Verification Report for:
Quest Carbon Capture and Storage Project 2nd Reporting period Offset Project Report - – Restatement for P5/P6/P7 and P9 emissions including waste heat

Proponent:
Shell Canada Limited, as Managing Partner and on Behalf of Shell Canada Energy (an Alberta Partnership)

Prepared by:
GHD Limited

Prepared for:
Shell Canada Limited, as Managing Partner and on Behalf of Shell Canada Energy (an Alberta Partnership)

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Final

Date:
December 18, 2018
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Instructions are in italics throughout and should not be deleted when report is complete. Some instructions are specific to the verification of facilities and for offset projects. The document is not restricted but do not alter the format, the layout, the headings or the overall 'look and feel' of the document. If is more useful to paste information outside of the text box, use the empty line just below the text box to drop text or tables in. This should not change the headings or the formats. There are several dropdown boxes in the document that must be completed.

- Complete report in Verdana 10pt font (no italics).
- After the report is complete, right click the table of contents and 'update field' which will update page numbers in Table of Contents.
- If an instruction only applies to facilities or only applies to offsets indicate 'not applicable'.
- Appendix F is available for additional tables, diagrams etc.
## 1.0 Summary – Offset Project

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Title</strong></td>
<td>Quest Carbon Capture and Storage (CCS) Project – Restatement for P5/P6/P7 and P9 emissions including waste heat</td>
</tr>
<tr>
<td><strong>Project Description</strong></td>
<td>The Project consists of two separate components: the CCS capture facility and three injection sites. The CCS capture facility captures CO₂ produced in the hydrogen manufacturing units (HMUs) at the Scotford Upgrader Facility via amine absorption. The CO₂ stream is then compressed and transported to one of three injection pads for underground sequestration.</td>
</tr>
<tr>
<td><strong>Project Location</strong></td>
<td><strong>CCS Capture Facility:</strong> 55522 Range Road 214 Fort Saskatchewan, Alberta Latitude: 53.74074, Longitude: 113.0231 <strong>Wellpads:</strong> Well #1: 07-11-59-20-W4 Well #2: 08-19-59-20-W4 Well #3: 05-35-59-21-W4</td>
</tr>
<tr>
<td><strong>Project Start Date</strong></td>
<td>August 23, 2015</td>
</tr>
<tr>
<td><strong>Offset Start Date</strong></td>
<td>August 18, 2016 (date the most recent Version of the Offset Project Plan was submitted)</td>
</tr>
<tr>
<td><strong>Offset Crediting Period</strong></td>
<td>There is no specific timeline defined by Shell. The <em>Quantification Protocol for CO₂ Capture and Permanent Storage in Deep Saline Aquifers</em> specifies the offset credit generation period at 20 years with optional 5 year extensions.</td>
</tr>
<tr>
<td><strong>Reporting Period</strong></td>
<td><strong>2nd Reporting Period:</strong> November 1, 2015 – March 31, 2016</td>
</tr>
</tbody>
</table>
GHG Assertion (Actual Emission Reductions/Sequestration Achieved)

Enter the actual emissions reductions / sequestration for the reporting period. Enter serial numbers if available.

The initial emissions offsets were 324,918 tonnes CO₂e

The total revised emissions offsets (with the addition of claimed waste heat) were 338,221 tonnes CO₂e

This limited scope verification was to verify the revised project emissions from the P5/P6/P7 and P9 emissions categories. The sum of these project emissions changed from 78,543 tonnes CO₂e in the initial assertion to 65,244 tonnes CO₂e in the revised assertion, a change of 13,299 tonnes CO₂e. All other baseline and project emissions were unchanged, and were not reviewed as part of this verification.

Protocol

Indicate the relevant protocol (if applicable)

Quantification Protocol for CO₂ Capture and Permanent Storage in Deep Saline Aquifers

Version 1.0, June 2015

Ownership

Enter offset project owner.

Shell Canada Ltd. is the managing partner for Shell Canada Energy. During the 2nd reporting period, ownership of the AOSP JV was split between Shell Canada Energy (60%), Chevron Canada Limited (Chevron) (20%) and Marathon Oil Canada Corporation (Marathon) (20%), and Shell Canada Energy held the necessary regulatory approvals for the project.¹

Project Activity

State how the project activity meets the eligibility requirements

The Project meets the eligibility criteria as per the following:

1. The Project occurs in Alberta
2. The Project results from actions not otherwise required by law and be beyond business as usual and sector common practices;
3. The Project results from actions taken after January 1, 2002
4. The Project is real, demonstrable, quantifiable and verifiable

¹ As of February 1, 2017, Canadian Natural Upgrading Limited (CNUL) purchased Shell Canada Energy’s share of the AOSP JV, and CNUL and Shell Canada Energy jointly purchased Marathon’s share. As a result, the ownership split was changed to CNUL (60%), Chevron (20%) and 1745844 Alberta Ltd. (20%), with CNUL and Shell each having 50% ownership of 1745844 Alberta Ltd. Shell Canada Energy remains operator of the Project. This ownership change does not affect the allocation of credits from the Project for the 2nd Reporting period.
5. The Project has clearly defined ownership  
6. The Project is counted once for compliance purposes

**Project Contact**  
*Enter contact name, company name, mailing address, phone number and email address.*

Charles Bower  
GHG Reporting Specialist, Shell Canada Limited  
55522 Range Road 214  
Fort Saskatchewan, Alberta T8L 4A4  
Charles.bower@shell.com

**Verifier**  
*Verifier name, verifier’s company name, address, phone number email etc.*

GHD Limited  
9426 51st Ave. NW, Suite 101  
Edmonton, AB  
T6E 5A6

**Verification Team Members**  
*Include verification team members, roles, training, training dates and qualifications.*

**Lead Verifier (and Designated Signing Authority):** Mr. Sean Williams, P.Eng.  
**Independent Peer Reviewer:** Mr. Gordon Reusing, P.Eng.

**Designated Signing Authority**  
*Enter the designated signing authority for this verification.*

Designated signing authority is Mr. Sean Williams

**Verification Strategy**  
*Describe the verification strategy used for the verification, including rationale for the approach. Note, if a controls reliance is used, provide justification for how the project is able to support this approach.*

GHD’s detailed verification strategy is summarized in Section 3.0 below.

### 2.0 Introduction

Provide an introduction to the facility or project, the verification, and the background.

*For Offset Project:* summary of offset project baseline, changes to the baseline since project start date and summary of changes at the project since the offset project start date or baseline period.

*For Facilities:* Description of compliance or baseline report, facility/project boundary, facility identification information, GHG historical performance, summary of changes since the baseline or since the last compliance report.

Shell Canada Limited, as Managing Partner and of Behalf of Shell Canada Energy (an Alberta Partnership) (Shell) retained GHD Limited (GHD) to undertake a limited scope verification on the restatement of the Quest Carbon Capture and Storage (CCS) Project (Project or Quest) 2nd Reporting period Offset Project Report (OPR). Shell is the project developer for the compliance period of November 1, 2015 through March 31, 2016 (2nd Reporting period). GHD completed
the verification in accordance with the requirements of the Carbon Competitiveness Incentive Regulation, Alberta Regulation 255/2017 and associated amendments, Climate Change and Emissions Management Act (CCIR) (ACCO, 2017). The applicable protocol for this Project is the Quantification Protocol for CO2 Capture and Permanent Storage in Deep Saline Aquifers, Version 1.0 (Alberta Climate Change Office (ACCO), June 2015) (Protocol).

GHD understands that the Shell OPR for the 1st reporting period (August 23, 2015 – October 31, 2015) was subject to an audit by TetraTech EBA Inc. (TetraTech). From this audit, TetraTech identified the following issues with allocation of steam between the Large Final Emitters (LFE), non-cogen and waste heat categories:

- The methodology was based on a conceptual, financial allocation methodology, and not based on direct measurement of the individual quantities of steam. As per the protocol, direct measurement of steam quantities prior to commencement of the Project are required to set baseline quantities.

- The quantity of waste heat claimed could not be proved to have been vented or dissipated prior to Quest.

As a result, a material discrepancy was identified in the calculation of project emissions from the P9 Off Site Generation of Heat project emissions category. It is further noted that the P5/P6/P7 emissions category is also affected, as the consumption of natural gas required to calculate emissions from this category is the same as the equivalent natural gas volumes from the P9 category.

In response, Shell submitted a variance request to both allow the use of a dynamic baseline (rather than fixed) and a new allocation methodology, which can more accurately estimate steam usage in the absence of Quest, demonstrating the quantities of waste heat used by Quest. An additional request was submitted and granted by ACCO to allow Shell to exclude waste heat from the quantification of steam for the initial submission of the 2nd reporting period Offset OPR, assuming all steam is from LFE, non-cogen sources during the development of the revised methodology and approvals process with ACCO. This initial submission was verified by GHD.

A revised steam allocation methodology has been developed by Shell, which uses the iSteam computer program, which uses real-time data (with Quest online) to simulate a baseline case where there is no Quest demand, re-allocating the excess steam throughout the system, which can then be used to determine the allocations of LP steam to Quest among the various sources. GHD had previously completed a pre-validation review (as requested by ACCO) of the new methodology, completed by GHD on September 18, 2017 and submitted to ACCO on September 20, 2017. This review constituted a review of the methodology, along with a limited review of specific cases when Quest was down to confirm the validity of the methodology. This methodology was subsequently submitted to ACCO by Shell as part of a variance request, and approved by ACCO on August 9, 2018.

Once this new methodology was developed and approved, the OPR for each affected reporting period (2nd through 5th) could then be resubmitted using the new methodology. Limited scope verifications of the values calculated by the new allocation methodology and claimed waste heat must then be completed. This report covers the limited scope verification of the 2nd reporting period for retroactive corrections to the waste heat methodology. No other baseline or project emissions were reviewed as part of this limited scope verification.

GHD prepared the Verification Plan and this Verification Report in accordance with the ISO Standard ISO 14064 Greenhouse gases – Part 3: Specification with guidance for the
Offset Credit Project Boundaries

The Project consists of two separate components: the CCS capture facility and three injection sites. The CCS capture facility is located at the Shell Scotford Site, and captures CO₂ produced in the hydrogen manufacturing units (HMUs) of the Scotford Upgrader Facility and contained within the raw hydrogen gas mixture produced from the reaction. CO₂ is absorbed from the raw gas stream through the use of a licensed Shell amine absorption system (ADIP-X) in a scrubbing tower located at each of the three HMUs. The CO₂-amine mixture from each absorption system is then sent through a regeneration column, separating the CO₂ from amine. The CO₂ stream undergoes dehydration (removal of water) and compression, and is then transported via pipeline to the well pads. There are three injection wells, one per well pad. Currently, two out of the three injection wells are in operation for sequestering the CO₂ approximately 2 kilometres below ground.

The overall Project consists of emissions associated with the capture of CO₂ and operation of the CCS capture facility and injection wells. The operation of the Scotford Site consists of the following facilities which, unless otherwise noted, are owned by the AOSP JV/Shell and operated by Shell:

- Quest CCS capture Facility
- Scotford Upgrader Facility (which itself consists of the Upgrader Base and Upgrader Expansion Facilities).
- ATCO Cogen facility (owned by ATCO Power Canada Limited, operated by Shell).
- Air Liquide Cogen facility (owned and operated by Air Liquide Canada).
- Air Products Facility (owned and operated by Air Products)
- Scotford Refinery.
- Shell Chemicals Facilities.

The Scotford Upgrader provides both the CO₂ for injection and heat (in the form of steam) for the Project operation. Other operations at the Scotford Site are indirectly linked to the Project through steam imports/exports, which are accounted for in the iSteam model and are part of the Upgrader’s steam balance. All other operations at the Scotford Site are not included in the project, and will not be reviewed.

Geographic Boundaries

The Project is located at the following addresses:

CCS Facility
55522 Range Road 214
Fort Saskatchewan, Alberta
Latitude: 53.74047 N, Longitude 113.0231 W

Injection Wells²
Well #1: 07 11 59 20 W4
Well #2: 08 19 59 20 W4
Well #3: 05 35 59 21 W4

² During the second reporting period two injection wells were in operation: Well #1: 07-11-59-20-W4 and Well #2: 08-19-59-20-W4
Description of Project Baseline and Project Conditions

During the baseline condition, CO₂ is produced in the hydrogen manufacturing units in the Scotford Upgrader through the steam-methane reforming reaction, and is then emitted to the atmosphere.

During the product condition, the CO₂ produced in the hydrogen manufacturing units is captured and separated from the raw gas stream by the CCS capture facility, compressed, transported to the injection wells, and then sequestered underground. Emissions from the project at the CCS capture facility include the following operations:

- Production and transportation of materials
- Production, transportation and combustion of fuels
- Production of off-site heat and electricity.
- Combustion of fuels at the CCS capture facilities
- Emissions associated with the loss, disposal and recycling of materials

Emissions from the project at the injection wells potentially include the following operations:

- Construction and drilling of new injection wells
- Production and transportation of materials
- Production, transportation and combustion of fuels
- Fugitives and venting at the well injection points
- Production of on-site and off-site electricity
- The use of aviation turbo fuel (for pipeline inspections)
- Loss of CO₂ containment from the subsurface.

Note that as part of this limited scope verification, GHD did not complete a full assessment of each project and baseline emission source, as this was previously completed as part of the initial full scope verification.

Focused Specific Reductions

The claimed offsets result from reductions in CO₂ released to the atmosphere due to the Project.

The emission offsets from the implementation of this Project specifically associated with the limited scope verification include the following:

- P5/P6/P7 – Extraction/Processing/Transportation of fuels used for on-Site and off-Site heat and electricity generation (CO₂, methane (CH₄), and nitrous oxide (N₂O))
- P9 – Off-Site heat generation (CO₂, CH₄ and N₂O)

Summary of Changes to Baseline Condition

There have been no changes made to the baseline condition since the project start date.

Summary of Changes to Project Since Project Start and/or Baseline Period

There were no changes to the Project which affect this limited scope verification beyond the changes to waste heat, as verified.

2.1 Objective

Describe the objective of the verification (should include expressing an opinion).
The objective of the verification is to provide Shell and ACCO with an opinion that there are no material misstatements in the restated OPR for the 2nd reporting period and that the information reported is accurate and consistent with the requirements of the SGER. This report has been prepared for the use of Shell and ACCO.

2.2 Scope

Define the scope in terms of: geographical, organizational, activities and processes, sources, sinks, categories and greenhouse gases included (considering the completeness of the inventory), GHG assertion time period.

For offset verifications: include the serial range (i.e. XXXX-XXXX-XXX-XXX-XXX-XXX to XXXX-XXXX-XXX-XXX-XXX) if assigned (i.e. in the case of government verification a serial range will be available, otherwise not applicable).

For Facilities: ensure all specified gases and source categories are evaluated. Include list of negligible emission sources and justification for Emission Performance Credits (EPCs). Include listing of end products.

The scope of this verification is described as follows:

- **Project Description** – The scope of the verification includes the greenhouse gas (GHG) project emissions resulting from the waste heat steam used by Quest. This specific limited scope verification will include a review of the following:
  - Assessment of the iSteam model runs. As outlined above, the methodology itself has been previously reviewed as part of the pre-validation review conducted by GHD (as requested by ACCO). GHD will reference this initial pre-validation review as part of the verification, and will further review the application of this program along with any changes made to the program since the initial review.
  - Final iSteam model results
  - Example manual recalculations of Quest parameters
  - Revised steam balance spreadsheets
  - Assessment of data management procedures associated with new methodology, including calibration procedures for meters associated with steam balances
  - Restated OPP and OPR, specifically relating to the methodologies and project emissions associated with the P5/P6/P7 and P9 categories.

- **GHG Types** – The claimed offsets result from reductions in CO2 released to the atmosphere due to the Project. The emissions during the operation of the Project result from:
  - Releases of CO2, CH4 and N2O due to combustion of fuels for heat.
  - Emissions of CO2, CH4 and N2O due to extraction, processing and transportation of fuels combusted

- **Time Period** – November 1, 2015 through March 31, 2016.

- **Use of this Report** - This report has been prepared for the use of Shell and AEP.

- **Relative Size** – The size of the claimed GHG reductions were 338,221 tonnes CO2e.
GHD will ensure and attest to the following:

- The accuracy of the reported data and restated emissions, and that all data and emissions accurately reflected the operation of the Project in the reporting period and are consistent with the approved Offset Project Plan (OPP).
- The project conditions during the 2nd reporting period were consistent with the requirements of the Protocol and OPP
- The reasonableness of the revised emission estimation methodologies, assumptions, and results.
- Whether any errors in data, estimations or methodology were adequately managed, documented, and either corrected or accounted for.
- Whether all measurement devices and sources of data are appropriate, well-maintained and reading accurately
- Whether the OPR is clear, well supported, and comprehensive.
- The reporting systems conform to relevant government mandated or industry standard quality assurance procedures.
- The assertion refers to the emissions, from the sources and sinks reported by the Project
- ISO principles such as consistency, conservativeness, transparency, etc. are met by the Project.
- The transparent backing-out of originally claimed waste heat and the addition of heat and waste heat as determined via the i-Steam model, i-Steam inputs and outputs and ability to compare inputs with actual operating conditions

2.3 Level of Assurance

The verification was conducted to a reasonable level of assurance.

*Choose type of verification from the dropdown box above.*

*Provide explanation on level of assurance.*

Reasonable assurance is a high level of assurance, or positive assurance. Reasonable assurance is a direct factual statement expressing the opinion of the verifier. If a verification statement can be provided, it is worded in a manner similar to "Based on our verification, the GHG emissions statement is, in all material aspects, in accordance with the approved quantification protocols."

2.4 Criteria

*Outline the program criteria used and relevant supporting documentation (acts, regulations, protocols, standards, guidance documents, project documentation etc).*

The Project was previously verified against the following criteria:

- Occur in Alberta
- Result from actions not otherwise required by law and be beyond business as usual and sector common practice
• Be real, demonstrable, quantifiable, and verifiable
• Result from actions taken on or after January 1, 2002
• Have clearly established ownership
• Be counted once for compliance purposes
• Be implemented according to a Government of Alberta-approved quantification protocol
• Be verified by qualified third-party

This assessment concluded that the Project was in accordance with the above criteria. This assessment was not conducted as part of this limited scope verification.

GHD has prepared this Verification Report in accordance with the ISO Standard \textit{ISO 14064 Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions} (ISO 14064-3) and the VVA Standard.

For this verification, GHD applied the following ISO and AEP criteria:

• ISO 14064 Greenhouse gases-Part 2: Specification with guidance at the project level for quantification and reporting of greenhouse gas emissions and removals, ISO, March 2006 (ISO 14064-2)
• ISO 14064 Greenhouse gases-Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions (ISO 14064-3)
• Carbon Competitiveness Incentive Regulation, Alberta Regulation 255/2017, Climate Change and Emissions Management Act, Province of Alberta, 2017
• Standard for Greenhouse Gas Emission Offset Project Developers, Version 1.0, AEP, 2017
• Standard for Validation, Verification and Audit, Version 2.0, AEP, 2018
• “Offset Protocol Deviation for the Quest Project”, Letter from Robert Hamaliuk to Charles Bower, AEP, March 13, 2017 (B1 Injection Variance Request)
• “Retroactive revision of waste heat methodology for the Quest Project”, Letter from Robert Hamaliuk to Charles Bower, AEP, September 28, 2017 (P9 removal of waste heat request)

2.5 Materiality

Define the materiality of the verification.

As the total project offsets are less than 500 ktonnes of CO$_2$e for the reporting period, quantitative materiality for this verification is set at absolute 5 percent of the restated 2$^{\text{nd}}$ reporting period offsets as per the AEP VVA Standard. In addition, a series of discrete errors, omissions or misrepresentations or individual or a series of qualitative factors, when aggregated (absolute values) may be considered material.

3.0 Methodology

\textit{Statement that the verification is performed according to ISO 14064-3.}
Summary of the assessments/tests/reviews/evaluations that were conducted during the verification.

The purpose of GHD’s verification procedures was to assess the following critical items:

- Accuracy and completeness of the current OPR.
- Consistency between baseline and project conditions.
- Conformance to the program criteria.
- Uncertainty of external data sources used.
- Compliance of the OPR to the verification standards and criteria.
- Completeness of the OPR in comparison to the structure and criteria presented in AEP guidance.
- Offset assumptions.
- Accuracy of emission calculations.
- Potential magnitude of errors and omissions.
- Integrity of the data management system and controls.
- ISO principles are met

3.1 Procedures

Description of how the verification was conducted including: description of the nature, scale and complexity of the verification activity, confidence and completeness of the responsible party’s GHG information and assertion, assessment of GHG information system and its controls, assessment of GHG data and information, assessment of GHG information system and controls, assessment against criteria, evaluation of the GHG assertion.

Describe steps of the verification including planning, assessment, site visit, off-site verification, and report preparation.

Describe how the risk based approach was implemented in the sampling plan. Identify categories of risk including inherent risk, and detection risk (organization and verifier). Include the Verification Plan with the Sampling Plan in Appendix A. Paste the risk assessment table in this section.

Verification Procedures

To sustain a risk-based assessment, the GHD Project Team identified and determined risks related to project GHG offsets during both the desk reviews and the follow-up interviews. The components of the document review and follow-up interviews were:

Document Review:

- Review of data and information to confirm the correctness and completeness of presented information.
- Cross checks between information provided in the OPP and OPR and information from independent background investigations.
Determine sensitivity and magnitude analysis for parameters that may be the largest sources of error.

Follow-up Interviews:

- On Site
- Via telephone
- Via email

The GHD Project Team interviewed Facility personnel to:

- Cross-check information provided by interviewed personnel, i.e., by source check or other interviews.
- Compare with projects or technologies that have similar or comparable characteristics.
- Test the correctness of critical formulae and calculations.
- Review data management and recording procedures.

Through the document review GHD established to what degree the presented OPR meets the verification standards and criteria.

The GHD Project Team's document review during the review process comprised an evaluation of whether or not:

- The documentation is complete and comprehensive and follows the structure and criteria given in the AEP guidelines and regulations.
- The OPR, and the emissions estimates therein, conform to the program criteria.
- The OPP and OPR are accurate, transparent and complete overview of the Facility's GHG emissions sources.
- The methodologies used in the GHG emission inventory are justified and appropriate.
- The assumptions behind the inventory are conservative and appropriate.
- The GHG emission calculations are appropriate and use conservative assumptions for estimating GHG emissions.
- The GHG information system and its controls are sufficiently robust to minimize the potential for errors, omissions or misrepresentations.
- The frequency of, and responsibility and authority for, monitoring, measurement, data recording activities and quality control/quality assurance/management control procedures is sufficient.

GHD completed data checks from the data source(s) (meter, scale, etc.) through the plant data management system to the GHG emissions data reports. A sample of raw data was collected for recalculation. If errors or anomalies were identified that could lead to a material misstatement, GHD requested further raw data samples to assess the pervasiveness of the errors or anomalies.

The specific verification tests conducted by GHD as part of the audit included the following:
• Review of third-party data and reports
• Tracing of data from output back to the measurement device(s)
• Full recalculations of key GHG supporting data and emissions
• Reasonableness checks of the sources of data and calculation methodologies

The specific documents received by GHD as part of the verification to conduct the verification tests outlined above is provided in Appendix F.1.

**Verification Steps**

GHD adhered to the following schedule for this verification:

*Conflict of Interest (COI) and Independence*

GHD completed a thorough evaluation for Conflict of Interest (COI) and Independence Verification for the Project. GHD confirmed that the verification could be successfully completed without undue risk to either GHD or Shell.

GHD has rigorous COI and Verifier Competency evaluation procedures that are followed for every verification project. Our documented procedures ensure that all COIs and Independence Verification criteria are properly evaluated. These procedures are documented in GHD's "Greenhouse Gas Validation and Verification Manual for Validation and Verification Activities, Completed in Accordance with ISO 14064" (GGAS Manual). The COI procedures and competency assessment procedures have been reviewed and approved by ANSI as part of GHD's Accreditation. GHD's COI program ensures that both the company and the Project Team have no potential COI's.

GHD also evaluated and approved the Verification Team's competencies. GHD's competency evaluation procedures, as documented in the GGAS Manual, include documentation of the qualifications and experience for each Lead Verifier, Verifier, Peer Reviewer and Technical Expert. Each employee in GHD's verification team must prepare a detailed memorandum outlining the employee's competency in the various sectors and scopes involved in the verification assignment. GHD's GGAS Manager and Audit Resources Manager ensure that the team selected for any verification project have the required competencies. GHD sets competency requirements in terms of education, years of experience, and work experience in the sector, such as refineries, upgraders, oil sands facilities, chemical plants and gas processing plants.

*Verification Plan*

Prior to completion of the site visit, GHD prepared a verification plan, including an overview of the verification process, a risk assessment, a sampling plan and the site visit agenda. In the sampling plan, GHD provided a comprehensive list of information and data requests. GHD utilized a risk-based approach to select a sample size of data and information for each facility.
Documentation Review and Emissions Recalculations

GHD reviewed the information provided by Shell and conducted recalculations of the emissions. GHD assessed the quantitative discrepancy based on the recalculations and determined whether there were any material issues.

The components of the document review and follow-up interviews are detailed above under “Verification Procedures”.

Site Visit

GHD initially completed a site visit as part of the initial verification of the 2nd reporting period in September-October 2016. GHD determined that a site visit was not required as part of the limited scope re verification, and as such no visit was completed.

Issues Logs

During the course of the document review and interviews, questions and clarifications were identified by the Project Team; these were communicated to Shell either verbally, by email, or in an Issues Log sheet. Shell had an opportunity to respond to identified issues prior to the completion of GHD’s draft and final verification reports.

Internal Peer Review

GHD conducted an independent peer review of the verification, including a review of findings and emission calculations developed by the verification team. This peer review was documented in a Peer Review Memo completed by the assigned independent peer reviewer. The verification report and statement was not finalized until approval was received from the peer reviewer.

Documentation and Deliverables

GHD prepared the following deliverables to document the verification services provided:

- COI Checklist, which will meet the CCIR requirements
- Statement of Qualification (included in the proposal)
- Verification Plan (prior to site visit and after receiving relevant information)
- Draft Verification Report
- Final Verification Report
- Statement of Verification (included in Verification Report)

Risk Assessment

Based on GHD’s review of the Site operations, GHD prepared the following table, which summarizes the potential risk and magnitude of potential errors, omissions, or misrepresentations:
### Allocation of Steam and Claimed Waste Heat

<table>
<thead>
<tr>
<th>Source</th>
<th>Attributes</th>
<th>Inherent Risk</th>
<th>Control Risk</th>
<th>Detection Risk Design</th>
<th>Consideration for Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>P5/P6/P7 – Extraction/Processing/Transportation of Fuels and P9 – Off-Site Heat Generation</td>
<td>Occurrence Completeness</td>
<td>High – Allocation of steam based on iSteam model, which is a complex computer simulation based on all meters used in steam header (over 100). Overall logic behind iSteam methodology had been previously reviewed by GHD and confirmed to be reasonable. Results from iSteam used in steam balance spreadsheet, which calculate equivalent natural gas based on natural gas composition and HHV.</td>
<td>High – Over 100 meters, valves and other measurement devices used to calculate steam balance. Only a limited number were part of Shell’s main PM system during the 2nd reporting period (requiring regular calibration).</td>
<td>Lowest</td>
<td>GHD reviewed one month of the detailed iSteam model results and iSteam summaries for full reporting period. GHD reviewed a demonstration of how iSteam determines these quantities. GHD confirmed iSteam methodology is consistent with previous review, and determined if changes are appropriate. GHD reviewed all steam balance spreadsheets to confirm allocated steam quantities have been appropriately used and that the steam emissions calculations are in accordance with the protocols.</td>
</tr>
</tbody>
</table>

### Accuracy

| | High – Complex simulation and steam balance used to quantify both quantities of LFE, non-Cogen and waste heat steam and associated natural gas usage. |

The final sampling plan developed based on the risk assessment is presented in the final Verification Plan, included as Appendix A to this report.

### 3.2 Team

List verification team members including peer reviewer(s).

Describe the qualifications and training of the team members and peer reviewer(s) including dates of training and certifications.

For Offsets: fill in the sample Statement of Qualification provided and included in Appendix B.

For Facilities: include the Statement of Qualifications from the facility compliance form in Appendix B.
# Verification Team

<table>
<thead>
<tr>
<th>Designated Signing Authority (DSA) (Same as Lead Verifier)</th>
<th>Sean Williams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed ISO 14064-3 Training? Y</td>
<td></td>
</tr>
<tr>
<td>Training Dates 4/9/2012</td>
<td></td>
</tr>
<tr>
<td>Minimum of 4 years of experience? Y</td>
<td></td>
</tr>
<tr>
<td>Technical experience as outlined in section 3(1) in Part 1? Y</td>
<td></td>
</tr>
</tbody>
</table>

**Description of team member experience and qualifications**

Mr. Williams has a Bachelor of Applied Science in Chemical Engineering from the University of Waterloo, and is a licensed Professional Engineer in the provinces of Alberta and Ontario. Mr. Williams has experience in completing permit applications, air and noise compliance assessments, completion of annual inventory reports under O. Reg. 455 and NPRI, and greenhouse gas verifications under the Alberta Specified Gas Emitters Regulation (SGER), Ontario Regulation 452/09, the Quebec Greenhouse Gas Regulation, the California Air Resources Board and The Climate Registry. Mr. Williams' has 5-years of experience as a lead verifier under multiple sectors and jurisdictions, including oil sands mining and extraction, refineries, chemical plants, power generation facilities and steel mills. Mr. Williams has undergone training of the ISO 14064 and ISO 14065 standards and is an accredited lead verifier as per GHD’s ANSI-approved lead verifier competency requirements. Mr. Williams has been approved as a Lead Verifier for over 5-years under GHD’s Greenhouse Gas Assurance Services (GGAS) program, which includes many training and competency requirements. Mr. Williams also has experience working in the accreditation audit process for GHD by ANSI.

<table>
<thead>
<tr>
<th>Peer Reviewer</th>
<th>Gord Reusing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed ISO 14064-3 Training? Y</td>
<td></td>
</tr>
<tr>
<td>Training Dates 12/7/2012</td>
<td></td>
</tr>
<tr>
<td>Minimum of 4 years of experience? Y</td>
<td></td>
</tr>
<tr>
<td>Technical experience as outlined in section 3(1)(f) in Part 1? Y</td>
<td></td>
</tr>
</tbody>
</table>
Verification Team

<table>
<thead>
<tr>
<th>Description of team member experience and qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Reusing is a Professional Engineer and holds a Masters of Science degree in Engineering from the University of Waterloo. He has over 25 years of extensive Canadian and US industrial sector air compliance experience in the oil and gas, chemical, cement, transportation, pulp and paper, general industrial, electronics, power generation, agriculture and waste management sectors. He is a greenhouse gas (GHG) Lead Verifier, Lead Validator, and Peer Reviewer with 9 years of experience including GHG Programmes in Alberta, BC, Ontario, Quebec, Nova Scotia, California, Massachusetts, and Programmes operated by the United Nations Framework Convention on Climate Change (UNFCC) Clean Development Mechanism (CDM), The Gold Standard, The Climate Registry (TCR), the Carbon Disclosure Project (CDP), and the Verified Carbon Standard (VCS). He has completed numerous GHG quantification studies for the oil and gas sector, including upstream, midstream and downstream facilities. Mr. Reusing has conducted GHG verifications as a Lead Verifier, Technical Expert and Peer Reviewer in many jurisdictions, including the Alberta Specified Gas Emitters Regulation (SGER), Ontario Regulation 452/09 (O. Reg. 452/09), British Columbia Greenhouse Gas Reduction (Cap and Trade) Act, (B.C. Reg. 272/2009), Quebec Regulation R.Q.c.Q-2, r.15 (Quebec Regulation), Massachusetts GHG Regulation, and California ARB. Mr. Reusing has been approved as a Lead Verifier for over 9 years under GHD’s Greenhouse Gas Assurance Services (GGAS) program, which includes many training and competency requirements. In addition, Mr. Reusing has completed specific courses on ISO 14064 parts 1, 2 and 3.</td>
</tr>
</tbody>
</table>

3.3 Schedule

Provide a list or table of verification activities and dates. Indicate when the verification was completed.

The following details the schedule of GHD’s verification, identifying the dates of key tasks and completion of major milestones:

- Submit Verification Plan to Shell – December 8, 2017
- Shell Verification Plan review period – December 8 – 11, 2017
- Request, receive and review documents and raw data from Shell – December 7, 2017 – June 18, 2018
- Issue initial draft Verification Report to Shell – December 18, 2017
4.0 Results

Add introduction to results section here, if desired.

4.1 Assessment of Internal Data Management and Controls

Provide a summary the information system(s) and its controls for sources of potential errors. Include information on the selection and management of data, process for collecting and consolidating data, data accuracy systems, design and maintenance of the GHG system, the systems and processes that support the GHG information system and results from previous assessments if applicable.

Data Management

GHD understands that the iSteam model program builds off Shell’s existing data management systems. All data into iSteam is taken from the existing PI historian (previously verified). The model runs along with initial QA/QC are completed by a designated Data Focal. The daily results of these runs are electronically transferred to a designated spreadsheet, which calculates the changes in steam usage between Quest on/off-line. These results are then transferred into the Steam balance spreadsheet, which uses the results to calculate the final Quest allocations, which are then transferred to SERS (in units of Gigajoules (GJ)). All data is in addition subject to Shell’s existing QA/QC procedures.

GHD has reviewed the transfer of data for each month of the reporting period and confirmed that there were no issues with data management. GHD had previously reviewed the overall data management systems in the initial full verification, with no issues identified.

Meter Calibrations

GHD had previously been provided the following calibration records as part of the initial verification (completed in 2016):

- FT-248004 – HP steam to Quest
- PI-251020A – HP steam pressure to Quest
- FT-246005, FT-246006, FT-246120 – LP steam to Quest
- PI-251022A – LP steam pressure to Quest
- PI-250003 – STG extraction steam pressure
- TI-250034 – STG extraction steam temperature
- PI-250101 – surface condenser pressure

GHD has confirmed that the above calibration records are reasonable and appropriate.
The full iSteam model balance contains multiple other meters throughout the Shell steam system. Shell has indicated that besides the meter list above, most of these meters are not regularly calibrated (as the requirement did not exist previously). Shell currently adjusts all input meter data as part of the initial simulation mode; this balance is reviewed by the Shell Data Focal in the QA/QC process to ensure that all balances are within meter tolerances as part of the input balance, with additional adjustments made to known problematic meters by the model or engineering estimates applied by the Data Focal. Without calibration records, it is difficult to confirm that these meters are actually operating within tolerances. Therefore, without recent calibration records, GHD cannot confirm that the meters were accurate in 2016. As there is no specific calibration frequency currently defined for steam meters, this is not a specific deviation with the protocol. GHD will add this as a qualification to the verification statement. This is further noted as Issue 02-01.

Conclusion

The management of data from iSteam through to the calculation software was determined to be reasonable and appropriate.

GHD reviewed available meter calibration records for the steam meters used in the iSteam balances. As the majority of meters were not calibrated during the 2nd reporting period, an emphasis of matter has been added to the verification statement.

4.2 Assessment of GHG Data and Information

Provide a summary of the information found during the verification of the GHG data and a summary of the GHG Assertion that was assessed.

For Facilities: Confirm that the quantification methodologies that were used in the compliance report are the same as those reported in the BEIA.

For Offset Projects: Confirm that the quantification methodologies that were used by the project proponent are the same as those described in the project plan. Indicate which quantification methodologies were used by the project proponent.

iSteam Model Summary and Changes Since Pre-Validation Review

As discussed in Section 2 above, Shell has updated the steam allocation methodology to utilize the iSteam computer program. On a high-level, this program simulates a baseline case where there is no Quest steam demand. This is done by importing balanced process data from the Upgrader steam header system on a daily basis, including Quest steam demand. The program then changes the Quest steam demand to zero, then completes iterative calculations to re-balance and optimize the steam system to reflect how the steam system would operate in the absence of Quest.

As part of the variance request, GHD was requested by ACCO to complete a review of the allocation methodology – this review has been included as Attachment G to this letter. This review included the following:

- A detailed summary of the original allocation methodology
- Discussion of the issues identified by TetraTech EBA Inc. (TetraTech) in their audit of the 1st reporting period (August 23, 2015 – October 31, 2015)
A summary of the iSteam inputs, including the adjustments made to meters to ensure a perfect balance

- The assumptions, limits and iSteam model parameters
- Summary of validation cases (specific historical scenarios where Quest was offline or reduced – the model was run to confirm it could recreate conditions with Quest offline)
- Review of verifiability of iSteam model. GHD summarized that it was verifiable, however the potential for recalculations is limited due to both the “black box” nature of the model and the number of calculations required.

As summarized in the pre-validation review, GHD had confirmed that the iSteam methodology is reasonable and able to determine the quantities of waste heat steam utilized by Quest.

Since the initial review, Shell has made updates to the iSteam model as well as to the overall steam balance calculations to reflect both some of GHD’s above findings, discussions with ACCO as well as other issues identified during the model runs. These updates are listed below:

- Shell has updated the iSteam balancing procedure to utilize the meter tolerances as part of the QA/QC process (previous models balanced on specific meters, and were done outside of defined tolerances)
- The previous model did not incorporate duct firing in the Cogen Heat-Recovery Steam Generator (HRSG), assuming that this would be constant with or without Quest. Duct firing is activated (by the operators) in multiple scenarios, including the following:
  - To burn excess fuel gas
  - To provide additional power
  - To provide additional steam
  - Duct firing testing

  In the case where duct firing occurs, this may be as a result of Quest and/or otherwise will change in the absence of Quest, so assuming it is constant is not appropriate. Therefore, the model was updated to incorporate duct firing, requiring an additional energy balance.

- Other changes as documented in validation report. GHD confirmed these changes were appropriate.
- The HP steam to Quest meter (FI-248004) was added to the model. This stream is not taken directly off the HP header system (rather it is taken from a specific source), however it was added for completeness (one Issue was identified with this as discussed below)
- The initial waste heat allocation methodology included a portion of waste heat from steam turbine extraction. The steam turbine generator produces electricity from HP steam. There is an extraction point located between the 9th and 10th stages of the generator which can produce LP steam. If this steam is not extracted, it is sent through the 10th-15th stages of the generator, with the subsequent steam condensed in the surface condenser. The initial methodology considered a portion of the steam turbine extraction steam (equivalent to the energy that would not have been used for electricity production in the absence of Quest) as waste heat. As per ACCO’s Approval Letter, the final methodology is not to consider this
source as a potential source of waste heat, with all steam condensed in the surface condenser counted as an LFE-non Cogen source of steam. ACCO has directed Shell calculate the potential reductions if this was considered waste heat as an additional calculation for information purposes. It is noted that the pre-validation review conducted by GHD included this source as a potential source of waste heat steam.

GHD was provided a revised iSteam validation report (prepared by Shell) which incorporates the above changes.

GHD has identified one minor Issue with the Quest HP steam:

- Shell has confirmed that the Quest HP steam has been added as part of the initial inputs to the model. When the model is run, the Quest LP steam is set to zero (as per above), but this is not applied to the HP steam to Quest (which is kept constant in iSteam). In the absence of Quest, this HP steam demand should also be changed to zero by definition. Shell has indicated this was originally not changed as it is a very small flow relative to overall Quest demand and the overall steam balance (between 0.62-0.67 tonnes/hour during the 2nd reporting period). As a test, Shell ran two separate days of iSteam with HP steam zeroed, which resulted in a difference of approximately 0.01 tonnes/hr. of condensate production, which will not result in any material issue. This is noted as Issue 02-02.

GHD has reviewed the report and one month of iSteam balance spreadsheets, and confirmed that the application of these changes are reasonable and consistent with Facility operation.

Review of Model Calculations

As discussed above, one of the issues identified during the pre-validation review was that the iSteam model could not be easily recreated outside of the program. This was due to the “black box” nature of the program and complexity of the calculations.

During this verification, GHD was provided additional details on the specific equations used by the iSteam model to calculate the steam. These calculations are as follows:

- Total electricity production out of the Upgrader is assumed constant. However due to the various Quest changes, the power generator from the Gas Turbine Generator (GTG) and Steam Turbine Generator (GTG) (include from steam turbine extraction) may change due to Quest being on/off-line. The GTG power changes result in changes to HRSG steam generation (which is based on the exhaust gas flowrate and temperature), while the STG power changes the quantities of steam consumption.

- The steam imports/exports at each header are based on simple mass/energy balance:
  - Mass Flow In = Mass Flow Out
  - Energy In = Energy Out
  - At the HP header, steam flow to the STG is adjusted first
  - When STG flow is at maximum and there is excess HP steam, letdowns (except for HP to LP, which is assumed 0) are adjusted
- If duct firing is occurring for steam support, the firing quantities and GTG, HRSG and STG energy/electricity production will be adjusted. If no duct firing is occurring the GTG, HRSG, STG energy balances (summarized in the bullets below) are not required

- For the IP and SHMP headers, the balances are adjusted through the letdowns

- For LP header, the balance is adjusted through the steam to excess condenser

• For the GTG, the power consumption (varied by iSteam) is used to calculate the following:
  - Required fuel consumption: calculated via a correlation equation (incorporating ambient temperature and the lower heating value of the natural gas)
  - Air consumption: calculated from fuel consumption based on a regression model
  - Exhaust flow rate and energy: calculated from a mass balance equation and energy balance
  - Exhaust temperature: calculated based on energy balance

• For the HRSG, the HRSG inlet gas temperature is based on the energy from the GTG exhaust gas plus energy from supplemental duct firing. The balance on steam production and balance on exiting HRSG stack gas are calculated by modifying the steam production and exit temperature of stack gas until it hits the minimum stack gas exit temperature or minimum exchanger approach temperature (i.e. minimum temperature difference between the steam exiting and stack gas entering) while also maintaining the proper steam mass/energy balances. These temperatures are plotted on a steam generation profile plot, which is used to quantify one value from the other.

• For the STG, the steam flow is calculated based on a balance on the HRSG and HP header flow. From this, extraction is minimized (maintaining LP steam header balance) with condensate extraction calculated based on a mass balance. Concurrently, the STG power is calculated based on the efficiencies of the STG.

GHD has reviewed the above equations and has concluded that various balance and correlation equations are reasonable and appropriate. As noted, the equations for GTG fuel/air consumption and HRSG gas exit temperature/minimum approach temperature are based on engineering correlations/regression models, which are unit specific and developed for this specific operation. The equations are based on fundamental engineering principles.

As an additional check for verifiability and reproducibility of iSteam, GHD requested Shell develop template manual recalculations based on two GHD-selected days, recreating the iSteam model in excel. Using these template sheets, GHD then completed its own recalculations for two other random days. These recalculations are summarized below:

**Shell-completed recalculations**

- November 5, 2015
- February 10, 2016
**GHD recalculations**

- November 15, 2015
- November 26, 2015

It is noted that duct firing occurred in each of the four days selected, ultimately requiring an energy balance.

The output from each of these manual recalculations were compared against the iSteam model results to confirm reproducibility. The comparison of each key model parameter is below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>iSteam</th>
<th>Manual</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>November 5 (Shell)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP Steam to Quest</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HSRG steam production</td>
<td>177.7</td>
<td>173</td>
<td>2.64%</td>
</tr>
<tr>
<td>HP-LP Letdown</td>
<td>-</td>
<td>0</td>
<td>Not modelled in iSteam</td>
</tr>
<tr>
<td>HP-IP Letdown</td>
<td>0.00</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>HP-MP Letdown</td>
<td>0.00</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>IP-LP Letdown</td>
<td>54.92</td>
<td>55.22</td>
<td>-0.55%</td>
</tr>
<tr>
<td>MP-LP Letdown</td>
<td>45.97</td>
<td>46.57</td>
<td>-1.31%</td>
</tr>
<tr>
<td>Excess Steam Condensate</td>
<td>74.56</td>
<td>76.49</td>
<td>-2.59%</td>
</tr>
<tr>
<td>STG HP steam in</td>
<td>332.16</td>
<td>326.83</td>
<td>1.60%</td>
</tr>
<tr>
<td>STG LP extraction</td>
<td>25</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>STG steam to surf condenser</td>
<td>307.16</td>
<td>301.83</td>
<td>1.73%</td>
</tr>
<tr>
<td><strong>November 15 (GHD)</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>LP Steam to Quest</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HSRG steam production</td>
<td>236.25</td>
<td>236.32</td>
<td>-0.03%</td>
</tr>
<tr>
<td>HP-LP Letdown</td>
<td>-</td>
<td>0</td>
<td>Not modelled in iSteam</td>
</tr>
<tr>
<td>HP-IP Letdown</td>
<td>0</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>HP-MP Letdown</td>
<td>0</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>IP-LP Letdown</td>
<td>29.33</td>
<td>29.63</td>
<td>-1.02%</td>
</tr>
<tr>
<td>MP-LP Letdown</td>
<td>17.92</td>
<td>18.42</td>
<td>-2.79%</td>
</tr>
<tr>
<td>Excess Steam Condensate</td>
<td>32.92</td>
<td>34.82</td>
<td>-5.77%</td>
</tr>
<tr>
<td>Parameter</td>
<td>iSteam</td>
<td>Manual</td>
<td>%</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>STG HP steam in</td>
<td>271.53</td>
<td>272.1</td>
<td>-0.21%</td>
</tr>
<tr>
<td>STG LP extraction</td>
<td>25</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>STG steam to surf condenser</td>
<td>246.53</td>
<td>247.1</td>
<td>-0.23%</td>
</tr>
</tbody>
</table>

**November 26 (GHD)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>iSteam</th>
<th>Manual</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP Steam to Quest</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HSRG steam production</td>
<td>102.34</td>
<td>106.60</td>
<td>-4.16%</td>
</tr>
<tr>
<td>HP-LP Letdown</td>
<td>0</td>
<td>0.00</td>
<td>Not modelled in iSteam</td>
</tr>
<tr>
<td>HP-IP Letdown</td>
<td>0</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>HP-MP Letdown</td>
<td>0</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>IP-LP Letdown</td>
<td>31.75</td>
<td>31.45</td>
<td>0.95%</td>
</tr>
<tr>
<td>MP-LP Letdown</td>
<td>18.12</td>
<td>17.82</td>
<td>1.67%</td>
</tr>
<tr>
<td>Excess Steam Condensate</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00%</td>
</tr>
<tr>
<td>STG HP steam in</td>
<td>183.8</td>
<td>183.70</td>
<td>0.07%</td>
</tr>
<tr>
<td>STG LP extraction</td>
<td>39.77</td>
<td>40.97</td>
<td>-</td>
</tr>
<tr>
<td>STG steam to surf condenser</td>
<td>144.1</td>
<td>142.77</td>
<td>0.90%</td>
</tr>
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</table>

**February 10, 2016 (Shell)**

<table>
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<tr>
<th>Parameter</th>
<th>iSteam</th>
<th>Manual</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP Steam to Quest</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HSRG steam production</td>
<td>110.2</td>
<td>110.6</td>
<td>-0.36%</td>
</tr>
<tr>
<td>HP-LP Letdown</td>
<td>-</td>
<td>0</td>
<td>Not modelled in iSteam</td>
</tr>
<tr>
<td>HP-IP Letdown</td>
<td>0.00</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>HP-MP Letdown</td>
<td>0.00</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>IP-LP Letdown</td>
<td>19.04</td>
<td>19.34</td>
<td>-1.58%</td>
</tr>
<tr>
<td>MP-LP Letdown</td>
<td>20.62</td>
<td>21.22</td>
<td>-2.91%</td>
</tr>
<tr>
<td>Excess Steam Condensate</td>
<td>28.10</td>
<td>30.17</td>
<td>-7.37%</td>
</tr>
<tr>
<td>STG HP steam in</td>
<td>208.71</td>
<td>208.26</td>
<td>0.22%</td>
</tr>
<tr>
<td>STG LP extraction</td>
<td>25</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>STG steam to surf condenser</td>
<td>183.70</td>
<td>183.26</td>
<td>0.24%</td>
</tr>
</tbody>
</table>
The differences in the above values were determined to be due to rounding as well as simplifications in approaches to some of the energy calculations in the manual recalculation as opposed to the iSteam model (these simplifications do not reflect any issues in iSteam, but were to help make the manual recalculation simpler). As a conservative check, GHD adjusted the recorded iSteam results by the worst-case differences above throughout the 2nd reporting period results – this resulted in differences of 0.16 percent in the overall assertion, which is not material. GHD notes that a potential opportunity for improvement would be to develop a manual recalculation template spreadsheet to use as a guide for third-party reviewers to review the iterations of iSteam and to show how the program works step-by-step and increase transparency. This is noted as OFI-01 below.

These comparisons demonstrate that the manual recalculation used by Shell/GHD can compare reasonably to the iSteam model. GHD does note that due to the volume of data and calculations involved, which vary on a daily basis, it is time-consuming to fully recreate an entire reporting period’s worth of iSteam model results just using excel templates, but it is possible to take a sample size of days and get values representative of iSteam. Therefore, GHD can confirm that the iSteam model is verifiable and reproducible.

**Overall Compatibility with the Protocol and Variance Request with ACCO**

As documented above, the main issues with the initial steam allocation methodology identified by TetraTech with respect to the protocol were the following:

- The methodology was based on a conceptual, financial allocation methodology, and not based on direct measurement of the individual quantities of steam. As per the protocol, direct measurement of steam quantities prior to commencement of the Project are required to set baseline quantities.

- The quantity of waste heat claimed could not be proved to have been vented or dissipated prior to Quest.

The iSteam model addresses the above issues. The model simulates a reasonable (based on GHD’s review as documented above) representation of steam header system in the absence of Quest. This presents a baseline case that can be considered representative in the absence of Quest, albeit one which is dynamic rather than based on direct measurement of steam prior to the commencement of Quest (as discussed below, this is subject to a Variance Request). Furthermore, through simulating this baseline case, it can be used to show how the waste heat quantities would have changed without Quest, demonstrating that waste heat would have been dissipated in the excess steam condenser without Quest. Therefore, GHD concludes that TetraTech’s findings were properly addressed by Shell.

**Confirmation of Other Non-Material Quest Re-Verification Findings**

In addition to the above-noted issue regarding the waste heat calculation, multiple other non-material findings were identified by Tetra-Tech. GHD’s confirmation of these findings is provided below:

_Issue 16-03: Negative Values were identified in the Steam Balance Spreadsheets_

GHD verified that there were no inappropriate negative values in the calculation of steam quantities (it is noted that the meters specifically identified by TetraTech are no longer used in
the steam calculations). Shell starting with the second reporting period has implemented a screening process to identify and remove negative values as appropriate.

**Issue 16-21: Incorrect Linking of Enthalpy Calculations**

GHD has confirmed that the steam enthalpy calculations is linked correctly for each full month. Shell has also update the enthalpy calculations to note when the measured temperature is below the saturation point, requiring differing sets of steam tables.

**Issue 16-22: Steam Tables Used**

Shell has confirmed that the steam tables are based on the most recent version of steam tables, namely IAPWS-IF97.

**Issue 16-23: Use of natural gas emission factor**

Shell has added a monthly monitoring check into the calculations to ensure that the most conservative (resulting in higher project emissions, and lower emissions offsets) set of emission factors between natural gas or base upgrader/expansion upgrader fuel gas is used in the calculation of emissions offsets.

**Issue 16-24: Classification of HRSG steam**

Shell has updated the classification to correctly assign it as LFE non-cogen.

**Issue 16-25: Use of Daily Aggregation**

Shell has elected to continue using daily aggregation of meter data, as this ensures consistency with the iSteam model runs. As this is not a material finding (was calculated to be 1 percent of P9 emissions by TetraTech), this will not result in a material discrepancy.

**Materiality Assessment**

Based on the information above, GHD recalculated emissions from the P5/P6/P7 and P9 emissions categories (as the emission factor methodologies are unchanged, GHD has used the same factors used by Shell). These recalculation result in the following differences in each project emission category:

- **P5/P6/P7** – 11.13 tonnes CO2e (overreported relative to project emissions and underreported relative to offsets), 0.01 percent of project emissions and <0.01 percent of total offsets
- **P9** – 96.10 tonnes CO2e (overreported relative to project emissions and underreported relative to offsets), 0.09 percent of project emissions and 0.03 percent of total offsets
- **Total Project Emissions** – 107.23 tonnes CO2e (overreported relative to project emissions and underreported relative to offsets), 0.03 percent of total offsets

The above differences were determined to have been primarily due to rounding in the steam calculations themselves, and are not due to any specific discrepancies in Shell’s calculations.

**Assessment of Surface Condenser Waste Heat Scenario and no Waste Heat Scenario**

As per ACCO’s email dated December 3, 2018, an additional assessment was requested for Shell to report the potential emissions offsets from waste heat to the surface condenser in a transparent fashion as an addendum to the Offset Project Report, and for the verifier to comment on this aspect.
GHD confirmed that Shell has included both the potential offsets if the surface condenser steam was counted as waste heat was included in the OPR as an appendix. These offsets were calculated using the methodologies for calculating waste heat using the iSteam model multiplied by the waste fraction as outlined in Shell’s initial OPP (based on the ratio of the enthalpy changes from HP to LP steam to the enthalpy change from HP steam to condensate). GHD reviewed this methodology and had no issues.

Based on GHD’s recalculations, a difference of 403.58 tonnes CO2e was calculated, or 0.10 percent of the offsets if the surface condenser steam was considered waste heat. This difference is due to rounding and is not due to any specific discrepancies in Shell’s calculations. GHD notes that this assessment does not count towards the overall assessment, and is included for informational purposes.

Shell has also included the initial offsets with no waste heat claimed in this Appendix. These values were previously verified by GHD, with no issues identified.

### 4.3 Assessment against Criteria

*Provide a description of how eligibility criteria is met or not met.*

**For Offset Project:** Complete Table 1 to indicate if the GHG Assertion conforms to the Regulation and Standard for Greenhouse Gas Emission Offset Project Developers eligibility criteria.

**For Facilities:** Delete Table 1 and Indicate if verification criteria are met or not met and explain.

GHD’s full verification of the initial submission included a review of offset criteria, which did not identify any issues. As none of the project criteria changed as a result of this resubmission, GHD did not complete an additional review.

### 4.4 Evaluation of the GHG Assertion

The verification assessment is that the GHG Assertion meets the requirements of the Carbon Competitiveness Incentive Regulation.

*Provide an assessment of the evidence collected during the verification. Determine if the data and information available support the GHG assertion. Provide a conclusion on whether the assertion meets the materiality requirements and the level of assurance agreed to at the beginning of the verification process.*

The verification assessment is that the GHG Assertion meets the requirements of the Carbon Competitiveness Incentive Regulation.

The resulting absolute difference between the Project offsets and GHD’s calculated offsets is 107.23 tonnes CO2e, which is equal to 0.03 percent of offsets. As the materiality threshold for this verification is 5 percent, the difference identified in the offsets means that the GHG assertion was not materially misstated. Appendix F.2 below presents GHD’s reconstructed emissions based on the raw data provided, the emissions reported by the Facility, and the resulting net/absolute discrepancies for each category.

Based on GHD’s review, the GHG assertion is in accordance with the CCIR to a reasonable level. The full verification opinion is provided in Section 9.1.
4.5 Summary of Findings

Provide a summary of material and immaterial discrepancies expressed in tonnes and as net and absolute error in Table 2. Include whether the discrepancy was an understatement or an overstatement.

Include a more detailed description and log of results in Appendix C the “Issues Log”. This log will include both resolved and unresolved issues from the verification. Unresolved issues should be brought forward to Table 2.
**Table 1: Summary of Findings**

Number the finding with the year and provide a unique # for each finding.

Note: A detailed description of all material and immaterial findings should be provided in Table 3 of Appendix C.

Provide only a summary statement (1-4 sentences) for each unresolved immaterial finding and each material finding (resolved or unresolved). If the finding is a resolved material finding, then put the tonnes net and absolute in the summary description column and indicate n/a in the net and absolute columns. Do not include the tonnes in the total error calculation.

Indicate the type of error (qualitative or quantitative).

Indicate the Source Category (for facilities) or the Source/Sink (for offsets).

Indicate if the finding is an understatement or overstatement.

Provide the total net error and the total absolute error in tonnes of CO₂ eq and as a % of the assertion.

<table>
<thead>
<tr>
<th>Result #</th>
<th>Type</th>
<th>Summary Description of Finding Source Category or Source/Sink</th>
<th>Understatement /Overstatement</th>
<th>Tonnes CO₂ eq % net</th>
<th>Tonnes CO₂ eq % absolute</th>
</tr>
</thead>
<tbody>
<tr>
<td>02-01</td>
<td>Qualitative</td>
<td>Calibration records were not available for 2016 for majority of key meters</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>02-01</td>
<td>Quantitative</td>
<td>Shell currently assumes that Quest HP steam is not changed through the iSteam balance. In the absence of Quest this stream would also be set to zero (similar to the LP steam).</td>
<td>Understatement</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

**Total Error**

<0.01 <0.01
4.6 Opportunity for Improvement

Provide feedback on the data management system and controls, transparency, completeness of the inventory, additions to the quantification methodology document or diagrams, etc. Include positive considerations and observations also.

Identify strengths and weaknesses that may help to improve the report/s for the current facility, sector, and compliance program. Identify ways in which the project/facility could be more easily verified.

OFI-01: Shell could develop manual calculation excel templates, reproducing the iSteam model calculations. This would add additional transparency to the iSteam model process as well as ease review and reproducibility of the iSteam model for both internal and third-party verification purposes.

5.0 Closure

5.1 Verification Statement

Include the signed verification statement in Appendix D.

Instructions to insert a pdf: 1. Click Insert>Object 2. In the Object dialog box click Create from File and then click Browse. 3. Find the pdf you want to insert then click Insert. 4. Click OK.

For Offset Projects: fill in the sample Verification Statement provided, sign, scan and paste.

For Facilities: paste a signed Version of the Verification Statement from the facility compliance form. Include the conclusion on the GHG assertion and any qualification or limitations and the level of assurance.

Provide the verification conclusion in the drop down box below.

The verification conclusion is:

Qualified

The qualification is due to the following:

- Calibrations were not performed on a majority of the meters used to set up the inputs to the iSteam model. The model inputs are reviewed prior to use in the iSteam model, with adjustments made by the iSteam model with review conducted to confirm these adjustments are within meter tolerances (unless the meter is known to have issues) to ensure balance. This review does provide additional assurance that the meter readings are reasonable; however, the lack of calibration records does add uncertainty to the data used. Shell has indicated that all iSteam meters will be reviewed and added to the calibration cycle on a go-forward basis.

5.2 Limitation of Liability

Include signed Conflict of Interest Checklist in Appendix E.

For Offset Projects: fill in the sample Conflict of Interest Checklist provided, sign, scan and paste.

For Facilities: paste the signed Conflict of Interest Checklist from the facility compliance form.

Insert limitation of liability statement and include information in an Appendix F if applicable.

Because of the inherent limitations in any internal control structure, it is possible that fraud, error, or non-compliance with laws and regulations may occur and not be detected. Further, the
verification was not designed to detect all weakness or errors in internal controls so far as they relate to the requirements set out above as the verification has not been performed continuously throughout the period and the procedures performed on the relevant internal controls were on a test basis. Any projection of the evaluation of control procedures to future periods is subject to the risk that the procedures may become inadequate because of changes in conditions, or that the degree of compliance with them may deteriorate.

The verification opinion expressed in this report has been formed on the above basis.

GHD’s review of the OPR claimed included only the information discussed above. While the review included observation of the systems used for determination of the claimed OPR, GHD did not conduct any direct field measurements and has relied on the primary measurement data and records provided by Shell as being reliable and accurate. No other information was provided to GHD or incorporated into this review. GHD assumes no responsibility or liability for the information with which it has been provided by others.

The information and opinions rendered in this report are exclusively for use by Shell. GHD will not distribute or publish this report without Shell’s consent except as required by law or court order. The information and opinions expressed in this report are given in response to a limited assignment and should only be evaluated and implemented in connection with that assignment. GHD accepts responsibility for the competent performance of its duties in executing the assignment and preparing this report in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

### 5.3 Confirmations

*Document information confirmed, including any discrepancies or inconsistencies, as per the Confirmations section in the Standard for Greenhouse Gas Verification.*

<table>
<thead>
<tr>
<th>Reported Item</th>
<th>Consistency of Offset Project Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification Procedure</td>
<td>Confirm that the offset project information is consistent across offset project documentation</td>
</tr>
<tr>
<td>Verification Findings</td>
<td>GHD reviewed the OPP and OPR. The posted OPP has not yet been updated for some corrections; Shell has indicated that these will be corrected at a later date. The variance requests are included in the OPR supporting this assertion, and the OPR fully documents these changes.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Multiple updates have not been made to the OPP, which are in the OPR. GHD understands these changes are to be updated.</td>
</tr>
</tbody>
</table>
6.0 References

Author. year. Title. (no hyperlinks)


All of Which is Respectfully Submitted,

GHD

Sean Williams, P.Eng., Lead Verifier

Gordon Reusing, P.Eng., Peer Reviewer
Appendix A: Final Verification Plan and Sampling Plan
December 18, 2018

Mr. Charles Bower
GHG Reporting Specialist
Shell Canada Ltd.
PO Bag 23
Fort Saskatchewan, Alberta
T8L 3T2

Dear Mr. Bower:

Re: Verification Plan – Limited Scope Verification for P9 Emissions from Waste Heat
Quest Carbon Capture and Storage Project 2nd Reporting period
Shell Canada Energy, Fort Saskatchewan, Alberta

1. Introduction

Shell Canada Limited, as Managing Partner and on behalf of Shell Canada Energy (an Alberta Partnership) (Shell) retained GHD Limited (GHD) to undertake a limited scope verification on the restatement of the Quest Carbon Capture and Storage (CCS) Project (Project or Quest) 2nd Reporting period Offset Project Report (OPR). Shell is the project developer for the compliance period of November 1, 2015 through March 31, 2016 (2nd Reporting Period). GHD completed the verification in accordance with the requirements of the Carbon Competitiveness Incentive Regulation, Alberta Regulation 255/2017 and associated amendments, Climate Change and Emissions Management Act (CCIR) (ACCO, 2017). The applicable protocol for this Project is the Quantification Protocol for CO2 Capture and Permanent Storage in Deep Saline Aquifers, Version 1.0 (Alberta Environment and Parks (AEP), June 2015) (Protocol).

GHD understands that Shell OPR for the 1st reporting period (August 23, 2015 – October 31, 2015) was subject to an audit by TetraTech EBA Inc. (TetraTech). From this audit, TetraTech identified the following issues with the P9 – Off-Site Generation of Heat project emissions category (it is further noted that the P5/P6/P7 emissions category is also affected as this is calculated using the same equivalent natural gas volumes as the P9 category):

- The methodology was based on a conceptual, financial allocation methodology, and not based on direct measurement of the individual quantities of steam. As per the protocol, direct measurement of steam quantities prior to commencement of the Project are required to set baseline quantities.
- The quantity of waste heat claimed could not be proved to have been vented or dissipated prior to Quest.

In response, Shell submitted a variance request to both allow the use of a dynamic baseline (rather than fixed) and a new allocation methodology, which can more accurately estimate steam usage in the absence of Quest, demonstrating the quantities of waste heat used by Quest. An additional request was
submitted and granted by ACCO to allow Shell to exclude waste heat from the quantification of steam for the initial submission of the 2nd reporting period Offset OPR, assuming all steam is from LFE, non-cogen sources during the development of the revised methodology and approvals process with ACCO. This initial submission was verified by GHD.

A revised steam allocation methodology has been developed by Shell, which uses the iSteam model program, which uses real-time data (with Quest online) to simulate a baseline case where there is no Quest demand, re-allocating the excess steam throughout the system, which can then be used to determine the allocations of LP steam to Quest among the various sources. GHD had previously completed a pre-validation review (as requested by ACCO) of the new methodology, completed by GHD on September 18, 2017 and submitted to ACCO on September 20, 2017. This review constituted a review of the methodology, along with a limited review of specific cases when Quest was down to confirm the validity of the methodology.

Once this new methodology was developed and approved, the OPR for each affected reporting period (2nd through 5th) could then be resubmitted using the new methodology. Limited scope verifications of the values calculated by the new allocation methodology and claimed waste heat must then be completed. This report covers the limited scope verification of the 2nd reporting period for retroactive corrections to the waste heat methodology. No other baseline or project emissions were reviewed as part of this limited scope verification.

GHD prepared this Verification Plan in accordance with the ISO Standard ISO 14064 Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions (ISO 14064-3) and with ACCO’s most recent version of the Standard for Validation, Verification and Audit (VVA Standard).

2. Verification Objective, Scope and Level of Assurance

The objective of the verification is to provide Shell and ACCO with assurance that there are no material misstatements in the restated OPR for the 2nd reporting period and that the information reported is accurate and consistent with the requirements of the SGER.

The scope of this verification is limited to the claimed reductions associated with waste heat steam used by Quest. This verification will include review of the following:

- **Project Description** – The scope of the verification includes the greenhouse gas (GHG) project emissions resulting from the waste heat steam used by Quest. This specific limited scope verification will include a review of the following:
  - Assessment of the iSteam model runs. As outlined above, the methodology itself has been previously reviewed as part of the pre-validation review conducted by GHD (as requested by ACCO). GHD will reference this initial pre-validation review as part of the verification, and will further review the application of this program along with any changes made to the program since the initial review.
- Final iSteam model results
- Revised steam balance spreadsheets
- Restated OPP and OPR, specifically relating to the methodologies and project emissions associated with the P5/P6/P7 and P9 categories.

**GHG Types** – The specific GHG types reviewed as part of this verification result from the following:
- Releases of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) due to combustion of fuels for heat.
- Emissions of CO2, CH4 and N2O due to extraction, processing and transportation of fuels combusted

**Time Period** – November 1, 2015 through March 31, 2016.

**Use of this Report** - This report has been prepared for the use of Shell and ACCO.

**Relative Size** – The initial size of the claimed GHG reductions (with no waste heat claimed) were 338,221 tonnes CO2 equivalent (tCO2e).

The verification will be conducted to a reasonable level of assurance. Reasonable assurance is a high level of assurance, or positive assurance. Reasonable assurance is a direct factual statement expressing the opinion of the verifier. If a verification statement can be provided, it will be worded in a manner similar to "Based on our verification, the GHG emissions statement is, in all material aspects, in accordance with the approved quantification methodologies." GHD will not be reviewing the other aspects of Shell's OPR unless it is related to the specific items outlined by ACCO. GHD further notes that the previous submissions of the Compliance Reports were verified to a reasonable level.

3. **Verification Standards and Criteria**

For this verification, GHD will apply the following ISO and ACCO verification criteria:

- ISO 14064 Greenhouse gases Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions (ISO 14064 3)
- Carbon Competitiveness Incentive Regulation, Alberta Regulation 255/2017, Climate Change and Emissions Management Act, Province of Alberta, 2017
- Standard for Validation, Verification and Audit, Version 2.0, ACCO, 2018 (VVA Standard)
4. **Project Operations**

The Project consists of the reduction of GHG emissions from the operation of carbon capture and storage facility to collect CO₂ produced at the Shell Canada Energy Scotford Upgrader Facility (Upgrader Facility), located in Fort Saskatchewan, Alberta. The carbon capture and storage facility is owned by the Athabasca Oil Sands Joint Venture (AOSP JV) and operated by Shell.

4.1 **Project Emissions Source Categories**

The claimed offsets result from reductions in CO₂ released to the atmosphere due to the Project.

The emission offsets from the implementation of this Project specifically associated with the limited scope verification include the following:

- P5/P6/P7 – Extraction/Processing/Transportation of fuels used for on-Site and off-Site heat and electricity generation (CO₂, CH₄ and N₂O)
- P9 – Off-Site heat generation (CO₂, CH₄ and N₂O)

4.2 **Geographical and Operational Boundaries**

The overall project includes the GHG emission sources resulting from the CCS facility and injection wells, which are located at:

**CCS Facility**

55522 Range Road 214
Fort Saskatchewan, Alberta
Latitude: 53.74047 N, Longitude 113.0231 W


**Injection Wells**

Well #1: 07-11-59-20-W4  
Well #2: 08-19-59-20-W4  
Well #3: 05-35-59-21-W4

The CCS facility and injection wells are owned by the Athabasca Oil Sands Project (AOSP) Joint-Venture and operated by Shell. The CCS facility is located at the Shell Scotford Site, which includes the following facilities, which, unless otherwise noted, are owned by the AOSP JV and operated by Shell:

- Scotford Upgrader Facility (which itself consists of the Upgrader-Base and Upgrader Expansion Facilities).
- ATCO Cogen facility (owned by ATCO Power Canada Limited, operated by Shell).
- Air Liquide Cogen facility (owned and operated by Air Liquide Canada).
- Scotford Refinery.
- Shell Chemicals Facilities.

The Scotford Upgrader provides both the CO₂ for injection and heat (in the form of steam) for the Project operation. Other operations at the Scotford Site are indirectly linked to the Project through steam imports/exports, which are accounted for in the iSteam model and are part of the Upgrader’s steam balance.

For the purposes of this limited scope verification, only the aspects directly associated with the emissions categories are reviewed; therefore, no aspects at the Injection sites were included in this verification.

### 4.3 Reporting Period

The reporting period is between November 1, 2015 and March 31, 2016.

### 4.4 Use of this Report

This report has been prepared for the use of Shell and ACCO.

### 5. Project Data Management Systems and Controls

The total quantities of emissions from the various baseline and project sources and sinks are determined based on either direct measurement, third-party data, and/or engineering estimates.

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1 During the second reporting period two injection wells were in operation: Well#1: 07-11-59-20-W4 and Well#2: 08-19-59-20-W4
The data management system used by Shell is built upon the existing systems at the Scotford Site, and is based on a network of Data Focals. The data management system specifies the personnel responsible for the collection and maintenance of data at key measurement points.

Metered data is collected from the measurement points by the Distributed Control System (DCS), and then stored in the Process Information (PI) system – data will be stored for at least seven years past the end of the project reporting period. All data is reviewed prior to use in the calculations by the assigned Data Focal. The final meter data is stored within the PI system. All meters involved have specified standards and practices to control uncertainty, including calibration and preventative maintenance activities.

The Data Focal collects all key data and enters this data into the Shell Environmental Reporting System (SERS), which is the Site’s emissions calculation software. The data and outputs from the SERS software is reviewed monthly, quarterly and yearly to ensure accuracy.

6. **Prior Verification Report and Findings**

GHD had previously completed a verification of the 2nd Reporting period. This verification initially included the project emissions with claimed waste heat, but this was revised due to the issues identified by TetraTech, and therefore the verified and submitted 2nd Reporting period OPR did not include waste heat. GHD provided an Unqualified Opinion with Emphasis of Matter to note that the variance request submitted by Shell regarding the steam methodology had not been approved by ACCO, otherwise no major findings were identified.

7. **Verification Schedule**

The following presents a draft verification schedule

- Submit Verification Plan to Shell – December 8, 2017
- Shell Verification Plan review period – December 8 – 11, 2017
- Request, receive and review documents and raw data from Shell – December 7, 2017 – June 18, 2018
- Issue initial draft Verification Report to Shell – December 18, 2017
- Issue revised draft Verification Report to Shell – June 19, 2018
- Issue final draft Verification Report to Shell – December 13, 2018
- Review draft Verification Report with Shell – December 13, 2018 – December 18, 2018
- Issue final Verification Report and Statement of Verification – December 18, 2018
8. **Assessment of Risk and Magnitude of Potential Errors, Omissions or Misrepresentations**

Based on GHD initial review of the Facility, a risk assessment summarizing the potential risk and magnitude of potential errors, omissions or misrepresentation, as currently known was completed. During the review, any new risks or material concerns that could potentially lead to errors, omissions and misrepresentations will be identified, reviewed and assessed.

The following table summarizes the potential risk and magnitude of potential errors, omissions or misrepresentations, as currently known:

<table>
<thead>
<tr>
<th>Correction Attributes</th>
<th>Inherent Risk</th>
<th>Control Risk</th>
<th>Detection Risk Design</th>
<th>Consideration for Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation of Steam and Claimed Waste Heat</td>
<td>Occurrence</td>
<td>High – Allocation of steam based on iSteam model, which is a complex computer simulation based on all meters used in steam header (over 100). Overall logic behind iSteam methodology had been previously reviewed by GHD and confirmed to be reasonable. Results from iSteam used in steam balance spreadsheet, which calculate equivalent natural gas based on natural gas composition and HHV.</td>
<td>High – Over 100 meters, valves and other measurement devices used to calculate steam balance. Only a limited number were part of Shell’s main PM system during the 2nd reporting period (requiring yearly calibration).</td>
<td>Lowest</td>
</tr>
</tbody>
</table>
9. **Sampling Plan**

GHD developed a sampling plan based on a review of the objectives, criteria, scope and level of assurance detailed above. The sampling plan is dynamic and will be revised, as required, throughout the course of the verification. The following table summarizes the sampling plan.

<table>
<thead>
<tr>
<th>Data/Information Description</th>
<th>Data/Information Source</th>
<th>Collection Frequency</th>
<th>Sample size/Action</th>
</tr>
</thead>
</table>
| Offset Project Plan          | Updated OPP             | N/A                  | • Updated OPP incorporating iSteam and new waste heat allocation methodology  
                              |                         |                      | • Confirm consistency new methodology and protocol requirements |
| Offset Project Report        | Updated OPR             | N/A                  | • Updated OPR incorporating iSteam and new waste heat allocation methodology  
                              |                         |                      | • Confirm consistency new methodology and protocol requirements  
                              |                         |                      | • Review revised P5/P6/P7 and P9 project emissions and resulting offsets |
| iSteam Model spreadsheets    | iSteam methodology document | N/A                  | • Review iSteam allocation methodology  
                              |                         |                      | • Confirm consistency between current iSteam model and previously-reviewed methodologies |
|                              | Changes to iSteam model (since pre-validation review) | N/A                  | • Review changes to iSteam model  
                              |                         |                      | • Confirm changes are reasonable |
| Results of iSteam            | Daily (for one month)   |                      | • Review one month (November 2017) of iSteam model spreadsheets  
                              |                         |                      | • Confirm reasonableness of results |
### Data/Information Description

<table>
<thead>
<tr>
<th>Data/Information Description</th>
<th>Data/Information Source</th>
<th>Collection Frequency</th>
<th>Sample size/Action</th>
</tr>
</thead>
</table>
| iSteam manual calculation examples | Two samples | • Two samples (November 5 and February 10) of iSteam model parameters  
• Manual recreation of iSteam model in excel |
| Allocated Steam | Steam balance spreadsheets | Monthly | • All steam balance spreadsheets for full reporting period  
• Confirm iSteam results have been correctly applied |
| Calculation of waste fraction | Continuous | • Review methodology for calculating fraction of LP steam from waste heat (note this is not used in final offset calculations but was included for review of Appendix information only) |
| Natural gas composition/HHV | As recorded | • All data for the duration of the reporting period for natural gas composition and HHV data from third party supplier |
| Combustion emission factors | N/A | • Confirm appropriateness of natural gas CO₂ emission factor calculated by Shell  
• Confirm appropriateness of published emission factors for other gas species |

### 10. Quantitative Testing

Quantitative data or raw data will be made available to GHD. GHD will review the allocated steam quantities, recalculate the total amounts of waste heat and natural gas from steam usage, and recalculate the total project emissions. The verifier must design the planning materiality, referred to as tolerable error, to detect quantitative misstatements in the assertion. The following table is a draft of the tolerable error assessment based on the previously submitted 2nd Reporting period OPR (with no waste heat). Exceedance of tolerable error is not an indication that a Facility is outside of the materiality threshold established in Section 11 below. Rather an exceedance serves to assist GHD in reviewing and updating its sample size and sample plan accordingly, to ensure that the values reported are accurately and conservatively represented.

<table>
<thead>
<tr>
<th>Baseline or Project</th>
<th>Source or Sink</th>
<th>Reductions (tonnes CO₂e)</th>
<th>% Tolerable Error</th>
<th>Tolerable Error (Rounded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>Fuel extraction/processing</td>
<td>4,561 CO₂, 89.17 CH₄, 0.24 N₂O, 6,862 CO₂e</td>
<td>10</td>
<td>686</td>
</tr>
</tbody>
</table>
### 11. Materiality Level

As the total project offsets are less than 500 ktonnes of CO$_2$e for the reporting period, quantitative materiality for this verification is set at absolute 5 percent of the restated 2nd reporting period offsets as per the ACCO VVA Standard. In addition, a series of discrete errors, omissions or misrepresentations or individual or a series of qualitative factors, when aggregated (absolute values) may be considered material.

### 12. Review Team

#### 12.1 Roles and Responsibilities

**Lead Verifier – Sean Williams, P.Eng.** – Mr. Williams will lead the verification and are responsible for development of the verification plan. Mr. Williams will review the risk assessment, recalculation of raw data, data management and draft findings. Mr. Williams will prepare and sign the verification statement and verification report.

**Peer Reviewer – Gordon Reusing, P.Eng.** – Mr. Reusing will conduct a peer review of the verification plan risk assessment and verification report and findings.

#### 12.2 Qualifications

**Sean Williams, P.Eng.** - Mr. Williams has a Bachelor of Applied Science in Chemical Engineering from the University of Waterloo, and is a licensed Professional Engineer in the provinces of Alberta and Ontario. Mr. Williams has experience in completing permit applications, air and noise compliance assessments, completion of annual inventory reports under O. Reg. 455 and NPRI, and greenhouse gas verifications under the Alberta Specified Gas Emitters Regulation (SGER), Ontario Regulation 452/09, the Quebec Greenhouse Gas Regulation, the California Air Resources Board and The Climate Registry. Mr. Williams’ has 5-years of experience as a lead verifier under multiple sectors and jurisdictions, including oil sands mining and extraction, refineries, chemical plants, power generation facilities and steel mills. Mr. Williams also has experience working in the accreditation audit process for GHD by ANSI, has knowledge of the ISO 14064 and ISO 14065 standards, and is an accredited lead verifier as per GHD’s ANSI-approved lead verifier competency requirements.

<table>
<thead>
<tr>
<th>Baseline or Project</th>
<th>Source or Sink</th>
<th>Reductions (tonnes CO$_2$e)</th>
<th>% Tolerable Error</th>
<th>Tolerable Error (Rounded)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Off-site heat</td>
<td>58,064</td>
<td>1.09</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>Total Project</td>
<td>62,265</td>
<td>90.27</td>
<td>1.22</td>
</tr>
<tr>
<td></td>
<td>Total Reductions</td>
<td>338,211</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: Units above are in tonnes of the specific GHG type (i.e. tonne CO$_2$, tonne CH$_4$, tonne N$_2$O) unless otherwise specified.
Gordon Reusing, M.Sc., P.E., P. Eng. – Mr. Reusing is a Professional Engineer and holds a Master’s of Science degree in Engineering from the University of Waterloo. He has over 25 years of extensive Canadian and US industrial sector air compliance experience in the oil and gas, chemical, cement, transportation, pulp and paper, general industrial, electronics, power generation, agriculture and waste management sectors. He is a greenhouse gas (GHG) Lead Verifier, Lead Validator, and Peer Reviewer with extensive experience including GHG Programmes in Alberta, British Columbia, Ontario, Quebec, Nova Scotia, California, Massachusetts, and Programmes operated by the United Nations Framework Convention on Climate Change (UNFCC) Clean Development Mechanism (CDM), The Gold Standard, The Climate Registry (TCR), the Carbon Disclosure Project (CDP), and the Verified Carbon Standard (VCS). He has completed numerous GHG quantification studies for the oil and gas sector, including upstream, midstream and downstream facilities. Mr. Reusing has conducted GHG verifications as a Lead Verifier, Technical Expert and Peer Reviewer in many jurisdictions, including the Alberta Specified Gas Emitters Regulation (SGER), Ontario Regulation 452/09 (O. Reg. 452/09), British Columbia Greenhouse Gas Reduction (Cap and Trade) Act, (B.C. Reg. 272/2009), Quebec Regulation R.Q.c.Q -2, r.15 (Quebec Regulation), Massachusetts GHG Regulation, and California ARB.

13. Verification Procedures

The verification procedures will be conducted to assess the following with respect to the limited scope of this verification:

1. Accuracy and completeness of the OPR.
2. Conformance to the Protocol.
3. Uncertainty of external data sources used.
4. Completeness of the OPR in comparison to the structure and criteria presented in ACCO guidance.
5. Offset assumptions.
6. Accuracy of emission calculations.
7. Potential magnitude of errors and omissions.
8. Integrity of the data management system and controls.
9. ISO principles are met

To sustain a risk-based assessment, the GHD Project Team will identify and determine risks related to offset reductions during both the desk reviews and the follow-up interviews. The GHD Project Team will
particularly focus on the accuracy and completeness of provided information. The components of the document review and follow-up interviews are:

- **Document Review:**
  - Review of data and information to confirm the correctness and completeness of presented information.
  - Cross-checks between information provided in the OPP and OPR and information from independent background investigations.
  - Determine sensitivity and magnitude analysis for parameters that may be the largest sources of error.

- **Follow-up Interviews:**
  - Via telephone
  - Via email

The GHD Project Team will interview Facility personnel to:

- Cross-check information provided.
- Test the correctness of critical formulae and calculations.
- Compare with projects or technologies that have similar or comparable characteristics.
- Test the correctness of critical formulae and calculations.
- Review data management and recording procedures.

The document review shall establish to what degree the presented Offset credits meets the verification standards and criteria.

The GHD Project Team’s document review shall comprise, but not be limited to, an evaluation of whether or not:

- The documentation is complete and comprehensive and follows the structure and criteria given in the ACCO guidelines and Protocol.
- The OPR, and the offset estimates therein, conform to the Protocol criteria.
- The OPP and OPR are accurate, transparent and provide a complete overview of the Project’s GHG emissions sources
- The methodologies are justified and appropriate.
- The offset credits calculations are appropriate and use conservative assumptions for estimating GHG emissions.
• The offset information system and its controls are sufficiently robust to minimize the potential for errors, omissions or misrepresentations.

• The frequency of, and responsibility and authority for, monitoring, measurement, data recording activities and quality control/quality assurance/management control procedures is sufficient.

• The GHG information system and its controls are sufficiently robust to minimize the potential for errors, omissions or misrepresentations.

14. Closure

The Verification Plan is considered to be a dynamic document that will require modification and adaptation to project conditions as encountered during the performance of the verification process. GHD will communicate the changes to the verification plan with Shell throughout the verification process.

All of which is respectfully submitted,

GHD

Sean Williams, P.Eng., Lead Verifier

SW/jm/4
Appendix B: Statement of Qualifications
Statement of Qualifications

Offset Report

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Offset Project ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quest Carbon Capture and Storage (CCS) Project</td>
<td>7306-8118</td>
</tr>
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<table>
<thead>
<tr>
<th>Reporting Company Legal Name</th>
<th>Report Type</th>
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<tbody>
<tr>
<td>Shell Canada Limited</td>
<td>Offset Report</td>
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<table>
<thead>
<tr>
<th>Reporting Period</th>
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</tr>
</thead>
<tbody>
<tr>
<td>November 1, 2015 – March 31, 2016</td>
<td></td>
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</tbody>
</table>

Signature of Third Party Verifier

I, Sean Williams (Third Party Verifier), meet or exceed the qualifications of third party verifiers described in Section 29 of the Carbon Competitiveness Incentive Regulation.

<table>
<thead>
<tr>
<th>Verifying Company Name</th>
<th>Signature of Third Party Verifier</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHD Limited</td>
<td></td>
<td>December 18, 2018</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Training Received Under ISO 14064 Part 3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Williams has received training under ISO 14064 Part 3 as required by GHD's internal lead verifier training. GHD is an accredited verification body under ISO 14065.</td>
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</table>

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Professional Designation</th>
<th>E-mail Address</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sean</td>
<td>Williams</td>
<td>P.Eng.</td>
<td><a href="mailto:sean.williams@ghd.com">sean.williams@ghd.com</a></td>
<td>780-705-7055</td>
</tr>
</tbody>
</table>

Lead Verifier

☒ Same as third party verifier?

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
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<th>E-mail Address</th>
<th>Phone Number</th>
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</table>

Peer Reviewer

<table>
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<th>E-mail Address</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gordon</td>
<td>Reusing</td>
<td><a href="mailto:Gordon.reusing@ghd.com">Gordon.reusing@ghd.com</a></td>
<td>519-884-0510</td>
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</table>

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Mr. Reusing has received training under ISO 14064 Part 3 as required by GHD's internal lead verifier training. GHD is an accredited verification body under ISO 14065. | |
Table 2: Detailed Findings and Issues Log

Number the Issue with the year and provide a unique # for the issue. If the Issue resolved during the verification, indicate that in the resolution column. If the Issue is not resolved during the verification, or if the Issue was material (whether resolved or not) record it as a finding in Table 2 and provide a cross reference to the finding # in the resolution column. 

Describe the issues investigated. State the verification criteria that are not met. Provide a description of how it is not met and provide the evidence. Indicate the Source Category (for facilities) or the Source/Sink (for offsets).

Indicate if the finding is an understatement or overstatement.

Summarize information between verifier and client.

Provide a conclusion including % discrepancy, if applicable.

<table>
<thead>
<tr>
<th>Item (YR-##)</th>
<th>Description of the Issues Investigated During the Verification</th>
<th>Summary of information exchanged between verifier and client</th>
<th>Resolution</th>
<th>Conclusion (including % discrepancy if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>02-01</td>
<td>With the new waste heat methodology, multiple meters were added as part of the Quest project primarily involving the steam balance in the Shell Upgrader. For the majority of these meters, calibration records were not available during the crediting period, and specific calibration and maintenance could not be located.</td>
<td>GHD requested all available calibration records for the meters added as part of the waste heat methodology.</td>
<td>Shell has indicated that these meters will be added to the calibration preventative maintenance program on an on-going basis. As no specific calibration frequency is defined for steam meters, there is no specific deviation from the protocol</td>
<td>No material issues. GHD has added this as a qualification to the verification statement.</td>
</tr>
<tr>
<td>02-02</td>
<td>GHD identified that the Quest HP steam meter is not set to zero as part of the iSteam model. By definition, HP steam should be adjusted as it will not exist in the absence of Quest.</td>
<td>GHD reviewed the iSteam model definitions and model runs.</td>
<td>The Quest HP steam meter has much lower flowrates than the LP steam, and as such will not substantially affect the models. As a test Shell ran iSteam for two separate days with HP steam zeroed, resulting in a change in condensate of 0.01 tonnes/hr, which is not material.</td>
<td>Confirmed to not result in any material discrepancies.</td>
</tr>
</tbody>
</table>
Appendix D: Statement of Verification
# Statement of Verification

## Associated Offset Submission

<table>
<thead>
<tr>
<th>Offset Project</th>
<th>Protocol</th>
<th>Project ID #</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Project Developer</th>
<th>Serial Range Start</th>
<th>Report Period</th>
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<tbody>
<tr>
<td>Shell Canada Limited</td>
<td></td>
<td>November 1, 2015 – March 31, 2016</td>
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</table>

## Statement of Verification

<table>
<thead>
<tr>
<th>GHG Assertion</th>
<th>Value</th>
<th>Units</th>
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<tr>
<td>Total Baseline Emissions</td>
<td>444,091</td>
<td>tonnes CO2eq</td>
</tr>
<tr>
<td>Total Project Emissions</td>
<td>105,870</td>
<td>tonnes CO2eq</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>tonnes CO2eq</td>
</tr>
<tr>
<td>Net Reductions</td>
<td>338,221</td>
<td>tonnes CO2eq</td>
</tr>
</tbody>
</table>

The Quest Carbon Capture and Storage Offset Project reported 338,221 tCO2e net offsets for the 2nd crediting period of November 1, 2015 through March 31, 2016.

## Statement of Assertion

Responsibilities of Project Developer and Third Party Verifier
Shell is responsible for completing an accurate offset project report and engaging a qualified third party verifier to conduct a verification of the offset project report form and assertion. GHD’s responsibility was to express a conclusion with respect to the offset project report (2nd crediting period).

**Conclusion**

The verification conclusion is qualified.

**Signature of Third Part Verifier**

**Verifying Company Name**

GHD Limited

**Signature of Third Party Verifier**

Date: December 18, 2018

First Name: Sean  Last Name: Williams

Professional Designation: P.Eng.

E-mail Address: sean.williams@ghd.com  Phone Number: 780-705-7055
Appendix E: Conflict of Interest Checklist
### Conflict of Interest Checklist

**Associated Offset Submission**

<table>
<thead>
<tr>
<th>Offset Project</th>
<th>Protocol</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Project Developer</th>
<th>Report Type</th>
<th>Report Period</th>
</tr>
</thead>
</table>

**Checklist**

**Respond either "True" or "False" to each of the following statements:**

1. The relationship between my firm and this reporting company poses unacceptable threat to or compromises the impartiality of my firm. **False**

2. The finances and sources of income of my firm compromise the impartiality of my firm. **False**

3. The personnel my firm has scheduled to participate in the verification may have an actual or potential conflict of interest. **False**

4. My firm participated in some manner in the development or completion of the associated offset submission for this reporting company. **False**

5. My firm provided greenhouse gas consultancy services to this reporting company. **False**

6. My firm will use personnel that have, are, or will be engaged or previously employed by the reporting company. **False**

7. My firm will outsource the Statement of Verification for the associated offset submission. **False**

8. My firm offers products or services that pose an unacceptable risk to impartiality. **False**

**Important:** If you have checked "True" to any of the above, you may not fulfill the "independence" requirement for third party verifiers. Please contact Alberta Environment and Parks for further instruction. If the potential conflict of interest is a sufficient threat to impartiality (perceived or actual), or cannot be effectively managed, your Third Party Verification Report will not be acceptable to Alberta Environment and Parks.

**Signature of Third Party Verifier**
I, **Sean Williams** (Third Party Verifier), have personally examined and am familiar with the information contained in this Conflict-of-Interest Checklist, and can demonstrate freedom from any conflict of interest related to the reporting company for which the verification was performed. I hereby warrant that the information submitted in this Conflict-of-Interest Checklist is true, accurate and complete to the best of my knowledge, and that all matters affecting the validity of this Conflict-of-Interest Checklist have been fully disclosed. Impartiality shall be monitored over the duration of the verification and any identified actual or potential conflict-of-interest situations will be communicated to AEP directly.

**Verifying Company**

<table>
<thead>
<tr>
<th>Name</th>
<th>Per:</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHD Limited</td>
<td></td>
</tr>
</tbody>
</table>

**Signature of Third Party Verifier**

<table>
<thead>
<tr>
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<tbody>
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<table>
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<tbody>
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<td>P. Eng.</td>
<td><a href="mailto:sean.williams@ghd.com">sean.williams@ghd.com</a></td>
</tr>
</tbody>
</table>

**Date:** December 18, 2018
Appendix F: Supplemental Diagrams/Tables/Figures
<table>
<thead>
<tr>
<th>Document No.</th>
<th>Document Title</th>
<th>Document Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>iSteam Model - Final Template Nov. XX</td>
<td>Daily iSteam model runs</td>
</tr>
<tr>
<td>2</td>
<td>iSteam Data Output - XXX YYYY (where XXX = month, YYYY = year)</td>
<td>Monthly summaries of iSteam model runs</td>
</tr>
<tr>
<td>3</td>
<td>February 10, November 5 excel files (and associated summary files)</td>
<td>Excel manual calculation spreadsheets and supporting summaries</td>
</tr>
<tr>
<td>4</td>
<td>ConsumptionValues (Nov. 1 to Dec. 31 and Jan. 1 to Mar. 31)</td>
<td>SERS Output - Consumption</td>
</tr>
<tr>
<td>5</td>
<td>EmissionValues (Nov. 1 to Dec. 31 and Jan. 1 to Mar. 31)</td>
<td>SERS Output - Emissions</td>
</tr>
<tr>
<td>6</td>
<td>Measurements (Nov. 1 to Dec. 31 and Jan. 1 to Mar. 31)</td>
<td>SERS Output - Measurements</td>
</tr>
<tr>
<td>7</td>
<td>Quest Protocol - Expand to level 4</td>
<td>Detailed SERS output summary</td>
</tr>
<tr>
<td>8</td>
<td>Quest Protocol Report Summary</td>
<td>SERS output summary</td>
</tr>
<tr>
<td>9</td>
<td>Quest Waste Heat - XXX YYYY</td>
<td>Monthly Steam Balance Spreadsheets</td>
</tr>
<tr>
<td>10</td>
<td>DL Quest Dynamic Baseline Variance Response 2018_08_08</td>
<td>Response from ACCO for variance request</td>
</tr>
<tr>
<td>11</td>
<td>Quest OPR-Nov. 1, 2015 to Mar. 31, 2016-Revised to Include Waste Heat-Dec. 10, 2018</td>
<td>Updated OPR</td>
</tr>
<tr>
<td>12</td>
<td>Appendix, total P9 emissions with and without waste heat-Dec. 12, 2018</td>
<td>Summary of waste heat with surface condenser included and no waste heat included</td>
</tr>
<tr>
<td>13</td>
<td>iSteam Model Description</td>
<td>Description of iSteam model</td>
</tr>
<tr>
<td>14</td>
<td>GTG-25001 &amp; GT-25001 Performance Data Sheet</td>
<td>GTG data sheets (for iSteam model)</td>
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</table>
### Shell Reported Emission Reductions

<table>
<thead>
<tr>
<th>Category</th>
<th>Protocol Description</th>
<th>CO2</th>
<th>CH4</th>
<th>N2O</th>
<th>CO2e</th>
<th>CH4</th>
<th>N2O</th>
<th>CO2e</th>
<th>Net (tonnes CO2e)</th>
<th>Absolute (tonnes CO2e)</th>
<th>Net % Diff.</th>
<th>Net % of B/P</th>
<th>Net % of ERs</th>
<th>Absolute % of B/P</th>
<th>Absolute % of ERs</th>
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</thead>
<tbody>
<tr>
<td>B1</td>
<td>Injected CO2</td>
<td>444,091.37</td>
<td>-</td>
<td>-</td>
<td>444,091.37</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>444,091.37</td>
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<td>Injection Well 2</td>
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<tr>
<td>Total Baseline</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>444,091.37</td>
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<tr>
<td>P3</td>
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<td>Production of Inputs</td>
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<td>Production of Fuels</td>
<td>4,561.48</td>
<td>89.17</td>
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<tr>
<td>P8</td>
<td>Off-Site Electricity</td>
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<td></td>
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<td>40,316.43</td>
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<tr>
<td>P10</td>
<td>On-Site Heat and Electricity</td>
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<tr>
<td>P18</td>
<td>Venting at Injection Sites</td>
<td>0.01</td>
<td>0.08</td>
<td>-</td>
<td>2.02</td>
<td>0.01</td>
<td>0.08</td>
<td>-</td>
<td>2.02</td>
<td>2.02</td>
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<td>Fugitives at Injection Sites</td>
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<td>2.31</td>
<td>0.03</td>
<td>-</td>
<td>2.97</td>
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<td>P20</td>
<td>Subsurface Emissions</td>
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</tbody>
</table>
September 18, 2017

Mr. Charles Bower
GHG Reporting Specialist
Shell Canada Energy
PO Bag 23
Fort Saskatchewan, Alberta
T8L 3T2

Dear Mr. Bower:

Re: Pre-Validation Review of Revised Steam Allocation Methodology
Shell Canada Energy Quest Carbon Capture and Storage Project, Fort Saskatchewan, Alberta

1. Introduction

Shell Canada Energy (Shell) retained GHD Limited (GHD) to undertake a pre-validation review of a revised calculation methodology for the allocation of steam usage, used to calculate project emissions from the Quest Carbon Capture and Storage (CCS) Project (Quest or Project) located at the Shell Scotford Site in Fort Saskatchewan, Alberta.

The Quest CCS Project captures CO₂ produced by the Scotford Upgrader Facility and stores the CO₂ in underground storage wells. The applicable protocol for this Project is the Quantification Protocol for CO₂ Capture and Permanent Storage in Deep Saline Aquifers, Version 1.0 (Alberta Environment and Parks (AEP), September 2015) (Protocol).

GHD understands that Shell is revising their calculation methodology for the allocation of low pressure (LP) steam as a result of findings from a third-party audit of the Quest Project conducted on behalf of the Alberta Climate Change Office (ACCO) by TetraTech Canada Inc. (TetraTech). As part of this methodology development, Shell would like a preliminary validation be conducted on the revised methodology prior to submission to the ACCO and potential formal validation of this methodology, to be conducted by an independent third party retained by ACCO.

2. Background

2.1 Steam Balance Overview

The Project utilizes both high pressure (HP) and LP steam as part of the CO₂ injection process; both types of steam are sourced from the Shell Scotford Upgrader Facility (which is considered a Large Final Emitter (LFE) by the protocol, as it reports annually under the SGER). As per the protocol, emissions from the off-Site generation of steam is a source of project emissions, and includes the generation of steam from cogeneration large final emitter (LFE cogen), non-cogeneration (LFE non-cogen) and/or waste heat
sources (LFE waste heat). Cogeneration and non-cogeneration sources will produce project emissions resulting from the combustion of fuel, while waste heat sources are considered to have zero emissions. These emissions are calculated as based on the requirements from the Protocol.

In the case of LP steam the Project does not receive steam from a specific source; rather, the Project receives steam from the Upgrader LP steam header. The LP header supplies and is supplied steam from multiple inputs and outputs from within the Upgrader boundaries, as well as imports/exports steam from other facilities within the Scotford Site (in particular the Upgrader Expansion and Refinery). The steam system in the Upgrader, including the headers and steam imports/exports is shown in Figure 1 below.

Due to the complex and dynamic nature of the LP steam system, there is no single source feeding the LP steam header that will be responsible for providing the increased steam requirements for the Project. Rather, the increased demand could potentially come from multiple sources, in particular the following:

- Steam from letdowns to the LP steam header. This includes steam from the medium pressure steam headers (IP and SHMP) let down in pressure to LP steam. This steam would otherwise remain as IP or SHMP steam in the absence of Quest (for use in other operations).

- Steam extracted from the steam turbine generator. The steam turbine generator produces electricity from HP steam. There is an extraction point located between the 9th and 10th stages of the generator which can produce LP steam. If this steam is not extracted, it is sent through the 10th-15th stages of the generator, with the subsequent steam condensed in the surface condenser.

- Steam not sent to the excess steam condenser. In the case that there is an excess of LP steam without the subsequent demand, steam from the LP steam header is routed through a condenser.

- Steam from various non-waste heat recovery sources. This includes steam from the RHC, A&V, equipment drivers, etc.

Of the above sources, steam from the letdowns and non-waste heat recovery sources are considered LFE non-cogen sources, as the steam is ultimately produced via the combustion of fuel and would otherwise have been used to produce useful energy in the absence of Quest. For steam extracted from the steam turbine generator, the portion of the steam which (if it was not extracted from the turbine) is condensed in the surface condenser is considered an LFE waste heat source, while the portion which would have generated electricity is considered an LFE non-cogen source. The steam that is not sent to the excess steam condenser is considered an LFE waste heat source.

While total LP steam to Quest is directly metered, the specific quantities of LP steam sourced from the above sources cannot be directly quantified. In order to calculate the project emissions, the Quest LP steam must be allocated between the various sources.
2.2 Summary of TetraTech Audit Findings

In the initial Project Plan, Shell and Cap-Op Energy (a third-party consulting firm retained by Shell) developed an allocation methodology to calculate the amount of steam from each of the above sources supplying the Project.

The initial allocation methodology developed by Shell is described in detail in the initial Project Plan and Project Report developed by Shell. On a high level, this methodology allocates steam to Quest based on a priority-allocation model, with the “most expensive” (i.e. the higher operational cost) steam allocated first, under the principle that this steam would not be generated in the absence of Quest. Of the above steam sources, the order of allocation was let-down steam, steam extracted from the turbine, and then heat recovery source steam. All metered and measured steam from each of these sources are allocated in order to Quest until the allocated steam equals the full metered Quest LP steam demand. It is noted that in the initial report, the excess steam condenser was not incorporated into the allocation.

The 1st crediting period project report and associated Project Plan underwent a third-party audit conducted by TetraTech EBA Inc. (TetraTech), retained by the Alberta Climate Change Office (ACCO). Based on TetraTech’s audit, multiple quantitative and qualitative material discrepancies were identified in the Project in the off-Site heat generation project emissions.

Of particular note, TetraTech identified that the calculation of the contribution from waste heat in the initial allocation methodology does not meet the protocol requirement that the waste heat “be measured and proven to be vented or dissipated during the baseline condition (page 22 of the Protocol)”. This misstatement relates to the initial allocation methodology assigning all metered turbine extraction steam to Quest (after the let-down steam, and up to the metered Quest demand). TetraTech’s finding identified that there is no evidence supporting the allocation of all turbine extraction steam to Quest, and that the baseline scenario by extension is an assumption and not based on a reasonable representation or reference. In reviewing historical data, steam turbine extraction was observed to occur before Quest came online; during the 1st crediting period, an average of 91 tonnes/hr. of steam was extracted, while before Quest came online, an average of 61 tonnes/hr. of steam was extracted; this indicates that steam turbine extraction does occur during the baseline period and which contradicts Shell’s allocation methodology.

As a result of this finding, Shell was required to update the steam allocation methodology in order to more accurately calculate the allocated steam quantities used by the Project and demonstrate that waste heat is being used. GHD notes that Shell is submitting a variance request to ACCO to allow for the use of a projection based, dynamic baseline rather than a historic fixed baseline, as specified by the Protocol.

3. Findings

3.1 Revised Methodology Summary

To calculate the quantities of Quest steam attributable to waste heat (and steam let-downs), Shell has developed a revised steam simulation model using the iSteam software package. iSteam is a computer
program developed by Process Integration Limited which allows for the development of a custom steam model. The model runs in two modes: simulation, which completes a perfect mass balance on the steam based on set input parameters, and optimization, which allows for the output to be fully optimized based on set parameters.

The purpose of the iSteam tool is to simulate a baseline case where there is no Quest steam demand. This is achieved by importing balanced process data from the Upgrader steam header system (with Quest online), then changing the Quest steam demand to zero. The iSteam model then completes the simulation to redistribute steam to reflect how the steam system should operate in the absence of Quest.

Once the simulation has completed, the following quantities are compared and calculated:

- Steam from let-downs. If more let-down steam is measured during the Quest offline vs. online scenarios, this indicates that let-down steam was utilized by Quest. The difference between the two is then allocated to Quest as LFE non-cogen steam.

- Condensate produced from the steam turbine surface condenser. If more condensate is measured during the Quest offline vs. online scenarios, this indicates the following:
  - Less steam was extracted from the turbine,
  - More steam was used to generate power in the turbine, which therefore results in;
  - More steam being ultimately condensed as waste heat

The measured difference between the condensate values is then allocated to Quest. The portion of this steam which would have been condensed in the condenser (vs. used to generate electricity) is considered LFE waste heat steam, while the remainder is LFE non-cogen.

- Condensate produced from the excess steam condenser. If more condensate is measured during the Quest offline vs. online scenarios, this indicates that more excess steam was produced and condensed as waste heat. The measured difference between the two is then allocated to Quest. All excess steam condensate is considered LFE waste heat steam.

- If there is still unallocated Quest steam, the difference is assumed to be from other non-waste heat recovery sources

GHD does note that using a simulation to predict the steam allocation is limited as by definition the model can only work based on the data that is available to it. Due to the dynamic nature of the steam system at the Upgrader, removing the Quest output may cause the system to behave in ways that are difficult to predict. Otherwise, GHD notes that the use of the model to allocate steam will provide a reasonable representation of the steam balance at the Facility.

As part of the validation process for this model, Shell has specifically focused on two separate scenarios which feature Quest undergoing normal operation close to a Quest slowdown or start-up. These scenarios are identified below:
**Scenario #1 – February 17, 2017**

- Normal operation – February 17, 2017, 3:00 am – 4:00 am. Quest was operating at an average of 173 tonnes/hr. of LP steam
- Slowdown – February 17, 2017, 7:00 am – 8:00 am. Quest was operating at an average of 46 tonnes/hr. of LP steam

**Scenario #2 – August 13-15, 2015**

- Quest offline – August 13, 12:00 am – August 14, 12:00 am. Quest was not operational at this time. Official start-up of Quest occurred at 6:00 am on August 14, with Quest LP steam usage at 4 tonnes/hr.
- Quest online – August 14, 6:00 pm – August 15, 6:00 pm. The Quest Capture Site started up, with LP steam usage at 88 tonnes/hr.

For these scenarios, Shell will utilize the meters (balanced) results during the Quest slowdowns to compare the results that iSteam calculates to determine the accuracy of the simulations. Further details on these results are described below.

### 3.2 iSteam Model Inputs

The iSteam model inputs are based on measured plant process data. This data is either directly measured using online calibrated meters or (in the case of the let-downs) are calculated based on measured valve positions and correlations. All data is retrieved by Shell from the on-Site process historian database. The iSteam model requires that the overall steam header system be perfectly balanced (i.e. 0 difference between inputs and outputs on each header), therefore adjustments are made on the inputs/outputs as needed to ensure a balance.

Shell balances the meters by designating a specific meter on each header for adjustment; these meters are listed below:

- HP Header: HMU 2 meter (August 2015 case only due to accuracy issues with this meter – flow readings were substituted during this time frame with an engineering estimate), HP-LP letdown, RHC import (if HP-LP letdown is closed)
- IP Header: SRC import
- SHMP Header: Import/export to Upgrader expansion
- LP Header: Import/export to Refinery

GHD notes that these adjustments were not based on the manufactured meter tolerances; rather the adjustments are made just to ensure a balance. For example, the Refinery import/export meter has a tolerance of ±1%, but for the February 2017 case, the steam export was adjusted from the originally metered quantity of 17 tonnes/hr. to 3 tonnes/hr., well outside the tolerance. Of the meters on the steam
header system, the tolerances ranged between 0.1%-2%, with the let-down valves having a higher
tolerance of 10% due to the correlations involved.

Shell has indicated that the majority of meters in the steam balance system are not on Shell’s PM system;
therefore the calibrations were not regularly maintained historically. The meters are to be added to the PM
system to correspond to the calibration frequency for meters on the Quest project (with a standard annual
calibration frequency). Once this is implemented, inaccuracies that may be present due to the lack of
maintenance could potentially be minimized. Additional inaccuracies may also be present in the
import/export meters for transfers between Scotford sites, as the flow can vary substantially in both
magnitude and direction (the transfer meters measure both imports and exports).

To confirm the potential impact of the adjustment procedures on the calculated waste heat, Shell
performed a sensitivity study on the meters. This study developed three separate cases based on the
August 2015 scenario, where the adjustment rules used achieve the balance were changed. These three
cases are as follows:

- Case 1: Adjustments made on Refinery steam import/export only (meter was adjusted by
  55 tonnes/hr.).
- Case 2: Equal adjustments made on four meters (Refinery import/export, HMU export, SRC export
  and raw water export)
- Case 3: Adjustments made on all meters to within tolerances. After these adjustments, an imbalance
  of 25 tonnes/hr. was remaining which was applied to the Refinery import/export

Each of these three cases were then run in iSteam, and the condensate produced from the two
condensers compared to determine the impact on waste heat.

In comparing the outputs from each case, the following was observed:

- No difference was calculated between cases 1 and 2 in the waste heat or the letdowns.
- Between case 1/2 and 3, a slight difference of approximately 1 tonne/hour of steam was calculated in
  the excess steam condenser (approximately 2% of total flow), and no difference was observed in the
  surface condenser. An approximately 9 tonne/hr. difference was observed in the let-down steam
  between cases 1/2 and 3 (a 10% difference); this difference can be confirmed to be equal to the initial
  adjustments made based on the tolerances. Therefore, it can be determined that the letdown steam
  quantities were ultimately not changed by iSteam.

This sensitivity study indicates that the adjustments made to the imports(exports on the steam header do
not substantially impact the calculation of waste heat. The allocation strategy employed by Shell currently
does not adequately correspond to the meter tolerances. GHD can confirm that this will not materially
affect the final steam quantities or project emissions.
3.3 iSteam Allocation Assumptions and Parameters

Once the input data is reconciled, the iSteam model simulates the final Quest offline scenario steam balance through the following steps:

- The metered Quest steam flow is set to 0 tonnes/hr. (or in the case of the validation periods, to the actual Quest flowrate during those time periods)

- iSteam runs in simulation mode to produce a mass balance based on the degrees of freedom set by the system

- iSteam runs in optimization mode to adjust other metered quantities to reflect actual optimal performance of the system based on previously set assumptions and parameters

The results from the optimized model are then used for the calculation of let-down steam and waste heat.

To develop the optimized model, iSteam incorporates multiple assumptions, operating parameters and minimum/maximum flow limits. These are listed below:

Assumptions

- Imports and exports out of the Upgrader limits are fixed (i.e. no change in steam imported/exported whether Quest is online or offline)

- There are no vents to the atmosphere

- Pressure and temperatures of the steam in the headers is fixed

Balance Parameters

- Balance on the HP Header:
  - Adjust flow to steam turbine generator (i.e. input to 1st stage)
  - HP steam to STG has min/max limits of 180 tonnes/hr. and 450 tonnes/hr., respectively.
  - Steam turbine extraction has min/max limits of 25 tonnes/hr. and 192 tonnes/hr., respectively
  - GTG power generation has min/max limits of 45 MW and 83 MW, respectively
  - HRSG steam production has min/max limits of 75 tonnes/hr. and 260 tonnes/hr., respectively
  - If STG input steam is at its max limit, adjust flows through HP-MP letdown. If STG input is at its minimum limit, HRSG duct firing is initiated.
  - HP-MP letdown has max limit of 420 tonnes/hr.

- Balance on IP Header:
  - Adjust flow through IP-LP letdown
  - IP-LP letdown has max limit of 80 tonnes/hr.

- Balance on SHMP Header:
  - Once HP header balance is maintained, fix the HP-MP letdown
- Adjust flow through MP-LP letdown
- MP-LP letdown has max limit of 466 tonnes/hr.

- Balance on LP Header:
  - Adjust flows to minimize steam to excess steam condenser

GHD has reviewed the available production limits for each piece of equipment and confirmed they are appropriate.

As discussed above, due to the dynamic nature of the system there potentially could be changes in operation in other units. As Quest in theory operates independently, these changes in operation should not occur during normal operation. Further, steam losses due to venting are not expected to be significant relative to the total steam supply, therefore the omission of this quantity should not substantially affect the final results.

GHD does note that the optimization of the steam balance by iSteam may not necessarily occur at all times due to the sometimes sudden nature of changes in the operations. In particular, the iSteam model minimizes the steam to the excess steam condenser, which may not always occur (as discussed below, this did in fact occur during one of the validation scenarios). In this particular case, it is noted that increasing the excess steam condensate quantity will ultimately increase the amount of claimed waste heat, which will result in lower project emissions. Therefore minimizing steam to the excess steam condenser during the Quest offline case is more conservative.

GHD can confirm that the assumptions and adjustments used are reasonable in the determination of the iSteam balance.

3.4 iSteam Model Validation Results

After running the iSteam model during the specific validation scenario time periods, Shell compared the iSteam results to actual process data during stable operation with Quest in turnaround or offline. The results of these scenarios are shown below:
## Scenario 1: February 2017 Case

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<th>QUEST TURNDOWN (7-8 am MT)</th>
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<td>MP--&gt; LP</td>
<td>86.3</td>
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</table>

For each scenario, comparing the reconciled data to iSteam does show a difference between the waste heat quantities for both the STG condensate and excess steam condensate. Shell has provided evidence which demonstrates the reasons for these differences:

- For scenario 1, it was determined that Shell operators were unable to fully optimize the system during the turnaround or trip, resulting in excess steam going to the condenser. As the iSteam operating assumption is that the system is optimized, the excess steam condensate is minimized by iSteam below the levels that the operators were actually able to achieve. Manually optimizing the actual
process data such that the excess steam condensate is set to 0 results in higher extraction steam condensate (although the total extraction steam condensate is still lower than that measured by PI during the actual turnaround or trip)

- For scenario 2, the difference between the excess steam condensate and steam turbine condensate partially is a result of the optimization done by Quest. As noted above, lower excess steam condensate is considered more conservative as there are zero emissions associated with waste heat.

- In reviewing the overall steam header operating data for both scenarios, it was observed that there were differences in the steam imports/exports the PI data used for the iSteam model and actual process data during the comparison time periods. As iSteam assumes this is fixed, this results in an imbalance between the iSteam results and the process data.
  - For scenario 1, it was calculated that 43.2 tonnes/hr. additional steam was imported/exported between 7-8 am vs. 3-4 am. If this steam were added to the balance, this will result in an almost exact match with the optimized process data (352.3 tonnes/hr.).
  - For scenario 2, it was calculated that 24.8 tonnes/hr. additional steam was imported/exported. Adding this steam to the balance results in an almost exact match with the process data for total condensate (Process data = 201.4 tonnes/hr. + 79.4 tonnes/hr. = 280.8 tonnes/hr., vs. iSteam data = 209.9 tonnes/hr. + 46.0 tonnes/hr. + 24.8 tonnes/hr. = 280.7 tonnes/hr.).

GHD has reviewed the validation reports and has not identified any major issues with the results of the iSteam model beyond the items identified by Shell above. On a going-forward basis, Shell should incorporate additional validations during applicable turnaround periods to ensure that the model remains representative of actual operations.

3.5 Future Verifiability of iSteam Allocation Model

Overall, GHD is of the opinion that the iSteam allocation model has been well documented and outlined by Shell in the supporting documents, with the steps and assumptions described. The reproducibility of the model is somewhat limited due to the following items:

- The “black box” nature of the calculations, with the calculations themselves performed within the iSteam model

- The number of data points and calculations performed (since the iSteam model will ultimately be performed daily, requiring daily average input flowrates and process data for each of the above parameters in the iSteam model)

As a result of these limitations, the ability for a third-party verifier to complete full recalculations of the source is limited. Sample calculations can be performed for specific dates as part of the verification to confirm that the steam balances are reasonable. As the other major aspects of the model are clear and documented, GHD is of the opinion that the model is verifiable.
4. Conclusions

GHD has completed the pre-validation review of the revised waste heat calculation methodology prepared by Shell utilizing the iSteam software. Based on GHD’s review, the revised waste heat methodology and iSteam model prepared by Shell is reasonable and will be able to determine the quantities of waste heat steam utilized by the Quest project in accordance with the SGER and applicable Protocol.

GHD notes that this review did not include a full verification of the source, rather a review of the proposed methodology for the purposes of determining its validity and conformance to the Protocol. If this methodology is ultimately accepted by ACCO, GHD will complete a full verification of the claimed project emissions as part of the completion of the 2nd, 3rd and any other subsequent crediting period Project Reports.

Sincerely,

GHD

Sean Williams, P.Eng.

Brent Boss, P.Eng.

SW/jm/1
September 28, 2017

Charles Bower
GHG Reporting Specialist
Shell Canada Limited
P.O. Box 100, Station M
Calgary, Alberta T2P 2H5

Dear Mr. Bower:

Subject: Retroactive revision of waste heat methodology for the Quest Project

This letter is to inform you that the variance request to be able to apply retroactive corrections to the waste heat quantification methodology within the Quest offset project, dated August 17, 2017, has been reviewed.

I hereby approve the request for the 2nd – 5th Quest project periods (Nov 1, 2015 – Sept 30, 2017) to be eligible for retroactive corrections on the waste heat quantification methodology, on the condition that the dynamic baseline methodology is approved by ACCO.

I request that the current verification of the 2nd – 5th project periods also include verification of the potential waste heat that may be claimed under the updated methodology. Additionally, a copy of this letter must be provided to the registry if the retroactive changes are made.

If there are any questions or concerns please direct them to Shan Pletcher with cc to AEP.GHG@gov.ab.ca.

Sincerely,

Robert Hamaliuk, MBA, P. Eng.
Director, Emissions Inventory and Trading

cc. Celina Duong
August 9, 2018

Charles Bower  
GHG Reporting Specialist  
Shell Canada Limited  
P.O. Box 100, Station M  
Calgary, Alberta T2P 2H5  

Subject: Dynamic baseline approach for the Quest Project’s waste heat  

Dear Mr. Bower:

This letter is to inform you that the variance request to use a dynamic approach for determining waste heat, specifically using the i-Steam model to quantify the waste heat baseline from the excess condenser has been reviewed.

I hereby approve the dynamic baseline approach for waste heat from the excess condenser. My email dated May 18, 2018 explained that the steam going to the surface condenser is not considered a waste heat source as it is useful heat in the low pressure turbine and would be used to generate electricity in the baseline. Use of this heat is a diversion from a less efficient to a more efficient use. Although Quest provided additional information on the surface condenser source, the Department maintains the position that it is not a waste heat source.

The Alberta Climate Change Office (ACCO) had previously approved eligibility for retroactive corrections on the waste heat quantification, on the condition the dynamic baseline methodology is approved by ACCO. Therefore, the 2nd – 5th Quest project periods (Nov 1, 2015 – Sept 30, 2017) are now eligible to correct for the excess condenser dynamic baseline. Although the i-Steam model approach is approved, the verifier must determine if the model meets the criteria for transparency, accuracy, consistency, conservativeness, relativeness and completeness.

I request that the revised verification of the 2nd – 5th project periods, include a detailed discussion of the dynamic baseline and the quantification of the claimed waste heat from the excess condenser.

If there are any questions or concerns please direct them to Shan Pletcher with cc to AEP.GHG@gov.ab.ca.

Sincerely,

Robert Hamaliuk, MBA, P. Eng.  
Director, Emissions Inventory and Trading
Verification Report

Shell Canada Limited, as Managing Partner and on Behalf of Shell Canada Energy (an Alberta Partnership)
Quest Carbon Capture and Storage Project

2nd Crediting Period

Prepared for:   Shell Canada Limited, as Managing Partner and on Behalf of Shell Canada Energy (an Alberta Partnership)
               Calgary, Alberta

GHD | 9426 51 Avenue NW, Suite 101, Edmonton Alberta T6E 5A6 Canada
11114350 | 03 | Report No. 2 | November 17, 2017
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Appendix B Conflict of Interest Checklist
Appendix C Verification Plan
Appendix D Final Issues Logs from TetraTech EBA Inc. ACCO Audit
1. Verification Summary

<table>
<thead>
<tr>
<th>Project Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Title</strong></td>
</tr>
<tr>
<td><strong>Facility Locations (Not mailing address)</strong></td>
</tr>
</tbody>
</table>
| Quest Capture Site: | 55522 Range Road 214  
Fort Saskatchewan, Alberta  
Latitude: 53.74074, Longitude: 113.0231 |
| Wellpads:          | Well #1: 07-11-59-20-W4  
Well #2: 08-19-59-20-W4  
Well #3: 05-35-59-21-W4 |

<table>
<thead>
<tr>
<th>Project Developer Contact Information</th>
</tr>
</thead>
</table>
| **Main Contact**                      | Charles Bower  
GHG Reporting Specialist, Shell Canada Limited  
55522 Range Road 214  
Fort Saskatchewan, Alberta T8L 4A4  
(780) 997-6285  
Charles.bower@shell.com |

<table>
<thead>
<tr>
<th>Verification Objective and Assertion Specific Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Verification Objective</strong></td>
</tr>
</tbody>
</table>
| **Project Crediting Period**                             | 2nd Crediting Period  
Start Date: November 1, 2015  
End Date: March 31, 2016 |
| **Claimed Emissions Reductions**                         | Total Emission Offsets are 324,918 tonnes CO₂e |
| **Materiality**                                         | 5 percent |
| **Level of Assurance**                                  | Reasonable |
| **Verification Summary**                                 | Based on GHD's verification, the compliance assertion provided in the 2nd Crediting Period Offset Project Report for the Quest Carbon Capture and Storage Project is free of misstatements, in all material aspects, and in accordance with the SGER and relevant criteria with an emphasis of matter. |

<table>
<thead>
<tr>
<th>Verification Team Members</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Co-Lead Verifier</strong></td>
</tr>
<tr>
<td><strong>Co-Lead Verifier</strong></td>
</tr>
<tr>
<td><strong>Peer Reviewer</strong></td>
</tr>
</tbody>
</table>
| **Report and Verification Dates** | Verification Activities: September 26, 2016 – November 17, 2017  
Site Visit: September 27, October 19-20, 2016  
Draft Report: November 9, 2017  
Final Report: November 17, 2017 |
2. Introduction

Shell Canada Limited, as Managing Partner and on Behalf of Shell Canada Energy (an Alberta Partnership) (Shell) retained GHD Limited (GHD) to undertake a verification of the Quest Carbon Capture and Storage (CCS) Project (Project) 2nd Crediting Period Offset Project Report (OPR). Shell is the project developer for the compliance period of November 1, 2015 to March 31, 2016 (2nd crediting period). GHD completed the verification in accordance with the requirements of the Specified Gas Emitters Regulation with amendments up to and including Alberta Regulation 104/2015, Climate Change and Emissions Management Act (SGER) (AEP, 2007). The applicable protocol for this Project is the Quantification Protocol for CO₂ Capture and Permanent Storage in Deep Saline Aquifers, Version 1.0 (Alberta Environment and Parks (AEP), September 2015) (Protocol).


2.1 Offset Credit Operational Boundaries

The Project consists of two separate components: the CCS capture facility and three injection sites. The CCS capture facility is located at the Shell Scotford Site, and captures CO₂ produced in the hydrogen manufacturing units (HMUs) of the Scotford Upgrader Facility and contained within the raw hydrogen gas mixture produced from the reaction. CO₂ is absorbed from the raw gas stream through the use of a licensed Shell amine absorption system (ADIP-X) in a scrubbing tower located at each of the three HMUs. The CO₂-amine mixture from each absorption system is then sent through a regeneration column, separating the CO₂ from amine. The CO₂ stream undergoes dehydration (removal of water) and compression, and is then transported via pipeline to the well pads. There are three injection wells, one per well pad. Currently, two out of the three injection wells are in operation for sequestering the CO₂ approximately two kilometres below ground.

The overall Project consists of emissions associated with the capture of CO₂ and operation of the CCS capture facility and injection wells. The operation of the Scotford Site consists of the following facilities which, unless otherwise noted, are owned by the AOSP JV or Shell Canada Limited and operated by Shell:

- Quest CCS capture Facility
- Scotford Upgrader Facility (which itself consists of the Upgrader-Base and Upgrader Expansion Facilities).
- ATCO Cogen facility (owned by ATCO Power Canada Limited, operated by Shell).
- Air Liquide Cogen facility (owned and operated by Air Liquide Canada).
- Scotford Refinery.
- Shell Chemicals Facilities.
The Scotford Upgrader provides the CO₂ for injection, while both the Scotford Upgrader and Scotford Refinery provide heat (in the form of steam) for the Project operation. All other operations at the Scotford Site are not included in the project, and will not be reviewed.

### 2.2 Geographical Boundaries

The Project located is at the following addresses:

**CCS Facility**
55522 Range Road 214
Fort Saskatchewan, Alberta
Latitude: 53.74047 N, Longitude 113.0231 W

**Injection Wells**

1. Well #1: 07-11-59-20-W4
2. Well #2: 08-19-59-20-W4
3. Well #3: 05-35-59-21-W4

### 2.3 Description of Project Baseline and Project Conditions

During the baseline condition, CO₂ is produced in the hydrogen manufacturing units in the Scotford Upgrader through the steam-methane reforming reaction, and is then emitted to the atmosphere.

During the product condition, the CO₂ produced in the hydrogen manufacturing units is captured and separated from the raw gas stream by the CCS capture facility, compressed, transported to the injection wells, and then sequestered underground. Emissions from the project at the CCS capture facility include the following operations:

- Production of materials
- Production and combustion of fuels
- Production of off-site heat and electricity.
- Combustion of fuels at the CCS capture facilities
- Emissions associated with the loss, disposal and recycling of materials

Emissions from the project at the injection wells potentially include the following operations:

- Construction and drilling of new injection wells
- Production of materials
- Production and combustion of fuels
- Fugitives and venting at the well injection points
- Production of off-site electricity

---

1 Currently two injection wells are in operation: Well#1: 07-11-59-20-W4 and Well#2: 08-19-59-20-W4
- The use of aviation turbo fuel (for pipeline inspections)
- Loss of CO₂ containment from the subsurface.

### 2.4 Focused Specific Reductions

The claimed offsets result from reductions in CO₂ released to the atmosphere due to the Project.

The emission offsets from the implementation of this Project occur from the following (listed by the protocol categories) – all non-applicable emissions are listed as “NA”:

**Table 2.1 Specified Emissions Reductions and Gas Types**

<table>
<thead>
<tr>
<th>Protocol Source Category</th>
<th>Specified Gas Type</th>
<th>Carbon Dioxide (CO₂)</th>
<th>Methane (CH₄)</th>
<th>Nitrous Oxide (N₂O)</th>
<th>Hydro-fluorocarbons (HFCs)</th>
<th>Per-fluorocarbons (PFCs)</th>
<th>Sulfur Hexafluoride (SF₆)</th>
<th>CO₂ Equivalent (CO₂e)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Condition</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1 – Injected CO₂</td>
<td></td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Project Condition</strong></td>
<td></td>
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</tr>
<tr>
<td>P3 – Well drilling reportable releases</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P4 – Production and delivery of material inputs</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P5/P6/P7 – Extraction/ processing and transportation of fuel used for on-Site and off-Site heat and electricity generation</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P8 – Off-Site electricity generation</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P9 – Off-Site heat generation</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
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<tr>
<td>P10 – On-Site heat and electricity generation</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P11 – CCS facility operation</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P18 – Venting of CO₂ at injection well sites</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P19 – Fugitive emissions at injection well sites</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P20 – Emissions from subsurface to atmosphere</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P21 – Loss, disposal or recycling of materials used in CO₂ capture process</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
</tbody>
</table>
2.5 Reporting Period

The reporting period is from November 1, 2015 through March 31, 2016 (2\textsuperscript{nd} Crediting Period). The GHG reductions claimed for the Project during the reporting period were 324,918 tonnes CO\textsubscript{2}e.

3. Objective

The objective of the verification is to provide Shell and AEP with an opinion that there are no material misstatements in the Project’s 2\textsuperscript{nd} Crediting Period OPR and that the information reported is accurate and consistent with the requirements of the SGER. This report has been prepared for the use of Shell.

4. Scope

The scope of this verification is described as follows:

- **Project Description** – The scope of the verification includes the greenhouse gas (GHG) offsets resulting from the capture and underground storage of carbon dioxide (CO\textsubscript{2}) that would otherwise have been emitted directly to the atmosphere.

- **GHG Types** – The claimed offsets result from reductions in CO\textsubscript{2} released to the atmosphere due to the Project. The emissions during the operation of the Project result from:
  - The venting and fugitive releases of CO\textsubscript{2} and CH\textsubscript{4} from the Project.
  - Releases CO\textsubscript{2}, methane (CH\textsubscript{4}) and nitrous oxide (N\textsubscript{2}O) due to combustion of fuels for Project operation and heat and electricity requirements.
  - Releases of CO\textsubscript{2}, CH\textsubscript{4} and N\textsubscript{2}O from the production and/or loss, disposal or recycling of the various chemical products and fuels required for the Project.
  - Emissions from venting releases from drilling or construction
  - Emissions due to loss of containment within the storage complex

- **Time Period** – November 1, 2015 through March 31, 2016.

- **Use of this Report** - This report has been prepared for the use of Shell and AEP.

- **Relative Size** – The preliminary size of the claimed GHG reductions was 324,918 tonnes CO\textsubscript{2} equivalent (tCO\textsubscript{2}e).

GHD will ensure and attest to the following:

- The accuracy of the reported data and calculated emissions, and that all data and emissions accurately reflected the operation of the Project in the crediting period and are consistent with the approved Offset Project Plan (OPP).

- The baseline and project conditions during the 2\textsuperscript{nd} crediting period were consistent with the requirements of the Protocol and OPP.
The reasonableness of the emission estimation methodologies, assumptions, and results.

Whether any errors in data, estimations or methodology were adequately managed, documented, and either corrected or accounted for.

Whether all measurement devices and sources of data are appropriate, well-maintained and reading accurately

Whether the OPR is clear, well supported, and comprehensive.

The reporting systems conform to relevant government-mandated or industry-standard quality assurance procedures.

The assertion refers to the emissions, from the sources and sinks reported by the Project

ISO principles such as consistency, conservativeness, transparency, etc. are met by the Project.

The verification was conducted to a reasonable level of assurance. Reasonable assurance is a high level of assurance, or positive assurance. Reasonable assurance is a direct factual statement expressing the opinion of the verifier. If a verification statement can be provided, it is worded in a manner similar to "Based on our verification, the GHG emissions statement is, in all material aspects, in accordance with the approved quantification protocols."

5. **Program Criteria**

GHD assessed the Project against the following criteria:

- Occur in Alberta
- Result from actions not otherwise required by law and be beyond business as usual and sector common practice
- Be real, demonstrable, quantifiable, and verifiable
- Result from actions taken on or after January 1, 2002
- Have clearly established ownership
- Be counted once for compliance purposes
- Be implemented according to a Government of Alberta-approved quantification protocol
- Be verified by qualified third-party

GHD has prepared this Verification Report in accordance with the ISO Standard ISO 14064 Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions (ISO 14064-3) and with AEP’s Specified Gas Reporting Standard (AEP, 2014).
For this verification, GHD applied the following ISO and AEP criteria:

- ISO 14064 Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions (ISO 14064-3)
- Specified Gas Emitters Regulation with amendments up to Alta Reg. 104/2015, Climate Change and Emissions Management Act, (Alta Reg. 139/2007), Province of Alberta, 2007
- Specified Gas Reporting Standard, Version 8.0, AEP, 2014
- “Offset Protocol Deviation for the Quest Project”, Letter from Robert Hamaliuk to Charles Bower, AEP, March 13, 2017 (B1 Injection Variance Request)
- “Retroactive revision of waste heat methodology for the Quest Project”, Letter from Robert Hamaliuk to Charles Bower, AEP, September 28, 2017 (P9 removal of waste heat request)

6. Verification Strategy

The verification strategy was based around the review and recalculation using original data taken from meters and measurements made at the Facility. The strategy was also based around interviews of Facility personnel to corroborate the data and provide an understanding of the Project.

Shell and GHD relied on controls throughout quantification and recalculation, respectively of emission offsets from the Project. The following controls were scrutinized for effectiveness along with the data administered by the controls:

- Process Information (PI), which collects all raw meter and analyzer data from the Data Collection System (DCS), and stores the data
- Shell Quality Assurance/Quality Control procedures, including quarterly Critical reviews required for the annual reporting as well as Shell’s internal reporting requirements
- Data Focals responsible for maintenance of source-specific data
- The data management system associated with the monitoring of emissions from the subsurface, as detailed in the Quest Project’s Measurement, Monitoring and Verification Plan (MMV) Plan
- Third party cardlock/invoices for propane, diesel and aviation fuel
- Shell Environmental Reporting System (SERS), which retains all data and calculates the GHG emission reductions
- Cross-checking between raw data and data utilized in SERS to ensure consistency

The verification findings detailed in Section 10 provide further detail regarding the scrutiny involved with assessing the effectiveness and data administered by the controls.

7. **Verification Plan**

GHD developed a Verification Plan, including a Sampling Plan based on a preliminary review of the data initially provided. GHD submitted the Verification Plan to Shell on September 26, 2016, prior to the Site visits. GHD's Verification Plan was revised, as required, throughout the course of the verification to address questions or initial concerns with data originally provided. The final verification plan is provided in Appendix C.

7.1 **Verification Methodologies**

The purpose of GHD's verification procedures was to assess the following critical items:
- Accuracy and completeness of the annual OPR.
- Consistency between baseline and project conditions.
- Conformance to the program criteria.
- Uncertainty of external data sources used.
- Compliance of the OPR to the verification standards and criteria.
- Completeness of the OPR in comparison to the structure and criteria presented in AEP guidance.
- Offset assumptions.
- Accuracy of emission calculations.
- Potential magnitude of errors and omissions.
- Integrity of the data management system and controls.
- ISO principles such are met.

To sustain a risk-based assessment, the GHD Project Team identified and determined risks related to annual GHG emissions during both the desk reviews and the follow-up interviews. The components of the document review and follow-up interviews were:

**Document Review:**
- Review of data and information to confirm the correctness and completeness of presented information.
- Cross-checks between information provided in the OPP and OPR and information from independent background investigations.
• Determine sensitivity and magnitude analysis for parameters that may be the largest sources of error.

Follow-up Interviews:
• On-Site
• Via telephone
• Via email

The GHD Project Team interviewed Facility personnel to:
• Cross-check information provided by interviewed personnel, i.e., by source check or other interviews.
• Compare with projects or technologies that have similar or comparable characteristics.
• Test the correctness of critical formulae and calculations.
• Review data management and recording procedures.

Through the document review GHD established to what degree the presented OPR meets the verification standards and criteria.

The GHD Project Team's document review comprised an evaluation of whether or not:
• The documentation is complete and comprehensive and follows the structure and criteria given in the AEP guidelines and regulations.
• The OPR, and the emission reduction estimates therein, conform to the program criteria.
• The OPP and OPR are accurate, transparent and provide a complete overview of the Project’s GHG emissions sources.
• The methodologies used in the GHG emission inventory are justified and appropriate.
• The assumptions behind the inventory are conservative and appropriate.
• The GHG emission calculations are appropriate and use conservative assumptions for estimating GHG emissions.
• The GHG information system and its controls are sufficiently robust to minimize the potential for errors, omissions, or misrepresentations.
• The frequency of, and responsibility and authority for, monitoring, measurement, data recording activities and quality control/quality assurance/management control procedures are sufficient.
7.2 Facility Key Emissions Sources

The Shell reported emissions sources include the following main groups, as listed in the Report:

<table>
<thead>
<tr>
<th>Source Group</th>
<th>Approximate Emissions (tonnes CO₂e)</th>
<th>Percentage of Emissions Offsets (Baseline or Project) (%)</th>
<th>Calculation Methodology</th>
</tr>
</thead>
</table>
| B1 – Injected CO₂ | 444,091 | 100% | • Total CO₂ sequestered is calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol  
• Composition of CO₂ is based on methodologies described in the approved Variance Request. |
| P3 - Well drilling reportable releases | 0.00 | 0% | • Total CO₂, CH₄ and N₂O emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol |
| P4 - Production and delivery of material inputs | 272.86 | 0.23% | • Total CO₂e emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol |
| P5/P6/P7 - Extraction/processing and transportation of fuels | 8,228 | 6.90% | • Total CO₂e emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol |
| P8 - Off-Site electricity generation | 40,316 | 33.8% | • Total CO₂e emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol |
| P9 - Off-Site heat generation | 70,315 | 59.0% | • Total CO₂, CH₄ and N₂O emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol |
| P10 - On-Site heat and electricity generation | 0.00 | 0% | • Total CO₂, CH₄ and N₂O emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol |
### Calculation Methodology

- P11 - CCS facility operation
  - Approximate Emissions (tonnes CO₂e): 20.03
  - Percentage of Emissions Offsets (Baseline or Project): 0.02%
  - Total CO₂, CH₄, and N₂O emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol

- P18 - Venting of CO₂ at injection well sites
  - Approximate Emissions (tonnes CO₂e): 2.02
  - Percentage of Emissions Offsets (Baseline or Project): <0.01%
  - Total CO₂ and CH₄ emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol

- P19 - Fugitive emissions at injection well sites
  - Approximate Emissions (tonnes CO₂e): 2.97
  - Percentage of Emissions Offsets (Baseline or Project): <0.01%
  - Total CO₂ and CH₄ emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol

- P20 - Emissions from subsurface to atmosphere
  - Approximate Emissions (tonnes CO₂e): 0.00
  - Percentage of Emissions Offsets (Baseline or Project): 0%
  - Total CO₂ emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol

- P21 - Loss, disposal or recycling of materials used in CO₂ capture process
  - Approximate Emissions (tonnes CO₂e): 15.53
  - Percentage of Emissions Offsets (Baseline or Project): 0.01%
  - Total CO₂e emissions are calculated based on methodologies described in Table 6: Quantification Methodology of the Protocol

### 7.3 Assessment of Risk and Magnitude of Potential Errors, Omissions or Misrepresentations

Based on GHD’s review of the Project operations, GHD prepared the following table, which summarizes the potential risk and magnitude of potential errors, omissions, or misrepresentations:

<table>
<thead>
<tr>
<th>Source</th>
<th>Attributes</th>
<th>Inherent Risk</th>
<th>Control Risk</th>
<th>Detection Risk</th>
<th>Consideration for Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Project Eligibility</strong></td>
<td>Occurrence Completeness</td>
<td>Medium – Project involves reductions due to the capture and storage of CO₂ from the Scotford Site. All activities at the CCS facility plus the capture site are owned by the AOSP JV and operated by Shell; however the project boundary will Low – Project was owned by the AOSP JV and operated by Shell during crediting period.</td>
<td>Lowest</td>
<td>Allowable detection risk is medium-high. However, as this is GHD’s first verification of the project, the detection risk has been set as lowest, as all available documentation to confirm that Project meets the applicable</td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>Attributes</td>
<td>Inherent Risk</td>
<td>Control Risk</td>
<td>Detection Risk Consideration for Procedure</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>---------------</td>
<td>--------------</td>
<td>---------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Data Management</td>
<td>Occurrence</td>
<td>Medium – Majority of quantities used for emission reduction are real-time data stored on PI or LIMS systems, or via third-party invoices. Some data for subsurface emissions (P20) are from additional data systems.</td>
<td>Medium – All data is managed and tracked by Shell personnel. Multiple systems are used to track data.</td>
<td>Protocol criteria was reviewed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td></td>
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<tr>
<td></td>
<td>Accuracy</td>
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<tr>
<td></td>
<td>Cut-Off</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Baseline Condition Sources and Sinks**

| Injected CO₂ | Occurrence | High – Based on total CO₂ injected. Metering points are located as close to the injection points as possible. Composition of CO₂ is primarily based on direct gas analysis, however issues with the analyzer have been identified, and data has been substituted with methods that are not in accordance with the protocol. A variance request was submitted and approved by Alberta Climate Change Office (ACCO) for use until analyzer was repaired. Potential venting/fugitives after metering point (at injection points) captured in project condition. | Low – One meter present at each injection well, and one composition measurement system. All meter and analyzer data is stored within Shell’s PI system, while sampling data is stored in LIMS. | Low – GHD reviewed all issues identified in third-party ACCO and Alberta Energy (AE) audits conducted on Project. |
| | Completeness | | | |
| | Accuracy | Low – Metering system present at each injection well and composition based on gas analysis on injected CO₂ stream. | | |
| | Cut-Off | Low – Crediting period is well established. | Low – Crediting period are well established. | |
### Project Condition Sources and Sinks

<table>
<thead>
<tr>
<th>Source</th>
<th>Attributes</th>
<th>Inherent Risk</th>
<th>Control Risk</th>
<th>Detection Risk Design</th>
<th>Consideration for Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Well drilling reportable releases

| Occurrence | Low – only reportable if gas is released during kicks and blowouts of wells as per the Alberta Energy Regulator (AER) Directive 059. Emissions during reportable releases are quantified using methodologies defined in the Directive 059 Reports. | Low – Emissions estimated based on procedures as per AER Directive 059. | High | GHD confirmed that there were no reportable gas releases from well drilling occurred during crediting period. |
| Completeness | Low – Classification of offsets is well defined within the system. | | | |
| Accuracy | Low – Crediting period is well established. No releases were reported during crediting period. | | | |
| Cut-Off | Low – Classification of offsets is well defined within the system. | | | |
| Classification | Low – Classification of offsets is well defined within the system. | | | |

#### Production and delivery of material inputs

<p>| Occurrence | Low – multiple materials used in CCS process, but each quantity is determined based on direct measurement or invoicing. Emission factors estimated based primarily on literature references. | Low – based on delivery and metered quantities of the different material inputs. All delivery invoices are stored on Shell’s servers, and meter data is stored in Shell’s PI system. | High | GHD reviewed total quantification of the material inputs as well as confirm appropriateness of emission factors. Significant discrepancies in emissions for this category do not result in material error. |
| Completeness | Low – Classification of offsets is well defined within the system. | | | |
| Accuracy | Low – Classification of offsets is well defined within the system. | | | |
| Cut-Off | Low – Classification of offsets is well defined within the system. | | | |
| Classification | Low – Classification of offsets is well defined within the system. | | | |</p>
<table>
<thead>
<tr>
<th>Source</th>
<th>Attributes</th>
<th>Inherent Risk</th>
<th>Control Risk</th>
<th>Detection Risk Design</th>
<th>Consideration for Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel extraction/processing</td>
<td>Occurrence</td>
<td>High – Only natural gas is quantified for this source. Total natural gas usage based on complex steam balance, which has been modified based on results of AEP third-party audit.</td>
<td>High – Total quantities of steam measured based on multiple steam meters, along with temperature and pressure transmitters. Steam metering data is stored on Shell’s PI system.</td>
<td>Lowest</td>
<td>GHD reviewed complete details of the steam balance and confirm total quantities of natural gas used. GHD confirmed appropriateness of emission factors.</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td>High – Complex steam balance used to quantify natural gas usage.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>High – Complex steam balance used to quantify natural gas usage.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
<td>Low – Crediting period is well established.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-Site electricity generation</td>
<td>Occurrence</td>
<td>Medium – Multiple electricity meters and invoices (for electricity usage at wellpads) used to quantify electricity usage by the Project. Standard emission factors are used.</td>
<td>Medium – the majority of electricity usage is based on direct metering. A small (&lt;1%) quantity is estimated. Electricity meter data is stored in Shell’s PI system. Electricity invoices for wellpads stored on Shell’s server.</td>
<td>Lowest</td>
<td>Allowable detection risk is medium. However, as this is a significant quantity of project emissions, GHD has set the detection risk as low to ensure no material error is present. GHD reviewed all electricity metering/invoiced quantities. GHD confirmed appropriateness of emission factors.</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td>Medium – Multiple electricity meters and invoices (for electricity usage at wellpads) used to quantify electricity usage by the Project. Standard emission factors are used.</td>
<td>Medium – the majority of electricity usage is based on direct metering. A small (&lt;1%) quantity is estimated. Electricity meter data is stored in Shell’s PI system. Electricity invoices for wellpads stored on Shell’s server.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>Medium – the majority of electricity usage is based on direct metering or invoicing. A small (&lt;1%) quantity is estimated.</td>
<td>Medium – the majority of electricity usage is based on direct metering. A small (&lt;1%) quantity is estimated. Electricity meter data is stored in Shell’s PI system. Electricity invoices for wellpads stored on Shell’s server.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
<td>Low – Crediting period is well established.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-Site heat generation</td>
<td>Occurrence</td>
<td>High – Total natural gas based on complex steam balance. During third-party AE/ACCO audit, a significant material error was identified in the claimed quantity of total natural gas consumed.</td>
<td>High – Total quantities of steam measured based on multiple steam meters, along with temperature and pressure meters. Steam metering data is stored on Shell’s PI system.</td>
<td>Lowest</td>
<td>GHD reviewed complete details of the steam balance and calculation of natural gas used. GHD reviewed all third-party composition data. GHD reviewed all steam metering and temperature and pressure meters. Steam metering data is stored on Shell’s PI system.</td>
</tr>
<tr>
<td>Source</td>
<td>Attributes</td>
<td>Inherent Risk</td>
<td>Control Risk</td>
<td>Detection Risk Design</td>
<td>Consideration for Procedure</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
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<td>-----------------------------</td>
</tr>
<tr>
<td>Waste heat. Shell has received approval from ACCO to resubmit the OPRs for the 2nd-5th crediting periods once a revised methodology is implemented and approved to allow for retroactive corrections for waste heat. Composition of natural gas based on third-party information.</td>
<td></td>
<td></td>
<td>data is stored on Shell's PI system.</td>
<td></td>
<td>issues identified in third-party ACCO audits conducted on Project.</td>
</tr>
</tbody>
</table>

### Accuracy
- High – Complex steam balance used to quantify natural gas usage.

### Cut-Off
- Low – Crediting period is well established.

### Classification
- Low – classification of offsets is well defined within the system.

### On-Site heat and electricity generation

#### Occurrence
- Low – based on total invoiced propane and metered natural gas usage. Default emission factors for propane, while natural gas emission factors calculated based on gas composition.

#### Completeness
- Low – total fuel consumption based on invoicing or metering. Invoices are stored on Shell's server.

#### Accuracy
- Medium – total fuel consumption based on invoicing (propane, aviation turbo fuel), cardlock records (gasoline and diesel) and

#### Cut-Off
- Low – Crediting period is well established. No releases during crediting period.

#### Classification
- Low – classification of offsets is well defined within the system.

### CCS facility operation

#### Occurrence
- Low – based on total consumption of diesel, gasoline and aviation fuel, calculated based on direct measurement or invoices. Default

#### Completeness
- Medium – total fuel usage as well as confirm appropriateness of emission factors. Based on 1st crediting period OPR,
<table>
<thead>
<tr>
<th>Source</th>
<th>Attributes</th>
<th>Inherent Risk</th>
<th>Control Risk</th>
<th>Detection Risk Design</th>
<th>Consideration for Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accuracy</td>
<td>emission factors for each fuel type used.</td>
<td>information tracked by Shell personnel (usage during workovers/logging of wells). Invoices are stored on Shell’s server.</td>
<td>significant discrepancies in emissions for this category are not expected to result in material error.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cut-Off</td>
<td>Low – Crediting period is well-understood.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venting of CO₂</td>
<td>Occurrence</td>
<td>Low – multiple vent event categories.</td>
<td>Low to Medium – multiple vent event types can occur, with different quantification methods for each. Calculations for the vented quantities are performed on spreadsheets stored on Shell’s server.</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td>Total gas vented and composition for each type based on either engineering calculations or direct measurements.</td>
<td></td>
<td>GHD reviewed methodologies of vented quantities and composition of vented gases. Significant discrepancies in emissions for this category are not expected to result in material error.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>Low – based on known equipment counts and measured gas composition.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fugitive emissions at well sites</td>
<td>Occurrence</td>
<td>Low – total fugitive emissions on fitting counts and default emission rates from each type of fitting. Gas composition based on measured injected gas composition.</td>
<td></td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td></td>
<td></td>
<td>GHD confirmed equipment counts and gas composition. Significant discrepancies in emissions for this category are not expected to result in material error.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
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</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emissions from subsurface</td>
<td>Occurrence</td>
<td>Low – emissions calculated only if a leak is detected. Methodologies to monitor subsurface storage of CO₂ and leaks performed by Shell using a number of methodologies at multiple levels – each methodology is described in the Measurement, Monitoring and</td>
<td>Medium – Shell’s PI and LIMS systems are the primary data storage location; however some data is stored in alternative locations, which is then manually downloaded and transferred by Shell personnel. All data is</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td></td>
<td></td>
<td>GHD reviewed all documentation and methodologies used to assess leaks from the subsurface and confirmed that no leaks occurred during the crediting period.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Source Attributes

<table>
<thead>
<tr>
<th>Source</th>
<th>Attributes</th>
<th>Inherent Risk</th>
<th>Control Risk</th>
<th>Detection Risk</th>
<th>Consideration for Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
<td></td>
<td>monitoring by Shell.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss, disposal or recycling of materials</td>
<td>Occurrence</td>
<td>Low – multiple materials used in CCS process that can potential be disposed, but quantities of each determined based on direct measurement disposal and recycling quantities. Emission factors estimated based on material balances.</td>
<td>Low – based on delivery and metered quantities of the different material inputs.</td>
<td>High</td>
<td>GHD reviewed total quantification of the material inputs as well as confirm appropriateness of emission factors. Significant discrepancies in emissions for this category do not result in material error.</td>
</tr>
<tr>
<td>completeness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>Low – based on delivery and metered quantities of the different material inputs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During the verification, any new risks or material concerns that could potentially lead to errors, omissions and misrepresentations identified by GHD were reviewed and assessed.

### 7.4 Final Sampling Plan

GHD developed a sampling plan based on review of the objectives, criteria, scope and level of assurance detailed above. The sampling plan is dynamic and was revised, as required, throughout the course of the verification.

The following table summarizes the final sampling plan of material sources:

<table>
<thead>
<tr>
<th>Data/Information Description</th>
<th>Data/Information Source</th>
<th>Collection Frequency</th>
<th>Sample size/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>OPP for the Quest Carbon Capture and Storage Project</td>
<td>N/A</td>
<td>• Reviewed OPP to confirm applicability with Protocol</td>
</tr>
<tr>
<td>Data/Information Description</td>
<td>Data/Information Source</td>
<td>Collection Frequency</td>
<td>Sample size/Action</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Project Boundary</td>
<td>OPR for the Quest Carbon Capture and Storage Project</td>
<td>N/A</td>
<td>Reviewed OPR to confirm applicability with Protocol and OPP</td>
</tr>
<tr>
<td>Data management</td>
<td>Quest CCS Project ownership and operation</td>
<td>N/A</td>
<td>Ownership and operation of the CCS</td>
</tr>
<tr>
<td></td>
<td>Data acquisition system</td>
<td>N/A</td>
<td>Confirmed division of Quest Facility from other Scotford Sites</td>
</tr>
<tr>
<td>1st Crediting Period Information</td>
<td>OPR from 1st Crediting Period</td>
<td>N/A</td>
<td>Reviewed previous findings and issues to confirm applicability to current crediting period</td>
</tr>
<tr>
<td></td>
<td>Verification Report from 1st Crediting Period</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Third-Party Audit conducted on behalf of AE/ACCO</td>
<td>Audit Report conducted by TetraTech EBA Inc. (TetraTech)</td>
<td>N/A</td>
<td>Reviewed third-party audit and issues to confirm applicability to current crediting period</td>
</tr>
<tr>
<td><strong>Baseline Condition Sources and Sinks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total CO₂ Injected</td>
<td>Gas injected at each injection well site:</td>
<td>Continuous</td>
<td>Mass balance spreadsheet with calculation of CO₂ injected</td>
</tr>
<tr>
<td></td>
<td>• FIT-702104</td>
<td></td>
<td>Flow of data from meters to GHG calculation system</td>
</tr>
<tr>
<td></td>
<td>• FIT-702204</td>
<td></td>
<td>Most recent calibration records for each meter</td>
</tr>
<tr>
<td></td>
<td>• FIT-702304</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gas downstream of compressor</td>
<td>Continuous</td>
<td>Composition of CO₂ stream injected into the well sites</td>
</tr>
<tr>
<td></td>
<td>• FIT-247004</td>
<td></td>
<td>Flow of data from analyzers to GHG calculation system</td>
</tr>
<tr>
<td></td>
<td>Gas composition analyzers AT-247001, AT247002</td>
<td>Continuous/ As-collected</td>
<td>Laboratory management and QA/QC procedures</td>
</tr>
<tr>
<td></td>
<td>Laboratory sampling data on CO₂ stream</td>
<td></td>
<td>Laboratory results for crediting period</td>
</tr>
<tr>
<td></td>
<td>Regression model for substitution of CO₂ analyzer</td>
<td></td>
<td>Regression model derivation and applicability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Audit Report conducted by TetraTech</td>
<td>N/A</td>
<td>Reviewed third-party audit and issues to confirm applicability to current crediting period</td>
</tr>
<tr>
<td></td>
<td>Variance Request</td>
<td>N/A</td>
<td>Confirmed approval of variance request by AE</td>
</tr>
<tr>
<td><strong>Project Condition Sources and Sinks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well drilling reportable releases</td>
<td>Total gas and composition of gas released if well kick or blowout occurred</td>
<td>As recorded</td>
<td>AER Directive 059 report for each well kick or blowout (if applicable)</td>
</tr>
<tr>
<td>Data/Information Description</td>
<td>Data/Information Source</td>
<td>Collection Frequency</td>
<td>Sample size/Action</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Material usage                    | Total usage of materials on-Site:  
  - Methyl diethanol amine (MDEA)  
  - Triethylene glycol (TEG)  
  - Activated Carbon  
  - Nitrogen  
  - Lubricant  
  - Utility/Instrument Air  
  - HFCs  
  - Sacrificial Anodes |
|                                  | As recorded/continuous  |                      | Mass balance spreadsheet with calculation of nitrogen used  
  Billing model for instrument air  
  Flow of data from meters/accounting to GHG calculation system  
  Confirmed purchases of other material quantities |
| Emission factors                  | N/A                     |                      | Review methods for determining emission factors                                                                 |
| Fuel extraction/processing        | Total steam usage:  
  - Low pressure (LP) steam from steam header  
  - High pressure (HP) steam from RHC unit |
|                                  | Continuous              |                      | Steam balance spreadsheet (for calculation of each type of steam produced, along with pressure and temperature)  
  Flow of data from meters to GHG calculation system  
  Most recent calibration records |
| Natural gas composition HHV       | As recorded              |                      | All data for the duration of the crediting period for natural gas composition and HHV data from third party supplier |
| Extraction/processing emission factors | N/A                     |                      | Confirm appropriateness                                                                                   |
| Off-site electricity generation   | Total electricity usage:  
  - 52-15B  
  - 52-16B  
  - 702-DP-A  
  - 702-DP-B  
  - 702-DP-C  
  - PM-44108A  
  - PM-44108B  
  - FI-25003  
  - FI-25007  
  - F-252F01A-J  
  - Various estimate electricity quantities |
|                                  | Continuous              |                      | Mass balance spreadsheet with calculation of electricity at Quest and electricity from Upgrader  
  Third-party invoices for electricity consumed at the well pads  
  Documentation and calculation methodologies for estimate electricity quantities  
  Flow of data from meters to GHG calculation system  
  Most recent calibration records |
| Grid Emission Factors             | N/A                     |                      | Confirm appropriateness of emission factors                                                                 |
| Off-site heat generation          | Total steam usage (multiple meters for each):  
  - Total low pressure (LP) steam to Quest  
  - HP steam from RHC unit |
|                                  | Continuous              |                      | Steam balance spreadsheet (for calculation of each type of steam produced, along with pressure and temperature)  
  Flow of data from meters to GHG calculation system  
  Most recent calibration records |
<p>| Natural gas composition HHV       | As recorded              |                      | All data for the duration of the crediting period for natural gas composition and HHV data from third party supplier |</p>
<table>
<thead>
<tr>
<th>Data/Information Description</th>
<th>Data/Information Source</th>
<th>Collection Frequency</th>
<th>Sample size/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion emission factors</td>
<td>N/A</td>
<td></td>
<td>• Confirm appropriateness of natural gas CO₂ emission factor calculated by Shell</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Confirm appropriateness of published emission factors for other gas species</td>
</tr>
<tr>
<td>Audit Report conducted by</td>
<td>N/A</td>
<td></td>
<td>• Reviewed third-party audit and issues to confirm applicability to current crediting</td>
</tr>
<tr>
<td>TetraTech EBA Inc. (TetraTech)</td>
<td></td>
<td></td>
<td>period</td>
</tr>
<tr>
<td>Approval from ACCO to</td>
<td>N/A</td>
<td></td>
<td>• Confirmed conformance of calculations with ACCO guidance</td>
</tr>
<tr>
<td>remove waste heat credit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-site heat and</td>
<td>Natural gas usage for local heating</td>
<td>Continuous</td>
<td>• All data for the duration of the crediting period for natural gas for local heating</td>
</tr>
<tr>
<td>electricity generation</td>
<td></td>
<td></td>
<td>(if applicable)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Flow of data from meters to GHG calculation system</td>
</tr>
<tr>
<td>Natural gas HHV</td>
<td>As recorded</td>
<td></td>
<td>• All data for the duration of the crediting period for natural gas composition and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HHV data from third party supplier</td>
</tr>
<tr>
<td>Propane usage (if applicable)</td>
<td>As recorded</td>
<td></td>
<td>• Invoiced quantities of propane usage for the duration of the crediting period</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(if applicable)</td>
</tr>
<tr>
<td>Combustion emission factors</td>
<td>N/A</td>
<td></td>
<td>• Confirm appropriateness of natural gas CO₂ emission factor calculated by Shell</td>
</tr>
<tr>
<td>(if emissions from this</td>
<td></td>
<td></td>
<td>• Confirm appropriateness of published emission factors for other gas species</td>
</tr>
<tr>
<td>source occurred during</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crediting period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCS facility operation</td>
<td>Diesel consumption</td>
<td>As recorded</td>
<td>• Cardlock fuel consumption measured for the duration of the crediting period</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline consumption</td>
<td>As recorded</td>
<td></td>
<td>• Cardlock fuel consumption measured for the duration of the crediting period</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aviation turbo fuel</td>
<td>As recorded</td>
<td></td>
<td>• Fuel consumption for flights quantities for the duration of the crediting period</td>
</tr>
<tr>
<td>consumption</td>
<td></td>
<td></td>
<td>• Pro-rated consumption of fuel for the Quest project</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustion emission factors</td>
<td>N/A</td>
<td></td>
<td>• Confirm appropriateness</td>
</tr>
<tr>
<td>Venting of CO₂</td>
<td>Total gas vented</td>
<td>As recorded</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Mass balance spreadsheet with calculations of total quantity of gas vented from</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>each venting event for the duration of the crediting period</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Data/Information Description</th>
<th>Data/Information Source</th>
<th>Collection Frequency</th>
<th>Sample size/Action</th>
</tr>
</thead>
</table>
| • Gas composition analyzers AT-247001, AT247002  
• Laboratory sampling data on CO₂ stream | Continuous | • Composition of CO₂ stream injected into the well sites  
• Flow of data from analyzers to GHG calculation system  
• Laboratory management and QA/QC procedures  
• Laboratory results for crediting period |
| Fugitive emissions at well sites | Fitting counts  
Gas composition analyzers AT-247001, AT247002 | As recorded | • Confirm total number of fittings  
• Composition of CO₂ stream injected into the well sites  
• Flow of data from analyzers to GHG calculation system |
| Emissions from subsurface | • Quantity of gas leaking from subsurface  
• Methodologies used to assess leakage from subsurface | As recorded | • Measurement, Monitoring and Verification (MMV) Plan and associated records  
• MMV Quarterly Reports for the crediting period  
• Lightsource documentation report  
• Flux chamber data for baseline (June 2015) and project for crediting period  
• Hydraulic Isolation Logs for crediting period  
• Confirm if any releases from subsurface occurred in crediting period |
| Loss, disposal and recycling of materials | Total quantities of materials lost/disposed/recycled on-Site:  
• Methyl Diethanol amine (MDEA)  
• TEG-glycol  
• Water (wastewater treatment)  
• Lubricant  
• Refrigerant HFC (R410a) | As recorded/continuous | • Disposal/off-site shipment records for the full crediting period  
• Wastewater treatment volumes for the full crediting period  
• Refrigerant charge records for the duration of the crediting period |
| Emission factors | N/A | • Review methods for determining emission factors |

### 7.5 Materiality

Quantitative materiality for this verification is set at plus or minus five percent of the reported 2016 emission offsets as per the AEP Technical Guidance for Greenhouse Gas Verification at Reasonable Level Assurance, Version 1.0. In addition, a series of discrete errors, omissions or misrepresentations or individual or a series of qualitative factors, when aggregated (absolute values) may be considered material.
7.6 Tolerable Errors

GHD recalculated GHG emission offsets related to the Project, and evaluated annual GHG emission offset calculation methodologies. GHD designed the planning materiality, referred to as tolerable error, to detect quantitative misstatements in the assertion. The following table is a comparison of the tolerable error and the actual discrepancies. Exceedance of tolerable error is not an indication that a Facility is outside of the materiality threshold established in Section 6.5 above. Rather an exceedance serves to assist GHD in reviewing and updating its sample size and sample plan accordingly, to ensure that the values reported are accurately and conservatively represented.

<table>
<thead>
<tr>
<th>Baseline or Project</th>
<th>Source or Sink</th>
<th>Reductions (tonnes)</th>
<th>%-Tolerable Error</th>
<th>Tolerable Error (Rounded) (tCO2e)</th>
<th>Actual Discrepancy (tCO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CO2</td>
<td>CH4</td>
<td>N2O</td>
<td>CO2e</td>
</tr>
<tr>
<td>Baseline</td>
<td>Injected CO2</td>
<td>444,091</td>
<td>-</td>
<td>-</td>
<td>444,091</td>
</tr>
<tr>
<td></td>
<td><strong>Total Baseline</strong></td>
<td><strong>444,091</strong></td>
<td>-</td>
<td>-</td>
<td><strong>444,091</strong></td>
</tr>
<tr>
<td>Project</td>
<td>Well Drilling/Construction</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Production of Inputs</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>272.86</td>
</tr>
<tr>
<td></td>
<td>Production of Fuels</td>
<td>5,470</td>
<td>106.9</td>
<td>0.29</td>
<td>8,228</td>
</tr>
<tr>
<td></td>
<td>Off-Site Electricity</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>40,316</td>
</tr>
<tr>
<td></td>
<td>Off-Site Heat</td>
<td>69,934</td>
<td>1.31</td>
<td>1.17</td>
<td>70,315</td>
</tr>
<tr>
<td></td>
<td>On-Site Heat and Electricity</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>CCS Facility Operation</td>
<td>19.90</td>
<td>0.00</td>
<td>0.00</td>
<td>20.03</td>
</tr>
<tr>
<td></td>
<td>Venting at Injection Sites</td>
<td>0.01</td>
<td>0.08</td>
<td>-</td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>Fugitives at Injection Sites</td>
<td>2.31</td>
<td>0.03</td>
<td>-</td>
<td>2.97</td>
</tr>
<tr>
<td></td>
<td>Subsurface Emissions</td>
<td>0.00</td>
<td>-</td>
<td>-</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Loss of Inputs</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.53</td>
</tr>
<tr>
<td></td>
<td><strong>Total Project</strong></td>
<td><strong>75,426</strong></td>
<td><strong>108.3</strong></td>
<td><strong>1.46</strong></td>
<td><strong>119,173</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total Reductions</strong></td>
<td><strong>324,918</strong></td>
<td><strong>2.5</strong></td>
<td></td>
<td><strong>8,123</strong></td>
</tr>
</tbody>
</table>

Note: Units above are in tonnes of the specific GHG type (i.e. tonne CO2, tonne CH4, tonne N2O) unless otherwise specified.

A discussion of the discrepancies reported for each emission category is provided in Section 10.1 below.
8. Verification Procedures

8.1 Project Boundaries

The Project boundaries include those operations associated with the capture of CO₂ produced by the Shell Scotford Upgrader and the injection underground at three injection wells. The Project located is at the following addresses:

**CCS Facility**
55522 Range Road 214
Fort Saskatchewan, Alberta
Latitude: 53.74047N, Longitude 113.0231 W

**Injection Wells²**
Well #1: 07-11-59-20-W4
Well #2: 08-19-59-20-W4
Well #3: 05-35-59-21-W4

As summarized above, the Shell Scotford Upgrader, Refinery and Chemicals Plant, along with all other operations at the Scotford Site were not reviewed except when applicable to the Project emissions.

During the Site visit and verification, the GHD Project Team reviewed the project operations and confirmed the emission sources and Project boundary. The findings from this review are provided in Section 10.1 below.

8.2 Comparability with the Project and Baseline Scenarios

As per the Protocol, the approved baseline condition is projection-based and is equal to the total metered quantity of CO₂ injected. GHD verified that this baseline scenario has been properly applied and quantified in accordance with the protocol.

8.3 Conformance to the Verification Criteria

The GHD Project Team verified the methods and procedures used by Shell to calculate GHG emissions and included an evaluation of whether or not:

- The documentation was complete and comprehensive and follows the structure and criteria given in the relevant AEP guidance documents.
- The assumptions for the emission estimates are conservative and appropriate.

² Currently two injection wells are in operation: Well#1: 07-11-59-20-W4 and Well#2: 08-19-59-20-W4
8.4 Data Management System Integrity

GHD reviewed the Shell’s documentation and interviewed the Site personnel responsible for the data management system. The data management systems used by Shell are summarized below.

The total quantities of emissions from the various baseline and project sources and sinks are determined based on either direct measurement, third-party data, and/or engineering estimates.

The data management system used by Shell is built upon the existing systems at the Scotford Site, and is based on a network of Data Focals. The data management system specifies the personnel responsible for the collection and maintenance of data at key measurement points.

Metered data is collected from the measurement points by the Distributed Control System (DCS), and then stored in the Process Information (PI) system – data will be stored for at least seven year’s past the end of the project crediting period. The final meter data is stored within the PI system. All meters involved have specified standards and practices to control uncertainty, including calibration and preventative maintenance activities.

At the injection sites, most of the data is integrated with the DCS/PI systems with the exception of the distributed temperature sensors in the injection wells; this data is stored in separate storage located on each well during the 2nd crediting period, then transferred for archiving.

The Data Focal collects all key data and enters this data into the Shell Environmental Reporting System (SERS), which is the Site’s emissions calculation software. The data and outputs from the SERS software is reviewed monthly, quarterly and yearly to ensure accuracy.

8.5 GHG Data Collection and Verification Testing

GHD collected the following data that was used by the Facility to develop the GHG assertion:

- OPR-Nov. 1, 2015 to March 31, 2016-Quest Carbon Capture and Storage Project – 2nd crediting period Offset Project Report
- Quest Offset Project Plan 2016 07 22 clean – Most recent Offset Project Plan
- Quest Protocol Summary report, Quest detailed summary report, Measurements, Consumptions and Emissions Output – Summary and detailed inputs and outputs from SERS
- Shell Audit Report IFU, Injection Certification for the Quest Project_IFU and other associated correspondence between TetraTech EBA Inc., Shell and ACCO – Detailed third-party audit report and other correspondence for Quest 1st crediting period conducted by TetraTech EBA Inc.
- Letters from ACCO (Rob Hamiliuk) to Shell - Shell variance request for B1 CO2 analyzer and approval to retroactively add project emissions from waste heat
- Letters from Charles Bower to ACCO/AE – Shell responses to findings from TetraTech EBA Inc. and variance requests
- Quest Offset Project, Audit Follow Up Form for ACCO - Oct. 12, 2017 – Draft audit follow-up form prepared by Shell
- Multiple pdf files – calibration records for all key GHG meters during the 2nd crediting period (or completed in period prior to 2nd crediting period)

- Quest Mass Balance – XXX 201Y (where XXX = November, December… and Y=5 or 6), XXX 201Y Consumption/Measurement Daily Upload – Monthly mass balance spreadsheets

- CO2 analyzer overview presentation – presentation outlining historical analyzer issues

- Various pdf and excel spreadsheets – results of independent laboratory sampling of injection gas at Shell laboratory and third-party laboratories

- Various emails and excel files – record of material purchases, air/nitrogen usage and diesel/gasoline/aviation turbo fuel usage

- XX – Monthly Quest YYY 201Z (Where XX=01, 02…, YYY = Jan, Feb… and Z = 5 or 6) – monthly steam balance spreadsheets

- Multiple presentations, diagrams and pdfs – presentations and diagrams of steam balance system

- Multiple pdf reports, SERS_Quest_GMandSCVF_summary – results of surface casing and gas migration well testing

- Fugitive Emission Estimate – XXX 201Y – Monthly fugitive emissions estimate summaries

- MMV_Pre-injection_plan_Jan2015_final and IEAGHG MMV – Quest Update – Detailed Monitoring, Measurement and Verification plan and associated summary presentation

- Hydraulic isolation logging – detailed hydraulic isolation logging test results


- 4th Annual Status Report_31MAR2016, P20_assessment_Q1_2016 – results of subsurface monitoring

GHD reconstructed GHG emission calculations using the above data/documents. A summary of verification tests and crosschecks completed by GHD is provided below:

<table>
<thead>
<tr>
<th>Emission Source</th>
<th>Percentage of Baseline/Project Emissions (%)</th>
<th>Action</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Emissions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injected CO2</td>
<td>100%</td>
<td>Full Recalculation</td>
<td>GHD reviewed all inputs into the emissions calculations including metered flow data, analyzer/composition/ regression model data, and confirmed the conformance of the methodologies used to the Protocol. GHD used this data to complete a full recalculation of the reported emissions and compared to the values reported by Shell.</td>
</tr>
<tr>
<td>Emission Source</td>
<td>Percentage of Baseline/Project Emissions (%)</td>
<td>Action</td>
<td>Details</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>---------------------------------------------</td>
<td>-------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Project Emissions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P3 - Well drilling reportable releases</td>
<td>0%</td>
<td>Reasonableness Check</td>
<td>GHD confirmed the quantity of releases from well drilling during the compliance period, and confirmed conformance to the Protocol.</td>
</tr>
<tr>
<td>P4 - Production and delivery of material inputs</td>
<td>0.23%</td>
<td>Reasonableness Check</td>
<td>GHD confirmed the quantity and appropriateness of all material used during the compliance period, and confirmed conformance to the Protocol.</td>
</tr>
<tr>
<td>P5/P6/P7 - Extraction/processing and transportation of fuels</td>
<td>6.90%</td>
<td>Full Recalculation</td>
<td>GHD reviewed all inputs into the emissions calculations including calculated/invoiced fuel data, composition data, emission factors, and confirmed the conformance of the methodologies used to the Protocol. GHD used this data to complete a full recalculation of the reported emissions and compared to the values reported by Shell.</td>
</tr>
<tr>
<td>P8 - Off-Site electricity generation</td>
<td>33.8%</td>
<td>Full Recalcation</td>
<td>GHD reviewed all inputs into the emissions calculations including calculated/invoiced data, emission factors, and confirmed the conformance of the methodologies used to the Protocol. GHD used this data to complete a full recalculation of the reported emissions and compared to the values reported by Shell.</td>
</tr>
<tr>
<td>P9 - Off-Site heat generation</td>
<td>59.0%</td>
<td>Full Recalcation</td>
<td>GHD reviewed all inputs into the emissions calculations including the calculation and applicability of the steam data, calculation of fuel data, composition data, emission factors, and confirmed the conformance of the methodologies used to the Protocol. GHD used this data to complete a full recalculation of the reported emissions and compared to the values reported by Shell.</td>
</tr>
<tr>
<td>P10 - On-Site heat and electricity generation</td>
<td>0%</td>
<td>Reasonableness Check</td>
<td>GHD confirmed the quantity and appropriateness of all fuels used for on-Site heat and electricity generation during the compliance period, and confirmed conformance to the Protocol.</td>
</tr>
<tr>
<td>P11 - CCS facility operation</td>
<td>0.02%</td>
<td>Reasonableness Check</td>
<td>GHD confirmed the quantity and appropriateness of all fuels used for CCS Facility operation during the compliance period, and confirmed conformance to the Protocol.</td>
</tr>
</tbody>
</table>
### Emission Source

<table>
<thead>
<tr>
<th>Emission Source</th>
<th>Percentage of Baseline/Project Emissions (%)</th>
<th>Action</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>P18 - Venting of CO₂ at injection well sites</td>
<td>&lt;0.01%</td>
<td>Full Recalculation</td>
<td>GHD reviewed all inputs into the emissions calculations, including the measured quantities of gas vented and composition analysis of the gas vented. GHD used this data to complete a full recalculation of the reported emissions and compared to the values reported by Shell.</td>
</tr>
<tr>
<td>P19 - Fugitive emissions at injection well sites</td>
<td>&lt;0.01%</td>
<td>Reasonableness Check</td>
<td>GHD confirmed the quantities of fugitive emissions at the injection well sites during the compliance period, and confirmed conformance to the Protocol.</td>
</tr>
<tr>
<td>P20 - Emissions from subsurface to atmosphere</td>
<td>0%</td>
<td>Full review of documentation</td>
<td>GHD reviewed of all methodologies and quarterly/annual reports prepared by Shell to confirm no emissions from subsurface to atmosphere, and confirmed conformance to the Protocol.</td>
</tr>
<tr>
<td>P21 - Loss, disposal or recycling of materials used in CO₂ capture process</td>
<td>0.01%</td>
<td>Reasonableness Check</td>
<td>GHD confirmed the quantity and appropriateness of all material disposed/recycled/losses during the compliance period, and confirmed conformance to the Protocol.</td>
</tr>
</tbody>
</table>

### 8.6 Details of Site Visit

On September 27, October 19 and October 20, 2016, Ms. Maggie Scott (September 27 and October 20, only), Mr. Brent Boss (October 19, only) and Mr. Sean Williams of GHD completed a Site visit of the Facility. Mr. Charles Bower, GHG Reporting Specialist and Ms. Celina Duong, Environmental Engineer of Shell arranged the Site visit, provided an overview of the Project, answered verification questions, and coordinated data retrievals. Mr. Bower and Ms. Duong are the primary staff members interviewed by GHD, and were responsible for the collection of data and preparation of the OPR. GHD also interviewed the following Shell personnel:

- Mr. Luc Rock, Hydrogeologist – MMV Coordinator, overview of P20 subsurface emissions monitoring program
- Mr. Steve Tessarolo, Quest Operations Support Engineer, overview of B1 injection site calculations, mass balance spreadsheets, and site tour of Quest Capture site
- Ms. Whitney Furman, Energy Focal, overview of P9 steam balance calculations
- Ms. Yuree Sung, Energy Focal, overview of P9 steam balance calculations
- Mr. David Sieben, Electrical Tech Support, site tour of electrical meters
- Mr. Tony Fleming (Instrument Specialist), site tour of steam meters
• Mr. Ken Hume, Analyzer Specialist, site tour of analyzer and overview of analyzer issues and maintenance procedures

• Ms. Anna Johnson, Finance Advisor, and Ms. Dominique Pillion, Finance Advisor, overview of electricity, diesel, gasoline and aviation fuel invoicing

**Site Visit Agenda – Day 1 (September 27, 2016)**

• Opening Meeting – Brief introduction and overview of verification process

• Review of the Quest Project

• Overview of emissions categories

• Review of P20 subsurface monitoring procedures

• Review of SERS calculation system

• Close out meeting

**Site Visit Agenda – Day 2 (October 19, 2016)**

• Opening Meeting – Update of verification process

• Site tour of Quest Capture Site

• Overview of B1 Injection CO2 analyzer issues

• Close out meeting

**Site Visit Agenda – Day 3 (October 20, 2016)**

• Opening Meeting – Update of verification process

• Site tour of Injection Well Site and overview of well site monitoring activities

• Update on steam balance calculations

• Close out meeting

It is noted that Ms. Scott was Co-Lead Verifier at the time of the Site visit, but left GHD between the site visit and the issuance of this draft report.

**9. Verification Schedule**

The following details the schedule of GHD's verification, identifying the dates of key tasks and completion of major milestones:

• Submit Verification Plan to Shell – September 26, 2016

• Shell Verification Plan review period – September 26 – 27, 2016

• Request, receive, and review documents and raw data from Shell – September 26 – November 9, 2017

• Site Visit - September 27, October 19 and October 20, 2016
10. Verification Findings

The following tables present GHD's reconstructed emissions based on the raw data provided. The emissions for each Protocol category reported by the Project have also been presented. The resulting absolute discrepancy between the Project’s and GHD's calculated emissions offsets is 665.8 tonnes CO₂e, which is equal to 0.20 percent. As the materiality threshold for this verification is five percent, the discrepancy identified in the emissions offsets means that the GHG assertion was not materially misstated.
<table>
<thead>
<tr>
<th>Source Group</th>
<th>Shell Reported Emissions (tonnes)</th>
<th>GHD Reconstructed Emissions (tonnes)</th>
<th>Discrepancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO2</td>
<td>CH4</td>
<td>N2O</td>
</tr>
<tr>
<td>B1 - Injected CO2</td>
<td>444,091</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>444,091</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P3 - Well drilling reportable releases</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>P4 - Production and delivery of material inputs used in CO2 capture process</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P5/P6/P7 - Extraction/processing and transportation of fuels</td>
<td>5,470</td>
<td>106.9</td>
<td>0.29</td>
</tr>
<tr>
<td>P6 - Off-Site electricity generation</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P9 - Off-Site heat generation</td>
<td>69,534</td>
<td>1.31</td>
<td>1.17</td>
</tr>
<tr>
<td>P10 - On-site heat and electricity generation</td>
<td>5,452</td>
<td>106.6</td>
<td>0.29</td>
</tr>
<tr>
<td>P11 - CCS facility operation</td>
<td>19.90</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>P18 - Venting of CO2 at injection well sites</td>
<td>0.01</td>
<td>0.08</td>
<td>0.00</td>
</tr>
<tr>
<td>P19 - Fugitive emissions at injection well sites</td>
<td>2.31</td>
<td>0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>P20 - Emissions from subsurface to atmosphere</td>
<td>0.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P21 - Loss, disposal or recycling of materials used in CO2 capture process</td>
<td>15.53</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>75,426</td>
<td>108.3</td>
<td>1.46</td>
</tr>
<tr>
<td>Total Baseline Emissions</td>
<td>444,091</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Project Emissions</td>
<td>119,173</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Emissions Offsets (Baseline – Project)</td>
<td>324,918</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Units above are in tonnes of the specific GHG type (i.e. tonne CO2, tonne CH4, tonne N2O) unless otherwise specified.
The following subsections provide details of GHD's findings as well as GHD's conclusions.

## 10.1 Verification Findings

The following presents the general findings and the material and immaterial discrepancies that GHD has identified during GHD's verification. GHD developed a verification issues log to document any issues identified and the resolution of those issues.

<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope Item Verified</strong></td>
<td>Project Eligibility</td>
</tr>
<tr>
<td>Verification Procedure</td>
<td>GHD reviewed the Project to confirm that all Project Eligibility Criteria are met. The Project Eligibility Criteria as defined in the Guidance are as follows:</td>
</tr>
<tr>
<td></td>
<td>1. Occur in Alberta;</td>
</tr>
<tr>
<td></td>
<td>2. Result from actions not otherwise required by law and be beyond business as usual and sector common practices;</td>
</tr>
<tr>
<td></td>
<td>3. Result from actions taken on or after January 1, 2002;</td>
</tr>
<tr>
<td></td>
<td>4. Be real, demonstrable, quantifiable, and verifiable;</td>
</tr>
<tr>
<td></td>
<td>5. Have clearly established ownership; and</td>
</tr>
<tr>
<td></td>
<td>6. Be counted once for compliance purposes;</td>
</tr>
<tr>
<td></td>
<td>7. Be implemented according to a Government of Alberta-approved quantification protocol;</td>
</tr>
<tr>
<td></td>
<td>8. Be verified by a qualified third party</td>
</tr>
<tr>
<td>Verification Findings</td>
<td>GHD’s assessment of the nine items is provided below:</td>
</tr>
<tr>
<td></td>
<td>1. The Quest CCS Facility is located at the Shell Scotford Site, located near Fort Saskatchewan, Alberta. The injection wells are located 50-80 km from the CCS Facility, and are all located in Alberta.</td>
</tr>
<tr>
<td></td>
<td>2. The implementation of carbon capture is not regulated by law or considered common practice in Alberta.</td>
</tr>
<tr>
<td></td>
<td>3. The Project start date was August 23, 2015, upon commencement of CO₂ injection</td>
</tr>
<tr>
<td></td>
<td>4. The Project results in real reductions of CO₂ that can be directly measured and accounted for using approved methods within the Protocol and the ACCO-approved Variance Request. GHD inspected the Project elements during the Site visit and verified the project documentation</td>
</tr>
<tr>
<td></td>
<td>5. The Project is currently operated by Shell and owned by the AOSP JV as verified by GHD during the Site Visit. During the 2nd crediting period, ownership of the AOSP JV was split between Shell Canada Limited (60%), Chevron Canada Limited (Chevron) (20%) and Marathon Oil Canada Corporation (Marathon) (20%). It is noted that on February 1, 2017 (after the 2nd crediting period), Canadian Natural Upgrading Limited (CNUL) purchased Shell Canada Limited’s share of the AOSP JV, and CNUL and Shell joint purchased Marathon’s share (creating 1745844 Alberta Ltd.). Therefore, as of February 1, 2017, the ownership split was changed to</td>
</tr>
</tbody>
</table>
Emission Source Group | General
---|---
| CNUL (60%), Chevron (20%) and 1745844 Alberta Ltd. (20%), with CNUL and Shell each having 50% ownership of 1745844 Alberta Ltd. Shell remains operator of the Project. This ownership change does not affect the allocation of credits from the Project for the 2nd crediting period.

6. GHD reviewed the Verified Carbon Standard (VCS) and CSA Clean Projects Registries, and confirmed that the Project was not registered on either program.

7. The Project was implemented according to the Quantification Protocol for CO2 Capture and Permanent Storage in Deep Saline Aquifers, Version 1.0 (AEP, 2015).

8. GHD Limited has completed the third-party verification for the 2nd (and 3rd, under separate cover) crediting periods. The 1st crediting period was confirmed to have been verified by another qualified third party verifier.

9. GHD confirmed that the project is registered on the Alberta Carbon Registries.

Conclusion | GHD confirmed that the Project adheres to the eligibility criteria.

Emission Source Group | General – Project Boundaries and Emissions Sources
---|---
Scope Item Verified | Assessment of completeness and inclusion of all emission sources
Verification Procedure | GHD reviewed documents provided by Shell and completed a review of operations during the Facility visit. Specifically, GHD completed the following:
- Review of process flow diagrams
- Review of the Offset Technical Guidance and Protocol
- Confirmation of inclusion of emission sources
Verification Findings | GHD reviewed the process flow diagrams included in the OPP and confirmed that they accurately represent the Project operations. As outlined in Sections 2.2 and 8.1 above, the Quest CCS Facility is located on a separate plot at the Scotford Site, which includes a number of other Facilities. All areas of the Scotford Site which are relevant to the Project are currently owned by the AOSP JV, and operated by Shell. No heat, electricity or other operations related to the Project are provided by the Air Liquide facility. Steam and electricity may be provided by the ATCO Cogen; this operation is considered to be part of the Scotford Upgrader boundary under the SGER, therefore any usage of this steam is still part of the Shell operation. All steam usage and a portion of the electricity usage is provided from the other Scotford Facilities, which are correctly assigned as Off-Site Heat/Electricity production. All other project emissions occurring at the Scotford Site specifically are from within the Quest Capture Site. The injection points are located on the three well sites (with two well sites currently undergoing injection) as outlined in Sections 2.2 and 8.1, and are all owned by the AOSP JV and operated by Shell, with all emissions part of the Project. Therefore, GHD can confirm that the Project boundaries are properly defined, and that all baseline and project emissions are within the Project boundaries.
GHD has further confirmed that all applicable Protocol sources have been included and accounted for in the OPP. No sources listed in the Protocol have been excluded from quantification. During the 2nd crediting period, it was observed that there were no reported emissions from Project categories P3, P10 and P20. GHD has confirmed that there were no emissions from each category occurring during the 2nd crediting period timeframe, as summarized below.

As summarized in the P4 and P21 categories below, a number of minor sources were not accounted for by Shell, based on the findings of the audit completed by TetraTech. Shell has acknowledged these missing sources, but has elected to not update their OPP or Report to include these sources. It has been confirmed that the total potential project emissions from these sources do not result in material discrepancy (final values are reported in the P4/P21 categories below).

**Conclusion**

GHD has confirmed that all protocol emission categories have been included in the OPP and OPR. A couple of minor emission sources were not included, which do not constitute a material discrepancy.

<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Data Management System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope Item Verified</td>
<td>Review of data management systems used on site</td>
</tr>
<tr>
<td>Verification Procedure</td>
<td>During the Facility Visits GHD reviewed the data management system.</td>
</tr>
<tr>
<td>Verification Findings</td>
<td><strong>Data Management System</strong></td>
</tr>
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<td></td>
<td>As discussed in Section 8.4 above, project data is taken via a combination of internal meter data, internal and external sampling and third-party invoicing, which is collected by various Data Focals and compiled into the SERS system to calculate emissions. It is noted that the use of the SERS system removes some transparency, as the system itself does operate as a “black box”, as the actual calculations used can be difficult to review (it is noted the calculations can be downloaded from SERS). The inputs and outputs from the system can be downloaded, which GHD reviewed and confirmed were appropriate.</td>
</tr>
<tr>
<td></td>
<td><strong>Meter Calibrations</strong></td>
</tr>
<tr>
<td></td>
<td>Multiple gas flow, steam and electricity meters are used as part of the data measurement and collection for the project (in particular the B1 injection CO2 and P9 heat generation categories). All meters are subject to Shell’s preventative maintenance (PM) program, and a minimum calibration frequency of annual has been set for all transmitters identified as “key” for the purposes of the Quest project.</td>
</tr>
<tr>
<td></td>
<td>As part of the verification, GHD has received the following calibration records:</td>
</tr>
<tr>
<td></td>
<td>• FIT-702104</td>
</tr>
<tr>
<td></td>
<td>• FIT-702204</td>
</tr>
<tr>
<td></td>
<td>• FIT-702304</td>
</tr>
<tr>
<td></td>
<td>• 52-15B</td>
</tr>
<tr>
<td></td>
<td>• 52-16B</td>
</tr>
</tbody>
</table>
Emission Source Group | Data Management System
---|---
- FC-246005  
- FC-246006  
- FI-246120  
- PI-251022A  
- TI-251020  
- FI-248004  
- PI-251020A  
- TI-251084

All of the above calibration records were performed either during the 2nd or 3rd crediting periods. GHD has reviewed each of the above calibration records, and confirmed that they were appropriate.

**Analyzer Calibrations**

One analyzer is used (under normal operation) as part of the Quest project, for the CO2 injection stream. GHD has confirmed that this analyzer is included in Shell’s PM program, and is calibrated regularly (at a minimum frequency of monthly at first). As discussed below, a number of issues were identified with the installation of the analyzer which resulted in significant performance issues – these issues are outside of normal calibration, and as a result the analyzer results were not utilized for much of the 2nd crediting period.

**Results of TetraTech’s Audits**

TetraTech EBA Inc. (TetraTech) was retained by ACCO to conduct a third-party verification audit on the Quest project for the 1st crediting period. The results of TetraTech’s audit were presented in their report to ACCO, dated March 7, 2017. For the purposes of GHD’s verification, GHD has reviewed and confirmed that any issue identified by TetraTech has been addressed by Shell; however as part of the verification GHD has also completed an independent review of these items to ensure the following:
- The validity of these issues with respect to the verification  
- If these issues are relevant, whether Shell has adequately addressed the issue

The specific issues found by TetraTech in their verification have been included in Appendix D to this report. Of these, Issues 16-01 – 16-04 are related to the data management. Issues 16-01 and 16-04 are discussed under the B1-Injection CO2 emissions category, while Issue 16-03 is discussed under the P9-Off-Site Heat Generation category.

For Issue 16-04, GHD did not identify any specific issues with the knowledge of each Data Focal interviewed with respect to its usage in the Quest Project for this specific verification.

**Conclusion**

GHD has confirmed that the management of data and calibration of key GHG meters are appropriate for the 2nd crediting period. The analyzer calibration is nominally appropriate, although significant issues (outside of normal operation) were identified.
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Baseline Emissions – B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope Item Verified</td>
<td>B1 – Injected CO₂</td>
</tr>
</tbody>
</table>
| Verification Procedure| GHD performed a detailed review of the following quantities to confirm the accuracy and conformance to the requirements of the Protocol and variance request:  
• Total quantity of injected gas  
• Composition of injected gas  
GHD further reviewed Shell’s application of the findings of TetraTech’s audit to confirm all identified issues had been addressed.  
GHD recalculated total baseline emissions from the CO₂ injected to determine the overall materiality. |
| Verification Findings | **Baseline Emission Description**  
As outlined in Section 2.1 and 2.3, the baseline condition involves the release of CO₂ from the production of hydrogen in each of the Scotford Upgrader’s three HMUs. During the project condition, this CO₂ is captured from the raw gas stream out of the HMU via the amine system, separated from the amine in the CCS facility, then compressed and transported for injection at the three injection sites.  
**Protocol Calculation Methodology and Requirements**  
As per the Protocol, the injected CO₂ is the only baseline emission included, and is the data point at which all project emissions are subtracted.  
As outlined in the Protocol, Section 4.1, Table 6, the calculation of injected CO₂ injected is based on the following equation:  
\[ Emissions_{injected\ CO₂} = \sum (Vol_{injected\ gas} \times \% CO₂ \times \rho_{CO₂}) \]  
Where:  
- \( Vol_{injected\ gas} = \) Total volume of gas injected.  
- \( \% CO₂ = \) volume percentage of CO₂ in injected gas  
- \( \rho_{CO₂} = \) density of injected CO₂  
The data management requirements of the volume of injected gas and CO₂ composition are outlined in Section 5.1.2, Table 8 of the Protocol, and are as follows:  
• Volume of injected gas: Continuous measurement of gas flow (defined as one measurement every 15 minutes). The volume measurements must also meet the following standards:  
  - Meter readings may be temperature/pressure compensated to standard temperature and pressure.  
  - The flow meters must be placed based on manufacturer’s specifications  
  - Must be placed downstream of the input to the gas transport equipment such that they are downstream of the capture and compression equipment to account for fugitives and venting |
### Emission Source Group

<table>
<thead>
<tr>
<th>Baseline Emissions – B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Flow meters should be as close as possible to injection wellheads to ensure accurate measurement of injected volumes</td>
</tr>
<tr>
<td>- Flow meters must be calibrated according to manufacturer’s specifications, and must be check/calibrated at regular intervals according to these specifications and industry standards</td>
</tr>
<tr>
<td>- Ownership must be clearly documented for CO(_2) transferred (third-party injection activity). GHD notes that this last item is not applicable, as the injection activity is owned by the AOSP JV and operated by Shell.</td>
</tr>
</tbody>
</table>

- Concentration of gas stream: Continuous measurement of gas composition (defined as one measurement every 15 minutes). The composition must also meet the following standards:
  - Gas composition must be metered downstream of the capture and processing equipment (while the volume is measured as close as possible to the point where the CO\(_2\) is injected into the deep saline aquifer)

GHD’s review of the measurement methodologies for the injected gas volume and composition and assessment of conformance to the protocol requirements is provided below.

**Measurement of Total Quantity of Gas Injected**

The total gas quantities sent for injection are measured by continuous flow meters at two distinct points within the system:

- FIT-247004 – located downstream of compressor at CCS Facility
- FIT-702104 – located at Injection Well 1
- FIT-702204 – located at Injection Well 2
- FIT-702304 – located at Injected Well 3

For the purposes of calculating the emissions reductions, Shell utilizes the three injection well meters, with the compressor meter used as a reasonableness check. The use of the three injection well meters satisfies the Protocol requirements that metering must be located downstream of the capture and compression equipment and located as close as possible to the injection wellheads. GHD, during the site tour of the well pads on October 20, confirmed the location of the meter at Injection Well 2 as being at the wellhead.

Each of the injection meters measure the flowrate on a mass basis. While the above equation from the protocol is based on the flow being measured on a volumetric basis, Section 5.1.2 of the protocol states “the mass of the gas stream must be determined based on the volumetric or mass flow, and composition of the gas stream”, therefore the use of mass flow is appropriate. Functionally, using the mass flowrate of the injected stream and the mass composition of CO\(_2\) (detailed below) is equivalent to the volumetric flow, molar/volumetric composition of CO\(_2\) and CO\(_2\).
density, so the reported injected quantities will be the same using either equation.

As documented in the Data Management Section above, Shell has provided calibration records for each of the three injection well meters. Each of the three injection well meters are Coriolis-type meters, which measure the flowrate continuously (at a rate greater than once every 15 minutes, aggregated to hourly and then daily for the purposes of calculations). The calibrations are performed on a yearly basis for each of the injection meters in accordance with the manufacturer’s requirements.

Based on GHD’s review, the total quantity of gas injected along with the meters used to measure these quantities are appropriate and in accordance with the Protocol requirements.

### Measurement of Composition of Injected Gas

#### Calculation of Mass Ratio

As per the protocol, the calculation of injected CO₂ is based on the volume of injected gas multiplied by the gas CO₂ composition and density. However, as discussed above the mass flowrate of injected gas was used by Shell, therefore the composition of CO₂ used in the equation must be on a mass basis (the mass ratio of CO₂). This mass ratio is calculated based on the expected major constituents of the injected gas stream of CO₂, CH₄, H₂, CO, and H₂O, which are all measured (as detailed below) on a volumetric or molar basis. The mass ratio is then calculated via the following equation:

\[
\text{Mass Ratio}_{\text{CO}_2} = \frac{\%\text{CO}_2 \times MW_{\text{CO}_2}}{\%\text{CO}_2 \times MW_{\text{CO}_2} + \%\text{CH}_4 \times MW_{\text{CH}_4} + \%\text{H}_2 \times MW_{\text{H}_2} + \%\text{H}_2\text{O} \times MW_{\text{H}_2\text{O}} + \%\text{CO} \times MW_{\text{CO}}}
\]

Where:
- \%\text{CO}_2, \%\text{CH}_4, \%\text{H}_2, \%\text{H}_2\text{O} and \%\text{CO} = volumetric composition of each constituent
- MW\text{CO}_2, MW\text{CH}_4, MW\text{H}_2, MW\text{H}_2\text{O} and MW\text{CO} = molecular weights of each constituent

The equation used by Shell to calculate total CO₂ injected would then be equal to the following:

\[
Emission_{\text{injected CO}_2} = \sum (\text{Mass}_{\text{injected gas}} \times \text{Mass Ratio}_{\text{CO}_2})
\]

As detailed above, this equation is functionally equivalent to the equation specified in the protocol.

#### Analyzer Measurements and Issues Identified

As originally defined by Shell in the OPP, the gas composition of the injected gas would be measured via a continuous online gas analyzer, located at the Quest CCS Facility (specifically located on the suction side of the seventh stage compressor). This analyzer measures data on a continuous basis (at a rate greater than once every 15 minutes), which is then aggregated by Shell on a daily basis for the purposes of calculating GHG emissions, which is in accordance with the protocol.

However, in early September 2015 (after the commencement of the Quest Project), Shell observed noticeable drifting in the...
measurement of CO₂ concentrations from the analyzer. Shell performed direct sampling and analysis in the Scotford laboratory to verify the composition of the injected gas, which confirmed that the analyzer results were not representative of the actual gas composition (analyzer results being as low as 91% CO₂, with the expected average CO₂ concentration being 99.4%). A limited number of analyzer results also drifted up to the high end of the range, with results up to 99.99% CO₂.

Upon further investigation, Shell identified the following three issues that contributed to the analyzer drifting:

- A manufacturer’s defect in the switching valve. This defect resulting in significantly higher wear and tear in the valves, causing leakage and therefore high variability in measured concentrations of CO₂
- Low accuracy in measurements due to low volume of injected gas samples
- High sensitivity in the analyzer to barometric pressure

Shell has indicated that the first two issues were resolved by the end of September 2016 through the installation of the higher-quality diaphragm valves and modifications to the injection loop that increased the analyzed sample volume, respectively. The third issue was resolved by Shell in February 3, 2017 through the use of an ambient pressure transmitter located elsewhere in the Upgrader to measure ambient pressure, which is used to correct the analyzer readings (a dedicated pressure transmitter for the analyzer was further installed in September 2017). Prior to February 3, 2017, the analyzer was therefore not considered reliable by Shell for the measurement of CO₂ composition for the duration of the 2nd crediting period.

For the other compounds in the injected gas stream (i.e. CH₄, H₂ and H₂O), no abnormalities in the analyzer measured composition values were specifically identified. For CO, this value is not measured by the analyzer; initially this value was estimated by dividing the CH₄ composition by 3.5, which was based on historical analysis.

**Alternative Methods to Substitute Data and Variance Request**

Due to the issues with the analyzer, the CO₂ composition of the injected gas stream was estimated based on a mixture of other methodologies for the 2nd crediting period. These methodologies are listed below:

- Analyzer data. Analyzer data was used when the sampled CO₂ concentration was greater than 99.0%. It is noted that some values (particularly when the analyzer was reading high – i.e. close to 99.99%) were not used, but were substituted using one of the two following methods.
- Laboratory analysis data. Shell collected grab samples of the injection gas stream, which are analyzed within the Scotford on-site laboratory via gas chromatography. During the 2nd crediting period, samples were not necessarily collected at a set frequency, with the following number of samples collected for each month of the crediting period:
Between September 1, 2015 and February 29, 2016, the laboratory analysis data was used to substitute analyzer data during periods when the CO₂ concentration measured by the analyzer dropped below 99.0%, or was high (i.e. 99.99%), which occurred between December 10, 2015 and January 28, 2016. GHD did observe that a number of analyzer results between January 28 and February 29, 2016 were substituted despite being above 99.0%, and well below 99.99%. This was done because Shell suspected that while the values are not necessarily outside of the expected range, they were higher than expected compared to laboratory sample results, and also include low swings. For recalculation purposes, GHD has elected to use a maximum threshold of 99.5% to screen out high results (this is equal to the highest CO₂ concentration measured by laboratory analysis during the 2nd and 3rd crediting periods), and has not screened out the January or February results from the analyzer unless they fail either of these criteria.

- Regression model. Due to the issues with the analyzer, Shell utilized laboratory sample data (for CO₂) and analyzer data (for CH₄ and H₂) to develop a regression model which would predict the CO₂ concentration in the stream from the CH₄ and H₂ composition. Shell has provided statistical data which demonstrates that the regression model developed showed a strong correlation between CH₄/H₂ and CO₂ concentration (a Multiple R value of 0.96). Shell has used this regression model data starting on March 1, 2016, and will replace analyzer data for the following conditions:
  - CO₂ (analyzer) – CO₂ (regression)<-0.3 (i.e. analyzer trending low), or
  - CO₂ (analyzer) – CO₂ (regression)>0.1 (i.e. analyzer trending high)

As per the Protocol, the required sampling frequency is not met when using the laboratory analysis or regression model, as the concentration is not directly measured continuously (while the regression model is using continuous data, it is not based on direct measurement). Therefore, the use of the laboratory analysis and regression model is a deviation from the Protocol.

In response to the analyzer issues, Shell submitted a variance request on August 24, 2016 (with a follow-up submitted on February 3, 2017) to allow for the use of the laboratory analysis and regression model to substitute the analyzer CO₂ in accordance with the schedules outlined above. This variance
<table>
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<th>Emission Source Group</th>
<th>Baseline Emissions – B1</th>
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<tr>
<td></td>
<td>request was approved by ACCO on March 13, 2017. Therefore, the above-noted substituting methodologies can be used by Shell for the 2nd crediting period. GHD has further confirmed that these substitution methodologies were actually used by Shell, with the one issue regarding the inconsistent laboratory sampling substitution for January and February noted above; the use of this data was determined to have an insignificant impact on the overall assertion.</td>
</tr>
<tr>
<td></td>
<td><strong>Results of TetraTech’s Audits</strong></td>
</tr>
<tr>
<td></td>
<td>TetraTech’s audit identified multiple discrepancies in this category. Of these, Issues 16-01, 16-02 and 16-05 – 16-10 are related to the B1-Injection CO2 emissions category. Issues 16-01 and 16-05 are addressed by the variance request, which is summarized above. Issue 16-02 was not relevant to the verification of the 2nd crediting period, as the injection CO2 meter was configured to record mass flow by the start of the 2nd crediting period. For the remaining items, the specific response by Shell along with GHD’s review of these issues is provided below:</td>
</tr>
<tr>
<td>16-06</td>
<td>GHD has confirmed that TetraTech’s finding (as it specifically relates to the data for the first crediting period) is valid; under normal operation of hydrogen plants, the main constituents of the effluent stream would consist of H2, CO2, CO and CH4 (the first three being the main reaction products, with CH4 being residual unreacted hydrocarbons), with minute quantities of other hydrocarbons. For the first crediting period (reviewed by TetraTech), quantities of other compounds were identified in the laboratory stream (for example, the average composition of N2 was 0.033%, H2S was 0.0027% and C2+ hydrocarbons was 0.044%); these compounds should not be present in the stream in these quantities. Shell has confirmed that this issue was due to improper purging of the laboratory analyzer, resulting in cross-contamination of the sample. Shell corrected this issue on September 30, 2016 through the purging of the analyzer prior to running samples from this stream. For the 2nd crediting period, Shell has not made any changes to the laboratory data used, which is consistent with the initial OPP as well as the variance request (it is noted that the mass ratio calculation ultimately corrects for impurities as it is only using the main constituents for the calculation).</td>
</tr>
<tr>
<td>16-07</td>
<td>GHD has confirmed that this finding is valid. The use of a normalized CO2 concentration and a molecular weight calculated with non-normalized data will change the mass ratio. Shell has modified this calculation in the SERS software by removing the normalization of the CO2 concentration.</td>
</tr>
<tr>
<td>16-08</td>
<td>GHD has confirmed that this finding is valid. The calibration gas used to calibrate the laboratory analyzer should be set to be as</td>
</tr>
</tbody>
</table>
close to the actual gas being measured as possible in order to ensure that the analyzer readings are representative, particularly in this case as the gas composition is not typical. Starting April 1, 2017, Shell commenced using a new calibration standard with a high CO₂ concentration, which corrects the finding. For the 2nd crediting period, as there is no additional suitable laboratory data available to substitute the Shell laboratory results, no changes have been made. GHD has been provided the daily laboratory analysis from before and after the implementation of the new calibration standard (September 1, 2016 to April 1, 2017 and April 1, 2017 to September 30, 2017, respectively). Comparing these readings to the previous laboratory analysis, the following was observed (for CO₂):

- Old calibration standard (September 1, 2016 – April 1, 2017):
  - Average: 99.36%
  - Standard Deviation: 0.348%
  - 95% confidence interval: 0.047%
  - Average: 99.43%
  - Standard Deviation: 0.057%
  - 95% confidence interval: 0.0085%

A statistical t-test analysis performed by GHD does demonstrate that these two averages are statistically different (with a confidence of p=0.0069). However, the difference is overall small enough as to not be materially different (it is noted this difference may be attributable to differences in the sample gas itself rather than the analyzer operation). Furthermore, while the standard deviation/confidence interval for the older analyzer data is higher, it is still small relative to the overall average, therefore there is minimal risk for material discrepancies.

16-09

GHD has confirmed that this finding is valid; comparing the laboratory results to the ratio calculation showed that CO was present in lower concentrations than what was calculated using the ratio. Starting October 1, 2016 (4th crediting period), Shell will be using an average of the CO measured by the on-site laboratory and third-party laboratory data. For the 2nd crediting period, Shell has elected to not change the method, using the ratio of 3.5. For GHD’s recalculations, the laboratory data has been used.

16-10

Based on a review of the analyzer data and Shell’s response to ACCO, it has been confirmed that this finding is not valid. The analyzer does measure all compounds on a wet basis (whereas TetraTech indicates it is a dry basis). Therefore Shell’s currently methodology is correct. No changes are required.
Emission Source Group | Baseline Emissions – B1
--- | ---

GHD has reviewed each of the above issues that were not corrected by Shell for the 2nd crediting period (Issues 16-06, 16-08 and 16-09). The assessment of materiality is provided below.

**Conclusion**

Based on GHD’s review, the variance request has been appropriately applied. All issues identified by TetraTech have been appropriately updated for future reports.

**Recalculations**

Based on the provided information, GHD has recalculated the B1 - Injection CO₂ emissions. These recalculations have yielded a difference of 102.3 tonnes CO₂, 0.02% of total baseline emissions and 0.03% of total reductions (overreported). This difference is primarily due to the issues identified above as well as rounding. This difference is not material. This further confirms that none of the issues identified by TetraTech that were not corrected by Shell (issues 16-06 and 16-08) will not result in material discrepancies.

**Conclusion**

The measurement of total gas injected is reasonable and in accordance with the Protocol.

A number of issues were identified with the analyzer installed to measure the CO₂ concentration and mass ratio. A variance request has been accepted by ACCO allowing Shell to use alternative substitution methodologies until the analyzer is deemed useable. GHD has confirmed that the variance request has been appropriately applied.

A number of minor discrepancies were identified by TetraTech; these issues will all be corrected by Shell for future reports. Some issues have not been updated for the 2nd crediting period.

GHD has confirmed that the reported emissions are materially correct. All uncorrected findings therefore do not result in a material discrepancy.

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Emission Source Group | Project Emissions – P3
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**Scope Item Verified**

P3 – Well Drilling and Construction Activities

**Verification Procedure**

GHD reviewed the methodologies used to quantify the total project emissions from well drilling and construction activities, and confirmed conformance to the requirements of the Protocol.

**Verification Findings**

In the Protocol, the emissions from construction and drilling activities can occur in vented gas due to kicks or blowout events. These events are reported on a per-event basis, with the emissions calculated based on the vented gas quantity and composition of the vented gas. During the second crediting period, Shell did not report any emissions from well drilling activities. GHD has confirmed there were no venting events due to well drilling in 2016, therefore this is appropriate.

**Conclusion**

No emissions were reported under well drilling or construction activities. GHD has confirmed that this is reasonable.
Emission Source Group | Project Emissions – P4
--- | ---
Scope Item Verified | P4 – Production of Material Inputs
Verification Procedure | GHD reviewed the methodologies used to quantify the total project emissions from the production of material inputs, and confirmed conformance to the requirements of the Protocol.

Verification Findings

**Project Emission Description**
The operation of the CCS requires a number of separate materials and chemicals. As outlined in the OPP, these materials include the following:
- Utility/Instrument Air
- Nitrogen
- Methyl diethanol amine (MDEA)
- Antifoam
- Activated Carbon
- Water
- Lubricant

Of the above chemicals, antifoam, lubricant and water emissions were considered insignificant by Shell in the initial submissions, and were therefore excluded.

**Protocol Calculation Methodology and Requirements**
As outlined in the Protocol, Section 4.1, Table 6, the calculation of material input emissions injected is based on the following equation:

$$Emiss_{Material inputs} = \sum (Input_i \times EF_{i,CO_2,CH_4,N_2O})$$

Where:
- \(Input_i\) = Total quantity of material consumed
- \(EF_{i,CO_2,CH_4,N_2O}\) = Emission factor for CO2, CH4, N2O or CO2e

There are no source-specific data management requirements for the consumption of material inputs beyond the general offset protocol guidance. GHD has reviewed the quantification of the consumption of material inputs and the emission factors used below.

**Calculation Methodology**

**Consumption of Material Inputs**
The total consumption of nitrogen is estimated based on a combination of metered quantities and engineering estimates. While a quantity of the nitrogen is directly metered, much of the nitrogen flow is below detection thresholds, requiring engineering calculations to estimate these flowrates. GHD has reviewed the estimation for nitrogen and confirmed that it is conservative and appropriate. It had been identified previously in TetraTech’s audit (Issue 16-13) that nitrogen used at the Injection Site was not included in the usage of nitrogen. Shell has since updated their calculations to include nitrogen usage at the wellpads, which GHD has verified has been completed.

The total consumption of utility/instrument air is estimated based on the maximum design flow rate of instrument air in the Quest project. This estimation method will give a conservative maximum.
Emission Source Group | Project Emissions – P4
---|---
| air usage rate, and therefore a conservative estimation of project emissions. For other materials, consumption is based on delivery records of materials to the Quest Facility. Materials are ordered on an as-needed basis to replace materials which are consumed in the project; the usage of the material during the crediting period is therefore assumed to be equal to the amount shipped during that time period. GHD notes that the actual consumption amounts may be different than the shipment amounts, however given the low amount of emissions associated with this source, this will not result in a material discrepancy in the claimed reductions. Emission Factor for Material Inputs The emission factors for each material inputs represent the total GHG emissions produced during the production and transportation of each input. For instrument and utility air, as air is supplied primarily by electric-driven compressors, the emissions associated with its production are based on the rated power for the compressor and air supply rate (0.597 MW of power divided by 4,500 sm³/hr = 1.327 x 10³ MWh/sm³), which is then multiplied by the Alberta grid emission factor for increased on-Site grid electricity usage (0.64 tonnes CO₂e/MWh). GHD has confirmed that this calculation is appropriate, and that the correct grid factor has been used. For other material inputs, Shell has utilized academic or related data to derive emission factors for the various materials. For example, the nitrogen emission factor has been derived based on a nitrogen production factor of 1.093 MWh/tonne N₂ published by the US Office of Technology Assessment, and the Alberta grid factor (since in this specific case, nitrogen is supplied by the Air Liquide Facility located on the Scotford Site). In some cases, no direct primary or secondary emissions data is available, so a reasonable analogue has been used; for example, data to calculate an emission factor for MDEA was not readily available, so a factor for monoethylamine (MEA) was derived and has been assumed to apply to MDEA (along with any other future amine solvents). GHD has reviewed the derivation of each material input emission factor, and has determined that the factors calculated are reasonable and conservative. Exclusion of Material Inputs from Project Emissions Of the above-listed materials, Shell has excluded the production emissions of antifoam, lubricant and water from the specific OPR reductions. The justification is that, based on the annual usage rate and calculated emission factors the annual project emissions would total less than 1 tonne CO₂e for each material, and are therefore not significant relative to the overall reductions. As per the Offset Guidance, there is no specific negligibility criteria beyond what is defined in the relevant protocol; therefore individual sources in emissions categories not defined as negligible cannot be excluded from the OPR. As the potential maximum emissions as calculated by Shell for each of the three materials could potential total a maximum of 1 tonnes CO₂e (as
defined in the OPP), this would represent a discrepancy of <0.01% of the total project emissions and reductions, and is therefore not material. GHD understands that the OPR has been updated to include the project emissions associated with lubricant usage; for the 2nd crediting period, there were no usages of lubricant.

**Result of TetraTech Audits**

TetraTech’s audit identified multiple discrepancies in the production of material inputs category. The specific responses by Shell along with GHD’s review of these issues is provided below:

**16-11**

GHD has confirmed that this finding is valid. The finding regarding lubricant is discussed above. For glycol and cathodes, GHD understands that Shell initially excluded these emissions from the quantification. It is noted that these were excluded as they are not considered to be directly part of the capture process itself. However GHD notes that as per the protocol this source includes emissions “resulting from increased upstream chemical production associated with project period chemical usage”. The implementation of the project results in the increased usage of glycol and cathodic protection. Furthermore, it is noted that the disposal/loss of these materials has been included in the P21 category. Therefore, GHD believes that the emissions from these two chemicals should be included in the project emissions. It is noted that no glycol was purchased during the 2nd crediting period, so these emissions are not applicable. For the cathodic protection, the amount added in the 2nd crediting period was unknown, so the potential emissions could not be calculated, however it is expected that this will be minimal. GHD understands that the OPR has been updated to include glycol and cathodic protection in the project emissions.

**16-12**

GHD has confirmed that this finding is valid, however Shell has provided an explanation (as part of the audit response to ACCO) that the emissions associated with water usage are already accounted for under the P8 electricity generation category. Water used by the project is sourced by the North Saskatchewan River, and is circulated via pumps and cooling fans, which are already included. Therefore no change is required.

**16-14/16-15**

GHD has confirmed these findings are valid. There is no required changes to emissions, as Shell will update the OPP to be consistent with the calculations.

**16-16**

GHD has confirmed that this finding is valid, and is discussed in additional detail above.

<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conclusion</td>
<td>Two non-material issues were identified in emissions associated with material inputs/outputs, which has since been updated. Otherwise the calculation of this category was determined to be appropriate.</td>
</tr>
</tbody>
</table>
### Emission Source Group | Project Emissions – P5/P6/P7
---|---
**Scope Item Verified** | P5/P6/P7 – Extraction/Processing of Fossil Fuels
**Verification Procedure** | GHD performed a detailed review of the methodologies used to calculate total fossil fuel usage and the emission factors used to confirm accuracy and conformance to the requirements of the Protocol.
GHD further reviewed Shell’s application of the findings of TetraTech’s audit to confirm all identified issues had been addressed.
GHD recalculated total project emissions from the extraction and processing of fuels to determine the overall materiality.

### Verification Findings

<table>
<thead>
<tr>
<th>Project Emission Description</th>
</tr>
</thead>
</table>
For the Quest Project, natural gas is the only fossil fuel required for either the on-site generation of electricity, the on-site and off-site generation of heat.

**Protocol Calculation Methodology and Requirements**
As outlined in the Protocol, Section 4.1, Table 6, the calculation of emission from fuel extraction and processing is based on the following equation:

\[
E_{Emission_{Fuel\ Extraction\ and\ Processing}} = \sum (Fuel_i \times EF_{i,CO_2,CH_4,N_2O})
\]

Where:
- Fuel\_i = Total quantity of fossil fuels consumed
- EF\_i, CO\_2, CH\_4, N\_2O = Emission factor for CO\_2, CH\_4, N\_2O or CO\_2e
Fuel consumption must be measured based on direct measurement of the quantity. For the emission factors, the factors must be from a specific reference document (no specific reference is set in the protocol).

**Calculation Methodology**

**Consumption of Fuels**
The total consumption of natural gas and GHD’s findings is documented in the findings for P9 (off-site heat generation) and P10 (on-site electricity and heat generation). As discussed below, issues were identified in the initial assertion for P9 regarding waste heat – Shell has elected to remove the waste heat credit for this assertion, and will add the waste heat back in once the revised methodology is approved.

**Emission Factor for Fuel Extraction/Processing**
The emission factors for fuel extraction/processing are taken from the “Carbon Offset Emission Factors Handbook”, Version 1.0, March 2015 (EF Handbook), published by AEP, Table 4. This table includes extraction and processing emissions for natural gas, diesel and gasoline.

**Result of TetraTech Audits**
One issue was identified by TetraTech (Issue 16-17); this issue is related to the multiple issues identified in the P9 category, which are discussed below. Beyond this issue, the calculation of emissions from the P5/P6/P7 categories are appropriate.

**Recalculations**
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P5/P6/P7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Based on the provided information, GHD has recalculated the P5/P6/P7 – Extraction/Processing of fossil fuel emissions. These recalculation have yielded a difference of 25.7 tonnes CO(_2)e, 0.02% of total project emissions and 0.01% of total reductions (overreported). This difference is primarily due to rounding. This difference is not material.</td>
</tr>
</tbody>
</table>

**Conclusion**
The input data and methodologies used to calculate emissions from fuel extraction and processing are reasonable and appropriate. Total reported emissions are materially correct.

<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope Item Verified</td>
<td>P8 – Off-Site Electricity Production</td>
</tr>
</tbody>
</table>

**Verification Procedure**
- GHD performed a detailed review of the methodologies used to calculate total electricity usage and the emission factors used to confirm accuracy and conformance to the requirements of the Protocol.
- GHD further reviewed Shell’s application of the findings of TetraTech’s audit to confirm all identified issues had been addressed.
- GHD recalculated total project emissions from the extraction and processing of fuels to determine the overall materiality.

**Verification Findings**

**Project Emission Description**
Electricity is required for the operation of multiple aspects of the Quest project:
- All equipment at the Capture Site, including compression, extraction equipment, lighting transformers and heat trace transformers
- Each of the injection sites (to run minor equipment)
- Electricity associated with increased usage of equipment in the Upgrader, specifically to run cooling tower fans

All off-site electricity for the 2\(^{nd}\) crediting period was taken from grid sources of electricity. GHD does note that the Scotford Site does contain a cogeneration unit producing both electricity and heat (located in the Shell Upgrader Facility); theoretically electricity from the cogen can be delivered to Quest (electricity from the cogen is delivered to the grid, then transferred to Quest), however separating this electricity is difficult to assume. It is noted that assuming grid electricity is more conservative (since the grid emission factor is by definition higher than a cogen).

**Protocol Calculation Methodology and Requirements**
As outlined in the Protocol, Section 4.1, Table 6, the calculation of emissions from off-site electricity production is based on the following equations:
### Emission Source Group

<table>
<thead>
<tr>
<th>Project Emissions – P8</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{Emission}_{\text{Off-Site Electricity Production}} )</td>
</tr>
<tr>
<td>( = \text{Electricity}<em>{\text{Grid}} \times EF</em>{\text{Grid}} + \text{Electricity}<em>{\text{LFE Cogen}} \times EF</em>{\text{LFE Cogen}} )</td>
</tr>
<tr>
<td>( + \sum \left( \text{Electricity}<em>{\text{LFE non-Cogen}} \times EF</em>{\text{LFE non-Cogen}} \right) )</td>
</tr>
<tr>
<td>( + \sum \left( \text{Electricity}<em>{\text{non-LFE}} \times EF</em>{\text{non-LFE}} \right) )</td>
</tr>
</tbody>
</table>

Where:

- \( \text{Electricity}_{\text{Grid}} \) = Total quantity of electricity sourced from the electrical grid (MWh)
- \( EF_{\text{Grid}} \) = Emission factor of grid electricity (tonnes CO\(_2\)e/MWh)
- \( \text{Electricity}_{\text{LFE Cogen}} \) = Total quantity of electricity from Large Final Emitter (LFE) (i.e. a Facility reportable under the SGER Annual Compliance Reporting program) cogeneration sources (MWh)
- \( EF_{\text{LFE Cogen}} \) = Emission factor of LFE Cogen electricity (tonnes CO\(_2\)e/MWh)
- \( \text{Electricity}_{\text{LFE non-Cogen}} \) = Total quantity of electricity from LFE non-cogeneration sources (MWh)
- \( EF_{\text{LFE non-Cogen}} \) = Emission factor of LFE Cogen electricity (tonnes CO\(_2\)e/MWh)
- \( \text{Electricity}_{\text{non-LFE}} \) = Total quantity of electricity from non-LFE Facilities (MWh)
- \( EF_{\text{non-LFE}} \) = Emission factor of non-LFE electricity (tonnes CO\(_2\)e/MWh)

In the case of the Quest Project for the 2\(^{nd}\) crediting period, all electricity is taken from grid electricity sources, so the above equation has therefore been simplified to the following:

\( \text{Emission}_{\text{Off-Site Electricity Production}} = \text{Electricity}_{\text{Grid}} \times EF_{\text{Grid}} \)

The data management requirements of the quantity of electricity consumed are outlined in Section 5.1.2, Table 9 of the Protocol, and are as follows (the requirements for Incremental, Directly Connected Electricity are listed below, however as all electricity provided is grid electricity, these requirements do not apply to the Quest Project):

- **Electricity Consumption**: Continuous measurement of electricity consumption or reconciliation of maximum power rating for each type of equipment and operating hours. Electricity meters must be calibrated by an accredited third-party in accordance with manufacturer specifications.
- **Incremental, Directly Connected Electricity**: Continuous measurement of electricity consumption or reconciliation of maximum power rating for each type of equipment and operating hours. Note that electricity under this category must meet the following three criteria:
  - Direct Connection: electricity source is directly connected to the site or through a recognized Industrial System Designation (ISD)
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Dedicated Electricity Contract: electricity is sourced using an electricity purchase agreement</td>
</tr>
<tr>
<td></td>
<td>- New or Unused Generating Capacity: electricity resulting from incremental electricity generating capacity that was not previous utilized (this electricity must either be newly installed or unused in an average hour over the three year period prior to and ending within 6 months of project initiation).</td>
</tr>
</tbody>
</table>

**Calculation Methodology**

**Consumption of Electricity**

As per above, there are three end-users of electricity associated with the Quest Project:

- **Quest Capture Site:** Total electricity at the Capture Site is measured via two electrical meters, one for the compressor motor power (52-16B) and one for the main Quest power (52-15B). Each of these two meters are maintained and calibrated by Shell at the Capture Site. The summation of these two meters provides the majority (approximately 97.5%) of total Quest electricity.

- **Quest Injection Site:** Total electricity at each of the three injection sites is metered based on third-party utility meters. Electricity invoices is provided to Shell’s production accounting department, who store all invoice data and provide the final monthly values.

- **Upgrader Electricity:** The incremental increase in electricity due to the Quest Project at the Upgrader is calculated based on engineering estimates. These estimates are summarized below:

  - For cooling towers, electricity usage is estimated based on the measured usage of the cooling towers, rated fan speed, measured total cooling water usage rate (on a daily basis) and the rated cooling water requirements of the Quest Project, as follows:

    \[
    \text{Electricity}_{CT} = \text{Fan Rating} \times \% - \text{Fan Load} \times \frac{\text{Quest cooling water}}{\text{Total cooling water}}
    \]

  - All other electrical sources (transformers, etc.) are calculated based on known rating an estimated annual load.

GHD notes that for the above unmetered quantities there is some risk that the values are not necessarily representative of total electricity. Compared to total electrical usage at the Capture and Injection Sites, the total electrical increase from Quest at the Upgrader has been estimated to be equal to approximately 2.3% of total Project electricity requirements, therefore there is minimal risk of material discrepancy.
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P8</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHD has reviewed the above methodologies and confirmed they are reasonable and conservative. Further, GHD has confirmed that the measurement of each type are in accordance with the protocol monitoring requirements and that the direct meters used are calibrated by an accredited third-party (Chemco Electrical Contractors Ltd., a member of the Electric Contractors Association of Alberta).</td>
<td></td>
</tr>
</tbody>
</table>

**Emission Factor for Off-Site Electricity**

The main grid electricity factor as published in the EF Handbook, Table 2 for “Increased on-Site grid electricity” was used by Shell. GHD has confirmed that the appropriate emission factor has been utilized.

**Result of TetraTech Audits**

No issues were identified by TetraTech regarding this finding.

**Recalculations**

Based on the provided information, GHD has recalculate the P8 – Off-Site Grid Electricity emissions. These recalculations have yielded a difference of 128.4 tonnes CO₂e, 0.11% of total project emissions and 0.04% of total reductions (overreported). This difference is primarily due to rounding. This difference is not material.

**Conclusion**

The methodologies and sources of data to measure total consumption of electricity are reasonable and conservative. The appropriate emission factors were used. Reported emissions are materially correct.

<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope Item Verified</strong></td>
<td>P9 – Off-Site Heat Production</td>
</tr>
<tr>
<td><strong>Verification Procedure</strong></td>
<td>GHD performed a detailed review of the methodologies used to calculate the following quantities:</td>
</tr>
<tr>
<td></td>
<td>• Total steam production</td>
</tr>
<tr>
<td></td>
<td>• Calculation of gas combustion from steam production</td>
</tr>
<tr>
<td></td>
<td>• The derivation of CO₂, CH₄ and N₂O emission factors</td>
</tr>
<tr>
<td></td>
<td>GHD then confirmed that these methodologies are accurate and conform to the requirements of the Protocol.</td>
</tr>
<tr>
<td></td>
<td>GHD further reviewed Shell’s application of the findings of TetraTech’s audit to confirm all identified issues had been addressed.</td>
</tr>
<tr>
<td></td>
<td>GHD recalculated total project emissions off-Site heat production to determine the overall materiality.</td>
</tr>
<tr>
<td><strong>Verification Findings</strong></td>
<td><strong>Project Emission Description</strong></td>
</tr>
<tr>
<td></td>
<td>Heat in the form of steam is used in multiple operations at the Capture Site, including the separation and compression of the CO₂ stream. All steam for the process is sourced from the Upgrader steam header system. Note that similar to electricity above, none of the steam contribution comes has been assumed to come Upgrader cogeneration sources.</td>
</tr>
</tbody>
</table>
Steam is generated in the Upgrader using either natural gas delivered via pipeline by TransCanada Pipelines Ltd. (TransCanada) or fuel gas produced and consumed within the Upgrader. For natural gas, all composition data is based on third-party monthly data from TransCanada, which is downloaded by Shell personnel from TransCanada's website via a controlled login. Fuel gas is based on monthly internal sampling conducted on the fuel gas streams, which is analyzed in the Upgrader's on-Site laboratory via gas chromatography.

Heat is delivered to the Capture Site as both high-pressure (HP) and low-pressure (LP) steam, with both types of steam used in different aspects of the separation and compression of the CO₂ stream. Figure 1 following this report presents an overview of the Upgrader steam system, showing all inputs and outputs including the Quest LP steam system (HP steam is taken from a specified equipment source, and is not shown on the diagram).

**Protocol Calculation Methodology and Requirements**

As outlined in the Protocol, Section 4.1, Table 6, the calculation of emissions from off-site heat production is based on the following equations:

\[
\begin{align*}
Emission_{\text{off-site Heat Production}} &= \sum (Heat_{LFE\text{ Cogen}} \times EF_{LFE\text{ Cogen}}) \\
&+ \sum (Heat_{LFE\text{ non-Cogen}} \times EF_{LFE\text{ non-Cogen}}) \\
&+ \sum (Heat_{\text{non-LFE}} \times EF_{\text{non-LFE}}) \\
&+ \sum (Heat_{\text{waste}} \times EF_{\text{waste heat}})
\end{align*}
\]

Where:

- \(Heat_{LFE\text{ Cogen}}\) = Total quantity of heat from LFE cogeneration sources (GJ)
- \(EF_{LFE\text{ Cogen}}\) = Emission factor of LFE Cogen heat (tonnes CO₂e/GJ)
- \(Heat_{LFE\text{ non-Cogen}}\) = Total quantity of heat from LFE non-cogeneration sources (GJ)
- \(EF_{LFE\text{ non-Cogen}}\) = Emission factor of LFE Cogen heat (tonnes CO₂e/GJ)
- \(Heat_{\text{non-LFE}}\) = Total quantity of heat from non-LFE Facilities (GJ)
- \(EF_{\text{non-LFE}}\) = Emission factor of non-LFE heat (tonnes CO₂e/GJ)
- \(Heat_{\text{waste}}\) = Total quantity of heat from waste heat sources (GJ)
- \(EF_{\text{waste heat}}\) = Emission factor of waste heat (tonnes CO₂e/GJ)

The emission factors are further calculated using the following equations:

\[
\begin{align*}
EF_{LFE\text{ Cogen}} &= \left\{ \begin{array}{ll}
1 & \text{NEIL} \\
2 & (1 - T) \times EF_{\text{Boiler Fuel}}/0.8/HHV
\end{array} \right.
\]

\[
EF_{LFE\text{ non-Cogen}} = (1 - T) \times EF_{\text{Boiler Fuel}}/0.8/HHV
\]

\[
EF_{\text{non-LFE}} = EF_{\text{Boiler Fuel}}/0.8/HHV
\]
Emission Source Group | Project Emissions – P9

Where:
- NEIL = Net emissions intensity limit for the cogeneration unit (if in units of tCO₂e/GJ)
- T = SGER Reduction Target (12% in 2015, 15% in 2016 for the Upgrader)
- $\text{EF}_{\text{Boiler Fuel}}$ = Emissions intensity for the fuel used in stand-alone boiler facility (i.e. source of heat)
- 0.8 = Assumed efficiency of source of heat
- HHV = Higher heating value of boiler fuel

The data management requirements of the quantity of fossil fuel combusted and associated energy produced are outlined in Section 5.1.2, Table 9 of the Protocol, and are as follows:

- Incremental Heat: continuous measurement of heat generation or reconciliation of maximum capacity rating for each type of equipment and operating hours. The incremental heat must either be from newly installed heat generating capacity or capacity that has not been utilized over the three year period prior to, and ending within 6 months of project initiation.

**Calculation Methodology**

**Consumption of High-Pressure Steam**

All HP steam used for the Quest Project is directly sourced from the Residual Hydrocarbon Conversion (RHC) unit at the Upgrader. The total consumption of HP steam (in units of tonnes/hr) delivered to the Quest Project is measured by a single meter, FI248004. In accordance with the Protocol, this source is considered an LFE non-Cogen source. GHD has reviewed this consumption methodology and confirmed it is in accordance with the requirements of the protocol (requiring direct measurement).

**Consumption of Low-Pressure Steam and Issues Identified**

Total LP steam used by the Quest Project is taken from the LP steam header in the Upgrader. There are three separate meters which measure LP steam usage (in units of tonnes/hr) from the LP steam header, FC246005, FC246006 and FI246120. The methodology to determine total LP steam is in accordance with the protocol (as it relates to total steam consumption only).

The LP header supplies and is supplied steam from multiple inputs and outputs from within the Upgrader boundaries, as well as imports/exports steam from other facilities within the Scotford Site (in particular the Upgrader Expansion and Refinery). Due to the complex and dynamic nature of the LP steam header system, there is no single source feeding the LP steam header that will be responsible for providing the increased steam requirements for the Project. Rather, the increased demand could potentially come from multiple sources, in particular the following:

- Steam from letdowns to the LP steam header. This includes steam from the medium pressure steam headers (IP and SHMP) let down in pressure to LP steam. This steam would otherwise remain as IP or SHMP steam in the absence of Quest (for use in other operations).
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Steam extracted from the steam turbine generator. The steam turbine generator produces electricity from HP steam. There is an extraction point located between the 9th and 10th stages of the generator which can produce LP steam. If this steam is not extracted, it is sent through the 10th-15th stages of the generator to produce further electricity, with the subsequent steam condensed in the surface condenser.</td>
</tr>
<tr>
<td></td>
<td>• Steam not sent to the excess steam condenser. In the case that there is an excess of LP steam without the subsequent demand, steam from the LP steam header is routed through a condenser.</td>
</tr>
<tr>
<td></td>
<td>• Steam from various non-waste heat recovery sources. This includes steam from the RHC, Atmospheric and Vacuum distillation units, equipment drivers, etc.</td>
</tr>
</tbody>
</table>

Of the above sources, steam from the letdowns and non-waste heat recovery sources have been defined by Shell as LFE non-cogen sources. GHD has confirmed this is appropriate, as the steam is ultimately produced via the combustion of fuel and would otherwise have been used to produce useful energy in the absence of Quest.

For steam extracted from the steam turbine generator, Shell has defined this steam under two categories:

|                       | • The portion of the steam which (if it was not extracted from the turbine) is condensed in the surface condenser is considered an LFE waste heat source. In the absence of Quest, this steam does not produce any useful heat, therefore this categorization is appropriate. |
|                       | • The portion which would have generated electricity is considered an LFE non-cogen source. Similar to above, this steam does produce useful energy, therefore this is appropriate. |

The steam that is not sent to the excess steam condenser is considered an LFE waste heat source, as no useful energy is produced.

While total LP steam to Quest is directly metered, the specific quantities of LP steam sourced from the above sources cannot be directly quantified. In order to calculate the project emissions, the Quest LP steam must be allocated between the various sources.

In the initial OPP, Shell and Cap-Op Energy (a third-party consulting firm retained by Shell) developed an allocation methodology to calculate the amount of steam from each of the above sources supplying the Project.

The initial allocation methodology developed by Shell is described in detail in the initial OPP and OPR developed by Shell. On a high level, this methodology allocated steam to Quest based on a priority-allocation model, with the “most expensive” (i.e. the higher operational cost) steam allocated first, under the principle that this steam would not be generated in the absence of Quest. Of the above steam sources, the order of allocation was let-down steam, steam extracted from the turbine, and then heat recovery source steam. All metered and measured steam from each of these
sources are allocated in order to Quest until the allocated steam equals the full metered Quest LP steam demand. It is noted that in the initial report, the excess steam condenser was not incorporated into the allocation.

In TetraTech’s audit of the 1st crediting period, multiple issues were identified; of specific note are Issues 16-18 and 16-19 (the other issues are summarized below).

**Issue 16-18:**
As per the protocol, Section 3.1, Table 4, all sources of off-site heat delivered to the project site must be able to be separated to quantify heat generated, and the quantity and type of fuels consumed to generate heat must be tracked. Furthermore, as per Section 4, Table 6 (page 39), the quantity of heat consumed for each category must be based on direct measurement used by the project. TetraTech concluded that this was not met by Shell, as the allocation methodology, as outlined above, is based on a financial allocation model, and is not based specifically on direct measurement of the actual quantities of the individual sources of LP steam sent to Quest.

**Issue 16-19:**
An extension of Issue 16-18, but more specifically related to the determination of steam from waste heat sources (in this case, from the steam turbine extraction). As per the initial methodology, all metered turbine extraction steam is assigned to Quest (after the let-down steam, and up to the metered Quest demand). As per the protocol, waste heat quantities must be directly measured, and furthermore must be proven to have been vented or dissipated to the environment during the baseline condition to be considered waste heat (protocol, Section 3.1, Table 4). Due to the above finding, the allocation methodology is not based on direct measurement, and therefore doesn’t prove that this waste heat was vented or dissipated to the atmosphere. In reviewing historical data, steam turbine extraction was observed to occur before Quest came online; during the 1st crediting period, an average of 91 tonnes/hr of steam was extracted, while before Quest came online, an average of 61 tonnes/hr of steam was extracted; this indicates that steam turbine extraction does occur during the baseline period and which contradicts Shell’s allocation methodology.

As a result of the above issues, the initial allocation methodology was determined to not be in compliance with the protocol requirements, and the calculation of the LFE non-cogen and waste heat LP steam is not appropriate.

**Variance Request and Retroactive Corrections to Waste Heat**
As a result of the above finding, Shell was directed by ACCO to update the steam allocation methodology in order to more accurately calculate the allocated steam quantities used by the Project and demonstrate that waste heat is being used. GHD understands that Shell has completed the following:
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• A variance request has been submitted to ACCO to allow for the use of a projection based, dynamic baseline rather than a historic fixed baseline for the P9 emissions.</td>
</tr>
<tr>
<td></td>
<td>• A new waste heat methodology has been developed that is based on more relevant plant data rather than a theoretical allocation model. This methodology was submitted as part of the variance request.</td>
</tr>
</tbody>
</table>

As of the completion of this verification report, the variance request is understood to still be under review by ACCO.

Shell has also submitted a request to ACCO to retroactively apply the waste heat credits for the 2nd-5th crediting periods once the waste heat methodology and variance request is approved by ACCO. Therefore, for the purposes of this verification, no waste heat has been claimed, and all steam usage and resulting emissions have been assumed to be from LFE non-cogen sources.

GHD has added an emphasis of matter to the verification statement to reflect the variance request currently under review for this source; this does not reflect a discrepancy on Shell’s part per se with the variance request, rather just to note the request and that waste heat is currently not being claimed.

**Calculation of Total Heat**

The total energy associated with the measured steam quantities as per above are calculated based on the enthalpy of steam and the mass and enthalpy of the condensate return from the Quest Project.

All condensate (from both HP and LP steam) is returned from Quest via a single meter, FI246085A. It has been assumed that 100% of the HP steam mass is returned as condensate, with the difference between the total measured condensate and HP steam equal to the condensate of LP steam returned. As the mass of HP steam used is much smaller than the mass of LP steam, this is conservative from an energy perspective (as it assigns additional energy to the LP steam) and is therefore reasonable.

The enthalpies are measured based on the measured temperature and pressure of the steam and condensate return. These quantities are measured via dedicated temperature and pressure transmitters on the Quest HP and LP steam and condensate lines:

- HP Steam – PI251020A (pressure), TI251084 (temperature)
- LP Steam – PI251022A (pressure), TI251020 (temperature)
- Condensate – PI246065 (pressure), TI246050 (temperature)

GHD has confirmed that this calculation is appropriate.

**Emission Factor for Natural Gas/Fuel Gas Consumption**

GHD has confirmed that the CO₂, CH₄ and N₂O emission factors are calculated using the equation for LFE non-cogen emission factor listed above, with fuel-specific CO₂ emission factors (in units of tonnes CO₂/m³), published CH₄ and N₂O emission factors (from the EF Handbook) and higher-heating values. The CO₂ emission factor and HHV are derived from gas sampling data. In reviewing the derivation of this factor, GHD has identified two issues:
The emission factor is calculated based on the target emissions intensity set by the SGER for the given compliance year (Protocol, Section 4, Table 6, page 38). GHD noted that in the OPP and calculations a target emissions intensity of 12%. GHD has confirmed this is the target emissions intensity for 2015 (so November-December of the 2nd crediting period), but for 2016 (January-March) it is 15%. Shell has confirmed that the target emission intensity was updated in SERS for the calculations.

The source of Upgrader steam consists of multiple gas-fired boilers (and waste heat sources), which are fueled either via third-party natural gas and/or internal fuel gas produced by the Upgrader. There are two separate fuel gas quantities, one for the Base Upgrader and one for the Expansion Upgrader. For the purposes of calculating the emission factors, Shell has utilized fuel-specific CO₂ tonne CO₂/m³ and HHV for third-party natural gas data only, despite some equipment utilizing fuel gas. This assumption was made by Shell to simplify the calculations, as well as it being assumed that natural gas is more conservative. As a comparison, GHD compared the CO₂ emission factors and HHV using Upgrader base plant fuel gas composition to natural gas and recalculated P9 emissions under the assumption all gas combusted is fuel gas. For the 2nd crediting period, this comparison yielded a discrepancy of 1,830.7 tonnes CO₂e (understated using the fuel gas factors) or 0.47%. This confirms that for the 2nd crediting period, the use of the natural gas composition is more conservative. This issue was also noted by TetraTech in their audit (Issue 16-23); Shell has indicated that the two sets of composition data will be compared monthly on a go-forward basis to confirm an emission factor based on natural gas is conservative for the crediting period.

Besides the above issues, GHD has confirmed that the derivation of the off-Site heat generation emission factor is appropriate.

**Result of TetraTech Audits**

TetraTech’s audit identified multiple discrepancies in the off-Site heat generation category. Issues 16-18, 16-19 and 16-23 and Shell’s responses to these issues are discussed above. For the other issues, the specific responses by Shell along with GHD’s review of these issues are provided below:

**16-20**

GHD has confirmed this finding is valid, however this is not applicable for this verification report as it specifically is related to the original waste heat allocation methodology, specifically the calculation of steam associated with let-downs. As per above, the waste heat credit (and as such the need for an allocation) has not been applied to this report, therefore this calculation is not needed and has not been reviewed by GHD for this verification.

Shell has acknowledged that with the new waste heat methodology (currently being reviewed), the steam from letdowns
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>has been calculated differently, therefore this issue is not as relevant. GHD has not performed a review of this calculation for this specific verification; once the waste heat allocation is added back to the project, this issue will be confirmed.</td>
</tr>
<tr>
<td><strong>16-21</strong></td>
<td>GHD has confirmed that this issue was corrected by Shell, with the proper links to LP steam pressure and temperature to calculate the enthalpy.</td>
</tr>
<tr>
<td><strong>16-22</strong></td>
<td>GHD has confirmed this issue is valid. As per TetraTech’s finding, the difference between the ASME 1967 and IAPWS-IF97 steam tables are immaterial. Shell has elected to continue to use the ASME 1967 tables for the initial 2nd-5th crediting periods reports (with no waste heat) due to the minor difference, but will update to the newer tables once the new waste heat methodology is implemented. GHD has used IAPWS-IF97 steam tables in the recalculations and confirmed that the differences are immaterial.</td>
</tr>
<tr>
<td><strong>16-24</strong></td>
<td>GHD has confirmed this change has been made to the OPP. This has no effect on the emissions calculations.</td>
</tr>
<tr>
<td><strong>16-25</strong></td>
<td>GHD has confirmed this finding is valid. The materiality of this issue calculated by TetraTech is 0.64% of total P9 emissions and up to 0.064% of total reductions (for the 1st crediting period), so this is not expected to be a material misstatement. Shell is proposing to ACCO to use a daily calculation interval to keep consistency with the new waste heat methodology (which requires daily calculations).</td>
</tr>
<tr>
<td><strong>Recalculations</strong></td>
<td>Based on the provided information, GHD has recalculated the P8 – Off-Site Heat Generation emissions. These recalculations have yielded a difference of 409.03 tonnes CO₂e, 0.34% of total project emissions and 0.13% of total reductions (overreported). This difference is primarily due to rounding. This difference is not material.</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>The measurement of total steam delivered to Quest is reasonable and in accordance with the Protocol. Significant issues had been previously identified by TetraTech regarding the baseline condition for off-site heat generation and allocation of waste heat, requiring a restatement of the waste heat allocation and variance request to allow for a dynamic baseline condition; these revisions have not yet been approved by ACCO. To allow for the issuance of credits, ACCO has allowed Shell to submit without a waste heat credit (conservatively assuming all steam is from non-waste heat sources), with retroactive corrections to include the waste heat once the revised methodology is approved.</td>
</tr>
</tbody>
</table>
### Emission Source Group | Project Emissions – P9
---|---
| | A number of minor discrepancies were identified by TetraTech; these issues will all be corrected by Shell for future reports. Additional issues were identified by GHD, which are all immaterial. For the revised project emissions (without the waste heat credit), GHD has confirmed the reported emissions are materially correct.

### Emission Source Group | Project Emissions – P10
---|---
| Scope Item Verified | P10 – On-Site Heat and Electricity Production
| Verification Procedure | GHD reviewed the methodologies used to quantify the total project emissions from on-Site heat and electricity production, and confirmed conformance to the requirements of the Protocol.
| Verification Findings | Potential emissions from on-Site heat and electricity generation include the combustion of natural gas or propane in equipment located at either the Capture Site or Injection sites. During the second crediting period, Shell did not report any emissions from on-Site equipment, with all heat and electricity requirements generated from off-Site sources. GHD has confirmed there was no on-Site usage, so this is appropriate.
| Conclusion | No emissions were reported under on-Site heat or electricity generation. GHD has confirmed that this is appropriate.

### Emission Source Group | Project Emissions – P11
---|---
| Scope Item Verified | P11 – CCS Facility Operation
| Verification Procedure | GHD reviewed the methodologies used to quantify the total project emissions from the operation of the CCS Facility, and confirmed conformance to the requirements of the Protocol.
| Verification Findings | **Project Emission Description**
The operation of the CCS Facility includes multiple transportation emission sources:
- Gasoline/Diesel – in various vehicles for inspection and maintenance
- Aviation Turbo Fuel – in light aircraft used for pipeline inspections

**Protocol Calculation Methodology and Requirements**
As outlined in the Protocol, Section 4.1, Table 6, the calculation of emission from CCS Facility operation is based on the following equation:

\[
Emission_{\text{CCS Facility Operation}} = \sum (Fuel_i \times EF_i,CO_2,CH_4,N_2O)
\]

Where:
- \(Fuel_i\) = Total quantity of fuels consumed
- \(EF_i,CO_2,CH_4,N_2O\) = Emission factor for CO\(_2\), CH\(_4\), N\(_2\)O or CO\(_2\)e

There are no specific requirements for fuel consumption, with aggregation of fuels allowed.

| Calculation Methodology |
### Emission Source Group

#### Project Emissions – P11

<table>
<thead>
<tr>
<th>Consumption of Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>The total consumption of diesel, gasoline and aviation turbo fuel are tracked on a monthly basis by the Shell accounting department. Diesel and gasoline are tracked via cardlock records of fuel purchased for each vehicle assigned to the Quest Project. For aviation turbo fuel, the invoices for each flight taken are provided directly by the fuel supplier. The use of each of these records are appropriate.</td>
</tr>
</tbody>
</table>

**Emission Factor for Fuel Extraction/Processing**

The emission factors for diesel and gasoline are taken from the EF Handbook, Table 7. This source is appropriate.

For aviation turbo fuel, the emission factors are taken from the most recent version of Environment Canada and Climate Change’s (ECCC) National Inventory Report (NIR). GHD identified that the initial OPR listed emission factors for aviation turbo fuel based on an older (out-of-date) version of the NIR. The CO2 factor of 2.534E-03 g/L listed in the OPP, while the most recent version applicable to the 2nd crediting period (1990-2013, published in 2015) had a CO2 factor of 2.560E-3 g/L. Shell has since updated their calculations to use the up-to-date factors.

The use of the above emission factors are appropriate.

**Result of TetraTech Audits**

One issue was identified by TetraTech (Issue 16-26), which relates to the emission factors for aviation turbo fuel identified above. As documented above, this issue has been resolved.

**Conclusion**

The records used to determine total fuel consumption for CCS facility operation are appropriate. One issue with the emission factors had been identified, which has since been fixed.

### Emission Source Group

#### Project Emissions – P18

<table>
<thead>
<tr>
<th>Scope Item Verified</th>
</tr>
</thead>
<tbody>
<tr>
<td>P18 – Venting at Injection Sites</td>
</tr>
</tbody>
</table>

**Verification Procedure**

GHD reviewed the methodologies used to quantify the total project emissions from venting of injection gas at the injection well sites, and confirmed conformance to the requirements of the Protocol.

**Verification Findings**

**Project Emission Description**

The only venting emissions which are included as per the protocol include venting occurring after the CO2 injection metering point (since the baseline emissions are based on the direct metering). This includes venting from well head facility blowdowns, surface casing venting and well workover vents.

**Protocol Calculation Methodology and Requirements**

As outlined in the Protocol, Section 4.1, Table 6, the calculation of emission from venting is based on the following equation:

\[
\text{Emissions}_{\text{Venting at Injection Well Sites}} = \sum (V_{\text{Gas vented}} \times \%_{\text{CO2,CH4,N2O}} \times \rho_{\text{CO2,CH4,N2O}})
\]
Emission Source Group | Project Emissions – P18
--- | ---

**Where:**

\[ \text{Vol}_{\text{gas vented}} = \text{Total volume of gas vented (for each venting type)} \]

\[ \%_{\text{CO}_2, \text{CH}_4, \text{N}_2\text{O}} = \text{Volume-percentage of CO}_2, \text{CH}_4 \text{ and N}_2\text{O} \]

\[ \rho_{\text{CO}_2, \text{CH}_4, \text{N}_2\text{O}} = \text{density of CO}_2, \text{CH}_4 \text{ and N}_2\text{O} \]

The volume of gas vented can be estimated or directly measured as per the protocol, while the composition should be based on the frequency of the injection gas composition (if used).

**Calculation Methodology**

**Gas Vented**

For blowdown and workovers, vented quantities are estimated for each venting event and tracked in the mass balance spreadsheet. None of these events occurred during the 2\(^{nd}\) crediting period.

Surface casing venting is estimated based on the results of yearly vent rate measurements for each well. These tests were completed in June 2015, and were assumed to occur at a constant rate throughout the 2\(^{nd}\) crediting period (and 1\(^{st}\) prior to that), and only changed when the next vent rate measurement occurred (during the 3\(^{rd}\) crediting period). Assuming a constant venting rate based on the vent rate measurement test is a conservative estimation method, and is appropriate.

**Composition of Vented Gas**

The composition of the surface casing vent gas is determined based on the sampling conducted during the vent rate measurement tests for each well. GHD observed that the composition results are then averaged for the wells using a straight average; due to the differing well vent rates, a weighted average would be more appropriate. Otherwise, the sampling of the well surface casing vent gas is appropriate.

**Result of TetraTech Audits**

No issues were identified for this source by TetraTech.

**Recalculations**

Based on the provided information, GHD has recalculated the P18 – Injection Well Venting emissions. These recalculations have yielded a difference of 0.30 tonnes CO\(_2\)e, <0.01% of total project emissions and total reductions (underreported). This difference is primarily due to using the weighted average composition vs. straight average. This difference is not material.

**Conclusion**

The quantification of total vented gas is reasonable. A non-material issue for the composition calculation was identified. The total project emissions are reasonable.

---

Emission Source Group | Project Emissions – P19
--- | ---

Scope Item Verified | P19 – Fugitives at Injection Sites

Verification Procedure | GHD reviewed the methodologies used to quantify the total project emissions from fugitive emissions at the injection well sites, and confirmed conformance to the requirements of the Protocol.
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P19</th>
</tr>
</thead>
</table>
| Verification Findings | **Project Emission Description**<br>Similar to venting, the only fugitive emissions which are included as per the protocol include fugitives occurring after the CO₂ injection metering point (since the baseline emissions are based on the direct metering). This includes fugitives from components located after the injection meter, along with gas migration.**Protocol Calculation Methodology and Requirements**<br>As outlined in the Protocol, Section 4.1, Table 6, the calculation of emission from fugitives is based on the following equation:<br>
\[
Emissions_{Fugitives \text{ at Injection Well Sites}} = \sum (Fitting_i \times ER_{Fitting_i}) + Other \text{ Fugitive Releases}
\]

Where:<br>
- **Fitting_i** = Number of each type of Fitting (including wellheads, valves and flanges)<br>- **ER_{Fitting_i}** = Emission rate for each fitting type<br>- **Other Fugitive Releases** = fugitives releases from other sources (gas migration, etc.)<br>

There are no specific monitoring requirements.<br>
**Calculation Methodology**<br>
**Fitting Counts and Emission Rates for Fittings**<br>For the fugitive emissions from fittings, the total fitting counts were done at project outset. The emission rates are based on the published emission factors published in the American Petroleum Institute “Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry” (API Compendium), Tables 6-4 and 6-12. These emission factors are for total organic compounds – to convert to CO₂, equation 6-10 of the API compendium (multiplying by the square root of the ratio of the CO₂ and CH₄ molecular weights).<br>
**Gas Migration Fugitive Emissions**<br>The fugitive releases from gas migration are calculated similarly to surface casing venting, using the gas migration fugitive rates (measured based on a once/year test) and the composition of the gas migration based on the annual tests. GHD has confirmed this is appropriate.<br>
**Result of TetraTech Audits**<br>Two issues were identified by TetraTech:<br>**16-27**<br>GHD has confirmed that this finding is valid. The API fugitive emission factors (referenced above) are for organic streams, and should, according to the protocol, be corrected based on the weight fraction of CH₄ to get the actual CH₄ rate prior to correcting for CO₂. Shell has indicated the method applied will result in conservatively high emission rates (since there is no weight fraction correction to lower the emission rate), therefore no change have been made. GHD has concluded that this is appropriate,
### Emission Source Group

**Project Emissions – P19**

Since it is ultimately a conservative estimate and, considering the minimal contribution of this source to total project emissions (<0.01%), any issue is unlikely to result in a material discrepancy. **16-28**

GHD has confirmed that this finding is valid. This issue is only present in the OPP and OPR, and does not affect the reported emissions.

**Conclusion**

The calculation of total fugitive emissions is reasonable and appropriate.

### Emission Source Group

**Project Emissions – P20**

#### Scope Item Verified

P20 – Emissions from Subsurface

#### Verification Procedure

GHD performed a detailed review of the various methodologies used to monitor and measure potential and actual CO₂ emissions from the subsurface to confirm accuracy, reasonableness and conformance to the requirements of the Protocol.

#### Verification Findings

**Project Emission Description**

This emission source includes passive venting occurring out of the storage reservoir(s) due to undetected faults, fractures or compromised equipment. It is expected that under normal operation this emission source will have negligible emissions (reflecting complete containment of the CO₂ underground). However the protocol requires a measurement, monitoring and verification (MMV) plan be conducted be approved at project outset which details the methodologies used by the proponent to quantify potential leaks from the reservoir.

**Protocol Calculation Methodology and Requirements**

As outlined in the Protocol, Section 4.1, Table 6, the calculation of emission from fugitives is based on the following equation:

\[
\text{Emission}_{\text{Subsurface to Atmosphere}} = \frac{\text{Mass CO}_2 \text{ leaked}}{\text{CO}_2 \text{ reported} \times (1 + \text{Uncertainty}_{\text{System}})}
\]

The maximum uncertainty shall be +7.5%; if the overall uncertainty is quantified to be greater than +7.5%, an adjustment shall be required. The CO₂ reported quantity is then adjusted to reflect the uncertainty as per Appendix B of the Protocol:

\[
\text{CO}_2,\text{reported} = \text{CO}_2,\text{quantified} \times (1 + \text{Uncertainty}_{\text{System}})
\]

The detailed MMV requirements for containment are listed in the Protocol, Section 5.1.3. These are summarized below:

- The MMV is required to be submitted as part of the Project application needed under the Mines and Minerals Act, as amended by the Carbon Capture and Storage Statutes Amendment Act (Alberta Regulation 68/2011).
- The directives which specify measurement and monitoring include:
  - Directive 007/017 – measuring and reporting acid gas injection
  - Directive 020 – requirements for well abandonment, leakage detection and mitigation
The project must have an MMV which is specific to the storage complex.

The MMV must be prepared in accordance with the requirements of the AER, and must demonstrate the project operates in accordance with the operating license. The MMV must be updated as required by the AER.

MMV requirements apply to the following four project phases:

- **Pre-Injection** – characterization and identification of risks, select monitoring approach, and acquire baseline data
- **Injection** – monitoring of activities to manage containment, and update as needed to ensure effectiveness
- **Closure** – monitor to manage containment risk and demonstrate permanent storage
- **Post-Closure** – monitoring requirements are transferred to the Government of Alberta to ensure storage is behaving in stable and predictable manner

**Quest Measurement, Monitoring and Verification Plan**

The most current version of the MMV plan as of the 2nd crediting period was prepared by Shell January 31, 2015. It is noted that an updated MMV plan was prepared by Shell on February 27, 2017, and approved by AER on May 10, 2017. This updated MMV plan was not applicable to the 2nd crediting period, and is noted here for reference.

The MMV was developed by Shell to focus on the monitoring of the storage reservoir and surrounding environmental domains to ensure both containment and conformance of CO₂ in the storage complex. Monitoring is completed in the following domains:

- **Atmosphere** – air above ground where the CO₂ reservoir is located.
- **Biosphere** – soil and ecosystems where organisms are located. Focuses on soil monitoring.
- **Hydrosphere** – includes all subsurface between ground surface and the base of groundwater protection (located at the top of the Geosphere). Primarily focuses on groundwater monitoring.
- **Geosphere** – rock formations below base groundwater protection. Includes the Basal Cambrian Sands (BCS) formation, which is the specific storage reservoir used by Quest for storage.

Multiple monitoring technologies are used in each domain. The rationale for selecting each technology is documented in the MMV plan.
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>plan. The specific monitoring technologies used in each domain are summarized below:</td>
</tr>
<tr>
<td><strong>Atmosphere</strong></td>
<td>Lightsource – a technology which utilizes laser monitoring systems to measure and map CO₂ emissions in real-time above a specific monitoring location (generally the well pads). Provides real-time data.</td>
</tr>
<tr>
<td></td>
<td>Eddy covariance – this technology was used in conjunction with Lightsource up to the end of 2015, after which it was discontinued due to the effectiveness of Lightsource</td>
</tr>
<tr>
<td><strong>Biosphere</strong></td>
<td>Surface CO₂ flux and soil gas monitoring – sampling of soil to measure the CO₂ concentrations and CO₂ flux measurements. These sampling events are defined as occurring semi-annually in 2015 and 2016.</td>
</tr>
<tr>
<td></td>
<td>CO₂ tracer analyses – measure the concentration of ¹³C CO₂ (i.e. carbon 13 isotopes of CO₂), based on the knowledge that the ratio of ¹³C CO₂ to ¹²C CO₂ is different between industrial and natural sources of CO₂ (therefore higher concentrations of ¹³C CO₂ indicate industrial CO₂ from the reservoir). Conducted in conjunction with soil gas sampling</td>
</tr>
<tr>
<td><strong>Hydrosphere</strong></td>
<td>Continuous groundwater monitoring – there are a total of nine groundwater wells located between the three injection sites (two at Wells #1 and 3, and 5 at Well #2). Each well is installed with probes which measure the groundwater pH and electrical conductivity in the groundwater. Continuous monitoring is in place for each parameter.</td>
</tr>
<tr>
<td></td>
<td>Discrete groundwater sampling – in addition to the continuous monitors, discrete sampling is conducted on a quarterly basis on both the project groundwater wells and on selected wells located on various landowner properties within a defined 1 km radius around each injection site (not all private wells are subjected to quarterly sampling). This discrete sampling includes pH, conductivity and tracer analysis along with the measurement of ion concentrations (arsenic, bicarbonate and other metals) to measure potential acidification.</td>
</tr>
<tr>
<td><strong>Geosphere</strong></td>
<td>Injection Wells – the injection wells each have the following monitoring systems:</td>
</tr>
<tr>
<td></td>
<td>- Wellhead pressure-temperature gauges</td>
</tr>
<tr>
<td></td>
<td>- Injection rate</td>
</tr>
<tr>
<td></td>
<td>- Downhole pressure-temperature gauges</td>
</tr>
<tr>
<td></td>
<td>- Fibre optic system for distributed temperature sensing (DTS)</td>
</tr>
<tr>
<td></td>
<td>- Annulus pressure gauges</td>
</tr>
</tbody>
</table>
The pressure/temperature gauges are used to monitor pressure changes in the geosphere to confirm if there is any pressure build-up due to loss of containment. All monitoring is conducted on a continuous basis. As noted above, the DTS data were stored in separate storage located on each well during the 2nd crediting period, then transferred for archiving.

In addition, time-lapse logging (cement bonds, ultrasonic casing and electromagnetic casing) will be completed every 5 years at each well. Hydraulic isolation logging was carried out pre-injection and will be carried out post-injection.

- Deep Monitoring Wells – one deep monitoring well is installed at each injection site. Downhole pressure-temperature monitors are located at each deep monitoring well. In addition, Well #2 also has a microseismic monitors (geophones), which measure seismic activity potentially caused by the injected gas.

- Time-lapse seismic surveys – Additional seismic surveys were conducted during the pre-injection and one just after injection to monitor the seismic changes. Additional surveys will be conducted in future timeframes after injection to image the CO₂ plume

- Interferometric Synthetic Aperture Radar (InSar) monitoring – a satellite-based system which is used to map displacements in the Earth’s surface potentially caused by the CO₂ injection (down to a precision of ±0.87 mm/year). Satellite image collection for InSar is performed on a monthly basis.

The results from all monitoring is summarized in quarterly reports. An annual status update report detailing the yearly monitoring results, status of the MMV plan and future activities is also prepared.

**Monitoring Conducting for 2nd Crediting Period**

GHD has confirmed that all of the above monitoring has been performed as required for the 2nd crediting period, or was otherwise conducted on schedule. Besides the continuous or monthly monitoring outlined above, the following analyses were conducted during (or conducted outside but were applicable to) the crediting period:

- Surface and soil sampling: Conducted June 2015 (prior to injection), October 2015 and June 2016. All sampling was conducted outside of the 2nd crediting period but in accordance with the semi-annual sampling requirements

- Groundwater – sampling events occurred in Q4 2015 and Q1 2016

**Results of Monitoring**

The 2015 annual status report along with the quarterly report for Q1 2016 have been provided to GHD. No trigger events were identified at any level of monitoring during the timeframe covered by either report. It was identified in both reports that the discrete groundwater sampling events showed that some results were outside the parameters from the pre-injection samples. None of
### Emission Source Group | Project Emissions – P20
--- | ---
|  | these sample results have been identified as significant with respect to loss of CO₂ containment. Therefore no emissions have been identified from the subsurface.

**Result of TetraTech Audits**

No issues were identified by TetraTech regarding this finding.

**GHD Review of Monitoring Activities**

GHD has been provided the 2015 annual status report and Q1 2016 summary report, along with the full MMV plan. GHD has reviewed the monitoring activities and results. GHD has confirmed that Shell has met the requirements of the protocol for monitoring.

Based on GHD’s review, the monitoring program utilized by Shell to monitor the subsurface emissions of CO₂ is very comprehensive and detailed, with multiple levels of monitoring from the reservoir itself up to the atmosphere. This detailed monitoring allows multiple levels of redundancy in both the detection and quantification of potential leaks from the subsurface.

With respect to the 2nd crediting period, GHD has confirmed that the requirements of both the protocol and Shell’s MMV plan have been met, and that the assertion of 0 emissions from the subsurface for the 2nd crediting period is reasonable.

**Conclusion**

Shell utilizes multiple levels of monitoring for emissions from the subsurface. GHD has confirmed that this monitoring program is both reasonable and in accordance with the protocol. GHD has confirmed that Shell’s assertion of 0 emissions is appropriate.

### Emission Source Group | Project Emissions – P21
--- | ---
| Scope Item Verified | P21 – Loss, disposal or recycling of materials
| Verification Procedure | GHD reviewed the methodologies used to quantify the total project emissions from the loss, disposal and recycling of materials for the Project, and confirmed conformance to the requirements of the Protocol.

**Verification Findings**

**Project Emission Description**

As summarized above, multiple materials and chemicals are used in the Quest project. Throughout the lifespan, these materials are ultimately lost or require disposal and recycling. outlined in the OPP, these materials include the following:

- Methyl diethanol amine (MDEA)
- Glycol
- Antifoam
- Wastewater
- Activated carbon
- Nitrogen
- Instrument/utility air
- Cathodic Protection
- Lubricant
- Refrigerants

Of the above chemicals, antifoam, activated carbon, nitrogen, instrument/utility air, cathodic protection and lubricant emissions
have been considered insignificant by Shell, and are therefore excluded. There would be zero emissions from the loss of nitrogen and instrument/utility air, as these materials do not result in GHG emissions.

**Protocol Calculation Methodology and Requirements**

As outlined in the Protocol, Section 4.1, Table 6, the calculation of material input emissions injected is based on the following equation:

\[
\text{Emissions}_{\text{Material Inputs}} = \sum (\text{Vol Use}_i \times \text{EF Used}_i,\text{CO}_2,\text{CH}_4,\text{N}_2\text{O})
\]

Where:

- \(\text{Vol Use}_i\) = Total quantity of material lost, disposed or recycled
- \(\text{EF Used}_i,\text{CO}_2,\text{CH}_4,\text{N}_2\text{O}\) = Emission factor for \(\text{CO}_2\), \(\text{CH}_4\), \(\text{N}_2\text{O}\) or \(\text{CO}_2\text{e}\)

There are no source-specific data management requirements for the consumption of material inputs beyond the general offset protocol guidance. GHD has reviewed the quantification of the consumption of material inputs and the emission factors used below.

**Calculation Methodology**

**Loss, Disposal or Recycled of Material Inputs**

For wastewater, the total consumed is measured based on metered quantities of wastewater to the on-Site Wastewater Treatment Plant. This quantity is determined via a single metered quantity (FC246009).

All other materials are quantified using similar methods as the usage of materials under the P4 category (generally using delivery records), as it has been assumed that any materials purchased are replacing materials lost, disposed or recycled. GHD has confirmed this is a reasonable assumption.

**Emission Factor for Material Loss, Disposal and Recycling**

The emission factors for each material loss, disposal or recycling represent the total GHG emissions produced during the disposal or recycling of each input. For amine, glycol, antifoam and lubricants, Shell assumes that these materials are disposed via complete combustion, which is considered the worst-case disposal method from a GHG perspective. The total carbon mass of each material is estimated (as the exact molecular formula is not known). For lubricants, emissions are estimated using the US Environmental Protection Agency (EPA) Emission Factor Hub.

For wastewater, the emission factor is calculated based on the measured chemical oxygen demand (COD) and equation 6-13 in the API Compendium. Shell has indicated that as the Upgrader WWTP is not overloaded, no anaerobic digestion occurs, therefore only \(\text{CO}_2\) emissions occur. \(\text{N}_2\text{O}\) emissions are considered to be minimal and are excluded.

For refrigerants, it is assumed to be lost to atmosphere, so the total top-up quantities are multiplied by the global warming potentials.
<table>
<thead>
<tr>
<th>Emission Source Group</th>
<th>Project Emissions – P21</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GHD has confirmed that the calculation of emission factors for each quantity above are appropriate. Exclusion of Material Inputs from Project Emissions Of the above-listed materials, Shell has excluded the loss, disposal and recycling of antifoam, activated carbon (discussed below) and cathodic protection. The justification is that, based on the annual usage rate and calculated emission factors the annual project emissions would total less than 1 tonne CO₂e for each material, and are therefore not significant relative to the overall reductions. As per the Offset Guidance, there is no specific negligibility criteria beyond what is defined in the relevant protocol; therefore individual sources in emissions categories not defined as negligible cannot be excluded from the OPR. As the potential maximum emissions as calculated by Shell for each of the six materials could potentially total a maximum of 1 tonnes CO₂e (as defined in the OPP), this would represent a discrepancy of &lt;0.01% of the total project emissions and reductions, and is therefore not material. GHD has confirmed that during the 2nd crediting period, the only reportable emission source was from wastewater, as no other materials were purchased (and therefore no other materials considered to have been lost, disposed or recycled). Result of TetraTech Audits TetraTech’s audit identified one discrepancy in the loss, disposal and recycling of material inputs category. The specific responses by Shell along with GHD’s review of these issues is provided below: 16-29 GHD has confirmed that this finding is valid. However, GHD understands that as per Shell’s response that activated carbon actually used in the process is typically recycled carbon, not newly produced, so in practice there should not be much in the way of recycling emissions from activated carbon, and any emissions would therefore be included in the P4 quantification. GHD also notes that the expected emissions from activated carbon usage is minimal, so this should not result in a material discrepancy. There were no purchases of activated carbon during the 2nd crediting period, therefore this finding is not applicable. Conclusion One non-material issue was identified in emissions associated with material loss, disposal and recycling. Otherwise the calculation of this category was determined to be appropriate.</td>
</tr>
</tbody>
</table>

### 10.2 Summary of Unadjusted Differences

A summary of the unadjusted differences described in the verification findings above is presented below:
<table>
<thead>
<tr>
<th>Unadjusted Difference Type</th>
<th>Description of Difference</th>
<th>Verification Findings Cross-Reference</th>
<th>Effect on the Greenhouse Gas Assertion</th>
</tr>
</thead>
</table>
| Quantitative Immaterial Misstatement | Multiple issues were identified in the CO₂ analyzer as initially installed. Shell received a variance request to utilize alternative CO₂ quantification methodologies to estimate CO₂ injected composition. | Section 10.2 “Baseline Emissions – B1”, pages 35-42 | • Alternative methods used to estimate CO₂ composition for 2nd crediting period  
• Variance request approved by ACCO |
| Quantitative Immaterial Misstatement | Multiple issues were identified by TetraTech (outside of the variance request). With respect to the CO₂ injection, three specific issues (16-06, 16-08 and 16-09) have not been specifically resolved for the 2nd crediting period (and will be resolved on an on-going basis). | Section 10.2 “Baseline Emissions – B1”, pages 35-42 | • Issue 16-06 was corrected by September 30, 2016. Very small quantities of impurities in gas stream were measured.  
• Issue 16-08 was corrected by April 1, 2017. GHD has confirmed that there is not a material difference in the samples, nor is the deviation in samples prior to the new calibration gas material.  
• Issue 16-09 was corrected by October 1, 2017. CO composition is minor in the injected gas.  
• GHD has confirmed that these issues result in a discrepancy of 102.3 tonnes CO₂, 0.02% of baseline emissions, which is not material |
| Quantitative Immaterial Misstatement | It was identified (by TetraTech) that the methodology for allocating LP steam, and in particular determining waste heat is based on a dynamic baseline and is based on a conceptual model, which is not in accordance with the protocol.  
• Shell has submitted a variance request to utilize a dynamic baseline methodology to allocate LP steam usage. A variance request has been submitted to ACCO to use a dynamic baseline. This request also includes a request to use a revised steam allocation methodology. This variance request and allocation method is still under review as of the preparation of this verification report. | Section 10.2 “Project Emissions – P9”, pages 50-58 | • Currently not allocating any steam usage to waste heat, with all steam emissions being generated from combustion sources  
• Emphasis of matter to reflect both the variance request currently being reviewed by ACCO and no waste heat being claimed by Shell. |
<table>
<thead>
<tr>
<th>Unadjusted Difference Type</th>
<th>Description of Difference</th>
<th>Verification Findings Cross-Reference</th>
<th>Effect on the Greenhouse Gas Assertion</th>
</tr>
</thead>
</table>
| Quantitative Immaterial Misstatement | • A further variance request has been approved to allow Shell to resubmit the OPR for the 2nd-5th crediting periods once the revised methodology is approved to allow for retroactive corrections for waste heat.                                                                                                                                                                                                                          | Section 10.2 “Project Emissions – P9”, pages 50-58                                                                 | • Shell has updated to use more recent steam tables on a go-forward basis  
• Immaterial discrepancy for 2nd crediting period                                                       |
| Quantitative Immaterial Misstatement | The steam tables used by Shell to estimate heat from steam (and subsequent gas usage) are based on an older version of steam tables (ASME 1967), which have been superceded (IAPWS-IF97).                                                                                                                                                                                                                               | Section 10.2 “Project Emissions – P18”, pages 59-60                                                                 | GHD has confirmed that these issues result in a discrepancy of 0.30 tonnes CO2, <0.01% of project emissions, which is not material                                                                                                                                |
| Quantitative Immaterial Misstatement | The surface casing vent gas composition has been measured at each well, and the average composition is calculated based on a straight average. Due to the differing venting rates, a weighted average would be more appropriate.                                                                                                                                                                                                                       | Section 10.2 “Project Emissions – P21”, pages 66-68                                                                 | All emissions are expected to be less than 1 tonnes CO2e/year. No usage in 2nd crediting period                                                                                                                   |
| Quantitative Immaterial Misstatement | The emissions from the usage of the following materials were not included in the project emissions:  
• Antifoam  
• Activated carbon  
• Cathodic Protection                                                                                                                                                                                                                                                                                                                                                       |                                                                                                           |                                                                                                                                                                                                                                                                       |

### 11. Confirmations

The following presents the confirmations performed by GHD to confirm that the information (besides the GHG assertion) reported by Shell within the OPR is accurate:

<table>
<thead>
<tr>
<th>Reported Item</th>
<th>Consistency of Offset Project Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification Procedure</td>
<td>Confirm that the offset project information is consistent across offset project documentation</td>
</tr>
<tr>
<td>Verification Findings</td>
<td>GHD reviewed the OPP and OPR and identified that the OPP has not been updated for a number of issues (specifically relating to the variance requests for B1 and P9 and a number of other minor changes in other sources). These changes have been identified in the OPR. Shell has indicated that the OPP will be updated once the revised waste heat methodology and variance request is approved by ACCO.</td>
</tr>
<tr>
<td>Reported Item</td>
<td>Consistency of Offset Project Information</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Multiple updates have not been made to the OPP, which are in the OPR. GHD understands these changes will be updated once the revised steam methodology is approved.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reported Item</th>
<th>Location of Offset Project and Applicable Approvals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification Procedure</td>
<td>Confirm that the location of the Offset Project is correctly applied in the project documentation and any applicable approvals</td>
</tr>
<tr>
<td>Verification Findings</td>
<td>The specific project location is provided in Section 2.2 above. GHD has confirmed that this is consistent with the project documentation and associated approvals.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>The location of the Offset Project is consistently applied in all documentation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reported Item</th>
<th>Availability of Methodology Documents and/or Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification Procedure</td>
<td>Confirm that the project has documented methodologies and procedures</td>
</tr>
<tr>
<td>Verification Findings</td>
<td>GHD has confirmed that the methodologies used by Shell are in accordance with the Protocol, Carbon Emissions Factor Handbook and other associated methodology documents.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>The project uses documented methodologies and procedures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reported Item</th>
<th>All Project Contacts, Dates and Emissions Reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification Procedure</td>
<td>Confirm that all project contacts, dates and emissions reductions are correctly reported in the project documentation</td>
</tr>
</tbody>
</table>
| Verification Findings | GHD reviewed the OPR and confirmed the Project contact and report date. A summary of the Project information is provided in Section 2.0.  
GHD reviewed the emissions and credits quantification methodology, and independently recalculated the emissions and credits assertions. |
| Conclusion    | GHD confirmed that Project information is correct, and the total credits claimed are accurate. |

<table>
<thead>
<tr>
<th>Reported Item</th>
<th>Process and Data Flow Diagrams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification Procedure</td>
<td>Confirm that all process and data flow diagrams prepared as part of the SGER submission are complete and accurate</td>
</tr>
<tr>
<td>Verification Findings</td>
<td>GHD reviewed the process flow diagrams. During the site visit, GHD confirmed that all required emission sources have been accounted for in the SGER Report (with minor exclusions as noted in Section 10.1).</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Based on GHD’s review, Shell has included all relevant emission sources as per the requirement of the SGER and Protocol.</td>
</tr>
</tbody>
</table>
12. Verification Team

12.1 Roles and Responsibilities

Co-Lead Verifier – Brent Boss, P.Eng., and Sean Williams, P.Eng. – Mr. Boss and Mr. Williams co-led the verification and were responsible for development of the verification plan. Mr. Boss and Mr. Williams reviewed the risk assessment, recalculation of raw data, data management and draft findings. Mr. Boss and Mr. Williams prepared and signed the verification statement and verification report. Mr. Boss and Mr. Williams conducted site visits of the facility.

Peer Reviewer – Gordon Reusing, P.Eng. – Mr. Reusing conducted a peer review of the risk verification plan risk assessment and verification report and findings.

12.2 Qualifications

Brent Boss, P.Eng. – Mr. Boss is a licensed Professional Engineer in Saskatchewan, Alberta and Ontario and has a Bachelor of Engineering in Environmental Engineering from the University of Guelph. Mr. Boss has experience in solid waste engineering and a range of greenhouse gas (GHG) validation and verification activities. As the Greenhouse Gas Assurance Services Manager for GHD, Mr. Boss works closely with the United Nations Framework Convention on Climate Change (UNFCCC) and the International Standards Organization (ISO) 14065 GHG accreditations. Mr. Boss assisted in leading the successful applications and approvals process in which GHD is now recognized as a Designated Operational Entity (DOE) with the UNFCCC and as a Validation/Verification Body under the ISO: 14065 program. Mr. Boss has also led GHD to become registered to complete Validation and Verification Services with The Gold Standard, the Fair Recycling Foundation (formerly the Swiss Charter Foundation), and the Verified Carbon Standard (VCS). Mr. Boss has completed over 100 GHG validation/verification projects as a lead auditor or peer reviewer/technical expert on over a wide range of sectoral scopes ranging from but not limited to renewable power generation (wind, geothermal, and hydroelectric), oil and gas, agricultural, and landfill gas/biogas combustion plants. Mr. Boss has also completed several methodology review processes under the VCS.

Mr. Boss has accreditation as a Lead Verifier and Offset Project Specialist in Ozone Depleting Substance (ODS), and Livestock projects under the California Air Resources Board (ARB) GHG Offset Reporting System and has assisted in the development of several agricultural manure digestion projects under the Climate Action Reserve (CAR) in California. Mr. Boss has also performed environmental and GHG reporting under Environment Canada's PERRL Initiative for several landfills within Ontario. Following the lifespan of the PERRL program, Mr. Boss continued to quantify and report emissions for these sites under the ISO: 14064 – Part 2 standards. Mr. Boss has developed ISO based audits for several large scale aerobic composting facilities within Ontario as well as an energy-from-bagasse plant in Brazil.

Mr. Boss has extensive experience in respect to landfill engineering with a focus on the development of landfill gas collection and control systems and general cell design and closure. Mr. Boss has completed detailed designs, specifications, and performed construction oversight/administration for both active and closed landfills across Canada. Additional works
completed by Mr. Boss have included collection of regulatory data through monitoring events and assistance in the preparation and review of annual reports as well as assistance with compliance assessments with agencies such as the Technical Standards and Safety Authority (TSSA), the Electrical Safety Authority (ESA) and other applicable regulatory bodies.

Mr. Boss has also worked closely with the permitting, approvals, and annual reporting processes for a number of organics composting facilities operated in Ontario.

**Sean Williams, P.Eng.** - Mr. Williams has a Bachelor of Applied Science in Chemical Engineering from the University of Waterloo, and is a licensed Professional Engineer in the provinces of Alberta and Ontario. Mr. Williams has experience in completing permit applications, air and noise compliance assessments, completion of annual inventory reports under O. Reg. 455 and NPRI, and greenhouse gas verifications under the Alberta Specified Gas Emitters Regulation (SGER), Ontario Regulation 452/09, the Quebec Greenhouse Gas Regulation, the California Air Resources Board and The Climate Registry. Mr. Williams' has acted as a verifier in the completion of ten verifications and re-verification audits (on behalf of ESRD) of oil sands mining, extraction, SAGD, upgrader, refinery and ethylene/polyethylene production facilities in Alberta under the SGER. Mr. Williams has also performed as a verifier and lead verifier under supervision for the verification of over 20 oil refineries, chemical manufacturing facilities, power generation facilities and steel mills in Ontario, Quebec and California. Mr. Williams also has experience working in the accreditation audit process for GHD by ANSI, and has knowledge of the ISO 14064 and ISO 14065 standards.

**Gordon Reusing, M.Sc., P.E., P. Eng.** – Mr. Reusing is a Professional Engineer and holds a Master's of Science degree in Engineering from the University of Waterloo. He has over 25 years of extensive Canadian and US industrial sector air compliance experience in the oil and gas, chemical, cement, transportation, pulp and paper, general industrial, electronics, power generation, agriculture and waste management sectors. He is a greenhouse gas (GHG) Lead Verifier, Lead Validator, and Peer Reviewer with extensive experience including GHG Programmes in Alberta, British Columbia, Ontario, Quebec, Nova Scotia, California, Massachusetts, and Programmes operated by the United Nations Framework Convention on Climate Change (UNFCC) Clean Development Mechanism (CDM), The Gold Standard, The Climate Registry (TCR), the Carbon Disclosure Project (CDP), and the Verified Carbon Standard (VCS). He has completed numerous GHG quantification studies for the oil and gas sector, including upstream, midstream and downstream facilities. Mr. Reusing has conducted GHG verifications as a Lead Verifier, Technical Expert and Peer Reviewer in many jurisdictions, including the Alberta Specified Gas Emitters Regulation (SGER), Ontario Regulation 452/09 (O. Reg. 452/09), British Columbia Greenhouse Gas Reduction (Cap and Trade) Act, (B.C. Reg. 272/2009), Quebec Regulation R.Q.c.Q -2, r.15 (Quebec Regulation), Massachusetts GHG Regulation, and California ARB.

### 13. Statement of Verification

GHD has prepared this Verification Report for Shell and AEP. The objective of the verification was to provide Shell and AEP with an opinion that there are no significant anomalies in the Facility's 2nd Crediting Period OPR and that the information reported is accurate and consistent with the requirements of the SGER.
The Shell Quest Carbon Capture and Storage Project reported 324,918 tonnes CO2e as the total offsets for the 2nd crediting period. This assertion includes the GHG emissions resulting from operating conditions from November 1, 2015 through March 31, 2016.

GHD's responsibility was to express a conclusion as to whether the assertions are fairly represented in all material respects, in accordance with *Specified Gas Emitters Regulation* and associated protocols.

GHD completed the verification in accordance with the *ISO 14064 Greenhouse gases - Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions, ISO 14064 Greenhouse gases – Part 2: Specification with guidance at the project level for quantification and reporting of greenhouse gas emissions and removals*, and the *Specified Gas Emitters Regulation*. GHD completed the work to provide a reasonable level of assurance. The verification criteria were selected from the guidelines presented in the *Specified Gas Emitters Regulation* and associated guidance documents. The work conducted is believed to provide an appropriate basis for this verification statement.

Based on GHD's verification, the assertion provided in the 2nd Crediting Period OPR for the Shell Quest Carbon Capture and Storage Project is free of misstatements, in all material aspects, and in accordance with the SGER and relevant criteria with the following emphasis of matter:

- During a completion of the third-party verification audit on behalf of ACCO, TetraTech concluded that the initial allocation methodology developed by Shell to allocate LP steam between LFE, non-Cogen sources and waste heat sources was not in accordance with the protocol for the following reasons:
  - The methodology was based on a conceptual, financial allocation methodology, and not based on direct measurement of the individual quantities of steam. As per the protocol, direct measurement of steam quantities prior to commencement of the Project are required to set baseline quantities.
  - The quantity of waste heat claimed could not be proved to have been vented or dissipated prior to Quest.

As a result of these issues, it was determined by TetraTech that the allocation model, and specifically the quantities of claimed waste heat are not appropriate.

In response, Shell has submitted a variance request to both allow the use of a dynamic baseline (rather than fixed) and a new allocation methodology which can more accurately estimate steam usage in the absence of Quest, demonstrating the quantities of waste heat used by Quest. This variance request is still under review by ACCO.

An additional request has been submitted and granted by ACCO allowing waste heat be excluded from quantification of steam for the initial submission of the 2nd crediting period Offset OPR, assuming all steam is from LFE, non-cogen sources. An amended OPR will then be submitted to ACCO once the variance request for the revised methodology is approved.

GHD has therefore added an emphasis of matter to the statement to note both the variance request under review at ACCO, as well as note that the claimed emissions offset do not include steam from waste heat sources.
This verification statement represents an "Unqualified Opinion with an Emphasis of Matter.

14. **Limitation of Liability**

Because of the inherent limitations in any internal control structure, it is possible that fraud, error, or non-compliance with laws and regulations may occur and not be detected. Further, the verification was not designed to detect all weakness or errors in internal controls so far as they relate to the requirements set out above as the verification has not been performed continuously throughout the period and the procedures performed on the relevant internal controls were on a test basis. Any projection of the evaluation of control procedures to future periods is subject to the risk that the procedures may become inadequate because of changes in conditions, or that the degree of compliance with them may deteriorate.

The verification opinion expressed in this report has been formed on the above basis.

GHD's review of the Compliance Report claimed included only the information discussed above. While the review included observation of the systems used for determination of the claimed Compliance Report, GHD did not conduct any direct field measurements and has relied on the primary measurement data and records provided by Shell as being reliable and accurate. No other information was provided to GHD or incorporated into this review. GHD assumes no responsibility or liability for the information with which it has been provided by others.

The information and opinions rendered in this report are exclusively for use by Shell. GHD will not distribute or publish this report without Shell's consent except as required by law or court order. The information and opinions expressed in this report are given in response to a limited assignment and should only be evaluated and implemented in connection with that assignment. GHD accepts responsibility for the competent performance of its duties in executing the assignment and preparing this report in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

GHD

Sean Williams  
(Co-Lead Verifier)

Brent Boss  
(Co-Lead Verifier)

Gordon Reusing  
(Peer Reviewer)
15. References


Appendices
Appendix A
Statement of Verification
Statement of Verification

GHD has reviewed the 324,918 tonnes CO₂eq of GHG offsets claimed in Shell’s Quest Carbon Capture and Storage Project Offset Project Report, dated November 15, 2017, for the period from November 1, 2015 to March 31, 2016 (2nd Crediting Period). The Project consists of reduction of GHG emissions from the implementation of the Quest Carbon Capture and Storage Project, which captures CO₂ produced from the Hydrogen Manufacturing Units at the Scotford Upgrader and Upgrader Cogeneration and injects the CO₂ underground in one of three injection wells. GHD’s scope was to perform the verification of the Project in accordance with ISO Standard ISO 14064 Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions (ISO 14064-3) and to express a conclusion as to whether anything has come to our attention to suggest that the GHG emission reductions claimed in the Project are not fairly represented, in all material respects, in accordance with Alberta Environment’s approved quantification Protocol. The verification was completed between October 2016 and November 2017.

Based on GHD’s verification, the compliance assertion provided in the 2nd Crediting Period Offset Project Report for the Quest Carbon Capture and Storage Project is free of misstatements, in all material aspects, and in accordance with the SGER and relevant criteria with an emphasis of matter:

GHD completed the review in accordance with the ISO 14064-3 Specification, the SGER and all associated guidance documents. The work was conducted to provide a reasonable level of assurance with respect to the claimed emission reductions. The work conducted is believed to provide a reasonable basis for this verification statement.

GHD notes the following findings that did not result in a material misstatement:

**B1 – Injected CO₂**

Quantification of Injected CO₂ emissions displaced in project is calculated accurately and meets the requirements of the Protocol. Overall potential materiality due to rounding of values is 0.03 percent (relative to overall offsets) and is considered immaterial.

**P5/P6/P7 – Extraction/Processing and Transportation of Fossil Fuels**

Quantification of emissions from the extraction, processing and transportation of fuels is calculated accurately and meets the requirements of the Protocol. A total discrepancy of 0.01 percent resulting from rounding was calculated and is considered immaterial.

**P8 – Off-Site Electricity Generation**

Quantification of emissions from off-site electricity generation is calculated accurately and meets the requirements of the Protocol. A total discrepancy of 0.04 percent resulted in the recalculations from rounding and is considered immaterial.

**P9 – Off-Site Heat Generation**

- During a completion of the third-party verification audit on behalf of ACCO, TetraTech concluded that the initial allocation methodology developed by Shell to allocate LP steam between LFE, non-Cogen sources and waste heat sources was not in accordance with the protocol for the following reasons:
The methodology was based on a conceptual, financial allocation methodology, and not based on direct measurement of the individual quantities of steam. As per the protocol, direct measurement of steam quantities prior to commencement of the Project are require to set baseline quantities.

The quantity of waste heat claimed could not be proved to have been vented or dissipated prior to Quest.

As a result of these issues, it was determined by TetraTech that the allocation model, and specifically the quantities of claimed waste heat are not appropriate.

In response, Shell has submitted a variance request to both allow the use of a dynamic baseline (rather than fixed) and a new allocation methodology which can more accurately estimate steam usage in the absence of Quest, demonstrating the quantities of waste heat used by Quest. This variance request is still under review by ACCO.

An additional request has been submitted and granted by ACCO allowing waste heat be excluded from quantification of steam for the initial submission of the 2nd crediting period Offset Project Report, assuming all steam is from LFE, non-cogen sources. An amended Project Report will then be submitted to ACCO once the variance request for the revised methodology is approved.

GHD has therefore added an emphasis of matter to the statement to note both the variance request under review at ACCO, as well as note that the claimed emissions offset do not include steam from waste heat sources.

- Quantification of emissions from off-site heat generation is calculated accurately and meets the requirements of the Protocol. A total discrepancy of 0.13 percent resulted in the recalculations from rounding and is considered immaterial.

**P18 – Venting of CO₂ at Injection Well Sites**

Quantification of emissions from venting at the injection well sites is calculated accurately and meets the requirements of the Protocol. A total discrepancy of less than 0.01 percent resulted in the recalculations from rounding and is considered immaterial.

Based on the procedures undertaken, it is our opinion that the Shell Quest Carbon Capture and Storage Project Offsets are supported by appropriate underlying evidence.

GHD confirms that it, and its staff involved in this review, have no ties or interest in the Shell Quest Carbon Capture and Storage Project, nor in any of the proponents or partners involved with the Project. GHD confirms that it, and its staff involved in this review had no involvement in the emission reduction measurements and calculations used to support the Offset Project Report. GHD confirms that it has relied on the information provided to it as being truthful, accurate, and complete and further confirms that, to the best of its knowledge, the information presented herein is correct.
Statement of Verification Place of Issuance:

9426 - 51st Ave NW Suite 101
Edmonton, Alberta
T6E 5A6

GHD Limited

Brent Boss, P.Eng. – Co-Lead Verifier
GHD Limited, Edmonton, Alberta

Sean Williams, P.Eng. – Co-Lead Verifier
GHD Limited, Edmonton, Alberta

Gordon Reusing, P.Eng. – Peer Reviewer
GHD Limited, Waterloo, Ontario
Appendix B
Conflict of Interest Checklist
# 1. Conflict of Interest Checklist

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Specifics</th>
</tr>
</thead>
</table>
| 1. Can the verifying organization or the verification team members directly benefit from a financial interest in the Project Developer or the Project Developer’s Project? For example:  
  - Owning shares of the Project Developer;  
  - Having a close business relationship with the Project Developer;  
  - Contingent fees relating to the results of the engagement;  
  - Potential employment with the Project Developer; or  
  - Undue concern about the possibility of losing the verification or other fees from the Project Developer. | X   |      | GHD has had no previous or recent involvement with Shell or the Quest Project. |
| 2. Can the verifying organization or verification team members be in a position of assessing their own work? For example:  
  - Provided greenhouse gas consultation services to the project;  
  - Provided validation for the project  
  - If providing non-greenhouse gas work for the company, consideration needs to be given as to how potential and perceived conflict of interests can be managed.  
  - A member of the verification team was previously employed with the company | X   |      | GHD has completed an internal conflict of interest check and no conflicts were identified. |
| 3. Does the verifying organization or a member of the verification team, or a person in the chain of command for the verification, promote or be perceived to promote, a project developer's position or opinion to the point that objectivity may, or may be perceived to be, compromised? For example:  
  - Dealing in, or being a promoter of, greenhouse gas credits on behalf of a project developer; or  
  - Acting as an advocate on behalf of the project developer in litigation or in resolving disputes with third parties. | X   |      | GHD has completed an internal conflict of interest check and no conflicts were identified. GHD is also not involved in promoting or dealing in GHG credits |
| 4. Is one or more of the verification team too sympathetic to the project developer's interests by virtue of a close relationship with a project developer, its directors, officer or employees? For example:  
  - A person on the verification team has a close personal relationship with a person who is in a senior greenhouse gas compilation role at the project developer; or  
  - The verification team or a person of influence on the verification team has accepted significant gifts or hospitality from the project developer. | X   |      | The GHD Project Team has completed an internal conflict of interest check with Shell and the Quest Project. |
| 5. Is a member of the verification team or a person in the chain of command | X   |      | The GHD Project Team has not |
of command deterred from acting objectively and exercising professional skepticism by threats, actual or perceived, from the directors, officers or employees of the Project Developer, for example:

- The threat of being replaced as a third party verifier due to a disagreement with the application of an greenhouse gas quantification protocol;
- Fees from the project developer represent a large percentage of the overall revenues of the verifying organization.
- The application of pressure to inappropriately reduce the extent of work performed in order to reduce or limit fees; or
- Threats of litigation from the project developer.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Specifics</th>
</tr>
</thead>
<tbody>
<tr>
<td>received any threats or professional skepticism from the Project Developer or Project Participants over the Verification Process.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C
Verification Plan
Verification Plan

Shell Canada Limited, as Managing Partner and on Behalf of Shell Canada Energy (an Alberta Partnership)  
Quest Carbon Capture and Storage Project  
2nd Crediting Period

Prepared for: Shell Canada Limited, as Managing Partner and on Behalf of Shell Canada Energy (an Alberta Partnership), Calgary, Alberta
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1. **Introduction**

Shell Canada Limited, as Managing Partner and on Behalf of Shell Canada Energy (an Alberta Partnership) (Shell) retained GHD Limited (GHD) to undertake a verification of the Greenhouse Gas (GHG) emissions offsets (Offsets) resulting from the implementation of the Quest Carbon Capture and Storage (CCS) Project (Project). Shell is the project developer for the compliance period of November 1, 2015 to March 31, 2016 (2nd crediting period). The applicable protocol for this project is *Quantification Protocol for CO$_2$ Capture and Permanent Storage in Deep Saline Aquifers, Version 1.0* (Alberta Environment and Parks (AEP), September 2015) (Protocol). GHD will complete the verification in accordance with the requirements of the Specified Gas Emitters Regulation with amendments up to and including Alberta Regulation 104/2015, Climate Change and Emissions Management Act (SGER) (AEP, 2007).

GHD has prepared this Verification Plan in accordance with the ISO Standard *ISO 14064 Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions* (ISO 14064-3) and with AEP's Specified Gas Reporting Standard (AEP, 2014).

2. **Verification Objective, Scope and Level of Assurance**

The objective of the verification is to provide Shell and the AEP with assurance that there are no material misstatements in the GHG Offset Project Report (OPR) and that the information reported is accurate and consistent with the requirements of the SGER.

The scope of this verification is described as follows:

- **Project Description** – The scope of the verification includes the greenhouse gas (GHG) offsets resulting from the capture and underground storage of carbon dioxide (CO$_2$) that would otherwise have been emitted directly to the atmosphere.

- **GHG Types** – The claimed offsets result from reductions in CO$_2$ released to the atmosphere due to the Project. The emissions during the operation of the Project result from:
  - The venting and fugitive releases of CO$_2$ and CH$_4$ from the Project.
  - Releases CO$_2$, methane (CH$_4$) and nitrous oxide (N$_2$O) due to combustion of fuels for Project operation and heat and electricity requirements.
  - Releases of CO$_2$, CH$_4$ and N$_2$O from the production and/or loss, disposal or recycling of the various chemical products and fuels required for the Project.
  - Emissions from venting releases from drilling or construction
  - Emissions due to loss of containment within the storage complex

- **Time Period** – November 1, 2015 through March 31, 2016.
• **Use of this Report** - This report has been prepared for the use of Shell and AEP.

• **Relative Size** – The size of the claimed GHG reductions were 324,918 tonnes CO$_2$ equivalent (tCO$_2$e).

The verification will be conducted to a reasonable level of assurance. Reasonable assurance is a high level of assurance, or positive assurance. Reasonable assurance is a direct factual statement expressing the opinion of the verifier. If a verification statement can be provided, it will be worded in a manner similar to "Based on our verification, the GHG emissions statement is, in all material aspects, in accordance with the approved quantification protocols."

### 3. Verification Standards and Criteria

For this verification, GHD will apply the following ISO and AEP verification criteria:

- “Offset Protocol Deviation for the Quest Project”, Letter from Robert Hamaliuk to Charles Bower, AEP, March 13, 2017 (B1 Injection Variance Request)
- “Retroactive revision of waste heat methodology for the Quest Project”, Letter from Robert Hamaliuk to Charles Bower, AEP, September 28, 2017 (P9 removal of waste heat request)

### 4. Facility Operations

The Project consists of the reduction of GHG emissions from the operation of carbon capture and storage facility to collect CO$_2$ produced at the Shell Canada Energy Scotford Upgrader Facility (Upgrader Facility), located in Fort Saskatchewan, Alberta. The carbon capture and storage facility is owned and operated by Shell.
### 4.1 Facility Emissions Source Categories

The claimed offsets result from reductions in CO₂ released to the atmosphere due to the Project.

The emission offsets from the implementation of this Project occur from the following (listed by the protocol categories) – all non-applicable emissions are listed as "NA":

**Table 2.1 Specified Emissions Reductions and Gas Types**

<table>
<thead>
<tr>
<th>Protocol Source Category</th>
<th>Specified Gas Type</th>
<th>Carbon Dioxide (CO₂)</th>
<th>Methane (CH₄)</th>
<th>Nitrous Oxide (N₂O)</th>
<th>Hydrofluorocarbons (HFCs)</th>
<th>Perfluorocarbons (PFCs)</th>
<th>Sulfur Hexafluoride (SF₆)</th>
<th>CO₂ Equivalent (CO₂e)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Condition</strong></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1 – Injected CO₂</td>
<td></td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Project Condition</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>P3 – Well drilling reportable releases</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P4 – Production and delivery of material inputs</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P5/P6/P7 – Extraction/processing and transportation of fuel used for on-Site and off-Site heat and electricity generation</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P8 – Off-Site electricity generation</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P9 – Off-Site heat generation</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P10 – On-Site heat and electricity generation</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P11 – CCS facility operation</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P18 – Venting of CO₂ at injection well sites</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P19 – Fugitive emissions at injection well sites</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P20 – Emissions from subsurface to atmosphere</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>P21 – Loss, disposal or recycling of materials used in CO₂ capture process</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Y</td>
</tr>
</tbody>
</table>
4.2 Geographical and Operational Boundaries

The verification will include the GHG emission sources resulting from the CCS facility and injection wells, which are located at:

**CCS Facility**

55522 Range Road 214  
Fort Saskatchewan, Alberta  
Latitude: 53.74047 N, Longitude 113.0231 W

**Injection Wells**

Well #1: 07-11-59-20-W4  
Well #2: 08-19-59-20-W4  
Well #3: 05-35-59-21-W4

The CCS facility and injection wells are owned by the Athabasca Oil Sands Project (AOSP) Joint-Venture and operated by Shell. The CCS facility is located at the Shell Scotford Site, which includes the following facilities, which, unless otherwise noted, are owned by the AOSP JV or Shell Canada Limited and operated by Shell:

- Scotford Upgrader Facility (which itself consists of the Upgrader-Base and Upgrader Expansion Facilities).
- ATCO Cogen facility (owned by ATCO Power Canada Limited, operated by Shell).
- Air Liquide Cogen facility (owned and operated by Air Liquide Canada).
- Scotford Refinery.
- Shell Chemicals Facilities.

The Scotford Upgrader provides the CO₂ for injection, while both the Scotford Upgrader and Scotford Refinery provide heat (in the form of steam) for the Project operation. All other operations at the Scotford Site will not be reviewed as part of the verification process.

4.3 Reporting Period

The reporting period is between November 1, 2015 and March 31, 2016.

4.4 Use of this Report

This report has been prepared for the use of Shell and AEP.

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1 Currently two injection wells are in operation: Well#1: 07-11-59-20-W4 and Well#2: 08-19-59-20-W4
5. **Facility's Data Management System and Controls**

GHD's current understanding of the data management system and controls (as based on the details in the Offset Project Plan [OPP]) is provided below. During the verification process, GHD will review the systems and controls in further details to confirm and elaborate on this understanding.

The total quantities of emissions from the various baseline and project sources and sinks are determined based on either direct measurement, third-party data, and/or engineering estimates.

The data management system used by Shell is built upon the existing systems at the Scotford Site, and is based on a network of Data Focals. The data management system specifies the personnel responsible for the collection and maintenance of data at key measurement points.

Metered data is collected from the measurement points by the Distributed Control System (DCS), and then stored in the Process Information (PI) system – data will be stored for at least 7 years past the end of the project crediting period. All data is reviewed prior to use in the calculations by the assigned Data Focal. The final meter data is stored within the PI system. All meters involved have specified standards and practices to control uncertainty, including calibration and preventative maintenance activities.

The Data Focal collects all key data and enters this data into the Shell Environmental Reporting System (SERS), which is the Site's emissions calculation software. The data and outputs from the SERS software is reviewed monthly, quarterly and yearly to ensure accuracy.

6. **Prior Verification Report and Findings**

Previous verification reports and findings will be reviewed as part of the verification process.

7. **Verification Schedule**

The following presents a draft verification schedule:

- Provide Verification Plan and Sampling Plan including information request to Shell – September 26, 2016
- Shell to review Verification Plan – September 26–27, 2016
- Conducted Quest Project Developer office visit – September 27, 2016
- Shell to provide requested information prior to site visit – Week of October 3, 2016
- Conduct Quest Project Site Visit – October 19-20, 2016
- Issue draft Verification Report to Shell – November 9, 2017
- Review draft Verification Report with Shell – Week of November 13, 2017
- Issue final Verification Report and Statement of Verification – November 24, 2017
It is noted that the office and site visits for the verifications of the second and third crediting periods are conducted together as the process operations, data management systems, and data sources will be the same for both crediting periods.

8. **Assessment of Risk and Magnitude of Potential Errors, Omissions or Misrepresentations**

Based on GHD initial review of the Project, a risk assessment summarizing the potential risk and magnitude of potential errors, omissions or misrepresentation, as currently known was completed. During the review, any new risks or material concerns that could potentially lead to errors, omissions and misrepresentations will be identified, reviewed and assessed.

The following table summarizes the potential risk and magnitude of potential errors, omissions, or misrepresentations, as currently known:

<table>
<thead>
<tr>
<th>Source</th>
<th>Attributes</th>
<th>Inherent Risk</th>
<th>Control Risk</th>
<th>Detection Risk Design</th>
<th>Consideration for Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Project Eligibility</td>
<td>Occurrence</td>
<td>Medium – Project involves reductions due to the capture and storage of CO(_2) from the Scotford Site. All activities at the CCS facility plus the capture site are owned by the AO_SP JV and operated by Shell; however the project boundary will need to be reviewed and defined clearly.</td>
<td>Low – Project was owned by the AO_SP JV and operated by Shell during crediting period.</td>
<td>Lowest</td>
<td>Allowable detection risk is medium-high. However, as this is GHD’s first verification of the project, the detection risk has been set as lowest, as all available documentation to confirm that Project meets the applicable protocol criteria will be reviewed.</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
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<tr>
<td></td>
<td>Accuracy</td>
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<td></td>
<td>Cut-Off</td>
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<tr>
<td></td>
<td>Classification</td>
<td></td>
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</tr>
<tr>
<td>Data Management</td>
<td>Occurrence</td>
<td>Medium – Majority of quantities used for emission reduction are real-time data stored on PI or LIMS systems, or via third-party invoices. Some data for subsurface emissions (P20) are from additional data systems.</td>
<td>Medium – All data is managed and tracked by Shell personnel. Multiple systems are used to track data.</td>
<td>Lowest</td>
<td>GHD will review all available documentation and the application of the data management systems.</td>
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<tr>
<td></td>
<td>Completeness</td>
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<tr>
<td></td>
<td>Accuracy</td>
<td></td>
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<tr>
<td></td>
<td>Cut-Off</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline Condition Sources and Sinks</td>
<td>Occurrence</td>
<td>High – Based on total CO(_2) injected. Metering points are located as close to the injection points as possible. Composition of CO(_2) is primarily based on</td>
<td>Low – One meter present at each injection well, and one composition measurement system. All meter and analyzer data is stored within</td>
<td>Lowest</td>
<td>GHD has set the detection risk as lowest to ensure that all aspects identified in variance request submitted by Shell are reviewed. GHD will review all CO(_2).</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>Attributes</td>
<td>Inherent Risk</td>
<td>Control Risk</td>
<td>Detection Risk</td>
<td>Consideration for Procedure</td>
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<td></td>
<td></td>
<td>direct gas analysis, however issues with the analyzer have been identified, and data has been substituted with methods that are not in accordance with the protocol. A variance request was submitted and approved by Alberta Climate Change Office (ACCO) for use until analyzer was repaired. Potential venting/fugitives after metering point (at injection points) captured in project condition.</td>
<td>Shell's PI system, while sampling data is stored in LIMS.</td>
<td>injected measurements, all analyzer issues and the methodologies used to substitute composition data. GHD will review all issues identified in third-party ACCO and Alberta Energy (AE) audits conducted on Project.</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>Low – Metering system present at each injection well and composition based on gas analysis on injected CO₂ stream.</td>
<td></td>
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</tr>
<tr>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
<td>Low – Crediting period are well established.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td>Low – classification of offsets is well defined within the system.</td>
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</tr>
</tbody>
</table>

**Project Condition Sources and Sinks**

<table>
<thead>
<tr>
<th>Well drilling reportable releases</th>
<th>Occurrence</th>
<th>Completeness</th>
<th>Accuracy</th>
<th>Cut-Off</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low – only reportable if gas is released during kicks and blowouts of wells as per the Alberta Energy Regulator (AER) Directive 059. Emissions during reportable releases are quantified using methodologies defined in the Directive 059 Reports.</td>
<td>Low – Emissions estimated based on procedures as per AER Directive 059.</td>
<td>High</td>
<td></td>
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<tr>
<td></td>
<td>Low – Crediting period is well</td>
<td></td>
<td></td>
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<tr>
<td>Source</td>
<td>Attributes</td>
<td>Inherent Risk</td>
<td>Control Risk</td>
<td>Detection Risk Design</td>
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<tr>
<td></td>
<td></td>
<td>established. No releases were reported during crediting period.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Occurrence</td>
<td>Low – multiple materials used in CCS process, but each quantity is determined based on direct measurement or invoicing. Emission factors estimated based primarily on literature references.</td>
<td>Low – based on delivery and metered quantities of the different material inputs.</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td>Low – based on delivery and metered quantities of the different material inputs.</td>
<td>Low – Total quantities of steam measured based on multiple steam meters, along with temperature and pressure transmitters. Steam metering data is stored on Shell’s PI system.</td>
<td>Lowest</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>Low – Crediting period is well established.</td>
<td>Low – Crediting period is well established.</td>
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<tr>
<td></td>
<td>Cut-Off</td>
<td>Low – classification of offsets is well defined within the system.</td>
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<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occurrence</td>
<td>High – Only natural gas is quantified for this source. Total natural gas usage based on complex steam balance, which has been modified based on results of AEP third-party audit.</td>
<td>High – Total quantities of steam measured based on multiple steam meters, along with temperature and pressure transmitters. Steam metering data is stored on Shell’s PI system.</td>
<td>Lowest</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td>High – Complex steam balance used to quantify natural gas usage.</td>
<td>High – Crediting period is well established.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>Low – Crediting period is well established.</td>
<td>Low – Crediting period is well established.</td>
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<td></td>
<td>Cut-Off</td>
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<td>Low – classification of offsets is well defined within the system.</td>
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<tr>
<td>Source</td>
<td>Attributes</td>
<td>Inherent Risk</td>
<td>Control Risk</td>
<td>Detection Risk Design</td>
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<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Off-Site electricity generation</td>
<td>Occurrence</td>
<td>Medium – Multiple electricity meters and invoices (for electricity usage at wellpads) used to quantify electricity usage by the Project. Standard emission factors are used.</td>
<td>Medium – the majority of electricity usage is based on direct metering. A small (&lt;1%) quantity is estimated. Electricity meter data is stored in Shell’s PI system. Electricity invoices for wellpads stored on Shell’s server.</td>
<td>Lowest</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td>Medium – the majority of electricity usage is based on direct metering or invoicing. A small (&lt;1%) quantity is estimated.</td>
<td>Low – Crediting period is well established.</td>
<td>Low – Crediting period is well established.</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>High – Total natural gas based on complex steam balance. During third-party AE/ACCO audit, a significant material error was identified in the claimed quantity of waste heat. Shell has received approval from ACCO to resubmit the OPRs for the 2nd-5th crediting periods once a revised methodology is implemented and approved to allow for retroactive corrections for waste heat. Composition of natural gas based on third-party information</td>
<td>Low – Total quantities of steam measured based on multiple steam meters, along with temperature and pressure meters. Steam metering data is stored on Shell’s PI system.</td>
<td>Lowest</td>
</tr>
<tr>
<td>Off-Site heat generation</td>
<td>Occurrence</td>
<td>High – Complex steam balance used to quantify natural gas usage.</td>
<td>High – Complex steam balance used to quantify natural gas usage.</td>
<td>Lowest</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td>High – Total natural gas based on complex steam balance. During third-party AE/ACCO audit, a significant material error was identified in the claimed quantity of waste heat. Shell has received approval from ACCO to resubmit the OPRs for the 2nd-5th crediting periods once a revised methodology is implemented and approved to allow for retroactive corrections for waste heat. Composition of natural gas based on third-party information</td>
<td>Low – Crediting period is well established.</td>
<td>Low – Crediting period is well established.</td>
</tr>
<tr>
<td>Source</td>
<td>Attributes</td>
<td>Inherent Risk</td>
<td>Control Risk</td>
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</tr>
<tr>
<td><strong>Cut-Off</strong></td>
<td>Low – Crediting period is well established.</td>
<td>Low – Crediting period is well established.</td>
<td></td>
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</tr>
<tr>
<td><strong>Classification</strong></td>
<td>Low – classification of offsets is well defined within the system.</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>On-Site heat and electricity generation</strong></td>
<td>Occurrence</td>
<td>Low – based on total invoiced propane and metered natural gas usage. Default emission factors for propane, while natural gas emission factors calculated based on gas composition.</td>
<td>Low – total fuel consumption based on invoicing or metering. Invoices are stored on Shell’s server.</td>
<td>High</td>
</tr>
<tr>
<td><strong>Completeness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>Low – Crediting period is well established. No releases during crediting period.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Classification</strong></td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CCS facility operation</strong></td>
<td>Occurrence</td>
<td>Low – based on total consumption of diesel, gasoline and aviation fuel, calculated based on direct measurement or invoices. Default emission factors for each fuel type used.</td>
<td>Medium – total fuel consumption based on invoicing (propane, aviation turbo fuel), cardlock records (gasoline and diesel) and information tracked by Shell personnel (usage during workovers/logging of wells). Invoices are stored on Shell’s server.</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Completeness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>Low – Crediting period is well-understood.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Classification</strong></td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Venting of CO₂</strong></td>
<td>Occurrence</td>
<td>Low – multiple vent event categories. Total gas vented and composition for each type based on either engineering calculations or direct measurements.</td>
<td>Low to Medium – multiple vent event types can occur, with different quantification methods for each. Calculations for the vented quantities are performed on spreadsheets</td>
<td>High</td>
</tr>
<tr>
<td><strong>Completeness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cut-Off</strong></td>
<td>Low – Crediting period is well established.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>Attributes</td>
<td>Inherent Risk</td>
<td>Control Risk</td>
<td>Detection Risk Design</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Fugitive emissions at well sites</td>
<td>Occurrence</td>
<td>Low – total fugitive emissions on fitting counts and default emission rates from each type of fitting. Gas composition based on measured injected gas composition.</td>
<td>Low – based on known equipment counts and measured gas composition.</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emissions from subsurface</td>
<td>Occurrence</td>
<td>Low – emissions calculated only if a leak is detected. Methodologies to monitor subsurface storage of CO₂ and leaks performed by Shell using a number of methodologies at multiple levels – each methodology is described in the Measurement, Monitoring and Verification Plan (MMV).</td>
<td>Medium – Shell’s PI and LIMS systems are the primary data storage location; however some data is stored in alternative locations, which is then manually downloaded and transferred by Shell personnel. All data is monitoring by Shell.</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cut-Off</td>
<td>Low – Crediting period is well established.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Low – classification of offsets is well defined within the system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss, disposal or recycling of materials</td>
<td>Occurrence</td>
<td>Low – multiple materials used in CCS process that can potential be disposed, but quantities of each determined based on direct measurement disposal and recycling quantities. Emission factors</td>
<td>Low – based on delivery and metered quantities of the different material inputs. All delivery invoices are stored on Shell’s servers, and meter data is</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 9. Sampling Plan

GHD developed a sampling plan based on a review of the objectives, criteria, scope and level of assurance detailed above. The sampling plan is dynamic and will be revised, as required, throughout the course of the verification. The following table summarizes the sampling plan.

<table>
<thead>
<tr>
<th>Data/Information Description</th>
<th>Data/Information Source</th>
<th>Collection Frequency</th>
<th>Sample size/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confirm Project Eligibility</td>
<td>OPP for the Quest Carbon Capture and Storage Project</td>
<td>N/A</td>
<td>• Will review OPP to confirm applicability with Protocol</td>
</tr>
<tr>
<td></td>
<td>OPR for the Quest Carbon Capture and Storage Project</td>
<td>N/A</td>
<td>• Will review OPR to confirm applicability with Protocol and OPP</td>
</tr>
<tr>
<td>Project Boundary</td>
<td>Quest CCS Project ownership and operation</td>
<td>N/A</td>
<td>• Ownership and operation of the CCS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Will confirm division of Quest Facility from other Scotford Sites</td>
</tr>
<tr>
<td>Data management</td>
<td>Data acquisition system</td>
<td>N/A</td>
<td>• Frequency of data collection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Interviewed key site personnel</td>
</tr>
<tr>
<td>1st Crediting Period</td>
<td>• OPR from 1st Crediting Period</td>
<td>N/A</td>
<td>• Will review previous findings and issues to confirm applicability to current crediting period</td>
</tr>
<tr>
<td></td>
<td>• Verification Report from 1st Crediting Period</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Third-Party Audit conducted on behalf of AE/ACCO</td>
<td>• Audit Report conducted by TetraTech EBA Inc. (TetraTech)</td>
<td>N/A</td>
<td>• Will review third-party audit and issues to confirm applicability to current crediting period</td>
</tr>
<tr>
<td>Data/Information Description</td>
<td>Data/Information Source</td>
<td>Collection Frequency</td>
<td>Sample size/Action</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Baseline Condition Sources and Sinks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total CO₂ Injected</td>
<td>Gas injected at each injection well site:  • FIT-702104  • FIT-702204  • FIT-702304  Gas downstream of compressor  • FIT-247004</td>
<td>Continuous</td>
<td>• Mass balance spreadsheet with calculation of CO₂ injected  • Flow of data from meters to GHG calculation system  • Most recent calibration records for each meter</td>
</tr>
<tr>
<td></td>
<td>• Gas composition analyzers AT-247001, AT247002  • Laboratory sampling data on CO₂ stream  • Regression model for substitution of CO₂ analyzer</td>
<td>Continuous/As-collected</td>
<td>• Composition of CO₂ stream injected into the well sites  • Flow of data from analyzers to GHG calculation system  • Laboratory management and QA/QC procedures  • Laboratory results for crediting period  • Regression model derivation and applicability</td>
</tr>
<tr>
<td></td>
<td>• Audit Report conducted by TetraTech</td>
<td>N/A</td>
<td>• Will review third-party audit and issues to confirm applicability to current crediting period</td>
</tr>
<tr>
<td></td>
<td>• Variance Request</td>
<td>N/A</td>
<td>• Will confirm approval of variance request by AE</td>
</tr>
<tr>
<td><strong>Project Condition Sources and Sinks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well drilling reportable releases</td>
<td>Total gas and composition of gas released if well kick or blowout occurred</td>
<td>As recorded</td>
<td>• AER Directive 059 report for each well kick or blowout (if applicable)</td>
</tr>
<tr>
<td>Material usage</td>
<td>Total usage of materials on-Site:  • Methyl diethanol amine (MDEA)  • Triethylene glycol (TEG)  • Activated Carbon  • Nitrogen  • Lubricant  • Utility/Instrument Air  • HFCs  • Sacrificial Anodes</td>
<td>As recorded/continuous</td>
<td>• Mass balance spreadsheet with calculation of nitrogen used  • Billing model for instrument air  • Flow of data from meters/accounting to GHG calculation system  • Will confirm purchases of other material quantities</td>
</tr>
<tr>
<td>Emission factors</td>
<td>N/A</td>
<td></td>
<td>• Review methods for determining emission factors</td>
</tr>
<tr>
<td>Fuel extraction/processing</td>
<td>Total steam usage:  • Low pressure (LP) steam from steam header  • High pressure (HP) steam from RHC unit</td>
<td>Continuous</td>
<td>• Steam balance spreadsheet (for calculation of each type of steam produced, along with pressure and temperature)  • Flow of data from meters to GHG calculation system  • Most recent calibration records</td>
</tr>
<tr>
<td>Data/Information Description</td>
<td>Data/Information Source</td>
<td>Collection Frequency</td>
<td>Sample size/Action</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Natural gas composition/higher heating value (HHV)</td>
<td>As recorded</td>
<td>• All data for the duration of the crediting period for natural gas composition and HHV data from third party supplier</td>
<td></td>
</tr>
<tr>
<td>Extraction/processing emission factors</td>
<td>N/A</td>
<td>• Confirm appropriateness</td>
<td></td>
</tr>
<tr>
<td><strong>Off-site electricity generation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total electricity usage:</td>
<td>Continuous</td>
<td>• Mass balance spreadsheet with calculation of electricity at Quest and electricity from Upgrader</td>
<td></td>
</tr>
<tr>
<td>• 52-15B</td>
<td></td>
<td>• Third-party invoices for electricity consumed at the well pads</td>
<td></td>
</tr>
<tr>
<td>• 52-16B</td>
<td></td>
<td>• Documentation and calculation methodologies for estimate electricity quantities</td>
<td></td>
</tr>
<tr>
<td>• 702-DP-A</td>
<td></td>
<td>• Flow of data from meters to GHG calculation system</td>
<td></td>
</tr>
<tr>
<td>• 702-DP-B</td>
<td></td>
<td>• Most recent calibration records</td>
<td></td>
</tr>
<tr>
<td>• 702-DP-C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• PM-44108A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• PM-44108B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• FI-25003</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• FI-25007</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• F-252F01A-J</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Various estimate electricity quantities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid Emission Factors</td>
<td>N/A</td>
<td>• Confirm appropriateness of emission factors</td>
<td></td>
</tr>
<tr>
<td><strong>Off-site heat generation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total steam usage (multiple meters for each):</td>
<td>Continuous</td>
<td>• Steam balance spreadsheet (for calculation of each type of steam produced, along with pressure and temperature)</td>
<td></td>
</tr>
<tr>
<td>• Total low pressure (LP) steam to Quest</td>
<td></td>
<td>• Flow of data from meters to GHG calculation system</td>
<td></td>
</tr>
<tr>
<td>• HP steam from RHC unit</td>
<td></td>
<td>• Most recent calibration records</td>
<td></td>
</tr>
<tr>
<td>Natural gas composition/HHV</td>
<td>As recorded</td>
<td>• All data for the duration of the crediting period for natural gas composition and HHV data from third party supplier</td>
<td></td>
</tr>
<tr>
<td>Combustion emission factors</td>
<td>N/A</td>
<td>• Confirm appropriateness of natural gas CO₂ emission factor calculated by Shell</td>
<td></td>
</tr>
<tr>
<td>Audit Report conducted by TetraTech EBA Inc. (TetraTech)</td>
<td>N/A</td>
<td>• Confirm appropriateness of published emission factors for other gas species</td>
<td></td>
</tr>
<tr>
<td>Approval from ACCO to remove waste heat credit</td>
<td>N/A</td>
<td>• Will review third-party audit and issues to confirm applicability to current crediting period</td>
<td></td>
</tr>
<tr>
<td><strong>On-site heat and electricity generation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural gas usage for local heating</td>
<td>Continuous</td>
<td>• All data for the duration of the crediting period for natural gas for local heating (if applicable)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flow of data from meters to GHG calculation system</td>
<td></td>
</tr>
<tr>
<td>Natural gas HHV</td>
<td>As recorded</td>
<td>• All data for the duration of the crediting period for natural gas composition and HHV data from third party supplier</td>
<td></td>
</tr>
<tr>
<td>Data/Information Description</td>
<td>Data/Information Source</td>
<td>Collection Frequency</td>
<td>Sample size/Action</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Propane usage (if applicable)</td>
<td>As recorded</td>
<td>• Invoiced quantities of propane usage for the duration of the crediting period (if applicable)</td>
<td></td>
</tr>
</tbody>
</table>
| Combustion emission factors (if emissions from this source occurred during crediting period) | N/A | • Confirm appropriateness of natural gas CO₂ emission factor calculated by Shell  
• Confirm appropriateness of published emission factors for other gas species |
| CCS facility operation | Diesel consumption | As recorded | • Cardlock fuel consumption measured for the duration of the crediting period |
| | Gasoline consumption | As recorded | • Cardlock fuel consumption measured for the duration of the crediting period |
| | Aviation turbo fuel consumption | As recorded | • Fuel consumption for flights quantities for the duration of the crediting period  
• Pro-rated consumption of fuel for the Quest project |
| | Combustion emission factors | N/A | • Confirm appropriateness |
| Venting of CO₂ | Total gas vented | As recorded | • Mass balance spreadsheet with calculations of total quantity of gas vented from each venting event for the duration of the crediting period |
| | • Gas composition analyzers AT-247001, AT247002  
• Laboratory sampling data on CO₂ stream | Continuous | • Composition of CO₂ stream injected into the well sites  
• Flow of data from analyzers to GHG calculation system  
• Laboratory management and QA/QC procedures  
• Laboratory results for crediting period |
| Fugitive emissions at well sites | Fitting counts | As recorded | • Confirm total number of fittings |
| | Gas composition analyzers AT-247001, AT247002 | Continuous | • Composition of CO₂ stream injected into the well sites  
• Flow of data from analyzers to GHG calculation system |
| Emissions from subsurface | • Quantity of gas leaking from subsurface  
• Methodologies used to assess leakage from subsurface | As recorded | • Measurement, Monitoring and Verification (MMV) Plan and associated records  
• MMV Quarterly Reports for the crediting period  
• Lightsource documentation report  
• Flux chamber data for baseline (June 2015) and project for crediting period  
• Hydraulic Isolation Logs for crediting period  
• Confirm if any releases from subsurface occurred in crediting period |
### Data/Information Description
- Loss, disposal and recycling of materials
  - Total quantities of materials lost/disposed/recycled on-Site:
    - Methyl Diethanol amine (MDEA)
    - TEG-glycol
    - Water (wastewater treatment)
    - Lubricant
    - Refrigerant HFC (R410a)

### Data/Information Source
- N/A

### Collection Frequency
- As recorded/continuous

### Sample size/Action
- Disposal/off-site shipment records for the full crediting period
- Wastewater treatment volumes for the full crediting period
- Refrigerant charge records for the duration of the crediting period

### Emission factors
- N/A
  - Review methods for determining emission factors

---

## 10. Quantitative Testing

Quantitative data or raw data will be made available to GHD. GHD will recalculate GHG emissions reductions, and will evaluate annual GHG emission calculation methodologies. The verifier must design the planning materiality, referred to as tolerable error, to detect quantitative misstatements in the assertion. The following table is a draft of the tolerable error assessment based on the preliminary emissions from the 2nd crediting period (November 1, 2015 – March 31, 2016).

### Table 10.1

<table>
<thead>
<tr>
<th>Baseline or Project</th>
<th>Source or Sink</th>
<th>Reductions (tonnes CO₂e)</th>
<th>%-Tolerable Error</th>
<th>Tolerable Error (Rounded)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CO₂</td>
<td>CH₄</td>
<td>N₂O</td>
</tr>
<tr>
<td><strong>Baseline</strong></td>
<td>Injected CO₂</td>
<td>444,091</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Baseline</strong></td>
<td></td>
<td>444,091</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Project</strong></td>
<td>Well drilling</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Material Inputs</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Fuel extraction/processing</td>
<td>5,470</td>
<td>106.9</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>Off-site electricity</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Off-site heat</td>
<td>69,934</td>
<td>1.31</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>On-Site heat/electricity</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>CCS facility operation¹</td>
<td>19.90</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Venting¹</td>
<td>0.01</td>
<td>0.08</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Fugitives¹</td>
<td>2.31</td>
<td>0.03</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Subsurface</td>
<td>0.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Disposal of materials</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Project¹</strong></td>
<td></td>
<td>75,426</td>
<td>108.3</td>
<td>1.46</td>
</tr>
<tr>
<td><strong>Total Reductions</strong></td>
<td></td>
<td>324,918</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Units above are in tonnes of the specific GHG type (i.e. tonne CO₂, tonne CH₄, tonne N₂O) unless otherwise specified.
11. **Materiality Level**

The quantitative materiality for this verification is set at plus or minus five percent of the Offsets as per the AEP Technical Guidance for Greenhouse Gas Verification at Reasonable Level Assurance, Version 1.0. In addition, a series of discrete errors, omissions or misrepresentations or individual or a series of qualitative factors, when aggregated (absolute values) may be considered material.

12. **Review Team**

12.1 **Roles and Responsibilities**

**Co-Lead Verifiers – Brent Boss, P.Eng. and Sean Williams, P.Eng.** – Mr. Boss and Mr. Williams will lead the verification and is responsible for development of the verification plan. Mr. Boss and Mr. Williams will develop the risk assessment, recalculate of raw data, review of data management and draft findings. Mr. Boss and Mr. Williams will prepare and sign the verification statement and verification report. Mr. Boss and Mr. Williams will conduct a Site visit of the Facility.

**Peer Reviewer – Gordon Reusing, P.Eng.** – Mr. Reusing will conduct a peer review of the risk verification plan risk assessment and verification report and findings.

12.2 **Qualifications**

**Brent Boss, P.Eng.** – Mr. Boss is a licensed Professional Engineer in Saskatchewan, Alberta and Ontario and has a Bachelor of Engineering in Environmental Engineering from the University of Guelph. Mr. Boss has experience in solid waste engineering and a range of greenhouse gas (GHG) validation and verification activities. As the Greenhouse Gas Assurance Services Manager for GHD, Mr. Boss works closely with the United Nations Framework Convention on Climate Change (UNFCCC) and the International Standards Organization (ISO) 14065 GHG accreditations. Mr. Boss assisted in leading the successful applications and approvals process in which GHD is now recognized as a Designated Operational Entity (DOE) with the UNFCCC and as a Validation/Verification Body under the ISO: 14065 program. Mr. Boss has also led GHD to become registered to complete Validation and Verification Services with The Gold Standard, the Fair Recycling Foundation (formerly the Swiss Charter Foundation), and the Verified Carbon Standard (VCS). Mr. Boss has completed over 100 GHG validation/verification projects as a lead auditor or peer reviewer/technical expert on over a wide range of sectoral scopes ranging from but not limited to renewable power generation (wind, geothermal, and hydroelectric), oil and gas, agricultural, and landfill gas/biogas combustion plants. Mr. Boss has also completed several methodology review processes under the VCS.

Mr. Boss has accreditation as a Lead Verifier and Offset Project Specialist in Ozone Depleting Substance (ODS), and Livestock projects under the California Air Resources Board (ARB) GHG Offset Reporting System and has assisted in the development of several agricultural manure digestion projects under the Climate Action Reserve (CAR) in California. Mr. Boss has also performed environmental and GHG reporting under Environment Canada’s PERRL Initiative for several landfills within Ontario. Following the lifespan of the PERRL program, Mr. Boss continued to
quantify and report emissions for these sites under the ISO: 14064 – Part 2 standards. Mr. Boss has developed ISO based audits for several large scale aerobic composting facilities within Ontario as well as an energy-from-bagasse plant in Brasil.

Mr. Boss has extensive experience in respect to landfill engineering with a focus on the development of landfill gas collection and control systems and general cell design and closure. Mr. Boss has completed detailed designs, specifications, and preformed construction oversight/administration for both active and closed landfills across Canada. Additional works completed by Mr. Boss have included collection of regulatory data through monitoring events and assistance in the preparation and review of annual reports as well as assistance with compliance assessments with agencies such as the Technical Standards and Safety Authority (TSSA), the Electrical Safety Authority (ESA) and other applicable regulatory bodies.

Mr. Boss has also worked closely with the permitting, approvals, and annual reporting processes for a number of organics composting facilities operated in Ontario.

**Sean Williams, P.Eng.** - Mr. Williams has a Bachelor of Applied Science in Chemical Engineering from the University of Waterloo, and is a licensed Professional Engineer in the provinces of Alberta and Ontario. Mr. Williams has experience in completing permit applications, air and noise compliance assessments, completion of annual inventory reports under O. Reg. 455 and NPRI, and greenhouse gas verifications under the Alberta Specified Gas Emitters Regulation (SGER), Ontario Regulation 452/09, the Quebec Greenhouse Gas Regulation, the California Air Resources Board and The Climate Registry. Mr. Williams’ has acted as a verifier in the completion of ten verifications and re-verification audits (on behalf of ESRD) of oil sands mining, extraction, SAGD, upgrader, refinery and ethylene/polyethylene production facilities in Alberta under the SGER. Mr. Williams has also performed as a verifier and lead verifier under supervision for the verification of over 20 oil refineries, chemical manufacturing facilities, power generation facilities and steel mills in Ontario, Quebec and California. Mr. Williams also has experience working in the accreditation audit process for GHD by ANSI, and has knowledge of the ISO 14064 and ISO 14065 standards.

**Gordon Reusing, M.A.Sc., P.E., P.Eng.** - Mr. Reusing is a Professional Engineer and holds a Master's of Science degree in Engineering from the University of Waterloo. He has over 25 years of extensive Canadian and US industrial sector air compliance experience in the oil and gas, chemical, cement, transportation, pulp and paper, general industrial, electronics, power generation, agriculture and waste management sectors. He is a greenhouse gas (GHG) Lead Verifier, Lead Validator, and Peer Reviewer with extensive experience including GHG Programmes in Alberta, British Columbia, Ontario, Quebec, Nova Scotia, California, Massachusetts, and Programmes operated by the United Nations Framework Convention on Climate Change (UNFCC) Clean Development Mechanism (CDM), The Gold Standard, The Climate Registry (TCR), the Carbon Disclosure Project (CDP), and the Verified Carbon Standard (VCS). He has completed numerous GHG quantification studies for the oil and gas sector, including upstream, midstream and downstream facilities. Mr. Reusing has conducted GHG verifications as a Lead Verifier, Technical Expert and Peer Reviewer in many jurisdictions, including the Alberta Specified Gas Emitters Regulation (SGER), Ontario Regulation 452/09 (O. Reg. 452/09), British Columbia Greenhouse Gas Reduction (Cap and Trade) Act, (B.C. Reg. 272/2009), Quebec Regulation R.Q.c.Q-2, r.15 (Quebec Regulation), Massachusetts GHG Regulation, and California ARB.
13. **Verification Procedures**

The verification procedures will be conducted to assess the following:

1. Accuracy and completeness of the OPR.
2. Conformance to the Protocol.
3. Uncertainty of external data sources used.
4. Completeness of the OPR in comparison to the structure and criteria presented in AEP guidance.
5. Offset assumptions.
6. Accuracy of emission calculations.
7. Potential magnitude of errors and omissions.
8. Integrity of the data management system and controls.
9. ISO principles are met

To sustain a risk based assessment, the GHD Project Team will identify and determine risks related to offset reductions during both the desk reviews and the follow-up interviews. The GHD Project Team will particularly focus on the accuracy and completeness of provided information. The components of the document review and follow-up interviews are:

- **Document Review:**
  - Review of data and information to confirm the correctness and completeness of presented information.
  - Cross-checks between information provided in the OPP and OPR and information from independent background investigations.
  - Determine sensitivity and magnitude analysis for parameters that may be the largest sources of error.

- **Follow-up Interviews:**
  - Site visit
  - Via telephone
  - Via email

The GHD Project Team will interview Facility personnel to:

- Cross-check information provided.
- Test the correctness of critical formulae and calculations.
- Compare with projects or technologies that have similar or comparable characteristics.
- Test the correctness of critical formulae and calculations.
- Review data management and recording procedures.
The document review shall establish to what degree the presented Offset credits meets the verification standards and criteria.

The GHD Project Team’s document review shall comprise, but not be limited to, an evaluation of whether or not:

- The documentation is complete and comprehensive and follows the structure and criteria given in the AEP guidelines and Protocol.
- The OPR, and the offset estimates therein, conform to the Protocol criteria.
- The OPP and OPR are accurate, transparent and provide a complete overview of the Project’s GHG emissions sources.
- The methodologies are justified and appropriate.
- The offset credits calculations are appropriate and use conservative assumptions for estimating GHG emissions.
- The offset information system and its controls are sufficiently robust to minimize the potential for errors, omissions or misrepresentations.
- The frequency of, and responsibility and authority for, monitoring, measurement, data recording activities and quality control/quality assurance/management control procedures is sufficient.
- The GHG information system and its controls are sufficiently robust to minimize the potential for errors, omissions or misrepresentations.

**Site Visit**

The Site Visit will generally adhere to the following agenda. Deviations from the proposed agenda may be necessary to respond to data gaps and or issues identified during the verification process:

**Project Developer Office (September 27, 2016)**

- Opening Meeting - Introduction and sign in, safety review, and overview of verification process and expectations (key personnel need to be present).
- Overview of Shell processes and data management system.
- Review of key Project sources.
- Interviews with Shell Data Focals for each source.
- Review of documentation requested (as available) based on the sampling plan (Section 9).
- Closing Meeting – Review issues identified and next steps in verification process.

**Project Site (October 19-20, 2016)**

- Opening Meeting - Introduction and sign in, safety review, and overview of verification process and expectations (key personnel need to be present).
- Completion of review of Shell processes, data management systems and key Project sources (that could not be reviewed during the initial office visit).
- Completion of interviews with Shell Data Focals.
Review of site operations and site walkthrough.
Closing Meeting – Review issues identified and next steps in verification process.
Additional documents and information will be requested as the verification progresses.

14. Closure

The Verification Plan is considered to be a dynamic document that will require modification and adaptation to project conditions as encountered during the performance of the verification process. GHD will communicate the changes to the verification plan with Shell throughout the verification process.

All of which is respectfully submitted,

GHD

Brent Boss, P.Eng.

Sean Williams, P.Eng.
15. **References**


Appendix D

Final Issues Logs from TetraTech EBA Inc. ACCO Audit
<table>
<thead>
<tr>
<th>Result #</th>
<th>Type</th>
<th>Summary Description of Finding Source Category or Source/Sink</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-01</td>
<td>Qualitative</td>
<td>B1 injection gas composition is largely substituted by lab sample data in the crediting period of August 23, 2015 – October 31, 2015 due to instrument drift identified in the online CO2 concentration results (primary instrumentation failure). Review of laboratory analysis and calibration procedures identified that these were not suitable to provide accurate data and resulted in intermittent cross contamination. Data accuracy is also compromised through the use of inappropriate GC calibration gas for laboratory analysis, and inadequate analysis and calibration procedures.</td>
</tr>
<tr>
<td>16-02</td>
<td>Qualitative</td>
<td>The inlet mass flow meter for B1 injection gas was configured to record volume data during most of the 1st crediting period, thus the balance between the inlet flow meter and injection meters is not possible.</td>
</tr>
<tr>
<td>16-03</td>
<td>Qualitative &amp; Quantitative</td>
<td>Negative values appear in the P9 offsite heat generation calculation spreadsheet. The negative values are retrieved from the PI system, and were not effectively filtered. Those data include Medium Pressure (MP) Letdown 4th flow in September for September 2 and 3, Cell T8 and T9 in the spreadsheet Monthly Quest Sept 2015 Rev 6. This is a quantitative overstatement. The discrepancies are estimated to be less than 2 t CO2e or 0.001% of net reduction.</td>
</tr>
<tr>
<td>16-04</td>
<td>Qualitative</td>
<td>Data management activities are delegated to several Data Focal (persons) resulting in a segregated and fragmented process. Emission sources are assigned to Data Focals, however, they are responsible for data collection, and are not fully aware of how the data is used nor do they have control over its use. The reporting personnel use the data provided by the Data Focal, and rely on the data that is accurate, appropriate and sufficient for the quantification of GHG emissions. In addition, some quantification methods were provided by 3rd party consultants (e.g. Waste Fraction).</td>
</tr>
<tr>
<td>16-05</td>
<td>Quantitative</td>
<td>B1 injection gas. Injection gas composition was not accurately monitored at the frequency required by the Protocol in the crediting period. One lab sample result is used to substitute 79% of the hourly data points in September 2015, and 7 lab sample results are used to substitute 100% of the</td>
</tr>
<tr>
<td>Result #</td>
<td>Type</td>
<td>Summary Description of Finding Source Category or Source/Sink</td>
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<td>hourly data points in October 2015. The Protocol requires to accurately monitor injection gas composition on a daily basis.</td>
</tr>
<tr>
<td>16-06</td>
<td>Quantitative</td>
<td>B1 injection gas. Inappropriate and insufficient sampling analysis and procedures are used for injection gas composition as data substitution, which results in intermittent cross contamination. The third-party laboratory which Tetra Tech consulted with for their expertise on laboratory GC analysis, recommended additional calibration and instrument verification including testing and confirming the response factor, pre-calibration and post – calibration.</td>
</tr>
<tr>
<td>16-07</td>
<td>Quantitative</td>
<td>B1 injection gas. Non – industry standard practice is used to calculate mass ratio of CO2 in the injection gas. The Shell’s method artificially changes the CO2 concentration by using normalized CO2 concentration divided by non-normalized molecular weight of injection gas for mass ratio of CO2. For example, GC device gives the final reading for the component concentration, it does not only normalize one particular component.</td>
</tr>
<tr>
<td>16-08</td>
<td>Quantitative</td>
<td>B1 injection gas. The calibration gas used by Shell on-site lab is inappropriate for injection gas composition analysis. The CO2 mol% in the calibration gas is well below the CO2 mol% in the injection gas. The accuracy of lab sample results relies on the calibration gas composition.</td>
</tr>
<tr>
<td>16-09</td>
<td>Quantitative</td>
<td>B1 injection gas. Conservativeness is not demonstrated for CO concentration in the absence of real time monitoring for CO. The maximum CO% on a wet basis is approximately 0.027 mol% based on the lab sample results, however, the CO% used for reporting is well below the maximum.</td>
</tr>
<tr>
<td>16-10</td>
<td>Quantitative</td>
<td>B1 injection gas. The mass ratio of CO2 is calculated using CH4% (dry basis), H2% (dry basis), CO2% (wet basis), CO% (wet basis), and H2O%. The on – line analyzer reading is on a dry basis. The mixed basis for calculation of the CO2 mass ratio introduces inconsistency. The dry based concentrations from the on-line analyzer should be converted to a wet basis to calculate CO2 mass ratio, as water is present in the injection gas stream and is measured by the injection gas mass flow meters.</td>
</tr>
<tr>
<td>16-11</td>
<td>Quantitative</td>
<td>P4 Material Input. Emissions associated with lubricant, glycol and cathodic protection were excluded from the quantification. Although lubricant, glycol, and cathodic protection are not used in the capture process, they are materials used in the Quest CCS offset project. The Protocol defines P4</td>
</tr>
<tr>
<td>Result #</td>
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<tr>
<td>16-12</td>
<td>Quantitative</td>
<td>P4 Material Input. Emissions associated with incremental water usage were not included as material input. Water usage is quantified under P21 material recycling by Shell. However, the emissions associated with production and delivery of the incremental water usage resulting from the Quest project should be included for material inputs, as defined in the Protocol, Page 24 and 25 of 64. Incremental water usage is not categorized appropriately. The discrepancy is a quantitative overstatement, and is estimated to be 3.73 t CO2e or 0.0022% of net reduction.</td>
</tr>
<tr>
<td>16-13</td>
<td>Qualitative</td>
<td>P4 Material Input. Emissions associated with the Standby N2 Source at the injection well sites was not reported and documented in the OPR. There are approximately 20 full-size bottles of N2 at each well site. The emissions associated with the production and delivery of this nitrogen source is not accounted for in the P4 source. However, this quantitative misstatement is not applicable to the 1st crediting period. No standby N2 cylinders were ordered in August 23, 2015 – October 31, 2015. The emissions associated with this additional standby N2 source needs to be reported in the OPR and included in future reporting.</td>
</tr>
<tr>
<td>16-14</td>
<td>Qualitative</td>
<td>P4 Material Input. The change in method used to determine the quantity of supplied air is not reported and documented in OPR. The method to estimate instrument/utilities air volume is different than the OPP. The OPP estimates 150 m3/hr for Quest. The quantification was conducted using the billing model to estimate the air volume at 650 m3/hr. The OPR did not report this change. This is a qualitative misstatement</td>
</tr>
<tr>
<td>16-15</td>
<td>Qualitative</td>
<td>P4 Material Input. The change in method to N2 consumption measurement at the Quest site is not reported and documented in the OPR.</td>
</tr>
<tr>
<td>Result #</td>
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<td>The OPP specifies that the N2 quantity is measured by meter FI246094. However, this meter is a low flow cut off meter. In the first crediting period, another meter FC248001 was used to estimate the quantity of N2 for the purposes of quantifying the emissions associated with the production and delivery of N2 used for Quest. The variation is not reported and the justification is not documented in the OPR. This is a qualitative misstatement.</td>
</tr>
<tr>
<td>16-16</td>
<td>Quantitative</td>
<td>P4 Material Input. Antifoam is excluded and considered as a negligible material without approval. It deviates from the Technical Guidance for the offset project.</td>
</tr>
<tr>
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<td>In the Technical Guidance for Offset Project Developer (Version 4.0, February 2013), “Projects must quantify all sources and sinks included in the protocol quantification requirement”. Excluding emissions associated with production and delivery of this source is a deviation from the Program Criteria.</td>
</tr>
<tr>
<td></td>
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<td>The discrepancy is a quantitative overstatement, and is estimated to be 1 t CO2e or 0.0007% of net reduction overstatement.</td>
</tr>
<tr>
<td>16-17</td>
<td>Quantitative</td>
<td>P5, P6 &amp; P7. Extraction, processing, and transportation of natural gas usage is not accurately estimated because of the inaccurate method used for P9 off-site heat generation</td>
</tr>
<tr>
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<td>Fuel usage associated with off-site heat generation (P9) was underestimated by Shell due to the overestimate of the waste heat quantities. Discrepancies for P9 source are noted. Please see P9 section for more details.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The discrepancy for P5, P6 and P7 due to P9 error is estimated to be 1,801 t CO2e or 1.1% of net reduction.</td>
</tr>
<tr>
<td>16-18</td>
<td>Qualitative</td>
<td>P9 Off-site Heat Generation. The Shell’s steam allocation model presented in the OPP and OPR does not present the actual operation, it is based on an adaptation from a financial impact (or energy cost conservation incentive) perspective.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Shell’s steam allocation model presented in the OPP and OPR does not present the actual operation, it is based on an adaptation from a financial impact (or energy cost conservation incentive) perspective. It is an assumption. This deviation from the protocol is not permitted.</td>
</tr>
<tr>
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<td><strong>This is a qualitative misstatement, as the total Quest LP steam supply quantity is not affected by the allocation method.</strong></td>
</tr>
</tbody>
</table>
| 16-19   | Quantitative | **P9 Off-site Heat Generation. An inaccurate methodology is used for quantifying waste heat. Waste heat must be measured and proven to be vented or dissipated during the baseline condition (Page 22 pf 64 in the Protocol). Shell uses a “Projection Based Baseline” approach to estimate waste heat. This dynamic approach for the P9 emissions results in the waste heat quantity being conceptual rather than real and measured.**  
Using Shell’s method, only LP Steam Turbine Extraction steam is used for waste heat calculation. Shell assumes that all LP STE steam would have gone to the 10-15th stage of Steam Turbine Generator without Quest in the 1st crediting period. The LP STE steam is approximately 91 t/h in August 23 – October 30, 2015. Based on the process description and evaluation of LP STE steam prior to Quest (2003 – 2014), the LP STE steam was approximately 61 t/h. There is no evidence that supports the entire LP STE steam quantity in the project period would have gone to the 10-15th stage of STG in the absence of Quest. In 2003 – 2014 (prior to Quest). **This is a quantitative misstatement** |
| 16-20   | Qualitative | **P9 Off-site Heat Generation. The quantity of MP LD steam using Shell’s method is determined by an instrumentation control strategy. Using this method, the MP LD steam quantity is highly dependent on the frequency of the data measurements used. The valve position values may change frequently as process steam demands vary. Shell uses average daily data to compare the two indicators’ values. Tetra Tech compared average daily Steam LP, MP LD net energy with hourly MP LP steam net energy. The MP LD steam net energy (GJ) supply is increased by 95% for September and 74% for October using hourly data, compared to average daily data. The higher data interval frequency changes the MP LD steam quantity using Shell’s method. Tetra Tech did not assess the impact of data frequency on accuracy for MP LD data at 15 minutes interval or higher frequency data. It is Tetra Tech opinion that the activity data used to determine the quantity of MP LD steam is not sufficiently frequent to be accurate.**  
**This is a qualitative misstatement, as the total Quest LP steam supply is not affected by the allocation method.** |
<table>
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<tr>
<td>16-21</td>
<td>Quantitative</td>
<td>P9 Off-site Heat Generation. In the first crediting period (August 23 – October 31, 2015), the enthalpy of total LP steam for the dates of 21 -26 and 30 for each month appears to be calculated incorrectly. The enthalpy data for these dates is not linked to the steam table based on pressure and temperature. The source for the enthalpy data is unknown. This is a quantitative misstatement, the discrepancies are estimated to be immaterial.</td>
</tr>
<tr>
<td>16-22</td>
<td>Quantitative</td>
<td>P9 Off-site Heat Generation. The steam table used appears to be ASME 1967 steam tables. The reason for not using IAPWS-IF97 steam table is unknown. This is a quantitative misstatement, the discrepancies are estimated to be immaterial.</td>
</tr>
<tr>
<td>16-23</td>
<td>Quantitative</td>
<td>P9 Off-site Heat Generation. The OPP states “the assumption that all gas consumed in this SS is natural gas and is conservative and simpler”. Tetra Tech reviewed the fuel gas supply CO2 emission factor (EF) for the Upgrader and Upgrader expansion and notes that assuming all fuel gas is equivalent to natural gas is not conservative. For example, the CO2 EF for fuel gas supplied to Upgrader Expansion is 4% and 7% higher than natural gas in September and October, respectively. Tetra Tech acknowledges the complexity of steam supply at Quest and implications for heat calculations, however, conservativeness should be considered by comparing three fuel sources on an appropriate frequency. This is a quantitative misstatement, the discrepancies are estimated to be immaterial.</td>
</tr>
<tr>
<td>16-24</td>
<td>Qualitative</td>
<td>P9 Off-site Heat Generation. Quest takes steam from Upgrader steam header. In the Quest OPP and OPR, the Scotford base heat recovery sources from HRSG steam is inaccurately categorized into LFE cogen. ACCO recently clarified interpretation of the Protocol and advised that the LFE Cogen facility refers to a facility where the only products are heat and/or electricity. Although HRSG steam in the Upgrader is a cogen steam source, the ‘Upgrader facility steam’ is boundary to define the source of steam supply to Quest. Therefore, this HRSG steam source should be LFE non cogen. This is a qualitative misstatement.</td>
</tr>
<tr>
<td>16-25</td>
<td>Quantitative</td>
<td>P9 Off-site Heat Generation. Shell uses hourly data multiplied by 24 hours for the daily data, then aggregates daily data into total for the steam consumed in the project condition in the 1st crediting period. Shell’s data aggregated approach is less accurate. The total Quest LP steam gross energy</td>
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**Quest Carbon Capture and Storage (CCS) Project**

*704-ENV.CENV03169-01.002 | March 2017*
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<td>using hourly data is 642,996 GJ, compared to 638,880 GJ using Shell’s approach. Shell’s method results in underestimating the total Quest LP steam energy consumption by 1%. This is a quantitative misstatement. The impact of this underestimation is estimated to be immaterial in this crediting period.</td>
</tr>
<tr>
<td>16-26</td>
<td>Quantitative</td>
<td>P11 CCS Facility The OPP EF for aviation turbo fuel is 0.026 kg CO2/L lower than the EF referenced in Environment Canada National Inventory Report 1990 - 2003 (2015), Table A6-11. The discrepancy is estimated to be 2 t CO2e or 0.001% of net reduction.</td>
</tr>
<tr>
<td>16-27</td>
<td>Quantitative</td>
<td>P19 Fugitive at Injection Well Site. The emission rate provided in API 2009 for valve and flange is not for CH4, it is a gas leak rate. The CO2 emission rate needs to be calculated based on API Equation 6-9, considering the CO2 weight fraction in the gas.</td>
</tr>
<tr>
<td>16-28</td>
<td>Qualitative</td>
<td>Quantification method for the fugitives at the injection well site is not full documented and reported in the OPR and OPP.</td>
</tr>
<tr>
<td>16-29</td>
<td>Quantitative</td>
<td>Exclusion of emissions associated with transport and combustion of waste material off site emission associated with Activated Carbon recycling processes.</td>
</tr>
</tbody>
</table>