FINAL TERMS OF REFERENCE
ENVIRONMENTAL ASSESSMENT REPORT

FOR THE PROPOSED

SHELL QUEST CARBON CAPTURE AND STORAGE PROJECT

ISSUED BY: **Alberta Environment**

DATE: **November 2, 2010**

Executive Summary

Shell Canada Limited (Shell, the proponent) proposes to construct and operate the Quest Carbon Capture and Storage (CCS) Project (the Project) in the Alberta Industrial Heartland region of the province, northeast of the City of Edmonton. Shell is seeking funding for the Project through the Government of Canada Clean Energy Fund, a program created as part of the federal economic action plan and administered by Natural Resources Canada (NRCan). Government of Canada funding of the Project triggers the need for an environmental assessment (EA) under the *Canadian Environmental Assessment Act* (CEAA) (Section 5(1)(b) of CEAA).

NRCan is the Responsible Authority (RA) for the EA of the Project (Section 11 of CEAA) as they are contemplating funding for this Project. Fisheries and Oceans Canada (DFO), Transport Canada and the Canadian Transportation Agency may be Responsible Authorities due to the potential requirement for permits and licenses that are *Law List Regulations* triggers pursuant to Section 5(1)(d) of CEAA. Environment Canada and Health Canada intend to act as federal authorities as these agencies possess specialist or expert information or knowledge with respect to the Project and have been requested by the Responsible Authorities to make that information or knowledge available.

The Government of Alberta has directed Shell to prepare and submit an Environmental Impact Assessment (EIA), under the Alberta *Environmental Protection and Enhancement Act* (EPEA), and associated regulations for the carbon dioxide (CO_2) storage component of the Project. A cooperative EA process will be conducted, in which Alberta Environment is the Lead Party, consistent with the *Canada-Alberta Agreement for Environmental Assessment Cooperation.* A single EA report that satisfies the requirements under both CEAA and EPEA will be prepared by Shell and submitted to the Government of Alberta concurrently with Shell's application to the Energy Resources Conservation Board (ERCB).

The purpose of this document is to define the Terms of Reference (TOR) for the EA report. The Terms of Reference are comprised of two parts. Part A identifies the Terms of Reference for the entire EA report and Part B identifies the specific EIA requirements of the Government of Alberta. All of the requirements listed in Part B are included in Part A.

The Project consists of three main components that comprise the scope of the Project for the purposes of the EA, and in particular as determined by the Responsible Authorities pursuant to Section 15 of CEAA: capture infrastructure, CO_2 pipeline and CO_2 storage. The capture infrastructure will be located on lands within the developed area of the Scotford Upgrader. The CO_2 pipeline will extend a distance of approximately 84 km from the Scotford Upgrader, north across the North Saskatchewan River, and terminating north of the village of Thorhild along an alignment to be confirmed through a route selection analysis. The specific locations and number of the CO_2 injection wells (estimated between 3 and 10 wells) and ancillary infrastructure are to be determined through an ongoing feasibility study, but will be situated within the subsurface study area.

The purpose of the Project is to capture CO_2 from the Scotford Upgrader using CCS technology. Project construction is expected to begin in 2012 through to 2015. The Project will be commissioned in 2015, and reach full operating capacity in the same year.

Shell has developed an engagement and consultation plan for the Project. This plan addresses regulatory, stakeholder and Aboriginal consultation, and provides a mechanism to track and respond to issues raised during engagement and consultation activities.

The EA of the Project will consider the mandatory factors as defined in Section 16(1)(a) to (d) of CEAA. Pursuant to Section 16(1)(e) of CEAA, the Responsible Authorities have included the following additional factors:

- a pipeline route selection analysis that considers environmental, social and engineering constraints
- a conservation and reclamation plan for the pipeline
- transportation of project-related materials and personnel in the study area
- a measurement, monitoring and verification plan for CO_2 storage
- the factors described in Section 16(2) of CEAA

The Responsible Authorities have determined pursuant to Section 16(3) that scope of the factors to be considered will be limited to and focused on valued environmental components (VECs) as described in this TOR:

- atmospheric environment
    - air quality
    - sound quality
- groundwater resources
- aquatic environment
- terrestrial environment
    - soils and terrain
    - vegetation and wetlands
    - wildlife and wildlife habitat
- archaeological and heritage resources
- the current use of land and resources, including for traditional purposes by Aboriginal persons
- land use
- public health and safety
- socio-economics

Table of Contents

Abbreviations

ACCS ..... Alberta Culture and Community Spirit
AENV ..... Alberta Environment
BCS ..... Basal Cambrian Sands
CCS ..... carbon capture and storage
CEAA ..... *Canadian Environmental Assessment Act*
CO_2 ..... carbon dioxide
DFO ..... Fisheries and Oceans Canada
EA ..... environmental assessment
EIA ..... environmental impact assessment
EPEA ..... *Environmental Protection and Enhancement Act*
ERCB ..... Energy Resources Conservation Board
GHG ..... greenhouse gas
HMUs ..... hydrogen manufacturing units
HRO ..... historical resources overview
H_2S ..... hydrogen sulphide
ISO ..... International Organization for Standardization
km ..... kilometre
m ..... metre
mm ..... millimetre
MMV ..... measurement, monitoring and verification
MOU ..... Memorandum of Understanding
MPMO ..... Major Project Management Office
NO_X ..... nitrogen oxides
NO_2 ..... nitrogen dioxide
NRCan ..... Natural Resources Canada
O_3 ..... ozone
PAI ..... potential acid input
$PM_{2.5}$ ..... fine particulate matter
PD ..... Project Description
RA ..... Responsible Authority
SARA ..... *Species at Risk Act*
Shell ..... Shell Canada Limited
SO_2 ..... sulphur dioxide
the Project ..... Quest Carbon Capture and Storage Project
TOR ..... terms of reference
VECs ..... valued environmental components

Part A: Terms of Reference for the EA Report

1 INTRODUCTION

Shell Canada Limited (Shell, the Proponent) intends to construct and operate the Quest Carbon Capture and Storage (CCS) Project (the Project), a fully integrated CCS project located in central Alberta. Shell proposes to construct and operate the Project in the Alberta Industrial Heartland region of the province, northeast of the City of Edmonton. Up to 1.2 million tonnes of carbon dioxide (CO_2) per year would be captured from the existing Scotford Upgrader. The CO_2 would then be transported by pipeline to injection wells north of the Shell Scotford complex and stored permanently more than 2 kilometres (km) below surface in the Basal Cambrian Sands.

The Project is subject to a federal environmental assessment pursuant to Section 5(1) of the *Canadian Environmental Assessment Act* (CEAA). Federally, it has been determined that a screening level environmental assessment is required. The Government of Alberta has directed Shell to prepare and submit an Environmental Impact Assessment report, under the Alberta *Environmental Protection and Enhancement Act* (EPEA), and associated regulations for the CO_2 storage component of the Project. A cooperative environmental assessment process consistent with the *Canada-Alberta Agreement for Environmental Assessment Cooperation,* in which Alberta Environment is the Lead Party, will be conducted. A single environmental assessment report that satisfies the requirements under CEAA and the requirements for an environmental impact assessment report under EPEA will be prepared by Shell ("the EA report"). The EA report will be submitted to the Government of Alberta concurrently with Shell's application to the Energy Resources Conservation Board (ERCB).

The purpose of this document is to define the terms of reference (TOR) for the preparation of the EA report. The TOR are comprised of two parts: A and B For the purpose of CEAA requirements, the EA report must be prepared in accordance with Part A. For the purpose of EPEA environmental impact assessment report requirements, which are restricted to the CO_2 storage component of the Project, the EA report must be prepared in accordance with Part B only. The requirements of Part B are duplicated in Part A consistent with the whole of the Project being subject to environmental assessment under CEAA.

1.1 Project Description

The following provides a description of the project location, components, purpose and schedule.

1.1.1 Project Location

The capture infrastructure will be located on lands within the developed area of the Scotford Upgrader. The CO_2 pipeline will extend a distance of approximately 84 km from the Scotford Upgrader, north across the North Saskatchewan River and terminating north of the village of Thorhild along an alignment to be confirmed through a route selection analysis. The specific locations and number of the injection wells (estimated between 3 and 10 wells, each with a pad measuring about 1 hectare and ancillary

infrastructure are yet to be determined through an ongoing feasibility study, but will be situated in the subsurface study area.

The Project footprint is defined as the area within which all on-site construction activities associated with the Project will ultimately take place. The Project footprint therefore includes:

- the capture infrastructure, located on pre-disturbed land within the development area of the existing Scotford Upgrader
- the pipeline right-of-way and temporary workspace
- the injection wells and associated site access roads and lateral pipelines.

1.1.2 Project Components

The Shell Quest CCS Project is briefly described as follows for each of the major Project components.

1.1.2.1 Capture Infrastructure

The Project will capture CO_2 from three existing Scotford Upgrader hydrogen manufacturing units (HMUs), which will reduce CO_2 emissions from the Scotford Upgrader by up to 35%. The HMUs manufacture hydrogen to upgrade oil sands bitumen. The method of CO_2 capture and compression includes multistage compression of the captured CO_2 into a dense-phase (called supercritical) fluid for transportation.

The capture infrastructure will capture CO_2 using an activated amine process (Shell's ADIP-X technology), which is a commercially proven amine technology in use at several Shell facilities. The captured CO_2 stream will be greater than 98% CO_2. The remaining 2% will be comprised of hydrogen, methane and trace levels of hydrogen sulphide (H_2S) at concentrations below consumer quality natural gas.

The raw synthetic gas from the existing HMUs will flow through the amine absorber, where approximately 80% of the CO_2 in the raw synthetic gas stream will be absorbed into the amine stream to form a rich amine. The treated gas will then be cooled to facilitate removal of liquid water, and sent to the pressure swing adsorption unit to undergo further purification. From there, the rich amine from all three existing HMUs will be commingled into a common line and sent to a stripping section. In the stripping section, a CO_2 stream and a lean amine stream will be produced.

1.1.2.2 Pipeline

Compressed CO_2 will be transported via a new pipeline from the capture infrastructure to a storage area located within 90 km north of the capture infrastructure site. The pipeline will be 305 mm (12 inches) in diameter, and will transport a dense-phase CO_2. Block valves will be spaced at distances of 15 km along the route and near selected locations, such as watercourse crossings.

The pipeline will follow existing pipeline right-of-ways for much of the route, with less than 75 km of new right-of-way required. More than 35 km of this pipeline will be adjacent to existing pipeline rights-of-way.

The pipeline will require an 18 m right-of-way and an additional 7 m of temporary workspace during construction. The majority of the pipeline route will be within agricultural land. The pipeline will cross a

number of permanent and ephemeral water bodies, the largest being the North Saskatchewan River. The preferred method for the North Saskatchewan River crossing is by horizontal directional drilling, but a contingency plan of open cutting will still be carried in this application. The pipeline will also cross several small wetlands. A route selection analysis will be conducted to connect the capture infrastructure and the injection well location(s). This analysis will consider engineering, environmental and social constraints while attempting to follow existing linear infrastructure to avoid fragmentation of habitat and property.

1.1.2.3 Storage

Injection wells will be designed for injection of CO_2 into the Basal Cambrian Sands (BCS), at a depth of approximately 2 km below surface, and will include a measurement, monitoring and verification (MMV) plan. The storage area is north of the capture infrastructure site. An exploration appraisal well program is underway that will provide necessary information for determining the final locations of the injection wells for permanent CO_2 storage.

Shell will complete the exploration appraisal well program, geophysical data gathering and studies to confirm the technical aspects of the site. Three exploration appraisal wells have been drilled.

Based on the current results, it is expected that approximately 3 to 10 injection wells will be drilled for injecting the CO_2 into the BCS storage formation. Confirmation of both the number of wells and their location will be made following review of results of the summer 2010 appraisal program.

Monitoring wells will also be drilled as part of the MMV plan. Shell will use MMV technologies and systems to ensure the storage site performs as expected. This will require data collection and analysis during CO_2 injection and before and after injection startup for adaptive management.

In addition, CO_2 capture and pipeline infrastructure will be part of the monitoring program to ensure CO_2 is handled and stored in a safe and secure way.

1.1.3 Project Purpose

The purpose of the Project is to capture CO_2 from the Scotford Upgrader using CCS technology.

1.1.4 Project Schedule

Project development, including planning, stakeholder and Aboriginal consultation, regulatory approvals, and detailed engineering began in 2008. Consultation will run through to the construction and operations phases of the Project. Construction is expected to begin in 2012 through to 2015. The Project is expected to be commissioned in 2015, and reach full operating capacity in the same year. The Project is expected to operate for the life of the Scotford Upgrader (i.e., greater than 25 years).

1.2 Regulatory Framework Applicable to the Project

1.2.1 *Canadian Environmental Assessment Act*

Shell is seeking funding for the Project, which is a project as defined in the Act, through the Government of Canada Clean Energy Fund—a program created as part of the federal Economic Action Plan and

administered by Natural Resources Canada (NRCan). Accordingly, the Project is subject to a federal environmental assessment because of this funding trigger under Section 5(1)(b) of CEAA. NRCan is a Responsible Authority (RA) under CEAA (Section 11 of CEAA). Federal authorities are required to provide notification of the Project, and a project description, to the other federal authorities, in accordance with the *Regulations Respecting the Coordination by Federal Authorities of Environmental Assessment Procedures and Requirements* (Federal Coordination Regulations). NRCan undertook federal coordination and Environment Canada and Health Canada have declared that they are federal authorities with expert knowledge pursuant to Section 12(3) of CEAA. Three agencies have identified that they may also act as Responsible Authorities as described below, depending on final design and the ultimate need for authorizations under laws that are identified as triggers for environmental assessment under the *Law List Regulations*.

Fisheries and Oceans Canada (DFO) may issue an authorization pursuant to Section 35(2) of the *Fisheries Act* for the harmful alteration, disruption or destruction of fish habitat (HADD) associated with the crossing of fish bearing watercourses, if applicable. Section 35(2) authorizations under the *Fisheries Act* are referred to in the *Law List Regulations* (Section 5(1)(d) of CEAA) and DFO might therefore act as a Responsible Authority pursuant to Section 11 of CEAA.

Transport Canada may issue an authorization for the Project pursuant to Section 5 of the *Navigable Waters Protection Act* for the crossing of a navigable water body, if applicable. Section 5 authorizations under the *Navigable Waters Protection Act* are referred to in the *Law List Regulations* (Section 5(1)(d) of CEAA) and Transport Canada might, therefore, act as an Responsible Authority pursuant to Section 11 of CEAA.

The Canadian Transportation Agency may be a Responsible Authority for the Project due to the potential need for issuance of a permit under applicable sections of the *Canada Transportation Act* that are referred to in the *Law List Regulations.*

There are no other known potential triggers for an environmental assessment of the Project under Section 5 of CEAA. The Project is not listed in the *Comprehensive Study List Regulations*, nor is it in the *Exclusion List Regulations*, under CEAA. The Project has not been referred directly to a mediation or panel review. Therefore, a screening is required under CEAA (Section 18(1) of CEAA).

The Canadian Environmental Assessment Agency will be the Federal Environmental Assessment Coordinator for this Project, pursuant to Section 12.4(1)(a) of CEAA.

The Major Project Management Office (MPMO) will provide overarching project management support to the Responsible Authorities for this Project, pursuant to the Cabinet Directive on Improving the Performance of the Regulatory System for Major Resource Projects and the associated Memorandum of Understanding (MOU). The MPMO will provide oversight and advice throughout the entire federal review in relation to the Project to ensure adherence to the service standards and roles and responsibilities of all Parties.

1.2.2 Alberta Environmental Assessment and Approvals

The Government of Alberta has directed Shell to prepare and submit an Environmental Impact Assessment (EIA), under the Alberta *Environmental Protection and Enhancement Act* (EPEA), and

associated regulations for the CO_2 storage component of the Project. The EIA report will be submitted to the Government of Alberta concurrently with Shell's application to the ERCB.

In addition, the capture component of the Project will require amendments to the Scotford Upgrader EPEA approval and the *Oil Sands Conservation Act* approval.

1.3 Coordinated Federal and Provincial EA

A cooperative EA process will be conducted in accordance with *The Canada–Alberta Agreement on Environmental Assessment Cooperation* (the Agreement). The Agreement establishes administrative mechanisms and guides federal-provincial cooperation for the environmental assessment of projects subject to both the CEAA and the Alberta EPEA. A cooperative EA that is consistent with the Agreement, meaning a single EA, will be prepared in which both parties cooperate through the process of the AENV (the Lead Party) to meet the legal requirements of both the CEAA and the EPEA.

1.4 Organization of the Terms of Reference

The remainder of Part A of this TOR is organized into three additional sections. Section 2 describes the Scope of the Assessment of the Project, including the scope of the Project, factors to be considered, and the scope of the factors, articulating the scoping decisions of Responsible Authorities under Sections 15 and 16(1) and 16(3) of CEAA, and in consideration of provincial concerns. Section 3 outlines the stakeholder and aboriginal consultation and engagement plan. Section 4 provides a brief description of Shell's planned environmental assessment methodology and proposed organization of the EA report.

Part B of this TOR identifies the specific EIA requirements of the Government of Alberta. All of the requirements listed in Part B are included in Part A.

2 SCOPE OF ASSESSMENT

Under CEAA, the scope of the environmental assessment includes the scope of the project (Section 15) and the factors to be considered (Section 16(1)), including the scope of the factors pursuant to Section 16(3).

2.1 Scope of the Project

The scope of the Project determined by Responsible Authorities, pursuant to authority under Section 15(1) of CEAA includes the following elements and activities:

- the construction of the capture infrastructure, CO_2 pipeline and storage facilities
- the operation of the Project, including normal operation as well as accidents or malfunctions that might occur during the course of its operation
- the decommissioning and abandonment of the Project at the end of its useful life, to the extent that is currently known.

The scope of the Project does not include:

- the manufacture of Project components outside of the study area
- the transportation of materials and personnel outside of the study area
- operation of the existing Scotford Upgrader
- any upstream extraction, processing and transportation of bitumen
- any downstream consumption, transportation or processing of bitumen, including its combustion.

2.2 Factors to be Considered

The EA will consider the mandatory factors outlined in Section 16(1)(a) to (d) of CEAA. Additionally, pursuant to Section 16(1)(e) of CEAA, the Responsible Authorities have included the following additional factors to be considered:

- a pipeline route selection analysis that considers environmental, social and engineering constraints
- a conservation and reclamation plan for the pipeline
- transportation of project-related materials and personnel in the study area
- a measurement, monitoring and verification (MMV) plan for CO_2 storage.

2.3 Scope of the Factors

Pursuant to Section 16(3) of CEAA, the scope of the factors to be considered in relation to the Project, are grouped by Valued Environmental Components (VECs). Issues related to the Project are identified from a variety of sources, including:

- regulatory requirements
- discussions with technical experts from various provincial and federal government agencies
- existing regional information and documentation regarding environmental and socio-economic components found in the Project area (e.g., species at risk)
- documentation relating to other projects and activities in the area of the Project
- professional judgment of the assessment practitioners, based on experience with similar projects elsewhere and other projects and activities in the area of the Project.

The following sections will identify the analytical approach, techniques and tools that will be employed to evaluate the environmental effects of the Project on each VEC, and as such, define the specific scope of the factors to be considered for each VEC pursuant to Section 16(3) of CEAA.

2.3.1 Atmospheric Environment

Project activities have the potential to result in adverse environmental effects to various components of the atmospheric environment. The potential environmental effects on air quality and sound quality will be considered in the EA.

2.3.1.1 Air Quality

The Project will add capture infrastructure to the existing Scotford Upgrader Base Plant HMU steam reformer stacks, as well as the existing HMU steam reformer stack at Scotford Expansion 1. This capture infrastructure will result in higher thermal generation of nitrogen oxides (NO_X), which is the main air emission change associated with the Project. The quantity of CO_2 recovered from the HMUs will be documented. Carbon balances including, at minimum, the quantity of greenhouse gases being emitted from the Scotford Upgrader will be provided detailing pre and post Quest. Any changes to the air emissions (e.g., change in location of point sources of emissions or relative importance of point sources) at the Scotford Upgrader and/or the operation, decommissioning, and abandonment of the HMUs due to the addition of the CO_2 capture of the Quest infrastructure will be discussed.

Beyond the substantial reduction of CO_2 emissions, the purpose of the Project, NO_X emissions are the primary emission change from the Project. As such, the detailed assessment will focus on the NO_X emission change and the consequences of these emissions. Other Project elements have nominal emissions and will not be considered beyond estimating their quantity and character. The assessment will also consider the changes to ambient nitrogen dioxide (NO_2) concentrations.

Baseline ambient air quality and emissions data in the vicinity of the Project will be collected from published sources (where available) to establish existing air quality conditions in the air quality study area.

Potential air quality issues will be evaluated in the context of Project emissions, other sources in the airshed, other users of the airshed and the existing regulatory framework. This will include analyzing recent monitoring data and updating existing air quality conditions in the Project region. Shell will also update the regional emissions inventory to incorporate the latest changes to existing, approved and planned industrial projects. As per the Alberta Environment Air Quality Model Guideline (Idriss and

Spurrell 2009), Shell will generate a five-year MM5 meteorological dataset to use in dispersion modelling. Modelling will be done for construction, operation and decommissioning and abandonment emission scenarios and all predicted concentrations of NO_2 will be compared with the Alberta Ambient Air Quality Objectives (AENV 2008). Modelling will be done using the CALPUFF model.

Potential project-related environmental effects related to ozone (O_3), as well as greenhouse gas emissions, will be discussed qualitatively as the Project is aimed at greenhouse gas (GHG) emissions reduction and changes in ozone emission will be limited. Also, potential environmental effects associated with factors including amine releases, sulphur dioxide SO_2, potential acid input (PAI), nitrogen deposition, fine particulate matter ($PM_{2.5}$) and visibility will be qualitatively discussed in the report.

Project construction-related environmental effects on air quality will be described qualitatively and include relevant mitigation measures.

2.3.1.2 Sound Quality

The intent of the noise assessment is to assess potential Project-related noise environmental effects on human dwelling receptors resulting from the Project and associated activities, and compare the results with regulatory requirements. Sound sources associated with the Project will be addressed in the noise assessment and will be focused on the capture infrastructure.

The environmental effects analysis will assess potential project-related environmental effects of noise on human dwelling receptors. The assessment will focus on operational noise sources from the capture infrastructure, since no continuous noise sources are expected for the pipeline or injection wells.

The ERCB regulates sound levels generated by energy facilities and their operations in Alberta. Sound quality will be assessed according to ERCB Directive 38: Noise Control Guidelines (ERCB 2007) for energy related facilities. Consideration will be given to the Noise Effects information detailed in Health Canada's *Useful Information for Environmental Assessment (October 23rd, 2009)*.

Modelling will be based on representative ground terrain and conservative meteorological conditions recommended in Directive 38. Noise propagation methods used in this assessment are those prescribed by the International Organization for Standardization (ISO) Standard 9613 (ISO 1993, 1996). The ERCB has accepted the ISO 9613 standard for noise assessments under Directive 38. Sound propagation will be calculated using the latest version of Cadna A (DataKustik 2008)—a noise modelling software package that incorporates ISO 9613 sound propagation algorithms.

2.3.2 Geology and Groundwater Resources

The Project has the potential to affect groundwater resources. Since the additional CO_2 capture infrastructure will be situated within the existing Scotford Upgrader footprint and the potential environmental effects related to the CO_2 pipeline will be primarily related to surface disturbance, the focus of the hydrogeology baseline and environmental effects assessment will be the CO_2 storage component.

Baseline hydrogeological conditions will be established for the CO_2 storage. The baseline assessment shall include a description of the existing geologic and hydrogeologic setting from the ground surface to the base of the BCS formation, including representative cross-sections. It shall also include the

methodology and sources of information used to determine the baseline groundwater resource environment.

The baseline assessment will include a description (with mapping/models) of the following:

- the location and depths of known groundwater resources in the study area, including any known buried channels and useable aquifers, defined in ERCB Directive 51 as groundwater with a total dissolved solids content of 4000 milligrams per litre or less
- the major aquifers, aquitards and aquicludes, their spatial distribution, hydraulic properties, hydraulic connections between aquifers, hydraulic heads, gradients, and groundwater flow directions and velocities. Cross sections that show hydraulic heads and groundwater flow directions relative to injection well sites, potable water wells and surface waters will be provided
- the physical and chemical properties of groundwater including baseline values for alkalinity, temperature, pH, Eh, electrical conductivity, major ions, nutrients, relevant minor and trace constituents, metals and hydrocarbons
- seasonal variations in groundwater quality, hydraulic heads and flow regime
- groundwater recharge and discharge zones
- areas of groundwater-surface water interaction, including interaction with wetlands
- potential hydraulic connection between BCS groundwater and shallower groundwater. If none exists, then evidence to this effect shall be presented
- the locations and depths of all known water wells (operating and abandoned), test holes and an inventory of groundwater users within the study area
- the locations and depths of known structure test holes, disposal wells, oil and gas wells (operating, suspended and abandoned) in the study area
- the pre-existing subsurface conditions, using an earth model, including a description of geologic formations, faults and fractures, a statement about seismic activity, a description of potential hydrocarbon bearing formations, illustrated by structure contour maps, cross sections, isopach maps and maps with well control (all drilled wells in the area, for which the information is publicly available from NEB and ERCB). These maps should illustrate depth, thickness and spatial extent of lithology, stratigraphic units and structural features
- the acid generating and metal leaching potential of the rocks in the study area.

Shell shall identify the Project components and activities that have the potential to affect groundwater resource quantity and quality and provide:

- an assessment of potential changes to groundwater quantity and quality with a focus on those hydrostratigraphic units above the Base of Groundwater Protection. The effects analysis will identify the potential for effects/changes to the overlying groundwater resources (quality, quantity, horizontal and vertical movement) and groundwater users in the study area. Consideration will be given to the Drinking and Recreational Water Quality information provided in Health Canada's *Useful Information for Environmental Assessment (October 23rd, 2009)*

- a discussion of the potential for groundwater and surface water interaction and the resulting effects on surface water quantity and quality
- a geochemical assessment of the compatibility of the receiving geological and hydrogeological setting to receive the injected CO_2. Include in the assessment a discussion of the potential chemical reactions between the CO_2 source and the BCS reservoir and seals
- a description/model of any pressure change (pressure build-up) in the BCS
- a discussion of the suitability of the BCS for CO_2 storage, including containment potential, injection capacity, and hydrodynamic flow regime. Present the methodology used to determine the reservoir capacity, including historical data, field data, and any assumptions used
- an assessment of the fate and transport of the injected CO_2
- a general characterization of contaminants and a discussion of impacts in the event of a release of these contaminants about the Base of Groundwater Protection
- the source and amount of any groundwater required
- an assessment of effects of construction and operation of the pipeline on groundwater flow along pipe at the pipeline crossing of the North Saskatchewan River
- details on the management of liquid/solid waste (hydrostatic water, drilling fluids/solids and formation water), including:
    - the source, composition and volume of each liquid waste,
    - any temporary storage sites for liquid waste,
    - the ultimate disposal site and/or treatment for liquid waste, and
    - chemical criteria used for the release of wastewater to the environment.
- the effects of potential perforation and/or fracturing of the BCS aquifer in terms of new fractures/fault reactiviating etc. as well as what the effects are of the higher pore pressures in the BCS as a result of the CO2 injection
- a risk assessment that will include the potential leak of CO2 and saline water from the BCS.

For each potential effect, the effects analysis will describe the:

- cause of the environmental effect
- likelihood of the environmental effect occurring
- nature of the environmental effect
- magnitude and duration of the environmental effect.

The EA shall also describe the drilling and completion activities for a representative injection well, including methods used to:

- protect groundwater resources
- prevent the release of CO_2 through or around the wellbore

- prevent upward migration of the saline water in the BCS.

The EA shall include a vertical cross-section from the ground surface to the base of the BCS formation of a representative injection well site, and a description of the operation and decommissioning of a representative injection well site.

Modeling

- For each model used in the effect analysis provide:
  - the justification for the model used
  - a detailed conceptual model
  - model input parameters
  - documentation of the calibration process, the validation process and the assumptions used to obtain the modeling predictions in the EA report
  - discussion of the limitations of the models, including sources of error and relative accuracy, and how these limitations were addressed in the EA report
  - a sensitivity analysis that includes extreme climatic variations.

Monitoring and Mitigation

Shell will provide a proposed program to monitor for potential environmental effects to groundwater resources and groundwater users. For the monitoring program, Shell will include a description of the purpose and the design (location, frequency of sampling and analysis, and parameters measured).

The monitoring program shall include:

- plans to share monitoring information with the public and with municipal, provincial and federal governments
- the process for addressing concerns from groundwater users reporting potential environmental effects to their groundwater source
- how the results of the risk assessment, mentioned above, were incorporated in the design of the monitoring program
- measures put in place for the early detection of potential contamination
- measures put in place to prevent environmental effects to groundwater resources and users
- measures put in place to mitigate/remediate environmental effects detected in the monitoring program and reported by groundwater users

Shell shall also provide:

- a description of each of the technologies to be considered for the measurement, monitoring and verification (MMV) activities at the Quest project and the criteria that will be applied when selecting the preferred option
- Rationale for the placement of the monitoring wells
- an MMV plan for each phase of the Project. Phases to be considered include:
  - pre-operational

- operational
- closure
- post-closure

For each phase, provide an outline of the monitoring technologies that may be employed and the frequency of their use.

For the post-closure period provide justification for the length of the groundwater monitoring proposed and describe what conditions must be met to reduce the monitoring frequency or to cease monitoring entirely.

- a description of Shell's experience with MMV at other CO2 sequestration projects internationally. For any project referenced, provide a description of the MMV programs employed.
- a plan to describe what Shell would do if the MMV program detected a CO2 release.

2.3.3 Aquatic Environment

The aquatic environment VEC will consider the environmental effects of the Project on fish populations and fish habitat in fish-bearing watercourses that are crossed by or near the Project. The description of the existing conditions will include considering:

- drainage areas of watercourses crossed by the Project
- presence of fish species in watercourses crossed by or proximal to the Project
- characterization of fish habitat in watercourses crossed by the Project
- proposed timing for all phases of the Project that are of relevance to fish and fish habitat (e.g., the timing of instream work or ground disturbance).

This assessment will include identifying Project components that might influence or affect identified fisheries or fish habitat, including species at risk (or critical habitat), discussions of anticipated environmental effects, the significance of potential environmental effects and design, construction and operational factors that might be used to minimize environmental effects and protect aquatic resources.

Should the Project involve harmful alternation, disruption or destruction of fish habitat, even in consideration of planned mitigation, a draft plan to offset any loss in the productivity of fish habitat will be developed.

2.3.4 Terrestrial Environment

The assessment of Project effects on the terrestrial environment will focus on Project activities that are expected to result in a measurable change in the terrestrial environment (i.e., environmental effects associated with the pipeline right-of-way, injection well pads and associated site access roads and pipeline laterals. There will be no new ground disturbance associated with the capture infrastructure). For each of these VECs, existing information will be considered and supplemented with recent field surveys, where required.

For each VEC, information obtained during the assessment will be used to identify site-specific mitigation measures and provide input to the conservation and reclamation plan so that potential environmental effects to the terrestrial environment are minimized.

2.3.4.1 Soils and Terrain

The soils and terrain VEC will focus on the project footprint, which includes the pipeline right-of-way, injection well pads and associated access roads and pipeline laterals. The description of the existing conditions in the project footprint will include:

- soil types and their distribution, including a soil survey report and associated maps
- suitability and availability of soils for reclamation
- descriptions and locations of sensitive soil types
- surficial geology and topography.

The assessment will describe physical changes to landforms (terrain) and soils (e.g., disturbance, erosion, changes in soil moisture, compaction and surface heave) that might result from the construction, operation and abandonment of the pipeline, and outline mitigation planned to minimize these changes where they are adverse.

2.3.4.2 Vegetation and Wetlands

Pipeline construction, operation and decommissioning and abandonment are expected to have an environmental effect on vegetation and wetlands (where they cannot be reasonably avoided) in the pipeline right-of-way, injection well pads, associated access roads and pipeline laterals. The description of the existing conditions in the Project footprint will include mapping:

- existing vegetation communities for each ecosite phase, including non-native plant species
- the relative abundance of species of rare plants and the ecosite phases where they are found.

The assessment will consider the environmental effects of the Project for all rare plant species listed in Schedules 1, 2 and 3 of the *Species at Risk Act* (SARA) and COSEWIC, as well as those species listed as At Risk, May Be at Risk and Sensitive in *Status of Alberta Wild Species* (ASRD 2005, Internet site). The assessment will also consider the environmental effects of the Project on wetlands identified in the right-of-way that cannot be reasonably avoided. Where the Project disturbs wetlands, an assessment, which includes consideration of the Federal Policy on Wetland Conservation, will be undertaken to help determine mitigation strategies or compensation (or both) to address any likely significant adverse environmental effects as required.

2.3.4.3 Wildlife and Wildlife Habitat

This VEC will take into consideration wildlife that are known, or that are likely to use the terrestrial habitat that will be adversely affected by the Project.

The assessment will consider the potential for the Project to result in adverse environmental effects on species listed in Schedules 1, 2 and 3 of SARA and COSEWIC, as well as those listed under the Alberta *Wildlife Act* as Endangered or Threatened. The assessment will also include planned mitigation for adverse environmental effects to wildlife and wildlife habitat.

The assessment will describe measures chosen by Shell to minimize impacts to Migratory Birds and their eggs and nests in accordance with the *Migratory Bird Convention Act*.

2.3.5 Archaeological and Heritage Resources

A historical resources overview (HRO) of the pipeline route will be undertaken and submitted to Alberta Culture and Community Spirit (ACCS) according to the Alberta *Historical Resources Act*. ACCS will issue requirements for the scope of studies relative to the historical resources. It is anticipated that the requirements will include field studies at selected sites along the pipeline route and an assessment of historical resources site significance.

Information on the likelihood of the pipeline component of the Project to encounter palaeontological resources during construction, as required under CEAA, will be obtained from ACCS.

An assessment of the effect of any change the Project might cause in the environment on any structure, site or thing that is of historical, archaeological, palaeontological or architectural significance will be considered in consultation with ACCS and will depend on the heritage resources encountered in the Project footprint.

2.3.6 Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons

Working with relevant federal and provincial Crown agencies, Aboriginal communities in the area will be identified and provided an opportunity to identify current use of land and resources for traditional purposes by Aboriginal persons that could be affected by the Project.

The assessment will consider the potential environmental effects of Project activities and components on lands and resources used for traditional purposes. Through consultation with Aboriginal community members, the analyses of environmental effects on traditional land and resource use will attempt to identify mitigation measures to minimize these potential environmental effects.

2.3.7 Land Use

The potential environmental effects of the Project on the current use of lands for agricultural, recreational, residential, commercial or other use will be considered in the assessment. Specifically, potential effects will be assessed on:

- current land uses including oil and gas development, agriculture, forestry, tourism, cultural use, food collection, trapping, fishing, hunting and other Aboriginal uses and outdoor recreational activities
- Crown land, including bed and shore as well as Crown Reservations
- unique sites or special features such as parks and protected areas, heritage rivers, historic sites, environmentally significant areas, culturally significant sites and other designations
- land use policies and resource management initiatives that pertain to the Project, and discuss how the Project will be consistent with the intent of these initiatives
- rail traffic and navigability on waterways.

Shell will include a discussion of the federally regulated rail crossings required for the Project, including a discussion of proposed crossing methods and potential effects. Shell will also provide an update on the status of the agreements between Shell and the federal railway authorities.

Mitigation measures to address adverse environmental effects will be identified, where applicable.

2.3.8 Public Health and Safety

A human health risk assessment will be carried out to assess the environmental effects of the Project's capture infrastructure air emissions on relevant receptors.

The health assessment will follow a four-stage paradigm, including problem formulation, exposure assessment, hazard assessment and risk characterization. A list of the chemicals of potential concern will be developed based the results of the air quality assessment. The effects analysis will include:

- assessing potential health implications of the compounds that will be released to the environment from the Project (capture facility) in relation to exposure limits established to prevent acute and chronic adverse effects on human health
- documenting any health concerns raised by stakeholders during consultation on the Project
- providing anticipated follow-up work, including regional cooperative studies.

How such work will be implemented and coordinated with ongoing air, soil and water quality initiatives will be included in the assessment.

2.3.9 Socio-Economics

The environmental effect of the Project on socio-economics will be assessed. The assessment will include consideration of:

- population changes
- Shell's policies and programs regarding the use of regional and Alberta goods and services
- workforce requirements for the Project, including a description of when peak activity periods will occur
- planned accommodations for the workforce during the life of the Project.

The environmental effects of the Project on the local social and economic conditions will be assessed. The assessment will consider potential environmental effects on municipal, provincial and federal fiscal conditions, and population changes and how they affect service providers. The environmental effects of the Project on traffic will also be considered.

2.3.10 Effects of the Environment on the Project

Because of the potential for adverse weather conditions (e.g., precipitation and flooding), there is the potential for an adverse effect of the environment on Project schedule and infrastructure. The Project might also be affected by the geology of the region, including seismic events and earthquakes.

The environmental assessment of climate and climate change will be limited to considering the potential effects of adverse weather conditions such as flooding, and other possible extreme weather events that might interact with the Project, such that Project schedule is compromised or that the Project design must be altered to minimize potential environmental effects or to protect human health.

2.3.11 Cumulative Environmental Effects

The environmental assessment must consider cumulative environmental effects that are likely to result from the Project in combination with other projects or activities that have been or will be carried out.

Where it is likely for this Project to contribute to existing and overlapping cumulative environmental effects on a VEC, further evaluation and discussion is required. This will include considering the general environmental effects of existing developments, projects or activities that have been approved and projects or activities that have been publicly disclosed, provided they have the potential to act in combination with the environmental effects of the Project.

The projects to be included in the cumulative effects assessment will be clearly identified and will include any projects proposing to inject CO2, water or other substances into the BCS, if applicable. To determine which other projects and activities need to be considered as part of the cumulative effects assessment, geographic and temporal boundaries will be defined. The cumulative environmental effects of those projects must overlap with those of the Project to be considered.

Proposed mitigation measures that reduce cumulative environmental effects will be identified. Shell will also include a description of any proposed monitoring, research and other strategies or plans. Residual contributions of the Project to cumulative environmental effects will also be identified and the responsibility for implementing of mitigation identified. This assessment will also include uncertainties and knowledge deficiencies, as well as follow-up requirements to address uncertainties.

3 STAKEHOLDER AND ABORIGINAL CONSULTATION

Shell has developed a stakeholder engagement and consultation plan for the Project. Stakeholder engagement was initiated in August 2008. As part of the roll out of the stakeholder engagement plan, Shell held an open house in Fort Saskatchewan in the fall of 2008. Engagement with landowners and occupants along the proposed pipeline route began in January 2010, followed by open houses in key communities in March 2010 (Fort Saskatchewan, Bruderheim, Radway and Thorhild). Shell will continue with stakeholder engagement and communication with the public as the Project evolves.

The Project stakeholder consultation and engagement program includes stakeholder meetings, information sessions and communications, such as:

- regular update meetings
- informal drop-in coffee sessions
- publicly advertised open houses
- face-to-face visits
- mail-outs
- telephone calls and e-mail
- an information phone line
- Quest project-specific email address
- comment cards at Shell-sponsored public events
- regular updates through the website: www.shell.ca/scotford
- quarterly community newsletter
- community survey.

These interactions with stakeholders allow Shell to identify and better understand ongoing interests and concerns well in advance of any planned projects. Issues identified during consultation will be considered in the evaluation of VECs in the EA report, and in developing mitigation measures to address potential Project effects.

3.1 Aboriginal Consultation

The Project is not expected to require access to, use or occupation of, Aboriginal reserve lands.

Shell will develop an Aboriginal consultation plan for the Project and will implement the plan in cooperation with relevant Crown agencies, including Responsible Authorities and Federal Authorities as appropriate. The plan will take into consideration:

- Alberta's First Nations Consultation Guidelines on Land Management and Resource Development
- public participation requirements under CEAA
- MPMO Guidelines *Early Aboriginal Engagement: A Guide for Proponents of Major Resource Projects*.

3.2 Regulatory Consultation

Shell has initiated consultation with all federal and provincial regulators and agencies previously identified as regulators for the Project. Consultation will continue throughout the Project to ensure that regulators are up-to-date on potential changes to the scope or components of the Project.

3.3 Tracking and Responding to Issues of Concern

Shell will document all consultation and engagement activities carried out with stakeholders and Aboriginal groups, including presentations, Project information provided to stakeholders and correspondence in a stakeholder engagement database. Information documented will include:

- names of the stakeholder or Aboriginal groups consulted and engaged
- date(s) of events
- means of consultation and engagement events (e.g., community and other meetings, telephone calls, e-mails, open houses or workshops)
- issues and concerns identified
- responses to issues and concerns and follow-up actions.

4 ENVIRONMENTAL ASSESSMENT METHODS AND REPORT STRUCTURE

The structure of the EA report is designed to meet federal and provincial assessment requirements, while presenting information sequentially to facilitate evaluation of Project-related environmental effects. The environmental assessment of the Project will be completed using a methodological framework developed to meet the requirements of the CEAA and the EPEA. The scope of the assessment is based on the requirements identified in CEAA, but has been augmented to address issues identified by both provincial and federal authorities.

4.1 Overview of Environmental Assessment Approach Methodology

The EA methods will address the mandatory factors under Sections 16(1)(a) to (d),the additional factors identified under Section 16(1)(e), and as scoped under Section 16(3).

The assessment will focus on specific environmental components (called Valued Environmental Components, or VECs) that have been identified through examination of Project activities and plans, or identified during regulatory consultation (including Federal Authorities) during scoping, as likely to be affected by the Project. VECs are defined as broad components of the biophysical or human environments that, if altered by the Project, would be of concern or “valued” to regulators, Aboriginal community, resource managers, scientists or the public.

Project-related environmental effects and cumulative environmental effects could be assessed sequentially, and in consideration of any planned mitigation measures. All Project-related environmental effects will be characterized using specific criteria (e.g., magnitude, geographic extent, duration, frequency and reversibility) that are defined for each VEC. The methodological framework will be consistent between VECs, and standard tables and matrices will used to facilitate comprehensive evaluation.

The environmental effects assessment approach to be used in this EA will involve:

- Scoping of the overall assessment, including selection of VECs (and, if required, key indicators); description of measurable parameters; description of temporal, spatial, and administrative/technical boundaries; definition of the parameters that will be used to characterize the project-related environmental effects and cumulative environmental effects, and identification of the standards or thresholds that will be used to determine the significance of environmental effects
- Assessment of project-related environmental effects, including descriptions of how an environmental effect may occur, mitigation and environmental protection measures proposed to reduce or eliminate the environmental effect, and evaluation and characterization of the residual environmental effects of the Project (i.e., environmental effects remaining after application of mitigation measures) on the biophysical and human environment for each development phase, as well as for accidents, malfunctions, and unplanned events

- Identification and assessment of cumulative environmental effects that overlap with those of the Project, for all phases of the Project (i.e., construction, operations and closure and post-closure phases), including those from accidents, malfunctions and unplanned events
- Evaluation of the residual cumulative environmental effects of the Project
- Determination of the significance of residual project-related and residual cumulative environmental effects
- Recommendations for follow-up to verify the accuracy of the environmental assessment and determine the effectiveness of any measures taken to mitigate adverse environmental effects.

The cumulative environmental effects screening will be conducted for any residual environmental effects to determine if there is potential for a cumulative environmental effect as defined in CEAA. A series of three questions is used to screen cumulative environmental effects:

- Is there a Project-related environmental effect?
- Does the Project-related environmental effect overlap with those of other past and future projects and activities that have been and will be carried out?
- Is the Project contribution to cumulative environmental effects substantive and measurable or discernible such that there is some potential for substantive cumulative environmental effects that are attributable to the Project?

If, on the basis of these three questions, there is potential for a cumulative environmental effect, it will be assessed to determine if it has the potential to result in likely significant adverse environmental effects on a component of the natural or human environment.

4.2 General Structure of the EA Report

In general, the EA report is expected to be organized in the following manner:

- Executive Summary
- Introduction, including regulatory framework
- Project Description
- Consultation and Engagement
- Environmental Assessment Methods
- Environmental Setting (i.e., a summary of existing conditions)
- Project Interactions with the Environment
- Environmental Effects Analysis, including one section for each VEC (e.g., atmospheric environment, groundwater resources, land use)
- Effects of the Environment on the Project
- Accidents, Malfunctions and Unplanned Events
- Follow-up
- Conclusion

- References.

Each of these sections is described separately below.

4.3 Executive Summary

The EA report will include an executive summary of the essential facts and findings of the assessment. The executive summary will include a brief description of the Project and a summary of the public, regulatory and Aboriginal consultation and engagement issues. Key results of the environmental effects analysis will be summarized, including a summary of potential residual and cumulative environmental effects and mitigation measures for all phases of the Project including accidents, malfunctions and unplanned events.

4.4 Introduction

The introduction will discuss the following elements:

- the purpose of the EA report
- a brief Project overview
- the proponent and expected operator of the Project
- the applicable regulatory framework to the Project

4.5 Project Description

The Project description portion of the EA report will provide a detailed description of Project activities and components. This will include, but will not be limited to:

- The legal entity that will develop, manage and operate the Project and hold the operating approvals
- the purpose of the Project
- alternatives to the Project
- alternative means of carrying out the Project that are technically and economically feasible
- a description of the Project facilities, including its geographic location, layout, and description of the facilities, assets, and infrastructure that are anticipated to be associated with the Project
- a description of the various phases (construction, operations and decommissioning or abandonment) of the Project, and activities to be conducted in each phase
- a description of the key environmental management initiatives that will be implemented to minimize environmental effects
- a discussion of key emissions and wastes associated with the Project, including a summary site specific waste handling and disposal procedures
- Shell's experience operating the Scotford facility and constructing and operating wells and pipeline in Alberta

- the linkages and interactions between the components of the Quest CCS project and other parts of the Scotford Upgrader
- Shell's commitment to environmental studies and community involvement
- an overview of the Quest CCS Project and the linkages between the carbon capture component, the pipeline component and the carbon storage component
- a map showing the proposed injection well sites and the nearest communities to the proposed injection well sites
- a map showing the vertical and horizontal extent of the Basal Cambrian Sands formation and the communities overlying the formation
- the proposed CO_2 disposal rates
- the proposed total CO_2 storage volume expected over the life of the Project
- a schedule for construction, start-up, operation and decommissioning or abandonment for all three Project components

The EA shall discuss how Shell has incorporated lessons learned from other carbon capture and storage projects, with specific reference to protection of overlying groundwater resources and groundwater users.

4.6 Consultation and Engagement

The EA report shall include a detailed account of stakeholder consultation, and aboriginal consultation activities conducted as part of the EA of the Project.

The EA report shall describe the concerns and issues expressed by the public and aboriginal communities, Shell's analysis of those concerns and issues, and the actions takes to address those concerns and issues.

The EA report shall demonstrate how the input received was considered and what changes to the process or Project were made as a result of those comments.

The EA report shall describe plans to maintain public and aboriginal engagement following completion of the EA report.

4.7 Environmental Assessment Methodology

The environmental assessment methodological framework that will be used throughout the EA report will be identified.

The methodology used for assessing Project interactions with the environment will involve assigning a rank according to the potential for an activity to interact with one or more valued components of the biophysical or human environment. The ranks are described as follows:

- **0 =** No interaction
- **1 =** Interaction occurs; however, based on past experience and professional judgment the interaction would not result in a significant environmental effect, even without mitigation; or

interaction would not be significant due to application of codified environmental protection practices that are known to effectively mitigate the predicted environmental effects

- **2 =** Interaction could result in an environmental effect of concern; the potential environmental effects are considered further in environmental assessment.

The environmental methods discussion will also address development of temporal, spatial and administrative or technical boundaries of the assessment.

The methodology applied to evaluation of residual environmental effects will be defined. This will include the following evaluations:

- **Direction:** Whether an environmental effect on a population or resource is considered to be positive, adverse or neutral
- **Magnitude:** The intensity or severity of an environmental effect. It is described as the amount of change in a measurable parameter or variable relative to baseline conditions. Magnitude is described as negligible, low, moderate or high
- **Geographical Extent:** The spatial area affected by an activity. It is identified as site specific, local or regional
- **Duration:** The length of time over which an environmental effect occurs. Duration considers the various phases of the Project and is divided into four classifications: short term, moderate term, long term or permanent
- **Frequency:** The number of times an activity occurs over the identified phase. It is described as once, sporadic, regular, or continuous
- **Reversibility:** The potential for an environmental effect on a measurable parameter to be returned to the conditions that existed before the Project. An environmental effect is defined as irreversible if the resource element cannot be returned to the conditions that existed before the Project within the long term
- **Ecological or Socio-Economic Context:** the general characteristics of the area in which the Project is located (i.e., undisturbed, disturbed, urban setting).

Finally, the methods for defining standards or thresholds for determining the significance of environmental effects will be identified.

4.8 Environmental Setting

The environmental setting section of the document will establish a general overview of the existing environment within the study boundaries. The description will reflect the dynamics of environmental components (biophysical, social, and economic), and identify trends in the context of predicted changes over time where applicable and appropriate. The summary will also include components of the environment that are not specifically VECs (e.g., Alberta Natural Region and Subregion).

4.9 Project Interactions with the Environment

The EA report will identify the key Project activities and the interactions between the Project and the environment, for each Project phase.

Interactions between Project phases and key Project activities to be conducted within each phase (identified in earlier sections of the EA report), and between each VEC will be identified and ranked. The ranked interactions will be presented in tabular form, according to the potential of an activity to interact with one or more of the VECs. Accompanying text will elaborate upon or describe the nature and/or extent of the interaction, or provide the rationale for activities that are determined to not result in an interaction with the VEC(s).

The analysis will provide a first order assessment of environmental effects of each phase or activity on each VEC. It will serve to focus the remainder of the environmental effects assessment on those issues that may result in substantive interactions or have potential for significant environmental effects.

4.10 Environmental Effects Analysis for each VEC

The approach to the environmental effects analysis will be outlined for each of the proposed VECs. Each VEC will be presented in an individual section, and a similar format will be used in each section. All VEC assessments will be organized in a standard format following the methodology described in Section 4.7 above. To that end, the individual VEC sections of the EA report will be organized as follows:

- Rationale for VEC selection
- Spatial (i.e., Local and Regional Study Areas), temporal, administrative and technical boundaries for the environmental assessment of the VEC, including the rationale for the selection these boundaries
- Criteria for establishing the threshold to determine the significance of environmental effects
- Description of the existing environment for the VEC to support the environmental effects assessment, the development of mitigation, and follow-up and monitoring
- Environmental effects analysis of the Project during construction, operation, and decommissioning and abandonment, that includes:
    - project-VEC interactions
    - assessment of the residual environmental effects (i.e., after mitigation has been applied) of the Project during each phase, and the identification of specific planned mitigation to minimize environmental effects
    - an integrated evaluation of Project-related and any cumulative environmental effects
    - determination of significance of the residual environmental effects of the Project during each phase, including cumulative environmental effects.

4.11 Effects of the Environment on the Project

Potential changes to the Project that might be caused by the environment will be described with reference to each Project activity that might be affected. The effects of the environment may include (but are not limited to) the following:

- seismic activity and other geological conditions
- extreme meteorological conditions and associated erosion, flooding and wind.

Based on the likely interactions, changes to the Project that might be caused by the environment will then be assessed. Proposed mitigation, including design strategies, will also be considered in the evaluation.

4.12 Accidents, Malfunctions and Unplanned Events

The environmental effects of malfunctions and accidents that might occur in connection with the Project will be assessed. A generalized description of potential malfunctions or accidents that might occur during construction, operations or decommissioning and abandonment of the Project will be provided in this section, followed by an environmental effects analysis of these malfunctions and accidents.

The following will be provided as applicable:

- a description of potential malfunctions or accidents that might occur as part of the Project during each applicable phase
- historical summaries or statistics on the occurrence of such events, if available
- information on the probability or likelihood of such events, where applicable
- mitigation measures, response procedures, or remedial measures to be undertaken to prevent these events, to minimize their extent, or to remediate their environmental effects
- the assessment of the environmental effects of each malfunction or accident for the Project on each applicable VEC, including cumulative environmental effects
- a determination of the significance of the residual environmental effects of each malfunction or accident on each of the associated VECs, including cumulative environmental effects, where applicable.

Some of the potential malfunctions or accidents that might be considered in the EA report include, but are not limited to, the following:

- fires and explosions
- process upsets with the capture infrastructure (e.g., failure of mechanical systems, power interruptions and unit trips)
- inability to operate the Project due to severe weather events (e.g., wind, freezing precipitation)
- CO_2 Pipeline rupture/releases
- CO_2 injection well leakage/releases
- leakage of CO_2 from the BCS to ground surface
- leakage of BCS brine to the ground surface

- leakage of amine to ground surface and atmosphere
- engineering failure at the well bore
- multiple casing failure.

The section will provide information on the steps that will be taken in the design, construction and operation of the Project to reduce/mitigate the effects of potential incidents on the public and the environment, including the development of appropriate response plans.

Shell shall prepare an Emergency Response Plan (ERP) for the Project. Upon its completion, the ERP will be distributed to RAs and Federal Authorities, for review prior to the start of Project construction.

4.13 Follow-Up

The section will consider the need for a follow-up program per the requirements of CEAA.

4.14 Conclusions and Recommendations

The conclusions of the EA report will be provided, including any recommendations that might result from the EA report with respect to the Project's environmental effects, mitigation measures, recommended follow-up and any limitations of the EA report.

Part B: Government of Alberta EIA Report Requirements

5 ENVIRONMENTAL IMPACT ASSESSMENT REPORT

5.1 Purpose

The Government of Alberta has directed Shell to prepare and submit an Environmental Impact Assessment report (EIA), under the Alberta *Environmental Protection and Enhancement Act* (EPEA), and associated regulations for the carbon storage component of the Project. The joint EA report that satisfies the requirements under both CEAA and EPEA will be submitted to the Government of Alberta concurrently with Shell's application to the ERCB.

The purpose of this document is to identify for Shell, aboriginal communities and appropriate stakeholders the information required by provincial government agencies for an EIA prepared under EPEA for the carbon storage component of the Project.

5.2 Scope of the EIA

The EIA shall be prepared considering all applicable provincial legislation, codes of practices, guidelines, standards and directives.

The EIA shall be prepared in accordance with Part B of these Terms of Reference and the environmental information requirements prescribed under EPEA, and associated regulations. The EIA will form part of the EA report and Shell's application to the ERCB. Shell will also provide an EIA summary report as part of the ERCB application.

5.3 Content of the EIA

The EIA shall focus on the CO_2 storage Component of the Project.

5.3.1 Public and Aboriginal Consultation

The EIA shall include a detailed account of stakeholder consultation and Aboriginal consultation activities conducted as part of the EIA of the Project.

The EIA shall describe the concerns and issues expressed by the public and Aboriginal communities, Shell's analysis of those concerns and issues, and the actions Shell has or will take to address those concerns and issues.

The EIA shall demonstrate how the input received was considered and what changes to the Project were made as a result of those comments.

The EIA shall describe plans to maintain public and Aboriginal engagement following completion of the EA report.

5.3.2 The Proponent

Shell shall provide a description of:

- the legal entity that will develop, manage and operate the storage component of the Project and hold the operating approvals
- Shell's experience operating the Scotford facility and constructing and operating wells and pipeline in Alberta
- Shell's commitment to environmental studies and community involvement
- how Shell has incorporated lessons learned from other carbon capture and storage projects into the development of this EIA, with specific reference to protection of overlying groundwater resources and groundwater users.

5.3.3 Project Description

The EIA shall provide:

- an overview of the Project carbon storage component
- a map showing the location of the storage components of the Project
- a map showing the proposed injection well sites and the nearest communities to the proposed injection well sites
- a map showing the vertical and horizontal extent of the Basal Cambrian Sands formation and the communities overlying the formation
- the proposed CO_2 disposal rates
- the proposed total CO_2 storage volume expected over the life of the Project
- a schedule for construction, start-up, operation and decommissioning or abandonment of the storage component.

The EIA shall describe the drilling and completion activities for a representative injection well, including methods used to:

- protect groundwater resources
- prevent the release of CO_2 through or around the wellbore
- prevent upward migration of the saline water in the BCS.

The EIA shall include a vertical cross-section from the ground surface to the base of the BCS formation of a representative injection well site, and a description of the operation and decommissioning of a representative injection well site.

5.3.4 Hydrogeology and Groundwater Resources

The Project has the potential to affect groundwater resources. Since the additional CO_2 capture infrastructure will be situated within the existing Scotford Upgrader footprint and the potential environmental effects related to the CO_2 pipeline will be primarily related to surface disturbance, the focus of the hydrogeology baseline and environmental effects assessment will be the CO_2 storage component.

Baseline hydrogeological conditions will be established for the CO_2 storage. The baseline assessment shall include a description of the existing geologic and hydrogeologic setting from the ground surface to the base of the BCS formation, including representative cross-sections. It shall also include the methodology and sources of information used to determine the baseline groundwater resource environment.

The baseline assessment will include a description (with mapping/models) of the following:

- the location and depths of known groundwater resources in the study area, including any known buried channels and useable aquifers, defined in ERCB Directive 51 as groundwater with a total dissolved solids content of 4000 milligrams per litre or less
- the major aquifers, aquitards and aquicludes, their spatial distribution, hydraulic properties, hydraulic connections between aquifers, hydraulic heads, gradients, and groundwater flow directions and velocities. Cross sections that show hydraulic heads and groundwater flow directions relative to injection well sites, potable water wells and surface waters will be provided
- the physical and chemical properties of groundwater including baseline values for alkalinity, temperature, pH, Eh, electrical conductivity, major ions, nutrients, relevant minor and trace constituents, metals and hydrocarbons
- seasonal variations in groundwater quality, hydraulic heads and flow regime
- groundwater recharge and discharge zones
- areas of groundwater-surface water interaction, including interaction with wetlands
- potential hydraulic connection between BCS groundwater and shallower groundwater. If none exists, then evidence to this effect shall be presented
- the locations and depths of all known water wells (operating and abandoned), test holes and an inventory of groundwater users within the study area
- the locations and depths of known structure test holes, disposal wells, oil and gas wells (operating, suspended and abandoned) in the study area.

Shell shall identify the Project components and activities that have the potential to affect groundwater resource quantity and quality and provide:

- an assessment of potential changes to groundwater quantity and quality with a focus on those hydrostratigraphic units above the Base of Groundwater Protection. The effects analysis will identify the potential for effects/changes to the overlying groundwater resources (quality, quantity, horizontal and vertical movement) and groundwater users in the study area. Consideration will be given to the Drinking and Recreational Water Quality information provided in Health Canada's Useful Information for Environmental Assessment (October 23rd, 2009)

- a discussion of the potential for groundwater and surface water interaction and the resulting effects on surface water quantity and quality
- a geochemical assessment of the compatibility of the receiving geological and hydrogeological setting to receive the injected CO2. Include in the assessment a discussion of the potential chemical reactions between the CO2 source and the BCS reservoir and seals
- a description/model of any pressure change (pressure build-up) in the BCS
- a discussion of the suitability of the BCS for CO2 storage, including containment potential, injection capacity, and hydrodynamic flow regime. Present the methodology used to determine the reservoir capacity, including historical data, field data, and any assumptions used
- an assessment of the fate and transport of the injected CO2
- a general characterization of contaminants and a discussion of impacts in the event of a release of these contaminants about the Base of Groundwater Protection
- the source and amount of any groundwater required
- the effects of potential perforation and/or fracturing of the BCS aquifer in terms of new fractures/fault reactiviating etc. as well as what the effects are of the higher pore pressures in the BCS as a result of the CO2 injection
- a risk assessment that will include the potential leak of CO2 and saline water from the BCS.

For each potential effect, the effects analysis will describe the:

- cause of the environmental effect
- likelihood of the environmental effect occurring
- nature of the environmental effect
- magnitude and duration of the environmental effect.

The EIA shall also describe the drilling and completion activities for a representative injection well, including methods used to:

- protect groundwater resources
- prevent the release of CO_2 through or around the wellbore
- prevent upward migration of the saline water in the BCS.

The EIA shall include a vertical cross-section from the ground surface to the base of the BCS formation of a representative injection well site, and a description of the operation and decommissioning of a representative injection well site.

Modeling

For each model used in the effect analysis provide:

- the justification for the model used
- a detailed conceptual model
- model input parameters

- documentation of the calibration process, the validation process and the assumptions used to obtain the modeling predictions in the EIA
- discussion of the limitations of the models, including sources of error and relative accuracy, and how these limitations were addressed in the EIA
- a sensitivity analysis that includes extreme climatic variations.

Monitoring and Mitigation

Shell will provide a proposed program to monitor for potential environmental effects to groundwater resources and groundwater users. For the monitoring program, Shell will include a description of the purpose and the design (location, frequency of sampling and analysis, and parameters measured).

The monitoring program shall include:

- plans to share monitoring information with the public and with municipal, provincial and federal governments
- the process for addressing concerns from groundwater users reporting potential environmental effects to their groundwater source
- how the results of the risk assessment, mentioned above, were incorporated in the design of the monitoring program
- measures put in place for the early detection of potential contamination
- measures put in place to prevent environmental effects to groundwater resources and users
- measures put in place to mitigate/remediate environmental effects detected in the monitoring program and reported by groundwater users.

Shell shall also provide:

- a description of each of the technologies to be considered for the measurement, monitoring and verification (MMV) activities at the Quest project and the criteria that will be applied when selecting the preferred option
- rationale for the placement of the monitoring wells
- an MMV plan for each phase of the Project. Phases to be considered include:
    - pre-operational
    - operational
    - closure
    - post-closure.

  For each phase, provide an outline of the monitoring technologies that may be employed and the frequency of their use.

  For the post-closure period provide justification for the length of the groundwater monitoring proposed and describe what conditions must be met to reduce the monitoring frequency or to cease monitoring entirely
- a description of Shell's experience with MMV at other CO2 sequestration projects internationally. For any project referenced, provide a description of the MMV programs employed

- a plan to describe what Shell would do if the MMV program detected a CO2 release.

6 WORKS CITED

Alberta Environment (AENV). 2008. Alberta Ambient Air Quality Objectives (AAAQO). Science and Technology Branch, Environmental Sciences Division, Environmental Service. Edmonton, Alberta.

Alberta Energy Resources Conservation Board (ERCB). 2007. Directive 038: Noise Control. Revised Edition. February 16, 2007. Calgary, Alberta.

Albert Sustainable Resource Development (ASRD). 2005. Status of Alberta Wild Species. Available at: http://www.srd.alberta.ca/BioDiversityStewardship/SpeciesAtRisk/GeneralStatus/StatusOfAlbertaWildSpecies2005/Default.asp. Accessed: July 2010.

DataKustik GmbH (DataKustik). 2008. Cadna-A: A Computer Aided Noise Abatement Model, Version 3.7.124). Munich, Germany.

Health Canada, 2009. Useful Information for Environmental Assessments. Last modified October 23, 2009

Idriss, A. and F. Spurrell. 2009. Air Quality Model Guideline. Climate Change, Air and Land Policy Branch, Alberta Environment. Edmonton, Alberta.

International Organization for Standardization (ISO). 1993. International Standard ISO 9613-1, Acoustics – Attenuation of Sound During Propagation Outdoors – Part 1: Calculation of Absorption of Sound by the Atmosphere. Geneva, Switzerland.

International Organization for Standardization (ISO). 1996. International Standard ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation. Geneva, Switzerland.