

# FIRST METHODOLOGY ASSESSMENT REPORT FOR SULPHUR CONCRETE IN PRECAST APPLICATIONS



**Stantec**

Document Prepared By Stantec Consulting Ltd.

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<b>Methodology Element Category:</b>	Methodology
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**Summary:**

Stantec Consulting Ltd. was retained to assess the proposed Methodology entitled *Quantification Methodology for the Use of Sulphur Concrete in Precast Applications, Version 1.2*.

This Methodology provides procedures for the quantification of net greenhouse gas (GHG) emission reductions from the substitution of calcium and/or magnesium carbonate-derived (“Portland”) cement with a modified heated sulphur product for precast applications (as opposed to poured in place applications), during the production of concrete and other concrete-based products such as precast pipe, paving stones, slabs and tanks.

Stantec assessed the Methodology against VCS program requirements found in the VCS Methodology Approval Process document, the *VCS Program Guide*, and the *VCS Standard*. An internal assessment document was used to conduct the detailed assessment and the findings are provided in this assessment report.

Stantec found that the Methodology in its current form, does not contain non-conformances that would affect the usability of the Methodology under the VCS program. Stantec concludes that *Quantification Methodology for the Use of Sulphur Concrete in Precast Applications, Version 1.2* meets all relevant VCS requirements for VCS methodology elements. Details of the findings are described in Section 3 of this report. A summary of required corrective actions and resolutions is provided in Table 4.1 of this report.

**Table of Contents**

**1 INTRODUCTION..... 1**

1.1 Objective ..... 1

1.2 Scope and Criteria ..... 1

1.3 Summary Description of the Methodology Element..... 1

**2 ASSESSMENT APPROACH..... 4**

2.1 Method and Criteria..... 4

2.2 Document Review ..... 4

2.3 Interviews ..... 4

2.4 Use of VCS-Approved Expert ..... 4

2.5 Resolution of Any Material Discrepancies ..... 4

2.6 Internal Quality Control ..... 5

**3 ASSESSMENT FINDINGS ..... 6**

3.1 Applicability Conditions ..... 6

3.2 Project Boundary..... 7

3.3 Procedure for Determining the Baseline Scenario..... 8

3.4 Procedure for Demonstrating Additionality ..... 8

3.5 Baseline Emissions ..... 8

3.6 Project Emissions..... 10

3.7 Leakage..... 10

3.8 Quantification of Net GHG Emission Reductions and/or Removals ..... 11

3.9 Monitoring..... 11

3.10 Data and Parameters ..... 12

3.11 Use of Tools/Modules ..... 12

3.12 Adherence to the Project Principles of the VCS Program ..... 12

3.13 Relationship to Approved or Pending Methodologies ..... 13

3.14 Stakeholder Comments..... 14

**4 RESOLUTION OF CORRECTIVE ACTION REQUESTS AND CLARIFICATION REQUESTS ..... 15**

**5 ASSESSMENT CONCLUSION ..... 25**

**6 REPORT RECONCILIATION ..... 25**

**7 EVIDENCE OF FULFILMENT OF VVB ELIGIBILITY REQUIREMENTS..... 25**

**8 SIGNATURE ..... 25**

**List of Tables**

Table 4.1 Summary of Corrective Actions..... 16

## 1 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by Shell Canada Ltd. (Shell) to assess the proposed Methodology, hereafter referred to as the “Methodology”, prepared by Shell and Prasino Group, entitled *Quantification Methodology for the Use of Sulphur Concrete in Precast Applications (Version 1.2, dated 28-June-2012)*.

### 1.1 Objective

The objective of the methodology assessment is to compare the Methodology against the requirements of the Verified Carbon Standard (VCS) criteria documents listed below in Section 1.2 and identify any non-conformances. The findings of this assessment are described in the report presented herein.

### 1.2 Scope and Criteria

The proposed Methodology assessed in this report is “*Quantification Methodology for the Use of Sulphur Concrete in Precast Applications (Version 1.2, dated 28-June-2012)*”.

The Methodology was compared to the requirements of the following documents:

- VCS Methodology Approval Process (Version 3.3, Feb, 2012);
- VCS Methodology Template (Version 3.1, Feb, 2012);
- VCS Standard (Version 3.2, Feb, 2012); and
- VCS Program Guide (Version 3.3, May, 2012).

The Methodology was also assessed for the principles of relevance, completeness, consistency, accuracy, transparency and conservatism in the context of the VCS program and industry practice.

### 1.3 Summary Description of the Methodology Element

This Methodology is based on the draft *Quantification Protocol for the Use of Sulphur Concrete in Precast Applications v0.4*, under the *Alberta Specified Gas Emitters Regulation*, developed by Shell.

The proposed Methodology was developed to provide guidance on the quantification of greenhouse gas (GHG) emissions reductions achieved by substituting the Portland cement content with a sulphur binder product in the production of sulphur concrete for precast applications.

A project is defined as an activity, initiative, or program to reduce GHG emissions compared to a known baseline scenario. The baseline scenario may be the existing condition or another scenario that the project developer has identified as being representative of the conditions had the project not proceeded.

The GHG emission reductions for this methodology arrive from the substitution of all of the of the Portland cement content with an alternative binder product, such as sulphur or a primarily sulphur product. The use of an alternative binder product eliminates the use of Portland cement, thereby eliminating the process and combustion emissions associated with the production of clinker during the calcination

process. This reduction of GHG emissions via the displacement of Portland cement is greater than the increase in energy under the project condition where the cement may need to be hot mixed, as opposed to conventional cold mixing. Material sources of GHG emissions under the baseline condition are the process and combustion emissions associated with the calcination process and the combustion emissions associated with the production of conventional cement.

Other upstream and downstream sources in the baseline are excluded from analysis and justification for those excluded sources is provided in the Methodology. There are no relevant GHG sinks or reservoirs associated with the proposed project activity.

The baseline scenario for this project is defined as the production of concrete using traditional cementitious binders derived from limestone and clay that rely on the chemical bonds formed upon contact with water to bind together aggregate material (sand and rock). This binder (“clinker”) is a key component of Portland cement. Project proponents must demonstrate that this is the most reasonable and credible baseline for their project using the CDM tools *“Combined tool to identify the baseline scenario and determine additionality Version 03.0.1”* and *“Tool for the demonstration and assessment of additionality v05.2.1”*.

The calculation of GHG emissions related to the production of Portland cement in the baseline condition is based on the mass of Portland cement that was not used in the project condition. An equivalency factor is used to provide functional equivalence between the mass of sulphur cement and Portland cement. Finally, an emission factor representing the mass of carbon dioxide equivalent (CO<sub>2</sub>e) / tonne of Portland cement displaced is applied. The project proponent must demonstrate that the chosen emission factor is representative and conservative for their project.

The project emissions include emission reductions resulting from the use of sulphur concrete (instead of Portland cement). These emissions include extraction and processing of fuel, emissions due to sulphur degassing, emissions due to the additional heating requirements of sulphur concrete, emissions due to heating the aggregate, emissions due to the transportation and storage of sulphur, and emissions due to the production and transportation and production of the sulphur modifier.

For sources other than the substitution of Portland cement, the Methodology specifies multiplying the activity level for project units (e.g., volume fuel consumed) by a generic emission factor for fuel combustion.

The Methodology requires the proponent to monitor:

- mass of precast products produced;
- ratio of Portland cement in finished product (% Portland cement in final product under the baseline scenario);
- volume of each type of fuel combusted during the project for sulphur degassing, aggregate heating and additional sulphur heating;
- volume of degassing vent gas incinerated;
- molar fraction of CO<sub>2</sub> in incinerated vent gas;

- mass distance of sulphur transported to the concrete facility;
- mass of modifier used in sulphur cement; and
- mass distance of modifier transported to the concrete facility.

Net GHG emission reductions are based on the difference between baseline emissions and project emissions.

## 2 ASSESSMENT APPROACH

### 2.1 Method and Criteria

Stantec reviewed the proposed Methodology against the requirements of the criteria listed in Section 1.2 above and documented any identified non-conformances in an internal assessment document based on the assessment criteria.

Stantec prepared this document specifically for the VCS program based on the VCS assessment report template. The internal assessment document was reviewed by the Stantec Peer Reviewer and the Lead Assessor prior to issuance.

### 2.2 Document Review

The Stantec team reviewed and identified the requirements of the VCS program by reviewing the documents listed in Section 1.2. Stantec then compared the Methodology against the criteria and requirements of the VCS program.

After the initial review of the Methodology (Version 1.0), clarification questions were posed to the methodology developers and potential discrepancies with the VCS program requirements were identified. The methodology developer provided initial responses and provided Stantec with an updated Methodology (Version 1.1). Several further corrective actions were noted by Stantec with regards to Version 1.1 resulting in the issuance of Version 1.2. The assessment results and final opinion contained within this report are based Version 1.2 while the overall assessment clarifications and corrective actions provided in Section 4 of this report are based on the final version as well as earlier versions of the Methodology.

### 2.3 Interviews

Stantec did not find it necessary to conduct any formal interviews other than discussions with the Methodology developers (Shell Canada and Prasino Group during this initial assessment of the Methodology).

### 2.4 Use of VCS-Approved Expert

Stantec did not rely on a VCS-approved expert as part of this assessment, as this Methodology is not relevant to Agriculture, Forestry, and Land Use (AFOLU) projects.

### 2.5 Resolution of Any Material Discrepancies

During the draft assessment, potential material discrepancies found during the review of the Methodology were identified, where they existed. Shell and Prasino Group are responsible for addressing these material discrepancies, in accordance with the *VCS Methodology Approval Process*. All discrepancies identified, and corrective actions taken are recorded in Table 4.1.

## 2.6 Internal Quality Control

Stantec is accredited with the American National Standards Institute (ANSI) (a member of the International Accreditation Forum) in accordance with ISO14065 (Accreditation ID #0805 issued to Stantec Consulting Ltd. Atmospheric Environment Group dated February 1, 2011 for greenhouse gas (GHG) verification). As part of the accreditation, Stantec developed a Validation and Verification Standard Operating Procedure (SOP) to be followed in conducting validation and verification projects. The quality control and assurance procedures described in the SOP were applied to this methodology assessment. A summary of the relevant quality control and assurance procedures include:

- development and use of standardized templates for assessment based on the most recent available GHG program guidance;
- review of internal sampling document and draft report by a Peer Reviewer: the Peer Reviewer is a Stantec employee knowledgeable in GHG estimation, validation, and verification, as well as being a senior practitioner within Stantec. The person fulfilling this role remains an independent reviewer during the course of the assessment;
- review of the internal sampling document and draft report by the Lead Assessor: the Lead Assessor is a Stantec employee knowledgeable in GHG estimation, validation, and verification, and is responsible for managing the assessment; and
- the Stantec team members have successfully completed the ISO 14064-3 Greenhouse Gas Verification and Validation Training course.

### 3 ASSESSMENT FINDINGS

#### 3.1 Applicability Conditions

*Assess whether and how the methodology's applicability conditions are appropriate, adequate and in compliance with the VCS rules.*

As described in the Methodology,

*"...this [protocol] is applicable to processes that involve the substitution of calcium and/or magnesium carbonate-derived ("Portland") cement with an alternative binder, such as a modified heated sulphur product, during the production of concrete and other concrete-based products such as pre-cast pipe, paving stones, slabs and tanks.*

*This Methodology is applicable to the production sulphur concrete for precast applications, where the following conditions are met:*

- the most reasonable and credible baseline scenario is the production of precast concrete products using Portland cement, as demonstrated using the methodology outlined in Section 6;*
- The handling, storage, mix production temperature and other key factors specified by the manufacturer for the proper and safe use of sulphur cement have been followed by the project proponent. Evidence of adherence to manufacturer specification must be made available during a verification site visit, conducted during precast product production;*
- The resulting sulphur concrete product meets local legal and technical requirements. In the absence of local technical specifications for concrete, project proponents must demonstrate that sulphur concrete produced under the project condition provides the equivalent function to concrete that would have been produced under the baseline condition.*

During the assessment of applicability, the United States Environmental Protection Agency's AP 42, *Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources – Chapter 11.12 – Concrete Batching*, document was reviewed by Stantec. This was used as a reference comparison for a description of concrete production process technologies. This document identified two types of concrete production – precast and standard.

In addition, the Cement Association of Canada's website<sup>1</sup> was reviewed and it referenced supplementary cementing materials (SCM) and blended cement as alternatives to Portland cement with lower associated greenhouse gas emissions.

#### **Findings: Pass**

The methodology's applicability conditions are considered appropriate, following the modifications made.

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<sup>1</sup> Website address: <http://www.cement.ca/en/Concrete-and-the-Environment.html>.

This methodology has identified the project activities to which it applies and has established criteria that describe the conditions under which the methodology can (and cannot, if appropriate) be applied. However, clarification on several points was deemed necessary by Stantec. Clarification regarding the application of this methodology to pour in place applications and to projects employing standard concrete production processes, or supplementary cementing material (SCM) products was made in Version 1.2 (as described in further detail in Table 4.1).

### 3.2 Project Boundary

*Assess whether and how the procedures for the definition of the project's physical boundary and sources and types of GHGs included are appropriate, adequate and in compliance with the VCS rules.*

The project [condition] is defined in the Methodology as the production of concrete, substituting all of the Portland cement content with a sulphur binder product.”

The project boundary is defined in the Methodology as including Sources, Sinks and Reservoirs (SSRs) that are within the project site (the physical, geographic location of the hot mix asphalt production facility), as well as others that are off-site. The temporal project boundary includes the operation of an existing precast concrete facility during the incorporation of a sulphur binder.

This project and baseline boundary definitions as reflected in Figure 1 and Figure 2 respectively include all of the SSRs to be quantified (and deemed to be “included”) as part of the “project”.

#### Methodology SSRs:

The Methodology identified the extraction and processing of fuel, emissions due to sulphur degassing, emissions due to the additional heating requirements of sulphur concrete, emissions due to heating the aggregate, emissions due to the transportation and storage of sulphur, and emissions due to the production and transportation and production of the sulphur modifier as the emission sources relevant to the offset project.

SSRs related to the construction and decommissioning of the facility are considered outside of the scope of the methodology and have been excluded from quantification.

#### Greenhouse Gases:

The Methodology states that:

*“.....the heat required for the calcination process is typically supplied from the combustion of fossil fuels, resulting in the emission of further carbon dioxide as well as smaller amounts of methane and nitrous oxide”.*

The greenhouse gases (GHGs) considered in this Methodology include Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>) and Nitrous Oxide (N<sub>2</sub>O). The Methodology specifically makes note that these emissions are the result of the calcination process and combustion of fossil fuels. Other GHGs, including HFCs, PFCs, and SF<sub>6</sub> are not included and this is considered reasonable.

#### Findings: Pass

### 3.3 Procedure for Determining the Baseline Scenario

*Assess whether and how the procedures for determining the baseline scenario are appropriate, adequate and in compliance with the VCS rules.*

The baseline [condition] identified in this Methodology is the production of concrete using traditional cementitious binders derived from limestone and clay that rely on the chemical bonds formed upon contact with water to bind together aggregate material (sand and rock). This binder (“Clinker”) is a key component of Portland cement. The baseline scenario for projects applying this Methodology is the production of precast concrete products using Portland cement.

The Methodology requires that project proponents demonstrate that this is the most reasonable and credible baseline for their project using the methodological tool “*Combined tool to identify the baseline scenario and determine additionality*” as published on the UNFCCC website. This is an appropriate tool.

The Methodology has provided one method (*i.e.*, the project method) for determining the crediting baseline.

**Findings: Pass**

### 3.4 Procedure for Demonstrating Additionality

*Assess whether and how the procedures and/or tools for demonstrating additionality are appropriate, adequate and in compliance with the VCS rules.*

The Methodology states that “additionality will be assessed and demonstrated using the most recent version of the methodological tool “*Combined tool to identify the baseline scenario and determine additionality* and the “*Tool for the demonstration and assessment of additionality V05.2.1*” as published on the UNFCCC website.

**Findings: Pass**

The approach for determining additionality is considered to be appropriate, adequate and in compliance with the VCS rules.

### 3.5 Baseline Emissions

*Assess whether and how the procedures for calculating baseline emissions are appropriate, adequate and in compliance with the VCS rules.*

The baseline scenario for this Methodology is the use of Portland cement in precast applications. Emissions are from two sources – industrial process emissions (conversion of limestone into clinker) and combustion related emissions associated with combustion of fossil fuels. Reduction in the use of Portland cement reduces both of these sources.

The Methodology states that:

*“.....the production of clinker results in the release of significant process GHG emissions and combustion GHG emissions. Carbon dioxide process emissions occur as a by-product of the calcination process, where a calcium or magnesium carbonate such as limestone is heated with clay to form clinker (primarily calcium oxide) and carbon dioxide. The heat required for the calcination process is typically supplied from the combustion of*

*fossil fuels, resulting in the emission of further carbon dioxide as well as smaller amounts of methane and nitrous oxide”.*

Emissions in the baseline scenario are attributed solely to the **production of Portland cement**. However, the baseline scenario emissions (for the production of Portland cement) are not quantified directly. Instead, the ‘avoided emissions’ due to the implementation of the project are quantified in the baseline.

The Methodology states that:

*“.....The calculation of the emissions related to the production of Portland cement in the baseline condition will be based on the mass of sulphur used in the project condition. An equivalency factor will be used to provide functional equivalence between the mass of sulphur cement and Portland cement. Finally, an emission factor representing the mass of carbon dioxide equivalent greenhouse gas emissions per tonne of Portland cement displaced will be applied.”*

The baseline scenario requires the following information:

- mass of finished precast products (in the project scenario); and
- ratio of Portland cement in finished product (for the baseline scenario).

*“Emissions due to the production of Portland cement under the baseline condition” are calculated by taking the mass of finished precast concrete produced in the project stage and multiplying this by an equivalency factor (ratio of Portland cement in finished product).*

*This value is then multiplied by an emission factor which represents the CO<sub>2</sub>e emissions for the production of Portland. The methodology describes this emission factor as “representing the mass of CO<sub>2</sub>e / tonne of Portland cement displaced”.*

## Findings: Pass

The VCS Standard requires that:

***“4.7.1 The methodology shall establish criteria and procedures for quantifying GHG emissions and/or removals for the selected GHG sources, sinks and/or reservoirs, separately for the project (including leakage) and baseline scenarios.***

***4.7.2 The methodology shall establish criteria and procedures for quantifying net GHG emission reductions and removals generated by the project, which shall be quantified as the difference between the GHG emissions and/or removals from GHG sources, sinks and reservoirs relevant for the project and those relevant for the baseline scenario. Where appropriate, net GHG emission reductions and removals shall be quantified separately for the project and the baseline scenarios for each relevant GHG and its corresponding GHG sources, sinks and/or reservoirs”***

The following potential discrepancies were identified and still remain, however; dismissed based on precedence of other methodologies accepted under the VCS in applying a similar approach. The approach is also deemed to be conservative (assuming the emission factor for Portland cement is conservatively chosen by the proponent), as fewer sources are quantified in the baseline in comparison to the project (thus potentially underestimating baseline emissions and resulting in less credits):

- The baseline scenario is the use (and therefore production) of Portland cement used in precast concrete products. Emissions under the baseline condition, are quantified in Equation (1) as the emissions due to the production of Portland cement.
- However, in Equation (2), the quantification of emissions due to the production of Portland cement under the baseline condition is actually the quantification of the emission reductions due to the displacement of Portland cement in the final precast concrete product. These “avoided emissions” are actually what you would occur due to the implementation of the project, and not the baseline (business as usual) scenario. It is noted that this type of baseline and project quantification is used in other CDM methodologies such as landfill gas and coal bed methane destruction projects.

### 3.6 Project Emissions

*Assess whether and how the procedures for calculating project emissions are appropriate, adequate and in compliance with the VCS rules.*

The Methodology identifies the emissions in the project scenario that the project proponent must account for direct emissions due to fuel combustion at the precast concrete facility for heating of aggregate and sulphur additive, and direct emissions due to the fuel combustion and process emissions outside the precast concrete facility for production of the sulphur modifier and transport of the modifier and modifier sulphur product. Indirect emissions are also identified for the extraction and processing of fossil fuels used and degassing of sulphur.

Total project emissions are calculated by summing the emissions from the following sources:

- emissions due to sulphur degassing;
- emissions due to the additional heating requirements of sulphur concrete;
- emissions due to heating the aggregate;
- emissions due to the extraction and processing of fuel
- emissions due to the transportation and storage of sulphur; and
- emissions due to the production and transportation of sulphur modifier.

The emissions from fuel extraction and processing, fuel combustion, should be calculated from direct measurement of the quantities of each component consumed. Emission factors published by the Intergovernmental Panel on Climate Change (IPCC) and other sources are acceptable defaults.

**Findings: Pass**

### 3.7 Leakage

*Assess whether and how the procedures for calculating leakage are appropriate, adequate and in compliance with the VCS rules.*

The Methodology states that there are “no known sources of leakage for this project activity”. Through follow-up correspondence with the Shell Canada representative, the following information was provided on the potential for leakage:

*“Discussed at the Feb 2011 public workshop in Edmonton: For the Alberta-specific case, use of Sulphur Concrete will displace some Portland cement (PC) made in AB, but as concrete products constitute 10-12% typically of total PC manufacturing volumes, and since it would be costly to export pc from AB to outside the province, leakage is not a material issue. Sulphur concrete is not expected to be used in all end uses, nor is it expected to capture 100% market share in any region or end use. Therefore, the net amount of Portland cement displaced by sulphur can be expected to be < 10%. Moreover, only 6% of cement production is traded internationally according to the article in the link below. This is the result of cement industries generally being created for domestic use. Generally speaking, high energy costs and a wide geographic dispersion of pc constituents (e.g., limestone) make it likely that a relatively minor reduction in pc production in a given region due to the introduction of sulphur concrete will not result in significant leakage. Incremental emissions due to transportation of sulphur are accounted for in an SS in the project condition. Other leakage sources, such as leakage from electricity consumption for conveyor systems for sulphur handling, are expected to be negligible given the small percent of net amount of Portland cement displaced and small percent of precast volume of total PC manufacturing volumes.”*

**Findings: Pass**

### 3.8 Quantification of Net GHG Emission Reductions and/or Removals

Net GHG emission reductions are calculated as baseline emissions minus project emissions.

**Findings: Pass**

### 3.9 Monitoring

The monitoring procedures provided in the Methodology are identified for each monitoring parameter, including a description of the measurement method and the frequency of monitoring. The Methodology requires the proponent to monitor:

- mass of precast products produced;
- mass of Portland cement used;
- volume of each type of fuel combusted during the project for sulphur degassing, aggregate heating and additional sulphur heating;
- volume of degassing vent gas incinerated;
- molar fraction of CO<sub>2</sub> in incinerated vent gas;
- mass distance of sulphur transported to the concrete facility;
- mass of modifier used in sulphur cement; and
- mass distance of modifier transported to the concrete facility.

For each of the parameters above, the Methodology outlines the appropriate measurement methods to use. The Methodology also provides the frequency of monitoring / data recording required. The Methodology includes general guidance on QA/QC procedures in Section 9.3, and requires the project proponent to develop detailed procedures.

**Findings: Pass**

**3.10 Data and Parameters**

*Assess whether and how the specification for monitored and not monitored data and parameters is appropriate, adequate and in compliance with the VCS rules.*

The Methodology identifies the parameters to be monitored as part of the project as well as parameters that are not monitored. For each identified parameter, the Methodology provides a description of the parameter, the units and a data source.

The parameters that are not monitored (and hence known at validation) are included in Section 9 to be:

- emission factor for the production of Portland cement ( $EF_{\text{Portland Cement Production}}$ );
- emission factors for fuel combustion ( $EF_{\text{Fuel } i, \text{GHG}}$ ); and
- emission factors for fuel extraction and processing ( $EF_{\text{Fuel } i, \text{GHG}}$ ).

The Methodology states that for the emission factor for the production of Portland cement ( $EF_{\text{Portland Cement Production}}$ ), project proponents may justify the factors are conservative to determine the emission factor for production of Portland cement in the absence of justification of site specific or region specific factors. This ensures uncertainty in the estimates is accounted for conservatively.

The parameters that are considered “accepted values” are appropriate and referenced in the methodology.

**Findings: Pass**

**3.11 Use of Tools/Modules**

*Where the methodology element references tools or modules approved under the VCS or an approved GHG program, assess whether and how the tools or modules are used appropriately within the methodology. Reassessment of the actual tools or modules is not required.*

The Methodology states that,

*“..additionality will be assessed and demonstrated using the most recent version of the methodological tool “Combined tool to identify the baseline scenario and determine additionality and the “Tool for the demonstration and assessment of additionality V05.2.1” as published on the UNFCCC website.”*

**Findings: Pass**

The tools and modules referenced are appropriate and appear to be used appropriately within the methodology.

**3.12 Adherence to the Project Principles of the VCS Program**

*The VCS Program principles are relevance, completeness, consistency, accuracy, transparency and conservativeness. Based on Stantec’s assessment, discussion of implementation of the VCS principles in the Methodology is provided below.*

**Relevance:**

The Methodology considered the emission sources during production of precast concrete product for the baseline (Portland cement) and project (sulphur substitute) scenarios. Relevance of included SSRs is considered adequately described and the methodology indicates that project proponents must justify the baseline and project SSRs selected for quantification in their project.

**Completeness:**

Sufficient detail is provided to guide proponents in the application of the Methodology.

**Consistency:**

No remaining issues with consistency are noted in the Methodology.

**Accuracy:**

In section 9.4 (Uncertainty Assessment), the Methodology requires that the project proponents apply the appropriate confidence deductions. Section 9.4 includes indication that meters used in quantification should be calibrated to manufacturer's specifications. The Methodology includes a discussion regarding uncertainty in measurements.

**Transparency:**

The Methodology transparently documents the emissions / reductions associated with both the baseline and project scenarios, and transparently describes the quantification methodologies, including the requirements for project proponents to provide evidence of the applicability of emission factors selected for their project.

**Conservativeness:**

The Methodology demonstrated conservativeness by suggesting that many of the SSRs be excluded for simplification as "the emissions are likely higher under the baseline condition".

**Findings: Pass****3.13 Relationship to Approved or Pending Methodologies**

*Assess whether and how any existing methodology could reasonably be revised to serve the same purpose as the proposed methodology.*

The Methodology indicates that it is based on the draft *Quantification Protocol for the Use of Sulphur Concrete in Precast Applications v0.4*, issued under the *Alberta Specified Gas Emitters Regulation*, developed by and that it is not based on any pending or approved CDM or CAR methodologies.

The methodology also states that:

*".....Approved and Pending methodologies for all sectoral scopes were reviewed to determine if an existing methodology could be reasonably revised to meet the objective of this proposed methodology. Two methodologies related to process changes in concrete production were identified, and are:*

- *ACM0015V3: Consolidated baseline and monitoring methodology for project activities using alternative raw materials that do not contain carbonates for clinker production in cement kilns, CDM March 2010; and*
- *ACM0005 v.5: Consolidated baseline methodology for increasing the blend in concrete production, CDM October 2009"*

In the CDM Methodology ACM0015V3, the emission reductions occurring due the project are described as:

*"The project activity mainly reduces CO<sub>2</sub> emissions through substitution of clinker in cement by blending materials. Emissions reductions in year y are the difference in the CO<sub>2</sub> emissions per tonne of BC in the baseline and in the project activity multiplied by the production of BC in year y. The emissions reductions are discounted for the percentage of additives for which surplus availability is not substantiated"*

The Methodology states that ACM00015V3 is not applicable to the production of sulphur concrete as the production of sulphur concrete requires significant process changes not reflected in existing methodologies and adaptation would not be feasible. Also, the project activity SSRs include calcination of raw materials and kiln emissions. Calcination does not occur in sulphur concrete and there is no clinker.

Other approved CDM, and VCS methodologies under the Manufacturing Industries sectoral scope were listed and deemed to be not applicable.

#### **Findings: Pass**

The Methodology developer provided a list of all existing CDM Methodologies with the same sectoral scope, and provided sufficient evidence to support that existing CDM methodologies (specifically ACM0015V3) within the same sectoral scope could not be easily revised.

### **3.14 Stakeholder Comments**

According to the VCS website for the proposed Methodology (<http://v-cs.org/methodologies/quantification-methodology-use-sulphur-concrete-precast-applications>) no stakeholder comments were received during the public review period, which occurred from 5 January 2012 until 3 February 2012.

#### **Findings: Pass**

#### **4 RESOLUTION OF CORRECTIVE ACTION REQUESTS AND CLARIFICATION REQUESTS**

Stantec developed Correction Action Requests and Clarification Requests relevant to the Methodology. Addressed requests (addressed between Version 1.0 and 1.2) are provided in Table 4.1.

Note that Corrective Action Requests are intended to be actions made to the Methodology document. Clarification Request responses may also be provided to Stantec in letter form, outside the Methodology document if deemed warranted.

Table 4.1 Sulphur Concrete Methodology Corrective Actions and Clarification Requests

Assessment Findings	Corrective Action or Clarification Request	Response (Prasino Group / Shell)	Stantec's Findings – June 12, 2012	Response – June 20, 2012 (Prasino Group/Shell)	Stantec's Findings-July 3, 2012
Applicability Conditions	Could this Methodology be applicable to standard concrete production and/ or to concrete currently produced with Supplementary Cementing Materials / and or blended cement?	<p>The Methodology <u>cannot be applied to standard production as it would entail different baseline emissions quantification method.</u> The parameters and equation in the baseline are specific to precast applications as opposed to poured in place applications.</p> <p>The Methodology could potentially be applied also to concrete produced with Supplementary Cementing Materials (SCMs) since sulphur concrete could be combined with such SCMs to make precast products. The emission factor for any SCM materials would be different from that of Portland cement production. These emission factors are, however, not easily calculated, and no figures exist currently in the industry. <u>Due to the above, the methodology at hand cannot be applied to standard concrete production and or to concrete produced with SCMs.</u></p>	<p>From the baseline section below, it is stated that <i>"All Portland cement production in the project would have occurred in the baseline as well. Portland cement that is equivalent between the project and baseline will have equivalent emissions and are null in the calculation. Only avoided Portland cement production contributes to the emission reduction and is considered in the baseline because this is where it would have occurred. The method determines avoided Portland production from project activities and calculates them as baseline"</i></p> <p>If a standard concrete production project simply swaps all Portland cement with sulphur cement, unsure why the baseline emissions quantification method described above would not be applicable? <u>Either way, details on the exclusion of standard concrete production should be explicitly stated in the Methodology to ensure transparency.</u></p>	Added, Section 2: "This Methodology is not applicable to projects employing standard concrete production processes, or supplementary cementing material (SCM) products. Sulphur concrete production has emissions related to the characteristics specific to the technology (hot mixing, etc.) and would entail different project/baseline emission quantification methods. The parameters and equations in the baseline of this methodology are specific to precast applications as opposed to poured in place applications."	Satisfactory.
Project Boundary	1. The GHG sources are not identified as controlled, related, or affected.	1. Information as to whether the SSR is controlled, related or affected has been provided next to the SSRs in Table 4	Satisfactory.	Not required.	Not required.
	2. Unclear how the SSRs were compared to the baseline condition and relevancy evaluated. The Methodology does not provide any criteria for inclusion of "relevant" SSRs.	2. SSRs comparison criteria are not included on the methodology level, but decided by the methodology developer during the development life cycle. In this Methodology's case, Shell and Leading Carbon concur that the SSRs as currently categorized best describe the reality for the methodology type at hand.	The VCS program requires a process and criteria to be provided. At a minimum, language explaining the project developer's responsibility to address this requirement should be added to the methodology.	Generic criteria for the inclusion or exclusion of any SSR is difficult to outline on the protocol/methodology level. It is the responsibility of the project developer to demonstrate what SSRs are material or not apart from the protocol's instruction.	Satisfactory.
	3. Figure 1 shows the project process flow diagram and identifies ALL potential SSRs but only has a line drawn around five SSRs while Table 4 identifies additional SSRs to be quantified. In addition, the figure is missing (or has mislabelled the following SSRs): <ul style="list-style-type: none"> <li>• sulphur transportation [and storage];</li> <li>• limestone [production];</li> <li>• fuel delivery (missing); and</li> <li>• electricity (missing).</li> </ul>	3. Clarification on project boundary and included excluded SSRs are added in Section 5, p.10.	<p>The SSRs identified in Table 4 and in the Project Figure are not consistent.</p> <p>In addition, on page 10 it does not note that project proponents must account for direct emissions (or avoided emissions) from the production of sulphur cement.</p> <p>In addition – the following SSRs are still unclear:</p> <ul style="list-style-type: none"> <li>• how is concrete recycling / disposal is a controlled emission source (is this end use of product?)</li> <li>• How is concrete transportation &amp; precast product transportation "related" SSRs, but precast product pouring/ forming and recycling /disposal controlled?</li> </ul>	<p>Figure 1, 2 and Table 4 have been revised to be consistent (table and figure edits not possible to do in track changes)</p> <p>Last sentence in first paragraph of pg 10 states "Project proponents must justify the baseline and project SSRs selected for quantification in their project." And the first bullet in the subsequent list now states "Direct emissions avoided by displacing Portland cement production and use with sulphur cement production and use"</p> <p>Recycling is controlled because it is under the direction of the project proponent at the end of life. It is not the end use. It is neglected because it is conservative compared the end of life of PC products. Transportation has been updated to be 'Controlled'.</p>	Satisfactory.
	4. A figure showing the baseline process	4. Baseline process flow diagram included	Satisfactory.	Not required.	Not required.

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Assessment Findings	Corrective Action or Clarification Request	Response (Prasino Group / Shell)	Stantec's Findings – June 12, 2012	Response – June 20, 2012 (Prasino Group/Shell)	Stantec's Findings-July 3, 2012
	flow and SSRs was not included.	Section 5, p.12.			
	5. Aggregate Heating” is not identified as a SSR in the Baseline, but it is identified as a controlled SSR in the project scenario. It is clear from the project description that heating of the sulphur is required, but it is not clear that the aggregate also need to be heated.	5. Aggregate Heating is only needed in the project condition. Unlike concrete made from Portland cement (which can be cold mixed), aggregate used in sulphur modified concrete needs to be heated too to the same temperature as the molten sulphur prior to mixing in order to maintain the heat in the sulphur product during the mixing process. Clarification added Section 2, p.7.	Satisfactory. Additional clarification provided.	Not required.	Not required.
	6. Transportation of sulphur product” is also listed as related SSRs. To be consistent with Figure 1 – should this sulphur product be called sulphur extender?	6. Transportation of Sulphur Extender” SSR is not in this methodology, but in the Bitumen Binder Methodology.	Satisfactory .	Not required.	Not required.
	7. Production of Portland cement” is identified as a SSR in the baseline. However the justification for inclusion is the “the quantity of Portland cement used in the project scenario also would have been used in the baseline scenario, The emissions related to the displaced quantity of Portland cement will be quantified”. Since the project conditions is the substitution of Portland cement with a sulphur product, unclear of how this justification applies?	7. Justification changed to “The emissions related to the production of displaced quantity of Portland cement in the finished product will be quantified. In the case where sulphur cement does not completely replace Portland cement in the project condition, the mass of Portland cement used in the finished product is accounted for in this SSR.”, Section 5, p.13.	This is still unclear:  “ <b>The emissions related to the production of displaced quantity of Portland cement in the finished product will be quantified.</b> ”  The baseline scenario is what would occur if there was no project – a.k.a production of precast concrete products using only Portland Cement.  So, in relation to the above sentence, are you trying to say that – the avoided emissions due to the production of concrete products using sulphur cement (in place of Portland Cement) will be quantified?	Justification changed to: “The production of Portland cement in the baseline condition has relevant emissions and must be included.” This is a more concise and relevant justification.  The issue of displaced production / avoided emissions does not belong in Table 4. The issue pertains more to the measurement and calculation method. The revision should resolve the issue because it focuses the justification in the table to simply state why the SSR is included (which it the intent in Table 4).  The quantification issue (avoided versus absolute) is addressed separately (see response baseline emissions 1).	Satisfactory.
	8. Fuel extraction / processing” has been included in the Methodology as a related SSR which needs to be quantified. However, no criteria has been included in the Methodology to provide guidance as to when a SSR is considered “material” and should be quantified (Is an SSR material when it is a %of the total emissions? A difference from baseline? A value?). In the case of this SSR, exclusion would be conservative thus should be permitted.	8. Generic criteria for the inclusion or exclusion of any SSR is difficult to outline on the protocol /methodology level. It is the responsibility of the project developer to demonstrate what SSRs are material or not apart from the protocol’s instruction. Fuel Extraction/Processing emissions are usually small compared to other emission sources in the project, but they are included in quantification to ensure accuracy and transparency.	The VCS program requires a process and criteria to be provided. At a minimum, language explaining the project developer’s responsibility to address this requirement should be added to the methodology.	Added, Section 5: “Project proponents must justify the baseline and project SSRs selected for quantification in their project” as last sentence in first paragraph.	Satisfactory.
	9. Although expected to be negligible, emissions from Cement Kiln Dust (generated by production of Portland cement) has not been identified as a SSR in the baseline scenario. Similar to other SSRs, even if an emission source is expected to be negligible, it should be identified as a source of emissions and then excluded based on “relevance” criteria?	9. “Cement Kiln Dust Production and Processing” new SSR has been added in both baseline and project conditions in Table 4 and process flow diagrams. Justification for exclusion has been given as follows: “Cement kiln dust (CKD) refers to the portion of the cement raw materials that does not become part of the clinker. CO2 might be emitted from CKD that is not recycled to the Portland cement production process. CKD	Satisfactory. Confirmed the addition of this emission source.	Not required.	Not required.

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		produced in the project condition would be less than the quantity in the baseline scenario, therefore it is conservative to exclude these emissions."			
Procedure for Determining Baseline Scenario	It appears that a common practice is to produce concrete with slag and fly ash as replacements for clinker. What additional barriers will need to be addressed to prove that the proponent would not have gone with slag or fly ash as possible replacements to clinker (and therefore lower GHGs)?	Fly ash / slag are considered potential components of the aggregate. See definition Section 3, p.8.	<p>From the following website:  <a href="http://www.slagcement.org/pdf/no11%20Slag%20Cement%20and%20Fly%20Ash.pdf">http://www.slagcement.org/pdf/no11%20Slag%20Cement%20and%20Fly%20Ash.pdf</a></p> <p>"Both [slag and fly ash] are used as a replacement for a portion of the portland cement. Slag cement replaces as much as 50 percent in normal concrete (and up to 80 percent in special applications such as mass concrete). Fly ash is usually limited to 20 or 30 percent".</p> <p>Slag and Fly Ash are typically referred to as "supplementary Cementing Materials", <a href="http://www.cement.org/basics/concretebasics_supplementary.asp">http://www.cement.org/basics/concretebasics_supplementary.asp</a>. Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and portland cement, are an essential ingredient in concrete. <a href="http://www.cement.org/basics/concretebasics_aggregate.asp">http://www.cement.org/basics/concretebasics_aggregate.asp</a></p> <p>From our research it appears that the aggregate remains the same, although fly ash / slag can replace a portion of the Portland Cement in the production of concrete (similar to replacing PC with SC). The question was "what is the procedure to ensure that the switch to SC is likely in the case of the project, and not using additional slag or fly ash", in the determination of the baseline scenario?</p>	<p>It is understood that fly ash / slag (SCM) are not inert in PC.</p> <p>There are likely no barriers to fly ash /slag incorporation in the baseline. Indeed, CDM exec board appears to have ruled that SCMs are business as usual.</p> <p>Fly ash/slag can be included in sulphur concrete as well, and therefore has been included as a component in aggregate because it can be mixed with the product in the baseline and project. It has no impact on project emissions but would on baseline emissions by reducing PC emission factor.</p> <p>The quantification method accounts for this with the clinker to cement ratio provided in Appendix A (equation at end). Current global SCM replacement rates are incorporated in the values listed in table A1 A2 and effectively reduce the emission factor for the production of Portland cement in the quantification method. The equation previously provided after table A2 (now moved to equation 3 in method) allows a project specific clinker replacement ratio to be used by proponents if they are unable to justify the use of the average values presented in the table.</p> <p>Definition of aggregate updated to clarify the role of SCM in PC and SC.</p>	Satisfactory.
Baseline Emissions	1. The baseline scenario is the production of Portland cement, however the baseline emissions quantification is actually the quantification of the emission reductions due to the displacement of Portland cement in the final precast concrete product. These "avoided emissions" are actually what you would occur due to the implementation of the project, and not the baseline (business as usual) scenario.	1. Clarification added Section 8.1, p.19. All Portland cement production in the project would have occurred in the baseline as well. Portland cement that is equivalent between the project and baseline will have equivalent emissions and are null in the calculation. Only avoided Portland cement production contributes to the emission reduction and is considered in the baseline because this is where it would have occurred. The method determines avoided Portland production from project activities and calculates them as baseline.	<p>It is understood that this Methodology simply considers everything to be equivalent between the project and the baseline condition, except for the substitution of Sulphur Cement for some / all of the Portland Cement and therefore quantifies "avoided emissions" only.</p> <p>However, The VCS Standard v3 .2 provides the following guidance:</p> <p><b>4.7 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS</b>  <i>General</i></p> <p><b>4.7.1 The methodology shall establish criteria and procedures for quantifying GHG emissions and/or removals for the selected GHG sources, sinks and/or reservoirs,</b></p>	<p>The methodology presented does not violate the guidance cited.</p> <p>If I understand correctly, the issue is absolute versus avoided emission quantification in baseline/project emissions. Other project types measure and quantify avoided emissions and often are a preferred form of quantification because it is a more direct measurement on the reductions achieved.</p> <p>Landfill gas and coal bed methane destruction projects are an example:</p> <ul style="list-style-type: none"> <li>• Methane is passively emitted in baseline.</li> </ul> <p>Project collects and destroys a volume of methane, while the landfill/coal seam continues to passively emit a lower volume of methane. The collected methane is</p>	Satisfactory.

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Assessment Findings	Corrective Action or Clarification Request	Response (Prasino Group / Shell)	Stantec's Findings – June 12, 2012	Response – June 20, 2012 (Prasino Group/Shell)	Stantec's Findings-July 3, 2012
			<p><u>separately for the project (including leakage) and baseline scenarios.</u></p> <p>4.7.2 The methodology shall establish criteria and procedures for quantifying net GHG emission reductions and removals generated by the project, which shall be quantified <u>as the difference between the GHG emissions and/or removals from GHG sources, sinks and reservoirs relevant for the project and those relevant for the baseline scenario.</u> Where appropriate, net GHG emission reductions and removals shall be quantified separately for the project and the baseline scenarios for each relevant GHG and its corresponding GHG sources, sinks and/or reservoirs.</p> <p>At this point I believe it would be prudent to get clarification from VCS as to whether or not “avoided emissions” quantification is an appropriate approach, rather than the Quantification of Baseline Emissions and Project Emissions separately.</p>	<p>measured and is quantified as a baseline emission. Measuring the emission rate of the landfill/coal seam in the baseline and project is much more complicated and less accurate than measuring the avoided emission. CDM ACM0001 (LFG) or VM0014 (CBM) are reference precedents to this approach, both acceptable under VCS.</p> <p>The method presented does quantify project and baseline emission <u>separately</u>. (re: 4.7.1) the avoided emissions are those in the baseline in excess of what occurs in the project. The project emissions are those that would not have occurred in the baseline.</p> <p>The method presented quantifies the <u>difference</u> (re: 4.7.2).</p>	
	2. The quantification of baseline emissions should include the quantification of emissions from the SSRs associated with the production of Portland cement. If not, a justification as to why a different approach is used would be required.	2. SSR 'Portland Cement Production' is the only SSR among other baseline SSRs that contribute to GHG emissions. Exclusion justification of each other SSR is presented in Table 4.	See above – the Methodology does not actually quantify emissions due to “Portland Cement Production”. Instead it quantifies avoided emissions due to production of precast concrete using “sulphur cement” as opposed to Portland Cement.	See Baseline Emission 1 response	Satisfactory.
	3. The ratio of Portland cement in the finished project (%PC): <ul style="list-style-type: none"> <li>It is unclear whether this is referring to the ratio of Portland cement used in the finished product under the baseline scenario (based on specifications) or found in the project scenario (based on actual product composition) or determined through the use of the “Combined tool to identify the baseline scenario and determine additionality” Does this ratio represent the amount of Portland cement actually contained within the finished product compared to other components such as aggregate, water, etc)?</li> <li>If the assumption is that the baseline is strictly based on the use of Portland cement without fly ash or other SCM product, then evidence needs to be provided as to why this assumption is reasonable (i.e., why a precast operation would not use these products to offset Portland cement?).</li> </ul>	3. %PC represents ratio of Portland cement used in the finished product under the baseline scenario, based on manufacturer specifications. Yes, it does represent the amount of Portland cement actually contained within the finished product (in the baseline) compared to other components such as aggregate, water. <p>Fly ash or other SCM products are included in the aggregate. Definition of aggregate in Section 3, p.8 states: “In addition to sand and rock, aggregate may include other materials that can be blended with cement to form a final product such as fly ash and slag.”</p>	<p>The Methodology should be updated to include this additional clarification</p> <p>See above “baseline scenario” for further issues with the definition of aggregate. our understanding is that fly ash /slag are considered supplementary cementing materials, and not simply “aggregate” as they replace the clinker.</p> <p>The question was more along the lines of whether the finished product may contain some combination of aggregate, SCM, PC, and SC? If not and the Methodology assumes that Portland Cement in the finished product will be substituted ONLY with Sulphur cement and no other SCM, explain why that is in the Methodology – (or add this limitation in the applicability section).</p>	<p>Definition of %PC updated under Equation 2 and in its table in Section 9.2 to: “the ratio of Portland cement used in the finished product under the baseline scenario, based on manufacturer specifications. This percentage represent the amount of Portland cement actually contained within the finished product (in the baseline) compared to other components such as aggregate, water. (unitless value)”.</p> <p>See response above. Acknowledged and the method accounts for SCM replacing PC through the %pc parameter.</p> <p>Originally the method was intent on quantifying products with mixed PC and SC (and SCM), however it was subsequently decided that this mixed product is not relevant and has been removed. The finished product may now contain SCMs with SC, but not PC with SC (with or without SCM).</p>	Satisfactory.

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Assessment Findings	Corrective Action or Clarification Request	Response (Prasino Group / Shell)	Stantec's Findings – June 12, 2012	Response – June 20, 2012 (Prasino Group/Shell)	Stantec's Findings-July 3, 2012
	<p>4. Mass of finished precast products:</p> <ul style="list-style-type: none"> <li>Is this value equivalent to the mass of total production over the reporting period, or just mass of precast products containing sulphur cement (from product scenario)?</li> </ul>	<p>4. It is the mass of each precast product containing sulphur cement in the project scenario. Clarification added Section 8.1, p.20.</p>	Satisfactory. Clarification provided.	Not required.	Not required.
	<p>5. Mass of Portland cement" used in the precast products (if sulphur cement does not completely replace Portland cement):</p> <ul style="list-style-type: none"> <li>Additional details are required to explain whether it is possible for one precast product to contain both sulphur cement and Portland cement, or if the Project Proponent is to take a measurement of ALL precast concrete products produced during the reporting period (assuming some batches made with Portland cement and some with Sulphur cement) and subtract out the mass of the products containing Portland cement.</li> </ul>	<p>5. It is possible for one precast product to contain both sulphur and Portland cement. This is implied in the definition of "Mass<sub>PortlandCement</sub> = the measured mass of Portland cement used in the precast products if sulphur cement does not completely replace Portland cement (tonnes)", Section 8.1, p. 20.</p>	Satisfactory.	Correction: It is not possible for one precast product to contain both. Mass <sub>portland cement</sub> removed from Equation 2 and throughout textual references in the method. This is because it was decided that it is not relevant as a product type currently and reduces clarity of method.	Satisfactory.
	<p>6. Emission factor for Portland cement production</p> <ul style="list-style-type: none"> <li>The final product is not "Portland Cement", but instead it is precast concrete products (which can only happen after Portland cement production, Portland cement transportation, concrete production, concrete mixing, concrete transportation and precast product pouring and forming). As Equation (2) uses the values for the mass of finished precast products additional justification for the use of EF for "Portland cement production" is required to confirm that all emissions are accounted for.</li> <li>In addition, in Appendix A, the EF is called EF Portland, which is not consistent terminology with the EF Portland cement production found in Equation (2).</li> <li>Also in Appendix A, the details around the EF for clinker should be detailed further in the Methodology as to what is embedded in the EF. Further discussion as to why regional differences are not required would provide additional transparency in the Methodology.</li> </ul>	<p>6. EF Portland Cement Production correctly captures the information needed to quantify Baseline Emissions of Portland (BE<sub>Portland</sub> in equation 1). EF Portland Cement Production represents emissions from the industrial process of Portland cement production from clinker. This factor is irrelevant of the mass of final precast concrete products.</p> <p>Corrected to EF Portland Cement Production, Appendix A, p.35.</p> <p>The factors in Table A1 include emissions from the chemical process of calcination and emissions from fuel combustion. Clarification added, Appendix A, p.34.</p>	<p>Although additional details are provided on where the emission factor is obtained (getting the numbers right report), there is no mention of the fact that the emission factors are based on reported information from a sampling of facilities and that less than 20% of facilities in the developing world have reported information. Due to this lack of information, we question the accuracy of the EFs in this report for developing countries. At minimum, the methodology should state the uncertainty with the EFs and provide some guidance on how to determine applicability or when to use alternate factors.</p>	<p>Appendix A and Section 8.1 have been updated to clarify the emission factor determination procedure. Site specific factors are allowed and this has been made more prominent in the Appendix and calculation steps.</p>	Satisfactory.
Project Emissions	<p>7. The project scenario (as stated) is the production of the same amount of precast concrete products using cement containing a sulphur substitute for</p>	<p>1. Some projects types' GHG quantification methodology involves making a measurement in the project condition, and plugging the result in the baseline</p>	<p>The VCS Standard v3 .2 provides the following guidance:  4.7 QUANTIFICATION OF GHG EMISSION</p>	See Baseline Emission 1 response.	Satisfactory.

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Assessment Findings	Corrective Action or Clarification Request	Response (Prasino Group / Shell)	Stantec's Findings – June 12, 2012	Response – June 20, 2012 (Prasino Group/Shell)	Stantec's Findings-July 3, 2012
	<p>"Portland cement". However, the project emissions quantification only quantifies the emissions associated with the use of sulphur, and not with the production of the concrete. The quantification of emissions for this scenario should take into account all the relevant SSRs identified, and not just the emissions associated with the use of the sulphur product.</p>	<p>equation(s) to quantify the baseline emission. The methodology at hand falls in this category of quantification method: in the project condition, a precast concrete product is produced using sulphur cement. Mass of this product (still in project scenario) is used with other variables in the baseline equation (%PC, Mass Portland Cement) to quantify baseline emissions. 'Project Emissions' would then be the extra emissions incurred due to the material substitution, in this case sulphur transportation, degassing and heating, aggregate heating, modifier production, etc.</p>	<p><b>REDUCTIONS AND REMOVALS</b> <i>General</i></p> <p>4.7.1 <i>The methodology shall establish criteria and procedures for quantifying GHG emissions and/or removals for the selected GHG sources, sinks and/or reservoirs, separately for the project (including leakage) and baseline scenarios.</i></p> <p>4.7.2 <i>The methodology shall establish criteria and procedures for quantifying net GHG emission reductions and removals generated by the project, which shall be quantified as the difference between the GHG emissions and/or removals from GHG sources, sinks and reservoirs relevant for the project and those relevant for the baseline scenario. Where appropriate, net GHG emission reductions and removals shall be quantified separately for the project and the baseline scenarios for each relevant GHG and its corresponding GHG sources, sinks and/or reservoirs.</i></p> <p>At this point I believe it would be prudent to get clarification from VCS as to whether or not "avoided emissions" quantification is an appropriate approach, rather than the Quantification of Baseline Emissions – Project Emissions.</p>		
	<p>8. The Methodology is unclear as to why the emissions for fuel extraction and processing would be considered relevant. The Methodology should provide the criteria for inclusion of "relevant" SSRs.</p>	<p>2. Generic criteria for the inclusion or exclusion of any SSR is difficult to outline on the protocol/methodology level. It is the responsibility of the project developer to demonstrate what SSRs are material or not apart from the protocol's instruction. Fuel Extraction/Processing emissions are usually small compared to other emission sources in the project, but they are included in quantification to ensure accuracy and transparency.</p>	<p>The VCS program requires a process and criteria to be provided. At a minimum, language explaining the project developer's responsibility to address this requirement should be added to the methodology.</p>	<p>Added, Section 5: "Project proponents must justify the baseline and project SSRs selected for quantification in their project" as last sentence in first paragraph.</p>	<p>Satisfactory.</p>
	<p>9. If sulphur cement does not entirely replace the Portland cement in a given batch of concrete, then presumably there is some water use required in the concrete. Given the need to preheat the aggregate, it would seem likely that water would also need to be heated. If this is the case, then the treatment and use of water should be included in the project scenario.</p>	<p>3. If Portland cement was blended in to the final mix, it would be made wet outside the mould, and then combined with the sulphur concrete mix. The latter mix contains no water. Further, the sulphur concrete mix is only heated to re-melt the sulphur if indeed, as the sulphur raw material is in solid form (in which it exists in ambient form). It could well be the case that molten sulphur is obtained via tanker truck.</p>	<p>Satisfactory.</p>	<p>Not required.</p>	<p>Not required.</p>
	<p>10. A source of GHG emissions (in the baseline) comes from the heat required for the calcination process typically supplied from the combustion of fossil</p>	<p>4. The EF<sub>Portland cement production</sub> include emissions from the chemical process of calcination and emissions from fuel combustion, and consider those facilities</p>	<p>See discussion on Emission Factors in "Data and Parameters" below. However, in addition:</p>	<p>Appendix A and Section 8.1 have been updated to clarify the emission factor determination procedure. Site specific factors are allowed and this has been made more</p>	<p>Satisfactory.</p>

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Assessment Findings	Corrective Action or Clarification Request	Response (Prasino Group / Shell)	Stantec's Findings – June 12, 2012	Response – June 20, 2012 (Prasino Group/Shell)	Stantec's Findings-July 3, 2012
	fuels, resulting in the emission of further carbon dioxide as well as smaller amounts of methane and nitrous oxide. It is unclear how these emission reductions are captured in the project scenario as fuel type is not factored into the EF <sub>Portland cement production</sub> , only kiln type.	that combust a wide range of carbon intensive and biogenic fuel sources (reference: <a href="http://www.wbcscement.org/pdf/CSI%20GMR%20Report%20final%2018%206%2009.pdf">http://www.wbcscement.org/pdf/CSI%20GMR%20Report%20final%2018%206%2009.pdf</a> , section 5.3, p.19 of the report). Clarification added in Appendix A, p.34 and Section 9.1, p.23.	<ul style="list-style-type: none"> <li>the emission factors in Appendix A only provide CO<sub>2</sub> / tonne clinker. What about smaller amounts of methane and N<sub>2</sub>O?</li> <li>Cement facilities can burn a wide variety of fuels, from biomass, to tires, to natural gas. The specific fuel consumed by the facility (as opposed to a generic factor based on a wide range of potential fuels) should be considered in determination of an appropriate emission factor and not just kiln type.</li> </ul>	<p>prominent in the Appendix and calculation steps.</p> <p>Regional values are provided in CO<sub>2</sub>equivalent. Data unit updated in Table in Section 9.1 to apply CH<sub>4</sub> and N<sub>2</sub>O.</p> <p>Specific fuel records may be used if a specific production facility is displaced.</p>	
Leakage	The Methodology states that there are “no known sources of leakage for this project activity” however in Methodology Version 1.0, there was a lack of guidance around how leakage was assessed and quantified.	Through follow-up correspondence with the Shell Canada, information was provided on the non-existent potential for leakage.	Satisfactory.	Not required.	Not required.
Quantification of Net GHG Emissions / Removals	The baseline scenario emissions are not quantified in a complete manner. Instead avoided emissions due the use of Sulphur concrete is quantified in the baseline. The Emission reductions calculation is simply the emissions from the project scenario (not subtracted from a baseline).	Check Project Emissions, point 1 of this table.	See discussion in “project emissions”. A discussion with VCS may be necessary at this stage (or finalization of the assessment report with this potential issue noted to be considered by VCS and second assessor).	See Baseline Emission 1 response.	Satisfactory.
Data and Parameters	1. No criteria are provided for ensuring the most accurate data and parameters are used.	1. Problems with data accuracy are inherently addressed in this methodology because the inputs into concrete production are metered to ensure mix specifications are met, there is a high degree of certainty in the measurements of associated with sulphur, aggregate, modifier, and volumes of fuel employed.	Satisfactory; however, this information should be provided in the Methodology. In addition, the Methodology has not identified QA/QC procedures for most of the monitored parameters. Please identify the minimum QA/QC procedures to ensure accurate and representative data is collected.	Clarification added, Section 9.4: “In general, measurement inaccuracies are inherently addressed in this methodology because the inputs into concrete production are metered to ensure mix specifications are met. Therefore, there is a high degree of certainty in the measurements of associated with sulphur, aggregate, modifier, and volumes of fuel employed. However, project proponents should address uncertainties in measured values by ensuring that meters are appropriately calibrated as prescribed by the manufacturer.”	Satisfactory.
	2. Clarification as to the conservativeness / accuracy of the use of the Emission factor for the production of Portland cement is needed.	2. Clarification added in Section 9.1, p.23: “Project proponents should justify that the EF Portland Cement Production in Appendix A is conservative for their project. Proponents may use site-specific emission factors.”	<p>Although additional details are provided on where the emission factor is obtained (getting the numbers right report), there is no mention of the fact that the emission factors are based on reported information from facilities and that less than 20% of facilities in the developing world have reported information. Due to this lack of complete information, we would question the accuracy of the EFs in this report for any specific site.</p> <p>From the Methodology:  <i>“Concrete and cement products made with modified heated sulphur releases far fewer GHGs than concrete made with Portland cement because it avoids the process emissions resulting from the calcination process used during clinker production, as well as the combustion emissions</i></p>	Appendix A and Section 8.1 have been updated to clarify the emission factor determination procedure. Site specific factors are allowed and this has been made more prominent in the Appendix and calculation steps.	Satisfactory.

**Table 4.1 Sulphur Concrete Methodology Corrective Actions and Clarification Requests**

Assessment Findings	Corrective Action or Clarification Request	Response (Prasino Group / Shell)	Stantec's Findings – June 12, 2012	Response – June 20, 2012 (Prasino Group/Shell)	Stantec's Findings-July 3, 2012
			<p><i>typically generated to supply heat to that process.</i></p> <p>No mention of how fuel type factors into this? Simply an average of calcination / fuel combustion, regardless of whether you're burning natural gas or tires?</p>		
	3. No references have been provided for the "accepted values".	3. References added in Section 10.	<p>References have been provided (however, as a note, conference proceedings and comments / recommendations report are not considered good practice guidance).</p> <p>The tables in 9.2 should be linked to the new references, still only state: "accepted values"</p>	New good practice references have been provided and linked to tables in Section 9.2.	Satisfactory.
Monitoring	The Methodology does not consistently outline the appropriate QA/QC procedures to apply.	QA/QC procedures are addressed in Section 9.2 to the parameters where they apply.	<p>QA/ QC procedures are left blank for the following parameters:</p> <ul style="list-style-type: none"> <li>• mass of Precast Products Produced;</li> <li>• ratio of Portland cement in finished product;</li> <li>• mass of Portland Cement used;</li> <li>• volume of degassing vent gas incinerated;</li> <li>• molar fraction of CO<sub>2</sub> in incinerated vent gas; and</li> <li>• emission factor for truck transportation.</li> </ul>	QA/QC procedures for each of the parameters follow the general QA/QC guidance provided in Section 9.3 and each parameter has been updated for clarification. Clarification added in parameter table (except for Mass of Portland Cement, which is deleted as per the new edits).	Satisfactory.
Adherence to the Project Principles of the VCS Program	The methodology does not adhere to all the VCS program principles (mainly Completeness, Accuracy and Transparency) set out in the VCS standard. Correction of other items identified in this table will rectify this.	Items corrected.	Pending Resolution of outstanding issues.	Not required.	Satisfactory.
Relationship to Approved or Pending Methodologies	1. The methodology stated that there are currently no approved or pending methodologies within the Manufacturing Industries, Construction or Transportation sectoral scopes. Upon review of the VCS website, there is a Methodology called "Methodology for Fuel Switch to Renewable Biomass for Thermal Applications", undergoing second assessment. This Method falls under the Manufacturing Industries sectoral scope and was open for public comment from 6-July-2010 until 4-August-2010.	1. Methodology has been updated to include approved or pending VCS methodologies within the appropriate sectoral scopes.	Satisfactory	Not required.	Not required.
	2. Not all CDM and/or CAR methodologies in the relevant sectors have been listed in the methodology document.	2. Methodology has been updated to include all relevant methodologies (within VCS or CDM).	Satisfactory	Not required.	Not required.
	3. The Methodology developer provided a list of all existing CDM Methodologies with the same sectoral scope, however did not provide sufficient evidence to support that existing CDM methodologies (specifically ACM0015V3) within the same sectoral	3. There are no precast CDM methodologies comparable to the Sulphur Concrete methodology at hand. SCEM-related methodologies are similar to a degree, but the final products here are not necessarily precast products, and so not directly comparable. <u>Furthermore,</u>	<p>The justification provided does not provide sufficient clarity as to why the existing CDM methodologies could not be reasonably revised. In particular:</p> <p>1. Although the CDM Methodology is not exclusively for precast applications, they</p>	<p>1. Noted. It is acknowledged that the original response should have focused on emissions SSR accounting in the existing methods rather than precast vs pour-in-place. Sulphur must be poured 'hot' meaning sulphur concrete (precast or PIP) would be a completely different</p>	Satisfactory.

Table 4.1 Sulphur Concrete Methodology Corrective Actions and Clarification Requests

Assessment Findings	Corrective Action or Clarification Request	Response (Prasino Group / Shell)	Stantec's Findings – June 12, 2012	Response – June 20, 2012 (Prasino Group/Shell)	Stantec's Findings-July 3, 2012
	scope could not be reasonably revised.	<u>these existing CDM methodologies are supplementary materials; i.e., there is still Portland cement used in the final product, just less than in the business-as-usual case.</u> Therefore, the comment on each of the Related Methodologies in Table 1 implies the above: "The production of sulphur concrete requires significant process changes not reflected in this methodology."	<p>can be used for precast applications.</p> <p>2. In the baseline emissions responses above it was stated that: <i>"It is possible for one precast product to contain both sulphur and Portland cement. This is implied in the definition of <math>Mass_{PortlandCement} = \text{the measured mass of Portland cement used in the precast products if sulphur cement does not completely replace Portland cement (tonnes)}</math>", Section 8.1, p. 20."</i></p> <p>Unsure how the use of sulphur cement to replace some (but not necessarily all of the Portland cement) is not equivalent to the supplementary materials approach in the CDM methodology.</p>	<p>operation and set of emissions. These would be specific to the 'hot' pour operation of sulphur concrete (more similar to bitumen laying than concrete pouring). These are not captured in other methods existing in CDM. In general, CDM methods look at supplementing conventional Portland cement whereas sulphur concrete obviates the need for Portland cement altogether in a product. Specifically, while baseline emission accounting in CDM methods could be construed to the baseline of sulphur concrete, the project emission accounting could not. Therefore the applicability is defeated by the nature of the sulphur technology rather than what pour type the existing CDM methods can accommodate.</p> <p>Specifically in ACM0015 – the project activity SSRs include calcination of raw materials and kiln emissions. Calcination does not occur in sulphur concrete and there is no kiln because there is no clinker in sulphur concrete. There is no accounting for the hot pour required as well. ACM0015 is not applicable. Justification updated in method as per above.</p> <p>2. Please see above. It is not possible to contain both SC and PC in one product now.</p>	
Compliance with VCS Methodology Template	1. The proposed methodology (Sulphur Concrete, Version 1.0) has been completed using the VCS Methodology Template. The VCS website lists the current Version as: Version 3.1 Issued: 1 February 2012. However, the template Version 3.0 was used for this Methodology. The most current template was not used.	1. Although an earlier version of the template was used the same information is required. Ben Block (VCS) also confirmed that the use of template Version 3.0 was ok as the changes were minor.	Satisfactory	Not required.	Not required.

**5 ASSESSMENT CONCLUSION**

Stantec conducted an assessment of the Methodology entitled *Quantification Methodology for the Use of Sulphur Concrete in Precast Applications (Version 1.2)* against the criteria of the VCS program identified in Section 1.2 of this draft report.

Following the initial review of the Methodology and subsequent review of revisions up to the current version (1.2), it is the considered opinion of Stantec that the Methodology does not contain any non-compliance with the VCS criteria that would affect the usability of the Methodology under the VCS program. The Corrective Action and Clarification requests for the Methodology are provided in Table 4.1 and have been resolved to our satisfaction through the assessment process.

**6 REPORT RECONCILIATION**

This section is intentionally left blank.

**7 EVIDENCE OF FULFILMENT OF VVB ELIGIBILITY REQUIREMENTS**

Stantec is accredited with the American National Standards Institute (ANSI), a member of the International Accreditation Forum (IAF), in accordance with ISO14065 (Accreditation ID #0805 issued to Stantec Consulting Ltd. Atmospheric Environment Group dated February 1, 2011 for greenhouse gas (GHG) verification). Stantec is an approved validator/verifier under the VCS program for 11 scopes, including scope 4 (Manufacturing Industries).

Stantec has not conducted over 10 validations or protocol assessments under the VCS program.

**8 SIGNATURE**

*Signed for and on behalf of:*

*Name of entity:* \_\_\_\_\_ *Stantec Consulting Ltd.* \_\_\_\_\_

*V Corning*

*Signature:* \_\_\_\_\_

*Name of signatory:* \_\_\_\_\_ *Vicki Corning, P.Eng.* \_\_\_\_\_

*Date:* \_\_\_\_\_ *July 4, 2012* \_\_\_\_\_