Validation Report

Version 1.3

July, 2022

Document Prepared by Vanessa Mascorro

Forest Carbon Partnership Facility (FCPF)
Carbon Fund

Validation Report (VAR)

ER Program Name and Country:	Ghana Cocoa Forest REDD+ Programme (GCFRP), Ghana
Crediting Period	11-06-2019 to 31-12-2024
Name of the VVB:	Scientific Certification Systems Global Services (SCS)
Contact information of the VVB:	2000 Powell Street, Suite 600, Emeryville, CA 94608, USA http://www.scsglobalservices.com Email: cpollet-young@scsglobalservices.com Telephone: +1 (510) 452-8000
Date of the Validation Report:	20 July 2022
Version:	V.1-0
Report Approved by	Christie Pollet-Young

1. VALIDATION STATEMENT

The review and cross-check of explanations and justifications included in the Monitoring Report dated 18-06-2021 and supporting documents have provided Scientific Certification Systems Global Services (herein referred to as SCS) with sufficient evidence to determine with a reasonable level of assurance the compliance of the Ghana Cocoa Forest REDD+ Programme (GCFRP) ER Program with the applicable validation criteria set out in the FCPF requirements.

The scope covered by the validation includes the ER Program´s crediting period 11-06-2019 to 31-12-2024, the selected Reference Period 01-01-2005 to 31-12-2014, the accounting area 5,914,425 hectares, the REDD Country Participant's Forest Monitoring System, the national REDD+ Programs and Data Management System, and the following GHG sources, sinks, REDD+ activities and carbon pools:

- GHG sources, sinks and/or reservoirs from REDD+ Activities:
  - Emissions from deforestation
  - Emissions from forest degradation
  - Removals from carbon stock enhancements
- Carbon pools:
  - Above Ground Biomass (AGB)
  - Below Ground Biomass (BGB)
  - Dead Wood
  - Litter
  - Soil Organic Carbon (SOC)
- Types of GHGs:
  - CO_2

A total of 3 MCAR, 10 mCAR and 1 Observation findings were raised as part of the Validation process. A total of 3 MCAR, 10 mCAR and 1 Observation were successfully addressed by the ER Program and closed by SCS assessment team. These findings are described in Appendix 1 of this report.

Regarding the Reference Level, it is SCS's opinion that the GCFRP ER Program meets the applicable Validation criteria set out in the FCPF requirements and that it is free of material misstatements. Hence, SCS recommends the FCPF Carbon Fund to continue with the relevant subsequent steps to proceed with the verification of the FCPF Emission Reductions units.

Statement Issuing Date: 20 July 2022

Intended User: World Bank Group, FCPF Carbon Fund Participants

TEAM LEADER: Vanessa Mascorro

LEGAL REPRESENTATIVE: Christie Pollet-Young

2. Agreement

2.1 Level of Assurance

The audit assessment was conducted to provide a reasonable level of assurance concerning material misstatements, errors, or omissions in conformance with the FCPF program validation criteria and scope stated in the FCPF Validation and Verification Guidelines. The provisions undertaken to ensure such a reasonable level of assurance included:

- Perform a risk-based assessment of the program area and program activities to ensure that the program, and the measuring, monitoring and quantification of GHG emission emissions and removals for the verification period conforms to the FCPF verification criteria.
- Assess and select samples of data and information from in order to confirm they meet a reasonable level of assurance and the materiality requirements of the program, as required by the FCPF.
- Assessment of the data collection, the selection of categories, the measuring, monitoring and reporting methods, standard operating procedures, the ER program documentation, the parameters, equations, calculations and supporting documentation are correct and in conformance with the FCPF program requirements.

Based on the previous provisions and considering the findings raised during the audit, a positive evaluation statement reasonably ensures that the FCPF Program GHG assertion is materially correct and is a fair representation of the GHG data and information provided in the ER Monitoring Report, including the Annex IV and supporting documentation.

2.2 Objectives

The assessment team conducted a systematic, independent, and documented process for the evaluation of the GHG assertion made by the FCPF Ghana Cocoa Forest REDD+ Program (GCFRP) Emissions Reductions Program (ER Program) against the FCPF criteria applicable to validation to determine if the program is in compliance to the agreed criteria.

The validation assessment included the following objectives:

- Review of the ER Monitoring Report and supporting information to confirm the correctness and completeness of presented information.
- Validate and confirm that the program methodological steps and data are publicly available.
- Ensure that the data reported enable the reconstruction of the reported Reference Level.
- Assess the reported Reference Level and ensure that it is materially accurate.
- Identify the sources of uncertainty and confirm they were properly identified and analyzed in compliance with applicable criteria.
- Review the components of the Forest Monitoring System and ensure they include areas of risk of future non-compliance.
- Review the ER Program's scope in terms of sources, sinks and carbon pools and ensure is in accordance with the applicable validation criteria.
- Ensure the ER Program's methods are in accordance with applicable validation criteria as per the latest IPCC Guidelines.
- Validate that the Reference Level is in accordance with the FCPF applicable validation criteria.

2.3 Criteria

The criteria applicable for the assessment included:

- FCPF Process Guidelines, Version 5.2
- Validation and Verification Guidelines, Version 2.4
- FCPF Methodological Framework, Version 3
- FCPF Glossary of Terms, Version 2.1
- Buffer Guidelines, Version 2
- Guidelines on the application of the MF Number 2, Technical Corrections to GHG Emissions and Removals Reported in the Reference Period
- Guidelines on the application of the MF Number 3, The Definition of Reporting Periods of Emission Reduction Programs
- Guidelines on the application of the MF Number 4, Uncertainty Analysis of Emission Reductions
- The guidelines contained in the ER Monitoring Report template and the Validation Report
- ISO 14064-3:2006
- ISO 14065:2013
- ISO 14066: 2011
- IAF MD 6:2014
- Any formal clarification provided by the FMT

The following guidance documents (or collections of documents) were considered to contain good practice in undertaking the assessment, though said documents were not formally considered to be part of the assessment criteria.

- 2006 IPCC Guidelines for GHG Inventories
- 2019 refinement to the 2006 IPCC Guidelines
- GFOI 2020 Methods and Guidance Document

2.4 Scope

The scope of the validation of the Ghana Cocoa Forest REDD+ Program (GCFRP included the following:

- The following time period:
    - Crediting period: 11-June-2019 to 31-December-2024
    - Reporting period: 11-June-2019 to 31-December-2019
    - Monitoring period: 1-January-2019 to 31-December-2019
- The ER Program Accounting Area
- The GHG sources and sinks associated with any of the REDD+ Activities accounted for as required by the Methodological Framework:
- The following GHG sources, sinks and/or reservoirs:
    - Emissions from deforestation
    - Emissions from forest degradation
    - Removals from carbon stock enhancements
- The following Carbon pools:
    - Above Ground Biomass (AGB)

- Below Ground Biomass (BGB)
- Dead Wood
- Litter
- Soil Organic Carbon (SOC)

- The following types of GHGs:
  - CO_2
- The GCFRP's National Forest Monitoring System comprised the following data collection components:
  - Satellite land monitoring system (SLMS) (providing AD on deforestation and forest degradation).
  - Field inventory data from the Forest Preservation Programme (providing EF for deforestation and forest degradation through a field inventory with data collected in 2012).
  - National Forest Plantation Development Programme (NFPDP) (providing statistics on planted areas, including details on species and whether planting was in- or outside reserve areas. Removals factors for enhancement through the conversion of non-forest land into forest land through plantation establishment are obtained from IPCC).
- The national REDD+ Programs and Projects Data Management System as described in the Monitoring Report.

2.5 Materiality

The materiality for this validation process is the same as for the first verification period. Since the first verification of the ER program is conducted concurrently, please refer to the Verification Report.

3. METHODOLOGY AND PLANNING

3.1 Validation Team

The validation team was conformed as follows:

Name	Role	Activities				
		Desk review	Site visit	Reporting	Supervision	Technical review
Vanessa Mascorro	• Lead auditor, Verification Forester	X		X	X	
Francis Eaton	• Auditor, Verification Forester	X				
Michael Hoe	• Verification Forester, Quantification expert	X				
Alexa Dugan	• Technical reviewer, Verification Forester, GHG Program Technical Manager					X
Richard Bonsi	• Technical Expert	X				

3.2 Validation schedule

An indicative schedule developed for the assessment of the milestones and activities planned, is included below. The table includes details of the start and end date of each of the milestones undertaken for the assessment.

Milestone	Start Date	End Date
Initial GHG Documents Received	Thursday, September 9, 2021	Thursday, September 9, 2021
Kick Off Call	Monday, September 13, 2021	Monday, September 13, 2021
SCS sends Sampling plan & data request	Friday, November 5, 2021	Friday, November 5, 2021
Internet based meeting "Reference Level"	Tuesday, November 16, 2021	Tuesday, November 16, 2021
Internet based meeting "Quantification call"	Wednesday, November 17, 2021	Wednesday, November 17, 2021

Internet based meetings "Uncertainty call"	Thursday, November 18, 2021	Thursday, November 18, 2021
SCS Data and Document Review of GHG components	Friday, November 19, 2021	Monday, December 13, 2021
SCS Closed - National Holiday	Thursday, November 25, 2021	Friday, November 26, 2021
SCS issuance of Findings round #1	Monday, December 13, 2021	Monday, December 13, 2021
Client Response to Findings #1	Monday, December 13, 2021	Thursday, January 27, 2022
SCS Closed - National Holiday	Friday, December 24, 2021	Sunday, January 2, 2022
SCS review findings #1,	Thursday, January 27, 2022	Thursday, February 10, 2022
Vanessa Out of Office	Monday, January 10, 2022	Friday, January 14, 2022
SCS Closed - National Holiday	Monday, January 17, 2022	Monday, January 17, 2022
SCS Issuance of Findings round #2	Friday, February 11, 2022	Monday, February 21, 2022
SCS Closed - National Holiday	Monday, February 21, 2022	Monday, February 21, 2022
Client Response to Findings #2	Monday, February 21, 2022	Monday, March 14, 2022
SCS Review of Responses to Findings	Monday, March 14, 2022	Friday, April 1, 2022
Vanessa Out of Office	Monday, March 21, 2022	Tuesday, March 22, 2022
Client Response to Remaining open Findings	Monday, April 4, 2022	Monday, April 18, 2022
Vanessa Out of Office	Friday, April 15, 2022	Friday, April 15, 2022
SCS Review of Remaining open Findings	Monday, April 18, 2022	Tuesday, April 26, 2022
Client Response2 to Remaining open Findings	Wednesday, April 27, 2022	Tuesday, May 10, 2022
SCS Review2 to Remaining open Findings	Tuesday, May 10, 2022	Wednesday, May 18, 2022
Client Response3 to Remaining open Findings	Thursday, May 19, 2022	Thursday, May 26, 2022
Vanessa Out of Office - CA National holiday	Monday, May 23, 2022	Monday, May 23, 2022
SCS Review3 to Remaining open Findings	Thursday, May 26, 2022	Monday, June 6, 2022
SCS Closed - National Holiday	Monday, May 30, 2022	Monday, May 30, 2022
Vanessa Out of Office	Tuesday, May 31, 2022	Wednesday, June 1, 2022
Conditional: Closure of all Findings	Monday, June 6, 2022	Monday, June 6, 2022
Conditional: SCS Val/Ver Report Writing	Tuesday, June 7, 2022	Wednesday, June 15, 2022
Conditional: SCS Technical Review	Thursday, June 16, 2022	Thursday, June 30, 2022
SCS Closed - National Holiday	Monday, June 20, 2022	Monday, June 20, 2022
Conditional: SCS Validation and Verification Separate Reports Writing	Tuesday, July 5, 2022	Wednesday, July 20, 2022

Conditional: SCS Technical Review of Separate Validation and Verification Reports	Wednesday, July 20, 2022	Friday, July 22, 2022
Conditional: SCS Issuance of Draft Validation and Verification Reports to FTM team	Monday, July 25, 2022	Monday, July 25, 2022
Conditional: World Bank FMT Review of draft Validation and Verification Reports	Friday, July 22, 2022	Tuesday, July 26, 2022
Vanessa Out of Office	Monday, July 25, 2022	Monday, August 1, 2022
Conditional: SCS Issuance of Draft Validation and Verification Reports to Client	Wednesday, August 3, 2022	Wednesday, August 3, 2022
Conditional: Client Response to Draft Reports	Wednesday, August 3, 2022	Monday, August 8, 2022
Conditional: SCS Issuance of Final Validation and Verification Reports	Wednesday, August 10, 2022	Wednesday, August 10, 2022
Conditional: Closing Meeting	Thursday, August 11, 2022	Thursday, August 11, 2022

3.3 Methodology description

The assessment was performed through a combination of document review and interviews with relevant personnel, as discussed in Section 3.5 of this report. At all times, the MR and the ER Program described therein were assessed for conformance to the criteria described in Section 2.3 of this report. As a result of this validation process, findings were issued to identify any actual or potential areas of risk or concern.

A risk assessment was conducted, and a sampling plan produced, in accordance with Sections 4.4.1 and 4.4.3 of ISO 14064-3:2006, respectively, following a proprietary approach developed by SCS. The process involved identification of key areas of "residual risk" (areas where there exists risk of a material discrepancy that is not prevented or detected by the QA/QC processes of the ER Program). Sampling and data testing activities were planned to address any risk where the likelihood of an area of nonconformance or material discrepancy going undetected by the assessment team was judged to be unacceptably high. A verification plan was created that took the sampling plan into account.

The assessment team took the following steps to assess whether the best available data sets, methods, models and assumptions have been used with transparency, consistency, completeness and accuracy, and are in conformity with the FCPF's Methodological Framework requirements:

- Held meetings with the program's technical team to gain a clear understanding of the process in determining the best available data sets, methods and models employed by the program.
- Independently reviewed available literature regarding the availability of datasets pertaining to forest inventory, land use change, and forest plantation program in Ghana to confirm that the best available data sets have been utilized by the program.
- Independently reviewed Ghana's Forest Reference Level quantification to assess whether the data, methods, and assumptions used to quantify the GHG emissions and removals are in conformity and represent the best available data in the country.

- If no country specific or region-specific information was available, the assessment team confirmed that the most relevant and accurate default values from the IPCC Guidelines were applied in conformance with Criterion 5 of the FCPF Methodological Framework requirements.

3.4 Review of documentation

The Monitoring Report, version 2.1 dated June 18th of 2021, was carefully reviewed for conformance to the FCPF assessment criteria. The following additional documents, provided by ER Program personnel in support of the MR, were also reviewed by the assessment team for consistency, accuracy, and appropriateness with regard to the FCPF Methodological Framework and associated requirements:

Document	File Name (If Applicable)
Presentations for the assessment team regarding procedures, methods and data inputs applied.	ErrorPropagation_forVerifiers.pptx, Nov2021-REDD+ results.pptx, Nov2021-Summary Ghana ER estimates.pptx
Ghana ERPD	GCFRP_FCPF_Ghana_ER_PD.pdf version dated 21 April, 2017
Spatial land use change data derived from Collect Earth	ADxEF-18_06_2022.xlsx, sheet CE_Data
Collect Earth User Manual	Collect_Earth_User_Manual_20150618_highres_full.pdf
Spatial datasets for the program area including the program area boundary and stratums	forest_mask_2000_2015_cocoa_area.tif, forest_mask_2000_2015_cocoa_area_VEGZONES.tif forest_mask_2000_2015.tif, area_mask.tif VegetationZones_cocoa_area_utm30n.shp, Landuse_2000.tif, Landuse_2020.tif, Landuse_2012.tif, Landuse_2015.tif, Ahafo_Ano_HIA.shp, Asutifi_Asunafo_HIA.shp, Atewa_HIA.shp, Juaboso_Bia_HIA.shp, Kakum_HIA.shp, Sefwi_Wiawso_Bibiani_HIA.shp, VegetationZones.shp
GCFRP grid of sample points	ADxEF-18_06_2022.xlsx, sheet CE_Data, Grid_Ghana_1000m_intensification_revised.xlsx
Good practices for estimating area and assessing accuracy of land change	Olofsson et al. 2014 pdf
Critical analysis of root: shoot ratios in terrestrial biomes	Mokany et al. 2005 pdf
Calculation workbooks for reference level and GHG ER estimation	ADxEF-19May2022.xlsx

Uncertainty calculation workbook and MonteCarlo simulation	Ghana MC 190522_FIXED_VALUES.xlsx
Ghana's Mapping of Forest Cover and Carbon Stock Report	Ghana_FPP_Manual.pdf, Ghana Final_Report_Main.pdf
Calculation workbook for estimating AD-Carbon Enhancements	Calculation tool for Enhancement May2021-2019 onlyNew.xlsx
Ghana's Forest Plantation Reports	Ghana Forest Plantation Strategy (GFPS) Biennial Report 2017 & 2018_final.pdf, Reforestation Achievements_ 2018_2019.xlsx, GCFRP Planted _Area_ 2001-2013 _ Removals_GHANA.xlsx GFPS_Annual_Report_2019_WebLoad_BAT.pdf, nfpdp_annual_report_2011.pdf, Planted areas 2018 2019
ERPA Agreement to Transfer Title	Appendix 3 of the MR
Stakeholder engagement agreement	Appendix 4 of the MR
Ghana's Second Biennial Update Report	gh_bur2_rev-2.pdf
Standard Operation Procedures	SOP 001 Estimating Annual Forest Emissions and Removals, SOP 002 Key Category Analysis, SOP 003 Acquisition of Remote Sensing Data and Generation of Activity Data, SOP 004 Stratification of Lands, SOP 005 Field Inventory Protocol, SOP 006 Estimation of Above- and Belowground Biomass and Deadwood, SOP 007 Estimating Emissions from Soil Organic Carbon, SOP 008 Estimation of Emissions and Removals from Timber Harvests, SOP 009 Estimation of Emissions from Extraction of Wood for Fuel, SOP 010 Emissions From Fire, SOP 011 Estimating National and Sub-National Forest Reference Emission Level, SOP 012 Combining Uncertainty

3.5 REDD Country Visit

Due to the COVID-19 pandemic and the travel restrictions, no site visit occurred during this assessment. In lieu of a site visit, the assessment team performed web-based meetings with program personnel and program partners. To ensure that a reasonable level of assurance was met relying entirely on a desk review, the assessment team performed a risk-based assessment and selected a sample of the remote sensing points used to derive the sources of activity data and independently verified them with satellite imagery to confirm that the materiality requirements of the project were achieved as required by the FCPF. For additional information on this, please refer to section 2.1 and section 4 on the assessment and validation of the program design.

The following remote interviews listed in the table below were performed:

Date(S)	Attendees	Purpose
16 November 2021	World Bank Group, World Bank FMT, Program Participants	Reference Level call
17 November 2021	World Bank Group, World Bank FMT, Program Participants	Quantification call
18 November 2021	World Bank Group, World Bank FMT, Program Participants	Data Management Systems, Uncertainty, & Reversal

4. VALIDATION OF ER PROGRAM DESIGN

4.1 Completeness of Report

After an extensive review of the ER Program information, the Monitoring Report, calculation workbooks, procedures, and supporting documentation, SCS confirms that the ER Program includes in the Annex IV of the Monitoring Report, the necessary information required by this validation engagement, and confirms that this validation does not include an extended scope.

4.2 Start date of the crediting period

The assessment team reviewed and confirmed the justification and evidence provided by the ER Program for the selection of the start date of the crediting period:

- The start date of the Crediting Period corresponds to the date that the ER Program signed the ERPA agreement (11 June 2019).
- The date is not earlier than the date the first ER Program Measure(s) (including any Sub-Program(s)) begins generating ERs, i.e. first implementation2.
- The date was justified and confirmed by the FCPF TAP process and the World Bank due diligence and was independently assessed by SCS during this validation.
- The date is not earlier than January 1st 2016.
- The date does not fall within the Reference period (2005-2014).
- It is demonstrated that the ER Program complies with requirements since the start date on safeguards, carbon accounting and double-counting as specified in the MF.

Therefore, SCS confirms the start date of the crediting period is in compliance with the definition of the Start Date of the Crediting Period provided in the FCPF Glossary of Terms.

4.3 Sources and Sinks

This section is intentionally left blank as this validation assessment did not include an extended scope.

4.4 Carbon pools and GHG

This section is intentionally left blank as this validation assessment did not include an extended scope.

4.5 Reference Period

This section is intentionally left blank as this validation assessment did not include an extended scope.

4.6 Forest Definition

This section is intentionally left blank as this validation assessment did not include an extended scope.

4.7 Calculation of average annual historical emissions

The assessment team reviewed the ER Program Monitoring Report, calculation workbooks, the methods, datasets and assumptions, including the equations and selection of parameters, used to calculate the average annual historical emissions during the Reference Period. Based on this assessment, SCS confirms that the ER Program applied a systematic and step-by-step assessment of the methods, assumptions, and approaches used for the calculation of the average historical emissions during the Reference Period and that the link between the equation parameters used and the activity data and emission factors parameters is clear and consistent.

4.8 Activity data and emission factors

4.8.1 Activity data

After reviewing the Monitoring Report, calculation workbooks, standard operating procedures and supporting documentation, SCS confirms that all data and parameters related to the activity data have been reported in conformance with the FCPF program requirements and the guidelines provided in the ER Monitoring Report template. The steps taken to conduct the assessment of the activity data are described as follows:

Activity Data Parameter:	Area of Deforestation & Forest Degradation
Free of error and material misstatement:	Yes
Assessment:	This parameter corresponds to the Activity data estimates of deforestation and forest degradation derived from sample-point interpretation. The sample point data set consists of 7689 samples points systematically located across the GCFRP region on a nested, multi-scale grid with random gaps. Experts in forestry and remote sensing with knowledge of the landscape were engaged to collect the sample data with a software named Collect Earth, that was used to generate the activity data. QA/QC measures were built into the response design, to avoid mistakes or inconsistencies in data collection. The assessment team conducted interviews with the ER program team to confirm the reliability and justification of the application of the Collect Earth program and sample point dataset for monitoring this parameter. The areas deforested and degraded in the reference level have changed since the original ERPD, due to a technical correction in the remote sensing procedures referenced in Section 2.2, Annex 4, and Section 8.3 of the monitoring report. This ultimately led to a reduction in the reference level. The assessment team performed independent data checks and recalculation of the following to assess the correctness of each step of monitoring from measurement to data transfer and calculation: the program area boundaries, the land-use and land-use change (LULUC) classification and transitions from forest to non-forest areas, the number of sample points within the program boundary, the stratum boundaries, and the area expansion factors. A sample of the Collect Earth plots was selected and

	assessed with remote sensing imagery to confirm the correct classification of the plot. Moreover, a spatial analysis was conducted with ARCGIS to confirm the boundaries of the program area, the boundaries of the stratum and the number of plots per stratum. Additionally, the assessment team performed a literature review of the methodology applied from Olofsson et al. (2014) for the quantification and estimation of the areas and corresponding uncertainties and therefore confirmed that methodological steps and data are publicly available in accordance with applicable criteria. The assessment teams confirms that the quantification of the activity data estimates of deforestation and forest degradation is correct and free of errors and material misstatements.

Activity Data Parameter:	Areas of on- and off-reserve planting
Free of error and material misstatement:	Yes
Assessment:	This parameter corresponds to the Activity data estimates of carbon removals derived from areas of non-forest converted to forest area. The data was obtained from the national census data of Ghana, reported by the National Forest Plantation Development Programme. The Plantation's Department of Forestry Commission undertakes an annual survival survey of all planted sites to derive survival rates. The assessment team took the following steps to assess whether the monitored data and parameter is sufficient, correct and free of errors and material misstatements: Independently reviewed the Monitoring Report and the National Forest Plantation Development Programme Annual Reports, the Ghana Forest Plantation Strategy (GFPS) Biennial Report, the National Forest Plantation Dev Programme report and supporting documentation to confirm the on and off-reserve planted areas, survival rates, the removal factors, the root to shoot ratio. To assess the correctness of each step of monitoring from measurement to data transfer and calculation the assessment team independently checked and recalculated the total areas planted by year, the removals enhancements and the ERs quantification for the Reference Level. Through review of these official published reports, the assessment team confirmed the reliability of the source and nature of the reported evidence and confirm that these sources are the best available data supporting the monitoring of this parameter and confirmed that methodological steps and data are publicly available.

	The assessment team confirms that the quantification of the activity data estimates of carbon removals is correct and free of errors and material misstatements.

SCS concludes that the amount of data and quality of the evidence provided about the identification and quantification of the activity data parameters, "Area of Deforestation & Forest Degradation" and "Areas of on- and off-reserve planting" is appropriate, sufficient, and free of error and misstatements to determine the GHG ERs. Moreover, SCS reviewed the Monitoring Report and the links provided to the Ghana REDD+ Hub (http://www.ghanaredddatahub.org/) and confirms that the methodological steps and data are publicly available in accordance with Criterion 6 of the FCPF Methodological Framework.

4.8.2 Emission Factors

The assessment team reviewed the Monitoring Report, calculation workbooks, standard operating procedures and supporting documentation and confirms that the calculation of the emission factors is in conformance with the FCPF program requirements and the guidelines provided in the ER Monitoring Report template. The steps taken to conduct the assessment of the emission factors are described as follows:

Emission Factor:	Emission factors for deforestation
Description:	The ER Program uses 10 different emissions factors for deforestation. These emission factors are set not change between the reference level period and the monitoring period assessments. However, as a result of this assessment, there are changes from the initial values for this validation process. The different EFs are as follows: Deforestation in open forest in Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones. Deforestation in closed forest in Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones Though the above mentioned 10 EFs for deforestation remain fixed, the average EF per deforested hectare over the reference and monitoring period will differ since deforestation may target forest structure (open or closed) and vegetation zones differently over both periods Data unit: tons of CO_2 equivalent per ha Free of error and material misstatement: yes
Assessment:	The assessment team reviewed the Monitoring Report, data, methods, and equations contained in the calculation workbooks

to confirm the reported values for the estimated emission factors for Deforestation in open forest and closed forest classes.

SCS confirmed through independent recalculation that the emission factors for deforestation are considering emissions from all five carbon pools. The gross EF is calculated as the sum of above-ground carbon (AGC), below-ground carbon (BGC), dead wood (DW), litter (L) and emissions from soil organic carbon (SOC). The net EF is obtained by subtracting from the gross EF the carbon stock in the post-deforestation land.

The reported emission factors differ from those reported initially in the ERPD, given a correction done in the soil emissions, to include the projected emissions over 20 years as suggested by the FCPF Guidance Note on accounting of legacy emissions/removals v1.

Emission Factors for Deforestation				
		tCO_2e/ha	±90% CI (tCO_2e/ha)	±90% CI (%)
Closed Forest	Wet Evergreen	401.3	502.3	125%
	Moist Evergreen	862.3	280.0	32%
	Moist Semi-deciduous NW	435.9	76.3	18%
	Moist Semi-deciduous SE	665.7	312.4	47%
	Upland Evergreen	494.9	141.8	29%
Open Forest	Wet Evergreen	169.3	102.4	61%
	Moist Evergreen	162.8	59.8	37%
	Moist Semi-deciduous NW	160.3	54.3	34%
	Moist Semi-deciduous SE	174.3	52.9	30%
	Upland Evergreen	196.0	64.0	33%

Based on this assessment, SCS validated the reliability of the source, quantification and nature of the reported emission factors for deforestation and confirms that the source of these emission factors is sufficient and appropriate to estimate the GHG emissions and removals of carbon enhancements.

Moreover, SCS confirms that the methodological steps and data are publicly available.

<table>
<tr><td>Emission Factor:</td><td>Emission factors for forest degradation</td></tr>
<tr><td>Description:</td><td>The ER Program has identified 6 different emission factors for the quantification of forest degradation. These emission factors are set not to change between the reference level period and monitoring period assessments. However, as a result of this validation assessment, there are changes from the initial values reported in the ERPD.

The different emission factors for forest degradation are as follows:
Five emission factors in closed forests: Wet Evergreen, Moist Evergreen, Moist Semi-Deciduous South-East, Moist Semi-Deciduous North-West and Upland Evergreen vegetation zones; and one emission factor for degradation in open forest (all vegetation zones).

Data unit: tons of CO_2 equivalent per ha

Free of error and material misstatement: yes</td></tr>
<tr><td>Assessment:</td><td>The assessment team reviewed the Monitoring Report, data, methods, and equations contained in the calculation workbooks to confirm the reported values for the estimated emission factors for Degradation in open forest and closed forest classes.

SCS confirmed through independent recalculation that the emission factors for degradation are considering emissions from AGC, BGC and DW. Emissions factors were derived from inventory measurements multiplied by the relative percentage canopy cover reduction observed in all degradation plots over the reference period. Then, the assessment team confirmed that the emission factors for degradation were calculated by multiplying the percentage reductions with the pre-degradation carbon contents in the pools provided.

The average relative canopy cover reduction in closed forest was 29.9%, while the average relative canopy cover reduction in open forest was 48.0%.

<table>
<tr><td colspan="5">Emission Factors for Forest Degradation</td></tr>
<tr><td colspan="2"></td><td>tCO_2e /ha</td><td>±90% CI (tCO_2e /ha)</td><td>±90% CI (%)</td></tr>
<tr><td rowspan="2">Closed Forest</td><td>Wet Evergreen</td><td>132.3</td><td>203.0</td><td>153%</td></tr>
<tr><td>Moist Evergreen</td><td>271.7</td><td>107.6</td><td>40%</td></tr>
</table>
</td></tr>
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	Moist Semi-deciduous NW	146.3	36.2	25%
	Moist Semi-deciduous SE	210.6	133.5	63%
	Upland Evergreen	154.1	60.3	39%
Open Forest	All vegetation zones	102.5	66.8	65%

Through this assessment, SCS validated the reliability of the source and nature of the reported evidence and confirms that the source of the emission factors used for forest degradation is sufficient and appropriate to estimate the GHG emissions and removals of carbon enhancements.

Moreover, SCS confirms that the methodological steps and data are publicly available.

Emission Factor:	Removal factor for teak
Description:	This emission factor corresponds to the removal factor for carbon stock enhancement through plantation of teak in forest reserves (AGB and BGB). Data unit: t CO_2 ha^{-1} yr^{-1} Free of error and material misstatement: yes
Assessment:	The assessment team independently reviewed the the Monitoring Report and published literature from Adu-Bredu S., et al. 2008 (https://www.fao.org/3/i2240e/i2240e.pdf#page=108) on total tree carbon stocks in teak stands in Moist Evergreen forests in Ghana (98 Mg C/ ha), which includes both aboveground and belowground carbon stocks and confirmed the removal factor used in the GHG ER calculations: 98 Mg C/ha^{-1} = 358 t CO_2/ha^{-1} Through this assessment, SCS validated the reliability of the source and nature of the reported evidence and confirms that the source of the removal factor used for teak is sufficient and appropriate to estimate the GHG emissions and removals of carbon enhancements. Moreover, SCS confirms that the methodological steps and data are publicly available.

Emission Factor:	Removal factor for other broadleaf species

Description:	This emission factor corresponds to the removal factor for carbon stock enhancement through the plantation of non-teak trees in forest reserves (AGB and BGB). Data unit: t CO_2 ha^{-1} yr^{-1} Free of error and material misstatement: yes
Assessment:	The assessment team independently reviewed the Monitoring Report and the published IPCC AFOLU report Vol. 4 table 4.8 that corresponds to above-ground biomass in forest plantations. The assessment team confirmed the selected values for 'Africa broadleaf >20 years' for three ecological zones in the GCFRP Accounting Area (tropical rain forest, tropical moist deciduous forest, and tropical dry forest). The values were averaged, and converted to carbon (81 t C/ha) using a carbon-to-biomass ratio of 0.47. The belowground biomass value was generated by applying a root-to-shoot ratio of 0.24 for tropical/subtropical moist forest/plantations >125 Mg ha^{-1} (Mokany et al.2006). SCS confirmed the resulting removal factor used in the GHG ER calculations: 101 Mg C/ha^{-1}= 370 t CO_2/ha^{-1} Through this review, the assessment team validated the reliability of the source and nature of the reported evidence and confirms that the source of the removal factor used for other broadleaf (non-teak) species is sufficient and appropriate to estimate the GHG emissions and removals of carbon enhancements. Moreover, SCS confirms that the methodological steps and data are publicly available.

SCS concludes that the amount of data and quality of the evidence provided about the identification and quantification of the emission factors is appropriate, sufficient, and free of error and misstatements to determine the GHG ERs. Moreover, SCS reviewed the Monitoring Report and the links provided to the Ghana REDD+ Hub (http://www.ghanaredddatahub.org/) and confirms that the methodological steps and data are publicly available in accordance with Criterion 6 of the FCPF Methodological Framework.

4.9 Adjustments to the average annual historical emissions over the reference period

The reference period for the construction of the reference level is from 2005-2014. Average annual historical emissions over this reference period were derived from Activity data to quantify GHG emissions and removals from deforestation and forest degradation. To address concerns raised by the FMT, the ER program participant applied technical corrections to the average annual historical emissions

over the reference level to improve the accuracy and reliability of the data, the methodology and the results. These technical corrections also included an updated accuracy assessment of change detection for deforestation and uncertainty analysis of the activity data for deforestation and forest degradation. As a result of the technical corrections applied and validated during this engagement, the reference level has been updated and therefore deviates from the reference level reported in the original ERPD and the Validation Report.

The assessment team took the following steps to validate whether the calculations and methods used to construct the reference level are in line with the FCPF program requirements, the IPCC guidelines as established in Criterion 5 of the FCPF Methodological Framework, and best practice approaches:

- Reviewed the application of the methods and datasets, including assumptions and selection of parameters used to construct the reference level emissions to assess whether they are in line with FCPF program requirements.
- Independently assessed the land use land cover (LULC) classification from a one percent sample with the use of ancillary imagery sources (i.e., Google Earth), to determine whether the Collect Earth tool, as well as the training and QA/QC processes employed, were appropriate to ensure high-quality data and minimize the impact of any measurement errors.
- SCS independently reviewed the correct application of the emission factors for all land cover classes and carbon pools to quantify the resulting emissions and removals from deforestation, forest degradation and carbon enhancements.
- Independently assessed the number of sample points within the boundaries of the Ghana Cocoa Forest REDD+ Program by performing an intersection of the sample points within the boundary.
- Independently replicated the quantification of the reference level emissions and removals using a combination of the complete datasets (e.g., land use conversions) and/or a sample of the datasets for the subcategories, applied by the ER program team to ensure that the calculation of the reference level ERs is free of material discrepancies.

Therefore, the SCS assessment team concludes that:

- The methods, including assumptions and selection of parameters, used to construct the reference level emissions are correct and in line with the FCPF program requirements.
- The data used to construct the reference level emissions is correct and complete for the subcategories ultimately selected.
- The reference level requirements have been applied correctly and the reference level emissions estimates have been calculated correctly and are free of material discrepancies.

4.10 Estimated Reference Level

The assessment team took the following steps to validate the correctness and completeness of the data, methods and procedures used on the estimation of the Reference Level:

- Independently reviewed Ghana's Forest Reference Level quantification to assess whether the data, methods, and assumptions used to quantify the GHG emissions and removals are in conformity and represent the best available data in the country.

- Selected a random sample of several data points from the remote sensing data from Collect Earth and independently assessed the LULC classification with other sources of remote sensing data to ensure the accuracy of the classification.
- Independently recalculated and quantified the Reference Level emissions for each subcategory to check the absence of errors in the quantification of net emissions and removals per land class as well as the relative contribution to total GHG emissions and removals associated with land conversions.
- The replication of the quantification included recalculation of the following: activity data, the number of sample points within the program boundary, program area vegetation zone boundaries, area expansion factors applied per vegetation stratum, subcategory selection of vegetation zones, and the quantification of GHG emissions and removals resulted from deforestation, forest degradation and carbon enhancements.

Based on the aforementioned assessment, SCS confirms that the Reference Level is accurate and free of material error.

The numbers in the table below correspond to the portion of the Monitoring Period that was assessed during this Crediting Period. Since the Crediting Period is not multiple of one year, 11-June-2019 to 31-December-2019 (203 days), the Reference Level emissions over the Crediting Period were multiplied by the fraction of $\frac{203}{365}$ = 0.56.

Crediting Period year *t*	**Average annual historical emissions from deforestation over the Reference Period (tCO_{2-e}/yr)**	**If applicable, average annual historical emissions from forest degradation over the Reference Period (tCO_{2-e}/yr)**	**If applicable, average annual historical removals by sinks over the Reference Period (tCO_{2-e}/yr)**	**Adjustment, if applicable (tCO_{2-e}/yr)**	**Reference level (tCO_{2-e}/yr)**
2019	2,064,745	482,232	-13,637		2,533,340

4.11 Consistency of the Program's Reference Level with national FREL/FRL and GHG Inventory

This section is intentionally left blank as this validation assessment did not include an extended scope.

4.12 Uncertainty of the Reference Level

4.12.1 Identification and assessment of sources of uncertainty

The assessment team took the following steps to validate whether a step-wise approach for uncertainty analysis has been applied correctly for the identification of sources of random and systematic errors related to the activity data and emission factors for the estimation of the Reference Level in conformance with Criterion 7 and 8 from the FCPF Methodological Framework:

- Reviewed the Monitoring Report, data, calculation workbooks, standard operating procedures (SOPs) and supporting documentation to validate that all potential sources of uncertainty from the activity data, the reference level and emission factors have been identified and assessed in conformance with the FCPF program requirements.
- Assessed whether a comprehensive approach to mitigate and reduce key areas of uncertainty have been addressed to minimize systematic errors (bias) through the implementation of a consistent and comprehensive set of SOPs and Quality Assurance / Quality Control (QA/QC) procedures.
- Assessed whether all assumptions and sources of uncertainty associated with activity data, emission factors, the equations and calculation methods that contribute to the uncertainty of the estimates of emissions and removals were assessed with a step-wise approach and are correct.
- Applied expert judgement to conclude that the assessment of sources of uncertainty in construction of the Reference Level Emissions is justifiable.

Based on the aforementioned assessment, SCS confirms that a step-wise approach has been applied correctly for the identification of sources of random and systematic errors related to the activity data and emission factors for the estimation of the Reference Level, and is in compliance with the FCPF program requirements.

4.12.2 Uncertainty of the estimate of the Reference Level

The audit team assessed the uncertainty analysis performed by the ER program to systematically identify the sources of uncertainty and assessed the correctness of the calculation of the uncertainty statistics of the Reference Level. The assessment team performed an independent review of the selection of sources of (residual) uncertainty included in the analysis, the calculation of their standard error, as well as the review of the steps and assumptions stated in the Monitoring Report, the inclusion of the assessment parameters in the calculation workbooks and supporting documentation.

For the quantification of the ERs uncertainty analysis the ER Program performed a Monte Carlo simulation analysis following the IPCC Guidelines (2006) - Chapter 3 and the Guidelines on the application of the Methodological Framework Number 4 on Uncertainty Analysis of Emission Reductions, using an Excel spreadsheet. Probably density functions were generated for all the modelled parameters, followed by a goodness-of-fit test to identify if the parameters follow a normal or non-normal distribution. To improve the accuracy of the estimates coming out from different runs, a total of 16,000 random values for each parameter were generated instead of 10,000.

Based on the aforementioned review, SCS confirms that the ERs uncertainty estimation was done in conformance with the Methodological Framework Criterion 9 and the Guidelines on the application of the Methodological Framework Number 4 On Uncertainty Analysis of Emission Reductions. SCS concludes that the assessment of the application of the Monte Carlo simulation and the quantification of the Uncertainty of the Reference Level were performed correctly.

4.12.3 Sensitivity analysis and identification of areas for improvement of the MRV system

The assessment team conducted an independent review of the sensitivity analysis provided by the ER program to estimate the relative contribution of each parameter to the overall uncertainty, including the sources from Activity Data, Emission Factors, and their integration. From a list of different scenarios set up in the calculation workbook prepared by the ER program and the assessment team independently run the Monte Carlo simulation, turning on and off the sources of uncertainty one at the time to identify the relative contribution of each parameter to the overall uncertainty of Emission Reductions of the activity data and emission factors.

While every time there are updates in the calculation workbook or the data has been refreshed, the simulation results will change and generate new values due to the stochasticity of the data, the assessment team was able to validate that the simulation runs produced similar results to the ones reported by the ER program in the Monitoring Report. The main sources of uncertainty identified are those associated with the activity data and the emissions factors.

Moreover, the assessment team reviewed the methods and actions to address sources of high uncertainty proposed in the Monitoring Report and confirms that they are aligned with the sensitivity analysis results.

4.13 Data quality and availability

The assessment team reviewed the quality and description of the data and methods used to construct the Reference Level following the steps described in the Monitoring Report and the calculation workbooks, to independently recalculate the estimates of the Reference Level. Based on this assessment, SCS confirms that the methodological steps and description of the data are detailed enough to enable the recalculation of the Reference Level estimates.

Moreover, the assessment team confirmed that the relevant information, maps, description of methods, standard operating procedures and data sources, are publicly available online in Ghana's data-hub (http://www.ghanaredddatahub.org/settings/uploadreports/) and the referenced links available in the Monitoring Report.

5. NON-COMPLIANCES AND OBSERVATIONS

As part of the validation process, any potential or actual discrepancies and non-compliances with the FCPF program requirements were identified and resolved through the issuance of findings. Findings are the formal mechanism used by SCS to identify any actual or potential areas of risk or concern.

This validation was comprised of 2 main formal rounds of findings with three additional rounds to clarify and/or request corrective actions to the findings submitted. The findings were issued to the ER Program personnel using a proprietary workbook-based approach, termed the Findings Presentation Workbook. This gave the ER Program personnel the opportunity to respond to the findings and allowed for efficient and transparent tracking of the current status of each finding. The following discusses the types of findings that were issued during the assessment process.

A Minor Corrective Action Request (mCAR) was issued when the assessment team determined that there was not enough information to make a decision regarding conformance:

- The evidence provided to demonstrate conformity is insufficient, unclear or not transparent, but does not lead to a material error, omission or misstatement, and/or a breakdown in the systems delivery
- Non-material errors, omissions or misstatements have been made in applying assumptions, in data or calculations

A Major Corrective Action Request (MCAR) was issued when the assessment team has identified that:

- The evidence provided to demonstrate conformity is insufficient, unclear or not transparent and may lead to a material error, omission or misstatement, and/or a breakdown in the systems delivery
- Underlying assumptions used to develop the reported estimates26 are not supported by data
- Material errors, omissions or misstatements have been made in applying assumptions, in data or calculations
- Non-compliance with Validation and Verification criteria
- The REDD+ Country Participant has failed to implement or made inadequate progress with the mCARs from the previous verification

An observation (OBS) was issued when:

- There was no objective evidence to prove that there was a non-conformity, but the VVB observed practices and/or methods that could result in future MCAR and mCAR
- The VVB identified an area of the Forest Monitoring System that requires attention and/or adjustment in future monitoring and reporting
- An area where immaterial discrepancies exist between the observations, data testing results or professional judgment of the assessment team and the information reported or utilized (or the methods used to acquire such information) within the ER Monitoring Report.
- An area where the expert judgement of the assessment team suggests that there are opportunities for improvement in the areas falling within the assessment scope.

As part of the audit process, 3 MCARs, 10 mCARs and 1 OBS were issued. All findings issued by the audit team during the audit process were satisfactorily addressed by the ER Program personnel and were closed. All findings issued during the audit process, and the impetus for the closure of each such finding, are described in Appendix 1 of this report.

APPENDIX 1: OVERVIEW OF NON-COMPLIANCES & OBSERVATIONS ISSUED DURING THE VALIDATION BY THE VALIDATION TEAM

Finding Type: mCAR, No.1 - Dated 13 Dec 2021

Standard Reference: FCPF Methodological Framework

Document Reference: ADxEF_18_06_2022.xlsx

Finding: Criterion 6 from the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction. ".

In recalculating the estimates of emission reductions for deforestation, the assessment team couldn't verify the source of the area per stratum reported in the workbook "ADxEF_18_06_2022.xlsx", sheet CE_data, Column fm_eco_area_ha_combined, and sheet Strata_check, Column U, in any of the shapefiles or maps provided. The assessment team requests additional information and demonstration of the source of these values.

Project Personnel Response: The areas can be calculated using the intersection of the forest mask and vegetation zones. The raster that was used to generate those areas can be found here: https://drive.google.com/drive/u/2/folders/1HpQE8Oz6kJbhbxeL53dXf6gGg_302vaE

Instructions for deriving strata areas:

The strata areas for the GCFRP were derived by first rasterizing the vegetation zone layer, using the same grid as the forest mask and then combining the forest map and vegetation zone layers by multiplying the vegetation zone by 10 and add the forest mask values. The raster file is in UTM zone 30 N for the purpose of deriving areas from the pixel count. The resulting values from the combined forest mask and vegetation zone map (forest_mask_2000_2015_cocoa_area_VEGZONES.tif) corresponding to the following:

0: Non-forest outside the vegetation zones

1: Forest outside the vegetation zones

10: Non-forest & moist evergreen

11: Forest & moist evergreen

20: Non-forest & Moist semideciduous (north west subtype)

21: Forest & Moist semideciduous (north west subtype)

30: Non-forest & Moist semideciduous (south east subtype)

31: Forest & Moist semideciduous (south east subtype)

40: Non-forest & Upland evergreen

41: Forest & Upland evergreen

50: Non-forest & Wet evergreen

51: Forest & Wet evergreen

The areas for the areas outside the GCFRP were calculated using only the vegetation zone map, which was rasterized projected in UTM zone 30 N.

To calculate the areas, the Raster Layer Unique Values Report can be used in QGIS 3.16, which will calculate the pixel count and areas in m2. In order to convert the areas into hectares, m2 should be divided by 10,000.

Auditor Response: Thanks for your comprehensive explanation. We were able to retrieve the spatial datasets and confirmed the areas. The audit team found some minor differences, mainly in the Moist semidecidious NW, the Moist evergreen and the Wet evergreen categories, that do not represent a materiality error. Therefore, the assessment team concludes this finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: mCAR, No.2 - Dated 13 Dec 2021

Standard Reference: FCPF_ER_Monitoring_Rerport_template, FCPF Methodological Framework

Document Reference: Ghana ER MR_Final_09022021.docx

Finding: Section 1.1 of the ER Monitoring Report template requires the following: "Provide a short description (2-page maximum) of the implementation of the ER Program, including:

- Progress on the actions and interventions under the ER Program (including key dates and milestones);
- Update on the strategy to mitigate and/or minimize potential Displacement.
- Effectiveness of the organizational arrangements and involvement of partner agencies
- Updates on the assumptions in the financial plan and any changes in circumstances that positively or negatively affect the financial plan and the implementation of the ER Program.

Highlight any key changes or deviations in the ER Program's design and key assumptions compared to the description of the ER Program in the ER-PD.

Refer to criterion 17.3 and 27 of the Methodological Framework" Criterion 17.3 of the FCPF Methodological Framework indicates that "By the time of verification, the ER Program has implemented its strategy to mitigate and/or minimize potential Displacement ".

In reviewing the Ghana ER Monitoring Report, Section 1.1 the assessment team found that the length of the description of the program is larger than the "2-page maximum", and does not provide an "Update on the strategy to mitigate and/or minimize potential Displacement.". Therefore, Section 1.1 of the ER-MR is not in conformance with the requirements of the program.

Project Personnel Response: The 'Update on the strategy to mitigate and/or minimize potential Displacement' has been provided in Table 2 of Ghana's Monitoring Report (MR). To ensure conformity, Table 2 would be moved from section 1.2 to section 1.1 of the MR.

Auditor Response: Thanks for your response. The assessment team confirmed the changes provided. Along with the agreed allowance to the template requirements for a longer description of the program in Section 1.1 by the FMT team, this is now in conformance. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: OBS, No.3 - Dated 13 Dec 2021

Standard Reference: FCPF_ER_Monitoring_Rerport_template, FCPF Methodological Framework

Document Reference: Ghana ER MR_Final_09022021.docx, ADxEF_18_06_2022.xlsx

Finding: The FCPF Guidelines in Uncertainty Analysis, Table 1, "Sampling" states that "Sampling uncertainty is the statistical variance of the estimate of area for the applicable forest transitions that are reported by the ER Program. This source of error is random, but the selection of the estimator might be a source of error. ER Programs shall use reference data and unbiased estimators for estimating activity data and its uncertainty, as recommended by the GFOI MGD. See FAQ on area estimation and section 5.1.5 of the MGD(GFOI 2016), Good practices for estimating area and assessing accuracy of land change by Olofsson et al. (2014), for more information on how estimates can be produced using unbiased estimators of activity data. " When reviewing the "Good practices for estimating area and assessing accuracy of land change by Olofsson et al. (2014)", Section 5.1.1. "Determining the sample size" states that "For simple random sampling and targeting overall accuracy as the estimation objective, Cochran (1977) suggests using a sample size of where O is the overall accuracy expressed as a proportion, z is a percentile from the standard normal distribution (z = 1.96 for a 95% confidence interval, z = 1.645 for a 90% confidence interval), and d is the desired half-width of the confidence interval of O". Moreover, in Section 8.3 of the Ghana ER MR_Final_09022021.docx report, section "Sampling design" also states that a value of z = 1.645 for the 90% confidence interval is used.

When reconstructing the calculation of the uncertainty and confidence intervals, the assessment team found that the z value used in the workbook ADxEF_18_06_2022.xlsx, sheet "National": Column E, sheet "deforestation by veg": Column U and AD, sheet "degradation by veg": Column U and AD, was 1.64 instead of 1.645, stated for the 90% confidence interval. The assessment team requests additional information and explanation of why a z value of 1.64 was used in the estimates instead of 1.645.

Project Personnel Response: The exact z value of a 90% CI would be 1.6448536270, in the simple error propagation in the excel spreadsheet this value was rounded to 1.64 while mentioned publications round it to 1.645. Though we agree with the auditors that the use of the value 1.645 would be more accurate we also like to remind the auditors that the simple error propagation is not used for assessing the uncertainty around the emission reductions as this is assessed with the Monte Carlo analysis. Therefore, using 1.645 instead of 1.64 will not impact the calculations in the Monitoring Report.

Auditor Response: Thanks for your explanation. The assessment team confirmed that in the recalculations, there is a very small difference that does not impact the materiality. For consistency, when you define in the report (e.g. Section 8.3 of the Ghana ER MR report, section "Sampling design") that a value of z = 1.645 for the 90% confidence interval is used, this should be the same value used in the calculations, or mentioned in the report that a value of 1.64 would be used instead. This finding is closed and chanced as OBS.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: mCAR, No.4 - Dated 13 Dec 2021

Standard Reference: FCPF_ER_Monitoring_Rerport_template, FCPF Methodological Framework

Document Reference: Ghana ER MR_Final_09022021.docx

Finding: Criterion 6 from the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction. ".

Section 2.2.2 "Calculation of Activity Data" of the Ghana ER MR_Final_09022021.docx report does not include the documentation of the exact source of the equations used in the different calculations. Moreover, it is unclear why in the calculation of "sampling design" (page 29) the description of the calculation mentions a different number of equation: "an approximate estimated total sample size n is assessed by equation 3" followed by a different number of equation: "Equation 1 Formula to determine overall sample size:". Same for the calculation of "Data analysis" (page 31): "the sample plots receive equal weights per vegetation zone and sampling density as shown in equation 4" followed by "Equation 2 The area of variable v in vegetation zone e", and the same with the following calculations, Equations 3 to 11 of the section.

The assessment team requests additional information to clarify the differences in the equation numbers. Also, the assessment team found the lack of reference to the specific source of each equation is a non-compliance with the FCPF Program requirements.

Project Personnel Response: We apologize for the incorrect numbering of the equations, which will be corrected.

Concerning the specific source of each equation, we can add these for most of the standard statistical equations but we believe it is rather challenging to provide references from the most obvious mathematical expressions. For example, weighting variables, rather than a particular reference, we think it is more informative to explain in detail what the equation does, which in the case of simple mathematical expressions is a more logical step. Hence, for some of the specific interim steps, e.g. the weighted post-deforestation carbon contents calculation, we think that explicitly mentioning how the weighting works is more informative than finding a particular document where the authors happen to use a similar approach. As such, we can rather explain what the equation effectively does and what principle it follows. Please find the sources/explanations below

- Formula to determine overall sample size: Cochran (1977)
- The area of variable v in vegetation zone e: This equation does area-based weighting. This means that each plot receives the same weight for the stratum where it belongs and the weight is calculated by dividing the area per stratum by the total number of plots in the stratum. This is the equivalent of equation 8 in Olofsson et al (2014)
- The half-width 90% confidence interval (CI) around the area of variable v in vegetation zone e and stratum: Snedecor and Cochran (1989)
- Propagation of errors for summation: This is the equivalent of equation 3.2 of IPCC (2006)
- Equation used for the weighted post-deforestation carbon contents (Baftere): Post-deforestation biomass is estimated from weighted post-deforestation land use per vegetation class, where the biomass in the post-deforestation land use is assessed through field measurements from the FPP. The principle of estimating emissions from each land use change stratum as the difference between the forest carbon stocks per unit area before conversion and the forest carbon stocks per unit area for the new land use after conversion is in line with GFOI (2016, page 59) and IPCC (2003).
- Equation used to calculate the half-width 90% confidence interval of the proportions: Snedecor and Cochran (1989)
- Emissions factor for deforestation for vegetation zone e and forest structure s during both the reference and monitoring period: This equation approximates emissions per hectare deforestation as the difference between the carbon (AGC, BGC, DW, L) in the forest before the deforestation event and the average carbon (AGB, BGB) in the land use following deforestation, plus the change in the soil carbon pool (where the change in soil carbon is calculated with equation 2.25 in IPCC, 2019).
- Confidence interval (±) around carbon contents in the different pools: Snedecor and Cochran (1989)
- Emissions factor for forest degradation for vegetation zone e during both the reference and monitoring period: this equation approximates emissions per hectare degradation multiplying the pre-degradation forest carbon stock with the assessed average canopy cover reduction rate per forest structure (open or closed). Reduction in canopy cover was taken as a proxy for degradation in FAO (2000)
- Reference level for the GCFRP landscape (tCO2e/year): This equation summarizes net emissions per stratum to obtain the total emissions for the GCFRP landscape and adds removals to get the net of forest based emissions and removals.
- Equation for emission reductions in year 2018 and 2019: This equation calculates emission reductions by deducting monitored emissions from historical average emissions over the reference period.

References:

- Cochran, W. G. (1977). Sampling techniques (3rd ed.). New York: John Wiley & Sons.
- FAO (2000). FRA 2000 – On definitions of forest and forest cover change. FRA programme, Working paper 33, Rome, Italy.

• GFOI (2016) Integration of remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests: Methods and Guidance from the Global Forest Observations Initiative, Edition 2.0, Food and Agriculture Organization, Rome.

• Intergovernmental Panel on Climate Change (IPCC) (2003). Good Practice Guidance

• for Land Use, Land-Use Change and Forestry. Penman J., Gytarsky M., Hiraishi T., Krug, T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., and Wagner F (Eds). IPCC/IGES, Hayama, Japan.

• Intergovernmental Panel on Climate Change (IPCC) (2006).IPCC Guidelines for National Greenhouse Gas Inventories. Volume 1: General Guidance and Reporting. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Hayama, Japan.

• Olofsson, P.; Foody, G.M.; Herold, M.; Stehman, S.V.; Woodcock, C.E.; Wulder, M.A. Good practices for estimating area and assessing accuracy of land change. Remote Sens. Environ. 2014, 148, 42–57.

• Snedecor, G. W. and Cochran, W. G. (1989), Statistical Methods, Eighth Edition, Iowa State University Press

Auditor Response: Thanks for your comprehensive review and response to this. The assessment team was able to confirm the changes provided. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: mCAR, No.5 - Dated 13 Dec 2021

Standard Reference: FCPF Methodological Framework

Document Reference: ADxEF_18_06_2022.xlsx

Finding: Criterion 6 from the FCPF Methodological Framework states that “Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country’s or ER Program’s policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction. ”.

In replicating the calculation of the emissions and removals, the assessment team has been unable to verify the source of the estimates of removals in the workbook ADxEF_18_06_2022.xlsx, sheet “reference level”, “projected removals for 2018 and 2019” (Cells B10 and G10); “removals enhancement 2018 and 2019” (Cells B20 and G20). The assessment team requests additional information and demonstration for how theses values were calculated from the data source.

Project Personnel Response: Removals were calculated in a separate spreadsheet titled "Calculation tool for enhancementMay2021.xlsx". This spreadsheet uses a different data source (plantation establishment statistics and measured survival rates). Including these tabs in the ADxEF spreadsheet would have made the file too large which is why the removals calculated in this spreadsheet are copied as values into the ADxEF file.

Auditor Response: Thanks for your response. The audit team was able to retrieve the “Calculation tool for enhancement May2021.xlsx” workbook and confirm the source of these values. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: MCAR, No.6 - Dated 13 Dec 2021

Standard Reference: FCPF_ER_Monitoring_Rerport_template, FCPF Methodological Framework

Document Reference: Ghana ER MR_Final_09022021.docx, ADxEF_18_06_2022.xlsx

Finding: Section 7 of the FCPF_ER_Monitoring_Report_template states "Please identify the major events or changes in ER Program circumstances during the Reporting Period that might have led to a Reversal or impact the risk of Reversals. Indicate if these events have previously been reported to the Trustee. Highlight any non-human induced Force Majeure event, impacting at least 25% of the ER Program Accounting Area.

Please confirm if any Reversals from ERs that have been previously transferred to the Carbon Fund have occurred during the Reporting Period. Refer to indicator 21.1 of the Methodological Framework". Moreover, indicator 21.1 of the Methodological Framework indicates "The ER Program Monitoring Plan and monitoring system are technically capable of identifying Reversals.".

In Section 7.3 Reversal Risk Assessment, the ER-MR states that "The reversal risk assessment using the CF Buffer Guidelines has not changed since the preparation of the revised final ERPD". However, when consulting the final ER-PD from the FCPF website, the assessment team found that the percentage of reversal risk set aside is different from the one reported in the ER-PD, 20% found in the ER-PD vs 18% found in the ER-MR. Moreover, in the excel calculations spreadsheet "ADxEF_18_06_2022.xlsx", sheet "reference level", Cell L22, the value used on the estimates is 17% which corresponds to 239,309 vs 253,286 reported in column K "Quantity of ERs to allocated to the Reversal Buffer and the Pooled Reversal Buffer" from table in Section 8. Therefore, the assessment team found this is a non-compliance with the FCPF Program requirements.

Project Personnel Response: There has not been any major event or changes (El Nino events) impacting the programme area.

The reversal risk assessment has not changed between the ERPD and the MR and you will find the qualitative description in the Table under section 1.19 in the MR to be the same as the ERPD. However, with the publication of the buffer guidelines in 2020 (see Table 2 in the buffer guidelines: https://www.forestcarbonpartnership.org/sites/fcp/files/2020/April/FCPF%20Buffer%20Guidelines_2020_1_Final_Posted.pdf) we realized the reversal risk set-aside percentages had not been calculated correctly in the ERPD and this has now been corrected in the MR from 20% to 18%. In specific, the error was in row C where in the ERPD the medium risk was translated as a 5% set-aside whereas the buffer guidelines specifies that a medium risk translates in a 3% set-aside. The set-aside value reported in the MR is 253,386 (line K in the Table of section 8). It is possible that inadvertently a wrong version of the excel has been shared with the auditors including a 17% set-aside instead of 18% set-aside. The correct excel file will be shared (the only change being this percentage)

Auditor Response: Thanks for the explanation provided. The assessment team was able to confirm this and the ERs allocated in the reversal buffer corresponding to the 18% in the new version of the ER MR (Ghana ER MR_Final_Version_Track_Changes.docx) and the calculation workbook (ADxEF-28May2021_Submitted.xlsx). This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: MCAR, No.7 - Dated 13 Dec 2021

Standard Reference: FCPF Methodological Framework

Document Reference: Ghana ER MR_Final_09022021.docx, ADxEF_18_06_2022.xlsx

Finding: Criterion 6 of the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction."

Moreover, Criterion 22 indicates that "Net ERs are calculated by the following steps:

1. Subtract the reported and verified emissions and removals from the Reference Level

2. Set aside a number of ERs from the result of step 1, above, in a buffer reserve. This amount reflects the level of uncertainty associated with the estimation of ERs generated during the Crediting Period."

In replicating the calculation of the emissions and removals during the reporting period, the assessment team has been unable to verify the value reported in the Ghana ER MR_Final_09022021.docx file, Section 4.3 "Total Reference Level emissions during the Reporting Period (tCO2-e)": the 4,896,800 value reported vs 2,753,667 recalculated and found in workbook ADxEF_18_06_2022.xlsx, sheet "reference level", Cell L16. The assessment team requests additional information and demonstration for how this value was calculated from the data source.

Project Personnel Response: We apologize for the oversight, this concerns a copy-paste error in the MR of the Reference Level emissions during the Monitoring Period. This might have sourced from the last minute revision of the monitoring period to the year 2019 instead of the year 2018 + 2019. The value 4,896,800 concerns a value from a previous version and should have been updated to 4,951,174 tCO2-e, which corresponds to the year 2019 emissions+removals. Accordingly, the length of the reporting period is 203 days / 365 days = 0.56 (the reporting period starts with the date of the ERPA signature). The reference level emissions during the reference period are therefore 4,951,174 x 0.56 = 2,753,667 tCO2-e

Auditor Response: Thanks for the clarification, however, the assessment team is still unable to confirm the values reported in the newer version of the ER MR shared "Ghana ER MR_Final_Version_Track_Changes.docx" and in the most recent version shared of the calculation workbook "ADxEF-28May2021_Submitted.xlsx".

The assessment team found in section 4.3, page 55, a Total Reference Level emissions during the Monitoring Period (tCO2-e) of 4,951,174 reported vs 9,926,869 found in sheet reference level, cell L9 of the calculations workbook "ADxEF-28May2021_Submitted.xlsx". Likewise, a value of Net emissions and removals under the ER Program during the Monitoring Period (tCO2-e) of 2,199,990 was reported vs 4,597,603 found in sheet reference level, cell L10 of the workbook. Also, the Emission Reductions during the Monitoring Period (tCO2-e) reported 2,751,185 vs 5,329,266 found in cell L11. Please revise and clarify accordingly.

Project Personnel Response 2: We apologize for the inconvenience. It appears the auditors are not referring to the most recent version of the ADxEF file, we will make sure to upload it. The differences quoted are related to the monitoring period which initially was the year 2018 and 2019 combined. Ghana had opted 2 years as monitoring period following our interpretation of the Guidelines on the application of the Methodological Framework Number 3 On the definition of reporting periods of Emission Reduction Programs: "3. In the case a REDD Country proposes a reporting period which is not multiple of one year: a. REDD countries will extend the estimation of GHG emissions and removals to a period (i.e. monitoring period) that fully includes the Reporting Period and that is multiple of one year." However, the FCPF FMT suggested to change the monitoring period to the year 2019 only. This change had not yet been made in the spreadsheet shared initially with the auditors. Please look at the latest version of the ADxEF file where the header of the table with values in tab "reference level" reads "Values in monitoring report 2019 only"

Auditor Response 2: Thank you for your explanation and the changes provided. We reviewed the changes provided in the most recent MR shared (Ghana ER MR_Final_Version_Track_Changes-GHANA__current.docx) and the new calculation workbook shared ADxEF-28May2021_GHANA_CURRENT.xlsx. However, the audit team is still having problems to confirm the "Net emissions and removals under the ER Program during the Monitoring Period (tCO2-e)" in file "ADxEF-28May2021_GHANA_CURRENT.xlsx", sheet "reference level" cell L10. It is unclear, why you are accounting the emissions from 2018 in the emission removals reported in 2019. Please refer to sheet "reference level", cell G20: -315,673. Values derived in the workbook "Calculation tool for Enhancement May2021.xlsx", sheet "new reference level", cell G26 (-315,673) that accounts emissions from cells G22 and G23 corresponding to 2018.

Project Personnel Response 3: We thank the auditors for this excellent observation. This issue is related to the last-minute change of the Monitoring period from 2018 and 2019 (which we had interpreted as being multiple of one year) to 2019 only: The Monitoring period for Deforestation and Degradation has been changed to the year 2019 only (as explained in I16) but the Monitoring period for enhancement still concerns a two-year period. The change in Monitoring period for Deforestation and Degradation has no impact on the assessed emission reductions from Def/Degr since these were already calculated pro-rata on the year 2019 only. However, since enhancement reporting follows the new guidance on legacy removals provided by the FCPF, the reported removal increases do change if the Monitoring period 2019 only is used instead of the 2018-2019 period. The removal results over the reporting period are then -117,259 tCO2e instead of -148,291 tCO2e, that is -65,215 tCO2e lower. It also means the amount of removals considered in the reference level are lower, meaning the emissions in the reference level are slightly higher: 4,975,695 tCO2e for the monitoring period instead of 4,951,174 tCO2e. The changes in removals imply the FCPF ERs are 1,105,117 tCO2e instead of 1,154,316 tCO2e - we have corrected this in the MR. We have also updated any remaining reference to the year 2018 in the Monitoring Period in the MR and we have updated the MC file, the Calculation tool for enhancement and ADxEF files. Also Figure 11 where the monitoring period was still 2018 and 2019 is now updated, and we updated Fig 4,6,8 for correct references to the equation and table numbers (changed in the previous round of comments). Updated MC file : https://www.dropbox.com/s/gr9xis5l04toksd/Ghana%20MC%20040422_FIXED_VALUES.xlsx?dl=0

Auditor Response 3: Thank you for your response and thorough revision and changes into the calculations. The audit team was able to verify the changes provided in the new Calculation tool for Enhancement workbook, as well as the updates to the Total emissions in RL-Monitoring. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: mCAR, No.8 - Dated 13 Dec 2021

Standard Reference: FCPF Methodological Framework

Document Reference: Ghana ER MR_Final_09022021.docx

Finding: Criterion 6 from the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction.".

In Section 3.2 Parameter "Areas of on- and off-reserve planting (2018 and 2019), discounted with failure rate", the assessment team couldn't confirm the planted areas reported in the link provided. When reviewing the web page of the National Forest Plantation Development Programme of Ghana to confirm the areas planted and survival rate in the annual reports, we couldn't find the statistics for the corresponding years of 2018, 2019. The available data was found only for the years 2003 to 2016. The assessment team requests additional information and demonstration for how these values were derived from the data source.

Project Personnel Response: The 2019 plantation data has not yet been published online but this data can be found in the excel spreadsheet "Calculation tool for enhancement" where you will find this information in the tab "AD-enhancements" in row 18 and 19

Auditor Response: Thank you for your response. We were able to retrieve the workbook "Calculation tool for Enhancement May2021.xlsx". However, the audit team was unable to confirm the values reported in the latest version of the ER MR (Ghana ER MR_Final_Version_Track_Changes.docx). In the ER MR, section 3.2, page 52 for 2018 there is a value reported of 2,086 vs 2,977 found in the indicated sheet "AD – Enhancements", row 18. Moreover, for 2019 there is a considerably large difference of 43,694 vs 3,516 found in row 19 of the enhancement's calculation workbook. Even the sum of the OFF Reserve areas + ON Reserve areas for the corresponding years doesn't match the reported areas. The assessment team requests to please revise and provide additional information and demonstration for how these values were derived.

Project Personnel Response 2: We thank the auditors for pointing this out and apologize for this oversight. These numbers are indeed incorrect. Since the report was compiled many months ago we are unable to reconstruct what went wrong copying these numbers into the report but you can find the correct areas in track-changes added now to the MR (page 55). The areas concern the planted areas (gross area), the area used to calculate removals are the planted areas multiplied by the survival rate for 2018 and 2019 respectively (net area).

Auditor Response 2: Thank you for the revision and updates provided to the MR. The audit team was able to confirm the changes made to the MR and the areas planted reported for 2018 and 2019 in the file shared: https://www.dropbox.com/s/p28dh0q90c2us8g/Planted%20areas%202018%202019.xlsx?dl=0. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: mCAR, No.9 - Dated 20 Feb 2022

Standard Reference: FCPF Methodological Framework

Document Reference: Ghana ER MR_Final_Version_Track_Changes.docx, Calculation tool for Enhancement May2021.xlsx

Finding: Criterion 6 from the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction.".

In the recalculation of the removals, the audit team couldn't confirm the AD areas used in the workbook "Calculation tool for Enhancement May2021.xlsx", sheet AD – Enhancements, cells B25:J25 in the NFPDP report. While we were able to retrieve the NFPDP report for 2011 from internet (https://www.yumpu.com/en/document/read/42160388/2011-annual-report-the-forestry-commission-of-ghana, Page 5), we were not able to locate the reported areas, nor in the NFPDP report from https://www.oldwebsite.fcghana.org/userfiles/files/Plantation%20Annual%20Report/FC%20AnnualReport%202016.pdf, page 6 (numbered Page 2), or any of the provided reports or the GFPS_Annual_Report_2019_WebLoad_BAT.pdf. The assessment team requests additional information and demonstration for how these values were derived from the data source.

Project Personnel Response: Please find the areas as calculated from the NFPDP database in the yellow highlighted cells in the following excel spreadsheet: https://www.dropbox.com/s/p28dh0q90c2us8g/Planted%20areas%202018%202019.xlsx?dl=0 These numbers would not feature in this aggregate format in the NFPDP report since the report provides national statistics, whereas for the MR only planting efforts inside the GCFRP are included.

Auditor Response: Thank you for sharing the document on the link of Planted Areas, it was key to confirm the source of the areas reported in Finding Number 8, corresponding to the years 2018 and 2019.

However, in the file shared we were not able to confirm the areas for the years 2005-2014. The file in the link provided only contains data corresponding to years 2018 and 2019. The assessment team is still unable to confirm the values in the "Calculation tool for Enhancement May2021.xlsx", sheet AD – Enhancements, cells B25:J25 that form the basis for the values estimated in the sheet "new reference level".

Moreover, the audit team found that Annex 3 of the MR, Page 176 also needs to be updated, as some of the areas planted do not correspond to the areas estimated in the calculation workbook. Please revise and update accordingly and provide demonstration of how the areas from the cells B25:J25 were derived.

Project Personnel Response 2: We thank the auditors for pointing out the required updating of planted area statistics, these areas have now been updated on Page 176 and where else needed in the MR.
In addition, we have included in the google drive the excel file labelled ''GCFRP planted_Area_2001-2013_Removal_Ghana'', sheet summary_reforest_ref_period, cells E309:L309 that confirm the source of reported reforested areas corresponding to the years 2005 to 2013 in the GCFRP Area. This forms the basis of how ''calculation tool for Enhancement May 2021-2019only New'' ,sheet AD-Enhancements, cells B25:J25 were derived.
Kindly note that no on-reserve plantation data were available for 2014, but activities persisted. As such, the average area planted for 2010-2013 was applied and survival of 40% used.

Auditor Response 2: Thank you for your revision and updates provided to the MR and the Calculation tool for Enhancement, along with the GCFRP Calculation Report of Removals from 2001_2013. We were able to verify and confirm the areas planted for the reference level. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Finding Type: mCAR, No.10 - Dated 20 Feb 2022

Standard Reference: FCPF Methodological Framework, Guidelines on the application of the Methodological Framework Number 4 On Uncertainty Analysis of Emission Reductions,

Guidance Note on estimating the uncertainty of emission reductions using Monte Carlo simulation

Document Reference: Ghana ER MR_Final_Version_Track_Changes.docx, Ghana MC_MR_18_05_2021.xlsx

Finding: Criterion 6 of the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction."

Moreover, Criterion 7 indicates that "Sources of uncertainty are systematically identified and assessed in Reference Level setting and Measurement, Monitoring and reporting ."

The audit team couldn't verify in column C of sheet "Sources_Uncertainty" in workbook "Ghana MC_MR_18_05_2021", the 'sampling error' for biomass measurements which are used as inputs to the Monte Carlo analysis. The assessment team has identified in the quantification included in cells C7:C18 (AGB and BGB) that it appears a combined uncertainty approach is being applied with the intent to increase uncertainty by 10% (per the comment in cell C7). However, given the current formula, the audit team found a 1.98% increase in uncertainty given a 50% error in biomass component (example: SQRT(.5^2+0.1^2) = 0.5099). Please revise and clarify the estimation of uncertainty for the above, and change the header of column C1 "Standard Deviation" as it is misleading.

Project Personnel Response: Concerning the question: Where can we locate the cited paper Särndal, C. E., Swensson, B., and Wretman, J. (1992) and can you provide more explanation on the application of equation number 3 and the estimation of the Standard Error and the Sampling Error:

Response: Many thanks for this question. Concerning the publication “Särndal, Swensson & Wretman (1992)”, this is a book, not a paper, hence we can not share it due to copyright issues. This book is one of the core publications regarding technical robustness, together with Cochran's 1977 book. However a quick alternative explanation can also be found in Olofsson et al. (2014): https://www.sciencedirect.com/science/article/pii/S0034425714000704) Eqs. 10 and 11, where what the reviewers find mentioned as SE is more specifically mentioned as the Standard Error of the estimated Area per stratum (which means that the equation the reviewers mention applies for each stratum). This standard error multiplies the actual total area (A) by the standard error of the proportion of area in each stratum.

The equation for the standard error of the proportion of area in each stratum follows a similar format to the standard error (SE) formula, where Wi stands for the proportion of area mapped as class i. Specifically, the p's are the proportions of the whole reference sample that were given class j but were mapped as class i, and they are the same as the p's shown as the ones in the Equation 3 of the ER MR.

Concerning the question: Can you please provide an explanation on the reported values in Column C of worksheet “Sources_Uncertainty” within workbook “Ghana MC _MR_18_05_2021”. It is unclear the use of the equation, it seems like you are already getting the standard deviation from ADxEF-28May2021_Submitted, sheet AGC, as an input on this equation in Column C “Standard Deviation”. Also provide details on how the values are increased by 10% and what the rationale was for selecting such an adjustment.

Response: Response 2) Indeed, the standard deviation values were taken from ADxEF-28May2021_Submitted, sheet AGC. First, the question from the auditors made us realize a small mistake: The unbiased estimator for the standard deviation is divided by (n-1), but the unbiased estimator for the standard error of the mean is simply divided by n. The standard error of the mean is [stderr= standard deviation/sqrt(n)]

As such the formula as it stands currently is:

SQRT((standard deviation/sqrt(n-1)/mean)^2 +0.1^2)*mean

This is now corrected to:

SQRT((standard deviation/sqrt(n)/mean)^2 +0.1^2)*mean

Which is the same as:

SQRT((stderr/mean)^2 +0.1^2)*mean

This correction makes that the uncertainties are slightly smaller but the effect is hardly noticeable. As you may recall, the MC values change (slightly) with each new simulation. For ease of comparing the values from the spreadsheet with the values in the report, in the version shared the values were fixed. Implementing the correction in above mentioned results in a new MC run and therefore the numbers change slightly again. The new fixed version can be assessed here:

https://www.dropbox.com/s/zh879gb351n7n69/Ghana%20MC%20070322_FIXED_VALUES.xlsx?dl=0

We updated the values in the Monitoring Report to match the updated MC simulation results with the correction made.

Now back to the question on the equation. This apparently awkward formulation is needed because we are here parting from two currently existing parameters: the standard deviation and the 10% (i.e., 0.1 in the formula) adjustment (see below explanation). Both squared terms (stderr/mean and 0.1) are to indicate coefficients of variation (as measure of uncertainty) based on the standard error of the mean, which means:

SQRT(CV^2 +0.1^2)*mean

The 10% adjustment

The sqrt term aims to follow the FCPF guidelines (page 6 https://www.forestcarbonpartnership.org/sites/fcp/files/FCPF%20Guidelines%20on%20Uncertainty%20Analysis_2020_0.pdf, on the error of the "biomass allometric model": "If Countries are not able to propagate this source of error through MC simulation (i.e. no covariance matrix available, lack of capacity) they may increase the sampling uncertainty of AGB or/and BGB by 10% at 90% confidence level using the quadrature approach6 and the combined error shall be propagated in the MC simulation."

Further, the footnote explains this: "For instance, if the sampling uncertainty is 10% and the allometric model uncertainty is 10%, the resulting uncertainty is sqrt(10%^2+10%^2) = 14%." Ghana does not have the necessary information available to model the allometric equation error, so it was necessary to first estimate the sampling error using standard approaches – and then to increase it by 10%. If there was an update to this FCPF guidance or this step was in fact not necessary, then we could happily remove the 10% increase.

Concerning the question in F19, the standard deviation is taken from the file ADxEF-28May2021_Submitted, sheet AGC. Indeed the header of column C in tab "Sources_Uncertainty" should read "Standard Error", not "Standard Deviation". We apologize for the oversight and change the header in the new MC version shared. In the above responses we explain why we "back-calculate" the standard error using standard deviation as an input and why we increase the sampling uncertainty with 10%. We fail to understand the following comment from the auditors "However, given the current formula, the audit team found a 1.98% increase in uncertainty given a 50% error in biomass component (example: SQRT(.5^2+0.1^2) = 0.5099)" Is this query resolved with the above answers? We do not understand the 50% error in biomass component. Can the auditors provide further explanation?

Auditor Response: Sorry for the confusion on the 50%, that was a typo error, it was meant to be 90% (referring to the 90% CI). Thank you so much for your revision and thorough explanation about the calculations. The audit team was able to confirm the changes and the estimates provided in the new calculation workbook "Ghana MC 070322_FIXED_VALUES.xlsx". This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA):

Finding Type: mCAR, No.11 - Dated 20 Feb 2022

Standard Reference: FCPF Methodological Framework, Guidelines on the application of the Methodological Framework Number 4 On Uncertainty Analysis of Emission Reductions,

Guidance Note on estimating the uncertainty of emission reductions using Monte Carlo simulation

Document Reference: Ghana ER MR_Final_Version_Track_Changes.docx, Ghana MC_MR_18_05_2021.xlsx

Finding: Criterion 6 of the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction."

Moreover, Criterion 7 indicates that "Sources of uncertainty are systematically identified and assessed in Reference Level setting and Measurement, Monitoring and reporting."

In Column C of sheet "Sources_Uncertainty" in workbook "Ghana MC_MR_18_05_2021.xlsx" reports the 'sampling error' for biomass measurements which are used as inputs to the Monte Carlo analysis. The assessment team has identified what appears to be an error in the quantification, included in cells C19:C30 (DW and L) where the standard error (Std.Dev. / SQRT(n-1)) is being reported rather than the uncertainty (sampling error). The assessment team requests to revise and provide additional information and demonstration for the calculation of the uncertainty for the above.

Project Personnel Response: The auditors are correct here: the header under Sources of uncertainty should be standard error of the mean. Therefore, the denominator should be SQRT (n), rather than SQRT(n-1) (see response in cell G19). This is the sampling error from a purely SRS design, the default here since we lack the specific raw data. It is also supposed to be a more conservative estimate of the standard error of the mean.

Auditor Response: Thank you for your response. The audit team was able to confirm the changes provided to the DW and L values in the new calculation workbook "Ghana MC 070322_FIXED_VALUES.xlsx". However, we couldn't confirm the value reported in Cell C19. It is unclear why for "DW (tC /ha) Open All forest" you divide by the SQRT of 23. Moreover, the audit team couldn't confirm the values updated in the table of Section 5.3 with the new results of the sensitivity analysis. Please revise and update accordingly.

Project Personnel Response 2: On the "DW (tC/ha) Open All forest" this concerns a copy-past error, n=26 not 23. We have changed this value in the MC spreadsheet and simulated several times with both 26 and 23. The difference in the final product is nil (the variation between successive runs of the algorithm is higher than whatever you get between using 26 and 23, because of the tiny contribution of DW in open forest). However, the correction of the monitoring period considered for removals also required changes to the MC file (see response cell K16). These changes have been implemented and the values of a new simulation result of the MC are included. We have now also updated section 5.3 with the new results of the sensitivity analysis.

Auditor Response 2: Thank you for your review and response. The audit team was able to confirm the changes provided. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA):

Finding Type: mCAR, No.12 - Dated 20 Feb 2022

Standard Reference: FCPF Methodological Framework, Guidelines on the application of the Methodological Framework Number 4 On Uncertainty Analysis of Emission Reductions,

Guidance Note on estimating the uncertainty of emission reductions using Monte Carlo simulation

Document Reference: Ghana ER MR_Final_Version_Track_Changes.docx, Ghana MC_MR_18_05_2021.xlsx

Finding: Criterion 6 of the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction."

Moreover, Criterion 7 indicates that "Sources of uncertainty are systematically identified and assessed in Reference Level setting and Measurement, Monitoring and reporting."

In the recalculation of the uncertainties, the assessment team has been unable to verify the source of the Degradation uncertainty for 2005-2015 in the workbook "Ghana MC _MR_18_05_2021.xlsx", sheet "Sources_Uncertainty", section "AD (ha /yr) Open All forest" value of 375 cell B93, and the "AD (ha /yr) Closed Moist Semideciduous NW" value of 1,354 in cell B97. The assessment team requests additional information and demonstration for how these values were calculated from the data source.

Project Personnel Response: We thank the auditors for the observation. The values were taken from an older version of the AD file and those values in the cells mentioned changed slightly. They have been updated in the new MC spreadsheet and come from "ADxEF-28May2021.xlsx", tab "degradation by Veg", SUM(cell I4:M4) and cell K14.

Auditor Response: Thanks for the revised and updated files. The assessment team was able to confirm the updated values (437 for AD- Open-All forest, and 1293 for AD-Closed-Moist Semideciduous NW) in the calculation workbook Ghana MC 070322_FIXED_VALUES, but couldn't confirm the changes in the recent MR provided Ghana ER MR_Final_Version_Track_Changes-GHANA_current.docx, Section 5.2, page 78, where the old values are shown. Please revise and update accordingly.

Project Personnel Response 2: We thank the auditors for this observation and have made the correction to the Monitoring Report accordingly

Auditor Response 2: Thank you for the changes provided. However, there is a problem with the calculation workbook and the audit team was not able to verify the changes in the new submitted file. It appears the links in the active cells were broken. Please upload a different version of the file so we can verify the changes.

Project Personnel Response 3: We apologize for the inconvenience and revised the file shared but did not find any broken links. The MC is now completely revised based on the projection of SOC emissions over 20 years instead of using committed emissions. Therefore a new version of the MC is shared. In case the issue with broken links persists in this new file, could you kindly indicate the cells in which this occurs, such that we can fix the issue if needed?

Auditor Response 3: Thank you for your revision and changes provided to this finding. The audit team was able to confirm the changes provided in the most recent version of the calculation workbook provided "Ghana MC 040522_FIXED_VALUES.xlsx", including the corresponding changes to the SOC values. However, the audit team was not able to confirm the changes reported in Section 5.2, table "Parameters and assumptions used in the Monte Carlo method" and Section 12.2 "Quantification of the uncertainty of the estimate of the Reference level". The values corresponding to the SOC categories don't correspond to the latest ones used in the MC workbook. Moreover, in section 12.2, the sections corresponding to "AD (ha /yr) Open All forest" and "AD (ha /yr) Closed Moist Semideciduous NW" need to be updated. Please revise and update accordingly.

This finding is closed, continues in Finding # 15.

Bearing on Material Misstatement or Conformance (M/C/NA):

Finding Type: mCAR, No.13 - Dated 26 Apr 2022

Standard Reference: FCPF Methodological Framework, IPCC 2019 Guidelines, V4 Ch2, FCPF Guidance Note on Accounting of legacy Emissions/Removals

Document Reference: ADxEF-28May2021_GHANA_CURRENT_2019onlyEnhancement.xlsx

Finding: Criterion 5 the FCPF Methodological Framework states that "The ER Program uses the most recent Intergovernmental Panel on Climate Change (IPCC) guidance and guidelines, as adopted or encouraged by the Conference of the Parties as a basis for estimating forest-related greenhouse gas emissions by sources and removals by sinks". The IPCC Guidelines, volume 4, chapter 2, section 2.3.3.1 Soil organic c estimation methods for Tier 1 state that "For mineral soils, the stock change factor method is based on changes in soil C stocks ($\Delta CMineral$) over a finite period of time of 20 years (Equation 2.25)".

Moreover, Section 4.1(b) of the FCPF Guidance Note on Accounting of legacy Emissions/Removals, Changes in the Soil Organic Carbon pool in mineral soils associated with deforestation states that "The assumed equilibrium following deforestation shall be conservatively determined and justified based on the expected deforestation land use. In this context, conservative means that the assumed equilibrium shall not overestimate the emissions associated with deforestation. It shall be assumed that the Soil organic C stock change during the transition to a new equilibrium SOC occurs in a linear fashion over a period of 20 years."

In the workbook ADxEF-28May2021_GHANA_CURRENT_2019onlyEnhancement.xlsx, sheet "EF for def", columns O through T, it appears that emission factors for belowground biomass, litter, deadwood, and SOC are combined. In tracking the SOC emission factor back to the SOC worksheet, the assessment team has been unable to find where the emission factor has been divided by 20 years to account for the linear transition of SOC over a period of 20 years as is required by the guidance note and IPCC guidelines. Please indicate how/if this requirement has been accounted for during this monitoring period and the reference level.

Project Personnel Response: We thank the auditors for this observation. Ghana's treatment of SOC emissions has not changed since the ERPD, meaning it assumed instant emissions or committed emissions, accounting the future emissions (reductions) in the year the action to reduce emissions occurred and not at a later point in time. The FCPF Guidance Note on accounting of legacy emissions/removals was published March 2021 when Ghana's Monitoring Report was already in an advanced stage, and we were unaware that this Guidance would change the assumptions included in the ERPD.

We have now recalculated SOC emissions, as SOC emissions from deforestation are now accounted as 1/20th during the monitoring period this reduces emissions and emission reductions. As a result, the FCPF ERs are reduced by 11%. We have included a new tab called "SOC recalc Guidance Note" which replicated the calculation of SOC ERs as included in the FCPF Guidance Note. This calculation was however quite cumbersome and complicated for the error propagation. As such, a simplified calculation was added in tab "SOC recalc simple". You will find a yellow highlighted cell in both tabs showing both calculations give the same results. Following the FCPF Guidance Note on accounting of legacy emissions/removals also signifies the reference level value will change for each subsequent monitoring year. You will find these different annual values in the Table in section 8.4.

Auditor Response: Thank you for your review and updates into the calculations of the SOC. The audit team was able to verify the changes provided in the calculations of the SOC Legacy emissions in the new workbook submitted, "ADxEF-May-10-2022.xlsx", sheet SOC recalc simple and sheet SOC recalc Guidance note and the updates into the MR. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA):

Finding Type: MCAR No.14 - Dated 18 May 2022

Standard Reference: FCPF Methodological Framework

Document Reference: ADxEF-May-10-2022.xlsx, Ghana ER MR_Final_Version_Track_Changes-GHANA__current-10-05-2022_updated.docx

Finding: Criterion 6 from the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction. ".

In the verification of the changes to the SOC legacy removals and recalculation of the quantification of deforestation emissions and removals, the audit team found that in the most recent version submitted of the MR, section 3.1, the values reported in the Parameter "Post-deforestation carbon content (interim in EF calculation)" for tCO2e/ha) are not consistent with the estimates derived in the most recent calculation workbook submitted "ADxEF-May-10-2022.xlsx", sheet "postdef-ratio". The assessment team also found that the values for the cells D12:L12 and D13:L13 correspond to a different category selected. Moreover, in the same section 3.1 of the MR, the assessment team found that the values reported in the table "EF for forest degradation" do not correspond to the ones used in the quantification of the emissions and removals reported in the calculation workbook ADxEF-May-10-2022.xlsx. Please revise and update these estimates and subsequent quantifications that are derived from these values.

Project Personnel Response: We thank the auditors for these observations.

Concerning the values reported in the Parameter "Post-deforestation carbon content (interim in EF calculation)" not being consistent with the estimates in the sheet "postdef-ratio": The values of tCO2e/ha are not found in the sheet "postdef-ratio" (this sheet only gives % on the occurance of these land uses, not their carbon contents), instead they are found in the sheet "postDef C-contents" cell B2:F4. You will find the CI in the spreadsheet is multiplied by a factor 2 (instead the parameter Table reports the actual CIs), which is explained on page 235: Equation 6 (Snedecor and Cochran 1989) provides the half-width 90% confidence interval (CI) for the post-deforestation ratios included in equation 5. It concerns a simplification since the correct calculation of the confidence interval should consider the stratification. However, this resulted in a highly complicated calculation for a detail (proportion of post-deforestation land use) that has a relatively small importance and impact on the calculation of the reference level. As such, Ghana has opted to maintain the simplified equation 6 but double the resulting confidence interval to be conservative. The sensitivity of the aggregate uncertainty of the reference level to the confidence interval of this proportion calculation is tested, doubling the CI around the proportion increased the aggregate uncertainty around the reference level value with 0.50%. Ghana therefore concludes the impact is small enough to allow for this simplification and the CI around the proportion is multiplied by two to be conservative. To avoid confusion, we add the following sentence under the description of this parameter: However, the calculation of the confidence interval is simplified as it does not consider the proper weights of the different strata. To avoid under-estimating the uncertainty through this simplification, the confidence interval is doubled and its impact is assessed and evaluated as insignificant (see page 235 for further details). Finally, these values are now changed due to the next observation by the auditing team (the change is reflected in the MR).

Concerning the observation "The values for the cells D12:L12 and D13:L13 correspond to a different category selected", this is a (minor) error indeed. Though it impacts the ER calculations with 0.6% only (because the emissions from deforestation are slightly smaller with a slightly larger percentage of deforestation going to perennial crops, 50% instead of 48%) it requires updating almost all values in the MR and updating the MC file. We have updated the three files (ADxEF, MR, MC).

Concerning the observation "the values in the table EF for forest degradation do not correspond to the ones in the workbook", we thank you for this observation and corrections were made in the MR.

Auditor Response: Thank you for the revisions and corrections provided. The audit team was able to confirm the changes. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA):

Finding Type: mCAR, No.15 - Dated 10 May 2022

Standard Reference: FCPF Methodological Framework, Guidelines on the application of the Methodological Framework Number 4 On Uncertainty Analysis of Emission Reductions,

Guidance Note on estimating the uncertainty of emission reductions using Monte Carlo simulation

Document Reference: Ghana ER MR_Final_Version_Track_Changes.docx, Ghana MC_MR_18_05_2021.xlsx

Continuation of Finding #12: Criterion 6 of the FCPF Methodological Framework states that "Key data and methods that are sufficiently detailed to enable the reconstruction of the Reference Level, and the reported emissions and removals (e.g., data, methods and assumptions), are documented and made publicly available online. In cases where the country's or ER Program's policies exempt sources of information from being publicly disclosed or shared, the information shall be made available to the third party validation and verification body and a rationale is provided for not making these data publicly available. In these cases, reasonable efforts shall be made to make summary data publicly available to enable reconstruction."

Moreover, Criterion 7 indicates that "Sources of uncertainty are systematically identified and assessed in Reference Level setting and Measurement, Monitoring and reporting."

In the recalculation of the uncertainties, the assessment team has been unable to verify the source of the Degradation uncertainty for 2005-2015 in the workbook "Ghana MC _MR_18_05_2021.xlsx", sheet "Sources_Uncertainty", section "AD (ha /yr) Open All forest" value of 375 cell B93, and the "AD (ha /yr) Closed Moist Semideciduous NW" value of 1,354 in cell B97. The assessment team requests additional information and demonstration for how these values were calculated from the data source.

Project Personnel Response: Continuation of Finding #12

These values have now been updated and corrected in the MR. We like to raise attention though that due to the observation in cell F23, the post-def LU (tC/ha) and SOC (tC/ha) have slightly changed due to a minor shift in post-def LU to perennial crops from annual crops. These values have also been updated

Auditor Response: Thank you for the revisions and corrections provided. The audit team was able to confirm the changes provided, and the new estimates. This finding is closed.

Bearing on Material Misstatement or Conformance (M/C/NA): C

Document information

Version	Date	Description
1.2	September 2021	Section 4.3 has been included to request information on the start date of the crediting period.
1.1	November 2020	Reference to the newly approved Guidelines on Uncertainty Analysis of Emission Reductions.
1.0	August 2020	Initial version adopted.