there is a reduction in CO_2 emissions when WIM is implemented at weigh stations. In the base case, 103.21 mega tonnes of CO_2 was released compared to 102.99 mega tonnes of CO_2 when WIM was implemented as shown in Figure 4. This is a difference of 228,000 tonnes of CO_2 or a 0.22% reduction in CO_2 compared to no use of WIM. This reduction represents 0.32% of the Kyoto reduction goal of 70.8 mega tonnes (14).

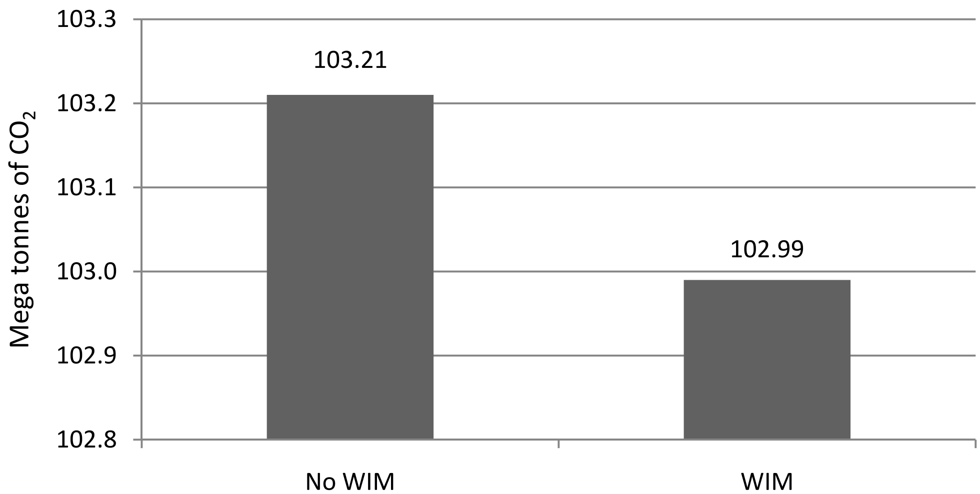

Figure 4: CO_2 Reductions (14)

6.1 Development of Base Protocol

The first step within the Offset System of developing an OSQP is the most critical and will be reviewed in detail below for how ITS applications and technologies can be applied at weigh stations to reduce emissions and to collect the information required to earn carbon offset credits. There are seven parts to the Base Protocol which are (3):

- Part I - Identification of the Protocol Developer
- Part II - Base Protocol Applicability and Development Approach
- Part III - Identification of “Relevant” Sources, Sinks and Reservoirs
- Part IV - Quantification of GHG Reductions
- Part V – Data Management
- Part VI – Summary of Instructions for Project Proponents
- Part VII – License, Moral Rights Waiver, Declaration, Consent and Signature

Part I – Identification of the Protocol Developer, only requires basic information regarding the Protocol Developer and other parties that are working on the Protocol. Part II – Base Protocol Applicability and Development Approach, requirements focus on the development approach and the applicability of the development approach. The information required for Part II and how this case study is applied is included following.

- Description of Project – The implementation of WIM at weight stations will allow agencies to enforce weight restrictions on trucks without requiring them to stop. Those vehicles that are in compliance with the restrictions will be allowed to continue on their route without stopping and as a result reducing the amount of GHGs generated.
- Description of Project-Specific Technology – The specific technology that is used is WIM as described in Section 5.0 above. Other technologies such as vehicle identification and vehicle

locators may also be utilized in cases where trucks use pre-clearance. Numerous other hardware and software system will be required to support these systems and to manage that data that is collected.

- Description of Real Reductions Achieved – Environment Canada specifically indicates that for projects to be eligible for offset credits, a new process or technology must be introduced. Simply reducing the production level of a product or process is not acceptable (3). With the implementation of ITS measures such as WIM and vehicle identification and locators, trucks on the road can be monitored and enforced for compliance in safety, weight, registration and other categories that are important to the industry without requiring vehicles to stop. When vehicles are required to stop at weigh stations the truck will be required to idle, start and stop resulting in decreased efficiencies and increased emissions.

The identification of "relevant" sources, sinks and reservoirs (SSRs) is required for Part III. With a weigh station there will be no carbon sinks or reservoirs that must be considered. The emission source for all weigh station projects will be the trucks that go through or are able to by-pass the weigh station. A baseline will be required to be constructed based on the use of a traditional weigh station. The baseline that will be used for this project would be the amount of emissions that are generated based on the requirement for all trucks to stop and be weighed. For the purposes of this paper the baseline developed by Couraud will be used (14). It is critical that overtime as vehicles change and become more fuel efficient that the baseline is updated to ensure that any offset credits generated, are reflective of the actual emissions of each vehicle type to ensure that the integrity of the Offset System is maintained.

Part IV – Quantification of GHGs, specifically quantifies the reduction of GHGs that are being observed in written and equation form. In the model that Couraud developed, it is detailed how a vehicle's rolling resistance, grade resistance, aerodynamic drag, fuel consumption and emission rates contribute to quantifying transport emissions (14). To quantify the GHG emissions that are reduced with the implementation of WIM the framework detailed in Figure 2 will be followed. Each truck that passes a weigh station may have different values for all of these parameters. With the use of transponders, inaging and or AVI this information can be relayed to the weigh station without the truck stopping. Equations must be developed to quantify the reductions that are being generated (3). These equations would be the same for each truck passing the station and based on the information collected from the truck the parameters collected would be entered into the equation.

Part V – Data Management, requires specific procedures in place to collect and maintain the data that is collected for a project. To maintain the integrity of the Offset System, it is critical that the data that is collected is quality data and it is important that the quality of that data is maintained throughout the entire project. This is why within the framework shown in Figure 2 that if all the information that is needed for the emission calculation from a truck is not collected no carbon credits will be generated. Often the nature of ITS systems and applications involve the process of data collection and management. Because of this, data management may be implemented without any significant additional requirements to the infrastructure that will be constructed for the implementation of WIM at a static weigh station. Quality Assurance/Quality Control procedures will be required to be developed which include standard operating procedures and calibration requirements (3).

Part VI – Summary of Instructions for Project Proponents provides to the Proponent a step by step procedure of what is required to allow the project to qualify for the generation of carbon credits. Summaries of Parts II – V are required (3). Lastly, Part VII requires that all parties involved in the development of the base protocol sign a License Agreement allowing Environment Canada to use the protocol, a Moral Rights Waiver and a Declaration indicating that the information provided in the protocol is accurate, complete and true (3).

6.2 Registration of the Project

The second step for the Offset System involves the registration of the project. For a project to be registered the six eligibility criteria – scope, real, incremental, quantifiable, verifiable and unique - must be met as detailed in Section 4.0. The case study presented meets all of these criteria as it is in Canada and it is quantifying the reduction of CO_2. The reductions that are being modeled are real and they are above any Canadian government incentives or requirements. Once the OSQP is implemented, the reduction of CO_2 will also be quantifiable and verifiable.

6.3 Implementation, Reporting and Certification

Steps three, four and five involve monitoring and verification of the data collected to quantify the reduced emissions achieved. The basis of ITS systems often involves information collection and processing so that the information can be used to make decisions. The ITS systems that are currently available for data collection and management can be used for monitoring and verification purposes over the life of a project to ensure that the data collected is of high quality. The WIM will verify the weight of the vehicle. The vehicle identification technology allows the information about the truck that is required to calculate the amount of emissions saved to be obtained by the weigh station and may include the make, model, weight and any other parameters that are required to determine the amount of emissions reduced. The software that is utilized to interpret the data may also be used to generate reports on the information that is collected. By customizing the report formats in the software that is used, agencies will be able to meet the reporting requirements of the Offset System without any significant additional work. All of this may be completed without the need of the truck to stop allowing it to be able to by-pass the weigh station and reduce emissions.

With this case study, the implementation of WIM resulted in a reduction 228,000 tonnes of CO_2 resulting in 228,000 offset carbon credits that may be sold for revenue. The value of the carbon credits will fluctuate as demand for the carbon offsets changes and Couraud found a wide range of published prices worldwide per tonne of emissions ranging from \$0.26 to \$233.26 (2007). Based on these values revenues for agencies could be between \$59,000 and \$53 million.

7.0 **SUMMARY AND CONCLUSIONS**

Canada ratified the Kyoto Protocol in 2002 and committed to the reduction of GHG emissions by six percent from 1990 levels by 2012 (2). To be able to achieve significant reductions of GHGs, all potential areas in which emissions can be reduced, must be pursued. Canada's Offset System for Greenhouse Gases was developed to encourage the reduction of GHG within any industry. Five steps are required under this system to be able to achieve and sell offset credits. Of these five steps, the first is the most critical where the OSQP is developed. The OSQP provides the technical background and the framework that will be used to have a specific project approved and later follow to produce carbon credits.

The Canadian economy depends heavily on the trucking industry to distribute goods throughout Canada. With trucks carrying more goods by weight and distance it is important that the infrastructure on which the trucks travel is protected. To protect this infrastructure, static weigh stations were constructed. Because trucks are required to stop at these weigh stations, delays are typically imposed on drivers of varying lengths depending on the number and frequency of trucks entering the weigh station. Emissions from the trucks were also increased due to required idling, starting and stopping. With the implementation of WIM and other ITS technologies at weigh stations the delays and emissions from trucks can be reduced.

The case study presented is based on the emission model created by Couraud at the University of Saskatchewan (14). With the use of the emissions model and the implementation of WIM at a weigh station, it was observed that there was a reduction in the amount of CO_2 emission generated of 228,000 tonnes or 0.22% (14). The applicability of this case study was reviewed to determine if the amount of carbon reduction may be used to achieve GHG offset credits.

The findings of this case study shows that all of the information and technological systems that would be required to first develop the Base Protocol Plan and then later the full OSQP are available with the use of ITS. Before a project is registered, it must pass six criteria and the case study was able to meet all of the criteria that are required by Environment Canada. Care must be taken to ensure that the information that is used within the GHG emission calculations is current and that the data that is being collected is high quality to ensure that the integrity of the Offset System will be maintained.

It is anticipated that in the future when applications of WIM and other ITS technologies are implemented OSQPs can be developed and accepted for offset credit generation. With the potential to generate revenue from the sale of offset credits, agencies may be able to use these funds to reinvest into their infrastructure and/or offset the costs of reduced revenues from fuel taxes because of the reduced fuel consumption by the trucks that may by-pass a weigh station.

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