Draft Intent to Develop Alberta Offset System Quantification Protocol: *Quantification Protocol for the Capture of CO_2 from Steam Methane Reforming and Permanent Storage in Deep Saline Geological Formations*

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

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

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

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

- How the proposed protocol meets the eligibility criteria in section 7 of the *Specified Gas Emitters Regulation;*
- Applicability of the proposed protocol against purpose and intent of the Alberta Offset System;
- Baseline adoption levels and credit potential for Alberta;
- Baseline, project condition, and key assumptions for the proposed protocol;
- Key stakeholders and technical experts in the field; and
- Relevant science and technical information

General Description of the Proposed Protocol

The capture and storage of carbon dioxide (CO_2) has been widely recognized as an important GHG emission reduction technology globally. In Alberta, carbon capture and storage (CCS) has been identified as a crucial technology to enable the province to meet greenhouse gas emission reduction targets outlined in Alberta's 2008 Climate Change Strategy.[1] The Alberta climate change strategy expects CCS projects to contribute 139 million tonnes (Mt) of CO_2-equivalent GHG reductions per year relative to business as usual by 2050. As such the development and implementation of CCS technologies is of major importance to Alberta and there is a need to develop accurate quantification methodologies that can be used by project developers to quantify project-based GHG reductions with a reasonable level of assurance to generate compliance grade emission reduction units.

Shell, on behalf of the Athabasca Oil Sands Project (AOSP), a joint venture between Shell Canada Energy (60%), Chevron Canada Limited (20%), and Marathon Oil Sands L.P. is planning to implement a carbon

[1] http://environment.gov.ab.ca/info/library/7894.pdf

capture and storage (CCS) project ("The Quest CCS Project") to reduce GHG emissions associated with hydrogen production from steam methane reformers (SMR) at the Scotford Upgrader and the Scotford Upgrader Expansion facilities, that upgrade bitumen to produce synthetic crude oil. The Quest CCS Project will result in the capture and storage of up to 1.2 million tonnes per year (Mtpa) of CO_2 from the Scotford Upgrader.

The Quest CCS Project consists of three main components:

- CO_2 capture infrastructure, which involves a process modification to the existing Scotford Upgrader. The method of capture is based on a licensed Shell activated amine technology called ADIP-X.
- A CO_2 pipeline to transport CO_2 from the Scotford Upgrader to the injection wells located north of Shell Scotford
- Storage of CO_2 through 3 to 10 injection wells, which will inject CO_2 into the Basal Cambrian Sands (BCS), a deep saline geological formation, for permanent storage at a depth of about 2km below ground level.

The proposed protocol has been developed specifically to quantify GHG emission reductions from the Quest CCS Project, and at this time, is not intended to be used to quantify GHG emission reductions from other CCS projects. Many elements of the proposed protocol will, however, be applicable to other CCS projects and may support future protocol development efforts.

The formal government approval of a CCS quantification protocol that fits the scope of the Quest CCS project will provide information necessary for Shell Canada and its partners to make investment decisions that hinge on the expected quantity and value of GHG reductions from this project.

At present there are two government-approved Alberta Offset System quantification protocols that are applicable to certain types of CCS projects. These are the *Quantification Protocol for Acid Gas Injection Projects* (May 2008, Version 1) and the *Quantification Protocol for Enhanced Oil Recovery* (September 2007, Version 1). The proposed protocol is intended to build off of these existing Alberta Government approved offset quantification protocols for Acid Gas Injection (AGI Protocol)[2] and CO_2-Enhanced Oil Recovery (EOR Protocol).[3] At present the AGI Protocol is too specific to sour gas processing operations to be fully applicable to other CCS Projects and the EOR Protocol is only applicable to projects that inject CO_2 into oil-producing reservoirs.

The scope of the proposed protocol is specific to the capture of CO_2 from steam methane reforming (hydrogen production), the transport of CO_2 via pipeline and the storage of CO_2 in a deep saline geological formation. The proposed protocol is only applicable to the capture of *industrial process emissions*[4] from hydrogen production. Industrial process emissions are not regulated under the Alberta

[3] http://environment.gov.ab.ca/info/library/7910.pdf

[4] "*Industrial process emissions* are defined as the direct emissions from an industrial process involving chemical or physical reactions, other than combustion, and where the primary purpose of the industrial process is not energy production. Examples of chemical processes resulting in industrial process emissions include steam methane reforming for hydrogen production (e.g. at refineries, bitumen upgraders and fertilizer production facilities), nitric acid production, ethylene oxide production, and cement production." (Specified Gas Emitters Regulation: Technical Guidance Document for Baseline Emissions Intensity Applications, AENV July 18, 2007. http://www.environment.gov.ab.ca/info/library/7811.pdf)

Specified Gas Emitters Regulation (SGER). The proposed protocol covers the full CCS chain from capture through compression, transport, injection and storage, but is specific in terms of the source of CO_2 (industrial process emissions from steam methane reforming) and the type of geological storage reservoir (only deep saline geological formations are included, producing reservoirs are not included under this protocol).

The proposed protocol has been developed based on best practice guidance from Natural Resource Canada's SMART-Lite Protocol[5], the International Organization for Standardization's (ISO) standard 14064-2 and Alberta Environment's Specified Gas Emitters Regulation (SGER). The proposed protocol also builds off of the government approved protocols for AGI and EOR Projects and the draft Carbon Capture and Storage Emission Reduction Quantification Methodology[6] that was submitted to Alberta Environment in April 2009 by Blue Source on behalf of the Integrated CO_2 Network (ICO_2N), following an initial technical review session (March 18, 2009). The CCS Emission Reduction Methodology was also presented to stakeholders during a second round of stakeholder review on October 29, 2009.[7] The proposed protocol is more limited in scope than the previous CCS methodology and focuses on the capture of industrial process CO_2 emissions from hydrogen production and CO_2 storage in deep saline geological formations. By narrowing the scope, it is expected that the proposed protocol will fit better with the Alberta SGER and Alberta Offset System frameworks.

Intent of the Proposed Protocol

The intent of the proposed protocol is to provide a detailed quantification methodology, following the ISO 14064-2 format and the requirements of the Alberta Offset System, that will allow Shell Canada, and its partners in the AOSP, to quantify the GHG reduction benefits from the implementation of the Quest CCS Project. The proposed protocol will quantify GHG emission reductions realized through the capture and storage of CO_2, normally emitted to the atmosphere from steam methane reforming used for hydrogen production.

Baseline Scenario

The baseline scenario for the proposed protocol is the continued practice of venting CO_2 to the atmosphere from industrial process emission stacks associated with steam methane reformers used for hydrogen production. The baseline emissions are quantified from the metered quantity of CO_2 that is captured and injected into the deep saline geological formation for permanent storage that would normally have been vented to the atmosphere. This type of baseline is commonly referred to as a projection-based baseline. The use of direct measurement to represent the baseline provides a high level of accuracy.

The proposed Quest Project would be the first commercial scale CCS project to be implemented in Alberta. Currently, all CO_2 generated from the steam methane reformers at the Scotford Upgrader is vented to the atmosphere. The implementation of the Quest CCS Project will result in the capture and

[5] SMARTLite is a streamlined version of the System of Measurement and Reporting for Technologies (SMART) Protocol developed by Natural Resources Canada, Environment Canada and Industry Canada

[6] http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ProtocolReviewProcess/5thCycleProtocolDevelopment/Carbon%20Capture%20Storage_Draftv2%20PostReview.pdf

[7] http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ProtocolReviewProcess/5thCycleProtocolDevelopment/Presentations/6%20Carbon%20Capture%20and%20Storage%20Methodology%20Presentation%20Oct29,2009.pdf

storage of up to 1.2 million tonnes per year (Mtpa) of CO_2 from the Scotford Upgrader. The net GHG reductions from the Quest Project, after accounting for energy inputs to operate the CCS project, will be between 0.972Mtpa to 1.025Mtpa, depending on the quantities and sources of steam and electricity used.

Project Condition

This project condition for the proposed protocol is the implementation of a project to capture CO_2 emissions from steam methane reformers used for hydrogen production and the injection of the CO_2 into a deep saline geological formation for permanent storage.

The proposed protocol has been specifically written for the Quest CCS Project, which will reduce GHG emissions (industrial process emissions) associated with hydrogen production from steam methane reformers (SMR) at the Scotford Upgrader and the Scotford Upgrader Expansion facilities, which upgrade bitumen to produce synthetic crude oil. The Quest CCS Project will result in the capture and storage of up to 1.2 million tonnes per year (Mtpa) of CO_2 from the Scotford Upgrader.

<u>The Quest CCS Project consists of three main components:</u>

- CO_2 capture infrastructure, which involves a process modification to the existing Scotford Upgrader. The method of capture is based on a licensed Shell activated amine technology called ADIP-X.
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Applicability

This protocol is applicable to the projects that capture CO_2 produced during hydrogen production from steam methane reforming and inject the CO_2 into deep saline geological formations for permanent storage. Projects that intend to apply this protocol must also meet the following criteria:

1. The Project captures CO_2 from a source of industrial process emissions that are not regulated under the Specified Gas Emitters Regulation (SGER). Only emission reductions from unregulated sources are considered eligible for offset creation under the proposed protocol.

2. The Project is only applicable to the geological storage of CO_2 from industrial process emissions in non-producing geological formations and is not applicable to enhanced oil recovery (EOR) or acid gas injection (AGI) projects associated with sour natural gas processing operations. Proponents with CO_2-EOR projects or AGI projects should refer to the applicable Alberta Offset System quantification protocols for those activities.

3. The CCS project must be in compliance with all operating permits and relevant regulations in Alberta. In particular, the project must demonstrate compliance with operating permits to demonstrate that the storage of CO_2 will be permanent.

Regulatory Requirements

Currently under the Alberta SGER, industrial process emissions are not subject to a GHG reduction requirement. The business as usual practice for hydrogen production from existing steam methane reformers is the continued venting of CO_2 to the atmosphere. Therefore, the investment in technologies to capture, compress, transport, inject and store the CO_2 produced from steam methane reforming is surplus to regulation.

Additionality

As stated above, the capture of industrial process emissions is not currently required by law. Any steps taken to reduce industrial process emissions through the implementation of carbon capture and storage technology would be surplus to regulation.

The proposed protocol will result in real, quantifiable and verifiable reductions through direct measurement of the quantity of CO_2 captured and injected into a deep saline geological formation for permanent storage.

No historical offsets will be claimed under this protocol as no commercial scale CCS projects have been implemented to date in Alberta. Therefore all projects that apply the proposed protocol will meet the Alberta Offset System start date eligibility criterion of January 1, 2002.

The use of this protocol to quantify carbon offsets will promote incremental GHG reductions by encouraging the capture and storage of CO_2 emissions that were previously vented to the atmosphere. The value of carbon offsets will be of great importance to the economics of this type of CCS project as no other sources of revenue exist. Since no other sources of revenue exist for this type of CCS project, the GHG reductions will be beyond business as usual.

Should the configuration of the Quest Project be modified in future to incorporate EOR, additionality will be addressed using the existing government-approved EOR protocol.

Additionality is also demonstrated by the large number of barriers that impede the implementation of CCS projects, which are described briefly in the following section.

Barriers

CCS projects face numerous barriers in Alberta and worldwide. For further information on barriers faced by CCS projects in Alberta, refer to the Alberta Carbon Capture and Storage Development Council March 2009 final report titled, *Accelerating Carbon Capture and Storage Implementation in Alberta*.[8] A partial list of barriers is provided below.

- High capital costs for installation of capture equipment, compressors, pipelines, injection wells, and monitoring infrastructure make CCS projects uneconomic
- The current cost of emitting CO_2 is insufficient to make CCS projects economic
- Pure CCS projects have to compete with CO_2-EOR projects which are likely to have more favorable economics provided that appropriate producing reservoirs exist in reasonable proximity to the CO_2 source.
- Significant energy inputs are required to operate capture and compression equipment, resulting in increased operational costs and lower operational efficiencies

[8] http://www.energy.alberta.ca/Org/pdfs/CCS_Implementation.pdf

- Long term liability may be difficult to accommodate into corporate investment horizons
- CCS projects are complex and most organizations lack of familiarity with the full CCS chain, such that project implementation may require partnerships and complicated commercial agreements
- Policy uncertainty exists around climate change regulations and GHG reduction requirements at the federal level in Canada and in Alberta beyond 2014, when the SGER is expected to expire.

Permanence

The proposed protocol is not applicable to CO_2-enhanced hydrocarbon recovery and is only applicable to the injection of CO_2 into deep saline formations where hydrocarbon production is not possible. Therefore, there are no risks related to CO_2 recirculation within the formation or leakage from producing wells.

In the proposed protocol, permanence will be addressed on a project-specific basis through the implementation of a complete measurement, monitoring and verification (MMV) plan, in accordance with regulatory requirements. For the Quest CCS Project, an MMV Plan was required by the Terms of reference pursuant to the Canadian Environmental Assessment Act and the Alberta Environmental Protection and Enhancement Act, Environmental Assessment Regulation. The MMV plan was included in the full Environmental Assessment, submitted to the Governments of Canada and Alberta in November 2010. For further information refer to Appendix A of the Shell Quest CCS Project Environmental Assessment. The geological storage scheme is defined in detail in the Quest Carbon Capture and Storage Project Directive 65: Application for an Acid Gas Storage Scheme submitted to the Energy Resources Conservation Board (ERCB) in November 2010.

The injection and storage of CO_2 in deep saline formations will result in permanent storage. The MMV program is designed to show that CO_2 has been stored permanently within the target formation.

Leakage

Leakage is defined as the shifting of emissions to outside of the project boundary and has been addressed by identifying the sources, sinks and reservoirs (SSRs) of GHG emissions through a full lifecycle analysis. The proposed protocol accounts for all relevant upstream and downstream emission sources.

The main types of GHG leakage that could occur from CCS projects would be related to the emissions from the extraction and processing of fossil fuels upstream of the project activity, the indirect emissions associated with heat or electricity purchased from off-site, and the downstream emissions associated with long term monitoring of the storage site and site decommissioning. All of these potential forms of leakage have been identified as SSRs within the proposed protocol and have been quantified where relevant.

Physical leakage of CO_2 from the storage reservoir into other zones outside of the intended storage formation will be prevented through site selection, field development plan design and well design, as well as operational practices. The early detection of any leak, and follow up actions, will be enabled by the implementation of a detailed MMV plan, as discussed in the Permanence section, above. Should the MMV program identify leakage of CO_2 outside of the storage formation despite preventative measures, a site specific remedial plan will be implemented.

Conservativeness

The proposed protocol will use direct measurement to quantify several key emission sources to ensure accuracy and will include appropriate measurement procedures for other emission sources that are not directly measured. The general approaches outlined in ISO-14064-2 and other sources of best practice guidance will be followed to ensure that emission reductions are not overestimated. Emission factors for fuel combustion and grid electricity consumption will be referenced from Alberta Offset System guidance documents and from the Environment Canada National Inventory. Due to the limited use of estimations in the proposed protocol, it is expected that conservative assumptions will not be needed as most parameters will be directly measured.

Aggregation

Carbon capture and storage projects are unique in terms of the scale at which they are applied, and generally require large point sources of CO_2 to be feasible. As such, aggregation is not expected to be necessary in the near term. In the longer term, if integrated pipeline networks are established, then multiple sources of CO_2 may be incorporated under a single CCS project. The proposed protocol is intended to be flexible enough to incorporate a shared CO_2 transportation and storage network, as applicable.

Verification

In order to support verification, the proposed protocol suggests that the following records be made available for verification purposes.

- Metered volumes of CO_2 captured and injected into the saline formation, measured at, or as close as practical to the injection wellheads
- Gas analyses reflecting the composition (% volume CO_2) of the injected gas stream
- Metered fossil fuel volumes consumed to operate the CCS Project
- Metered electricity and steam usage at the capture site
- Calibration and maintenance records for all meters
- Relevant permits for operating CCS facilities and proof of compliance with these permits
- Documentation and records of measurement, monitoring and verification (MMV) activities completed for the CCS project

Ownership

For consistency with other approved Alberta Offset System protocols, this quantification methodology also does not explicitly assign ownership. As such, it is the responsibility of the project proponent to provide proof of ownership of all emission reductions claimed at the time of third party verification or upon request by Alberta Environment (e.g. through contracts with other relevant participants involved in the CO_2 capture, transportation, injection and storage processes).

Where multiple proponents are involved in a project, each proponent would be required to provide documentation of the transfer of CO_2 from the point of capture through to the point of injection to ensure that emission reductions are only counted once, consistent with the Alberta Offset System guidelines. Given the large scale of CCS projects and the significant value of the offsets that can be generated from these projects, it is expected that proponents will establish the necessary commercial agreements as part of the normal course of business and should not have much difficulty providing documentation to demonstrate ownership of offsets.

Related Protocols and/or Methodologies

The proposed protocol draws upon best practice guidance from two approved protocols under the AOS: The *Quantification Protocol for Acid Gas Injection Projects* and the *Quantification Protocol for Enhanced Oil Recovery*. The proposed protocol also builds off of the draft Carbon Capture and Storage Emission Reduction Quantification Methodology[9] that was submitted to Alberta Environment in April 2009 by Blue Source Canada on behalf of the Integrated CO_2 Network (ICO_2N), following an initial technical review session (March 18, 2009). The proposed protocol is more limited in scope than the previous CCS methodology and focuses on the capture of industrial process CO_2 emissions from hydrogen production and CO_2 storage in deep saline geological formations. By narrowing the scope, it is expected that the proposed protocol will fit better with the Alberta SGER and Alberta Offset System frameworks.

Other best practice guidance from outside of Alberta that has been referenced in the development of the proposed protocol included the June 2007 American Petroleum Industry (API) International Petroleum Industry Environmental Conservation Association (IPIECA) document titled, *Oil and Natural Gas Industry Guidelines for Greenhouse Gas Reduction Projects Part II: Carbon Capture and Geological Storage Emission Reduction Family*. Additional quantification guidance was taken from the Draft Carbon Capture and Geologic Storage Emission Reduction Quantification Methodology (September 2010) developed by Blue Source for the North American Carbon Capture and Storage Association (NACCSA) and submitted to the Pew Centre on Global Climate Change in 2010 for further stakeholder and expert technical review.

Various other project-specific methodologies were drawn on for guidance. These include projects from the Canadian Standards Association (CSA) and American Carbon Registry (ACR) and are listed in the references section of this document for background information.

Other Benefits

The primary purpose of carbon capture and storage (without enhanced oil recovery) is to reduce GHG emissions to the atmosphere. The implementation of CCS to reduce emissions in Alberta is another example of the Government of Alberta's leadership in environmental management. The demonstration of CCS technologies at the scale proposed by the Shell Quest project will enable other CCS projects world-wide. The Government of Alberta's leadership in the demonstration of these technologies may create future opportunities if these technologies are later exported to other parts of the world. The Quest project itself will provide employment and contracting opportunities in Alberta.

Adverse Effects

The Quest CCS Project is subject to a federal environmental assessment under the Canadian Environmental Assessment Act (CEAA) and a Provincial Environmental Impact Assessment pursuant to the Environmental Protection and Enhancement Act (EPEA). A harmonized Environmental Assessment that combined the required CEAA screening-level environmental assessment (EA) and an EPEA EIA was submitted by Shell to the Canadian Environmental Assessment Agency and Alberta Environment in November 2010. The EA considers all three Project components: capture infrastructure, pipeline, and injection wells and geological storage.

For the EA, a list of potential valued environmental components (VECs) was developed and used in the

[9] http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ProtocolReviewProcess/5thCycleProtocolDevelopment/Carbon%20Capture%20Storage_Draftv2%20PostReview.pdf

assessment. For each VEC, potential Project interactions and potential environmental and socio-economic effects are evaluated. The components considered were: air quality, sound quality, geology and groundwater, aquatic resources, soils and terrain, vegetation and wetlands, wildlife and wildlife habitat, historical resources, land use, public health and safety, and socio-economics.

The findings of the EA concluded that the Quest CCS Project will not have a significant adverse effect on any biophysical or socio-economic resource provided the mitigation procedures identified in the EA are implemented. For further information, refer to the full EA, available via the Canadian Environmental Assessment Agency website.[10]

Proposed Timing for Submission into the Offset System Review Process

A draft protocol is expected to be submitted to Alberta Environment in the second quarter of 2011 for review. It is anticipated that this stage of the review process will be iterative in nature and will result in several revisions to the draft protocol during the second quarter of 2011. The draft protocol is expected to be submitted for Technical Review no later than September 2011, pending receipt of approval to proceed from Alberta Environment.

Following the Technical Review, and upon receipt of approval to proceed from Alberta Environment, it is proposed that the revised protocol be submitted to Alberta Environment for inclusion in the Stakeholder Review held annually in the fall, typically in late October or early November.

In order for Shell and joint-venture partners to make a final investment decision for the Quest CCS Project, it is requested that best efforts be made by all parties to work towards a target date for final approval of the proposed protocol by February 1st, 2012.

[10] http://www.acee-ceaa.gc.ca/050/Viewer_e.cfm?CEAR_ID=55916#Documents

References for Additional Background Information

Alberta Offset System. Quantification Protocol for Enhanced Oil Recovery. Alberta Environment (AENV). October 2007.

Alberta Offset System. Quantification Protocol for Acid Gas Injection Projects. Alberta Environment (AENV). May 2008.

American Carbon Registry. Merit Energy, PetroSource, Sandridge Pikes Peak, Anadarko Monell and Salt Creek EOR Projects.

American Petroleum Institute (API) - International Petroleum Industry Environmental Conservation Association (IPIECA). Oil and Natural Gas Industry Guidelines for Greenhouse Gas Reduction Projects. Part II: Carbon Capture and Geological Storage Emission Reduction Family. June 2007.

Blue Source Canada ULC. Draft GHG Quantification Methodology for Carbon Capture and Storage Projects. Prepared on behalf of ICO_2N and presented to Alberta Environment April 2009.

Blue Source Canada ULC. Draft Carbon Capture and Geologic Storage Emission Reduction Quantification Methodology (September 2010, Version 5). Prepared for the North American Carbon Capture and Storage Association (NACCSA).

Canadian Standards Association Clean Projects Registry and GHG Reductions Registry. Anadarko Monell, Salt Creek and Hays EOR Projects; MEGlobal Prentiss 1&2 EOR Projects, PetroSource EOR Project; and Denbury Resources EOR Project

Clean Development Mechanism. NM0167: Recovery of anthropogenic CO_2 from large industrial GHG emission sources1 and its storage in an oil reservoir

Clean Development Mechanism. NM0168: The capture of CO_2 from natural gas processing plants and liquefied natural gas (LNG) plants and its storage in underground aquifers or abandoned oil / gas reservoirs.

Clean Development Mechanism. Capture of CO_2 from the front-end of integrated Gas-to-Liquid (GTL) plants, transport via pipeline and long-term containment in appropriately selected and well-managed geological storage complexes.

International Organization for Standardization (ISO). Standard 14064: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements. March 2006.

World Resources Institute (WRI). Guidelines for Carbon Dioxide Capture, Transport, and Storage. October 2008.