DNV·GL

3 March 15

VERIFICATION REPORT: "1ST ASSESSMENT - TOOL FOR MEASURING ABOVEGROUND LIVE FOREST BIOMASS USING REMOTE SENSING"

REPORT № 2013-9201

REVISION NO. 02

Methodology Element Title	Tool for measuring aboveground live forest biomass using remote sensing	
Version	Version DRAFT 3.4.4 Dated 27 February 2015	
Methodology Element Category	Methodology	
	Methodology Revision	
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	Tool	**X**
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Prepared By	Det Norske Veritas (U.S.A.) Inc. Climate Change & Environmental Services
Contact	155 Grand Avenue, Suite 500 Oakland, CA 94612 Tel: +1 415 318 3918
Approved By	Dave Knight
Reviewed By	Edwin Aalders
Work Carried Out By	Andres Espejo (Lead Assessor); Alfredo Fernández (RS Expert)

Summary:

The purpose of a first methodology element assessment is to have an independent third party assess the Methodology Element Documentation's (MED) conformance with the requirements and principles set out in the *VCS Standard* as well as whether the methodology conforms with scientific and other best practice.

The MED was reviewed against AFOLU requirements: VCS Version 3.4 /2/ and VCS Version 3.4 /1/.

It is DNV GL's opinion that the MED "Tool for measuring aboveground live forest biomass using remote sensing", Version DRAFT 3.4.4 as described therein, is in compliance with the methodological requirements set in AFOLU requirements: VCS Version 3.4 and VCS Version 3.4. Hence, DNV GL recommends the approval of "Tool for measuring aboveground live forest biomass using remote sensing".

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1 INTRODUCTION

1.1 Objective

The purpose of a second methodology element assessment is to have an independent third party assess the Methodology Element Documentation's (MED) conformance with the requirements and principles set out in the *VCS Standard* as well as whether the methodology conforms with scientific and other best practices.

1.2 Summary Description of the Methodology Element

The proposed MED provides a specific method for determining average Aboveground Live Forest Biomass (ALFB) density at the stratum or an Area of Interest (AOI) through a combination of remote sensing data and field measurements. The MED allows to use different Remote Sensing (RS) information (e.g. LiDAR, RADAR, hyperspectral/hyperspatial imagery) in combination with a relatively small number field plots and can be used to achieve a statistically valid estimator of the average ALFB. It is important to note that the MED is intended for use in estimating average ALFB density at a specific point in time, and that it does not present methods for detection of change in ALFB over time or wall-to-wall carbon density mapping.
The intention is that this tool may be used in combination with approved VCS methodologies which prescribe traditional simple random sampling or stratified random sampling methods to estimate average ALFBs.

2 ASSESSMENT APPROACH

2.1 Method and Criteria

2.1.1 *Method*

The assessment was based on the recommendations of the VCS Validation and Verification Manual /6/ as required by VCS standard Version 3 /1/.
The validation consisted of the following five phases:

I a desk review of the MED
II follow-up interviews with project stakeholders
III the resolution of outstanding issues
IV Internal quality control
V Issuance of the final assessment report

2.1.2 *Criteria*

The MED is reviewed against the criteria stated in the VCS standard Version 3 Requirements Document:

Ref.	Document
/1/	VCSA: VCS standard: VCS Version 3.4, 8 October 2013
/2/	VCSA: AFOLU requirements: VCS Version 3.4, 8 October 2013
/3/	VCSA: Program Definitions: VCS Version 3.5, 8 October 2013

Ref.	Document
/4/	VCSA: JNR Requirements: VCS Version 3.1, 4 October 2013
/5/	VCSA: AFOLU Non-Permanence Risk tool: VCS Version 3.2, 4 October 2012
/6/	VCSA: Validation and Verification Manual, Version 3.0, 4 October 2012
/7/	VCSA: VCS Module/Tool Template, Version 3.3, 8 October 2013
/8/	IPCC (2006): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme. Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds).Published: IGES, Japan
/9/	IPCC, 2003: Good Practice Guidance for Land Use, Land-Use Change and Forestry, prepared by the National Greenhouse Gas Inventories Programme, Jim Penman, Michael Gytarsky, Taka Hiraishi, Thelma Krug, Dina Kruger, Riitta Pipatti, Leandro Buendia, Kyoko Miwa, Todd Ngara (eds). Published: IGES, Japan. URL: http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html
/10/	GOFC-GOLD, 2012, A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals caused by deforestation, gains and losses of carbon stocks in forests remaining forests, and forestation. GOFC-GOLD Report COP18 version 1, (GOFC-GOLD project office, Natural Resources Canada, Alberta Canada).

2.2 Document Review

The following tables list the documentation that was reviewed during the assessment

Ref.	Document
/11/	Terra Global Capital LLC: Methodology Element Document “Tool for measuring aboveground live forest biomass using remote sensing” -First version 1.3 dated March 2014 -Final version DRAFT 3.4.4 dated 27 February 2015
/12/	Terra Global Capital LLC: Methodology Element Document Approved VCS Methodology VM0006
/13/	CDM Executive Board: ‘Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities’ (version 4.1.0)
/14/	CDM Executive Board: ‘Calculation of the number of sample plots for measurements within A/R CDM project Activities’ (version 2.1)
/15/	Asner, G. P., & Mascaro, J. (2014). Mapping tropical forest carbon: Calibrating plot estimates to a simple LiDAR metric. *Remote Sensing of Environment*, *140*, 614-624.
/16/	Asner, G. P., Mascaro, J., Anderson, C., Knapp, D. E., Martin, R. E., Kennedy-Bowdoin, T., … Bermingham, E. (2013). High-fidelity national carbon mapping for resource management and REDD+. *Carbon balance and management*, *8*(1), 7. doi:10.1186/1750-0680-8-7
/17/	Asner, G.P. et al., 2012. A universal airborne LiDAR approach for tropical forest carbon mapping. Oecologia, 168(4), pp.1147–60. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22033763 [Accessed May 26, 2014].
/18/	Chave, J., Réjou-Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M. S., Delitti, W. B.C., Duque, A., Eid, T., Fearnside, P. M., Goodman, R. C., Henry, M., Martínez-Yrízar, A., Mugasha, W. A., Muller-Landau, H. C., Mencuccini, M., Nelson, B. W., Ngomanda, A., Nogueira, E. M.,

Ref.	Document
	Ortiz-Malavassi, E., Pélissier, R., Ploton, P., Ryan, C. M., Saldarriaga, J. G. and Vieilledent, G. (2014), Improved allometric models to estimate the aboveground biomass of tropical trees. Global Change Biology. doi: 10.1111/gcb.12629
/19/	Chave, J., Helene C. Muller-Landau, Timothy R. Baker, Tomás A. Easdale, Hans ter Steege, and Campbell O. Webb. 2006. Regional and phylogenetic variation of wood density across 2456 neotropical tree species. Ecological Applications 16:2356–2367.
/20/	Chave, J., Andalo, C., Brown, S., Cairns, M. A., Chambers, J. Q., Eamus, D., … Yamakura, T. (2005). Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia*, *145*(1), 87–99. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15971085
/21/	McRoberts, R. E., Gobakken, T., & Næsset, E. (2012). Post-stratified estimation of forest area and growing stock volume using lidar-based stratifications. *Remote Sensing of Environment*, *125*, 157-166.
/22/	Meyer, V., Saatchi, S. S., Chave, J., Dalling, J. W., Bohlman, S., Fricker, G. A., ... & Hubbell, S. (2013). Detecting tropical forest biomass dynamics from repeated airborne Lidar measurements. *Biogeosciences*, *10*(8), 5421-5438.
/23/	Næsset, E., Gobakken, T., Solberg, S., Gregoire, T. G., Nelson, R., Ståhl, G., & Weydahl, D. (2011). Model-assisted regional forest biomass estimation using LiDAR and InSAR as auxiliary data: A case study from a boreal forest area. *Remote Sensing of Environment*, *115*(12), 3599-3614.
/24/	Neigh, C. S., Nelson, R. F., Ranson, K. J., Margolis, H. A., Montesano, P. M., Sun, G., ... & Andersen, H. E. (2013). Taking stock of circumboreal forest carbon with ground measurements, airborne and spaceborne LiDAR. *Remote Sensing of Environment*, *137*, 274-287.
/25/	Picard, N., Saint-André, L., & Henry, M. (2012). Manual for building tree volume and biomass allometric equations: from field measurement to prediction. *Food and Agricultural Organization of the United Nations*.
/26/	Särndal, C.E., (1984). Design-consistent versus model-dependent estimation for small domains, Journal of the American Statistical Association, 79, 624–631.
/27/	Särndal, C.E., B. Swensson, J. Wretman, (1992), Model assisted survey sampling, Springer-Verlag, Inc, New York, 694 pp.
/28/	Weisbin, C. R., Lincoln, W., & Saatchi, S. (2013). A Systems Engineering Approach to Estimating Uncertainty in Above-Ground Biomass (AGB) Derived from Remote-Sensing Data. *Systems Engineering*.
/29/	Zanne, A.E., Lopez-Gonzalez, G.*, Coomes, D.A., Ilic, J., Jansen, S., Lewis, S.L., Miller, R.B., Swenson, N.G., Wiemann, M.C., and Chave, J. 2009. Global wood density database. Dryad. Identifier: http://hdl.handle.net/10255/dryad.235.

2.3 Interviews

DNV GL held various interviews with the methodology proponents.

Date	Name	Organization	Topic
26 March 2014	Jeff Silverman	Terra Global	- Kick-off meeting

Date	Name	Organization	Topic
	Peter Tittman	Capital	
18 June 2014	Peter Tittman	Terra Global Capital	- Discussion on findings
20 June 2014	Peter Tittman	Terra Global Capital	- Discussion on findings
24 July 2014	Peter Tittman Sassan Saatchi	Terra Global Capital NASA	- Discussion on findings

2.4 Assessment Team

The validation team is in accordance with the requirements of the VCS Version 3.4.

Role	*Last Name*	*First Name*	*Country*	*Type of involvement*							
				Project management	Desk review	Interviews	Reporting	Supervision of work	Technical review	TA 14.1 competence	VCS AFOLU expert
Project Manager	Silon	Kyle	USA	✓							
Team leader (Assessor)	Espejo	Andres	Spain		✓	✓	✓	✓		✓	
Remote Sensing Expert	Fernández	Alfredo	Spain		✓		✓			✓	
Technical reviewer	Aalders	Edwin	Norway						✓	✓	✓

2.5 Resolution of Findings

The objective of this phase of the MED assessment is to resolve any outstanding issues which need be clarified prior to DNV GL's positive conclusion on the project design. All the findings are listed in Appendix A of this report and the findings are expressed as follows:

A corrective action request (CAR) is raised if one of the following occurs:

(a) An element of the MED is not in compliance with a specific requirement of the VCS Standard;

(b) An element of the MED contains typos, mistakes, errors or lack of internal consistency;

(c) An element of the MED is not in compliance with VCS main principles as set in Section 2.4 of VCS Version 3.4;
(d) An element of the MED is not in line with scientific and other best practice;
(e) An element of the MED needs more clarity;

A clarification request (CL) is raised if the Assessor requires some clarification from the MED proponent on an element of the MED;

An Observation (OBS) is raised when areas of improvement are identified. The MED proponent is not required to address these observations and may consider them voluntarily for the improvement of the MED.

A total of 10 CARs, 9 CLs and 1 OBS were raised during the assessment prior to the reconciliation process. As part of the reconciliation, 2 additional CARs, 1 additional CL and 1 additional OBS was open. These were solved satisfactorily by the MED proponent by revising the MED and providing clarifications. A summary of these may be found in Appendix A of this assessment report.

The assessment report underwent a technical review before DNV GL approved the MED. The technical review was performed by a qualified technical reviewer in accordance with DNV GL's qualification scheme.

3 ASSESSMENT FINDINGS

3.1 Relationship to Approved or Pending Methodologies

The MED is a tool that has to be used within the framework of applicable VCS approved methodologies or tools. DNV GL checked the VCS website and confirmed that there are no tools or modules that enable to estimate AFLB averages with the same methods as the proposed in the MED.

3.2 Stakeholder Comments

In the period from 24 April 2014 until 24 May 2014, the MED was published in the VCS website for the 30-day stakeholder consultation period and received comments from six stakeholders (http://www.v-c-s.org/methodologies/tool-remote-sensing-biomass-measurement).
DNV GL received these comments after the issuance of the first list of findings from the customer, so some of these issues were not taken into account in the first version of the list of findings yet they were already addressed by the project proponent in the first revision of the MED.
DNV GL is able to confirm that all issues raised have been addressed by the project proponent or are no longer applicable.

Comment by: Merga Diyessa; FARM Africa; Ethiopia; merga2840@yahoo.com

Comment:

I'm Ethiopian and GIS specialist by profession working for FARM Africa mainly on Bale REDD+ project. Really I found the tool very interesting. For us as we are the first REDD+ project in the country we really lack skill like this which we really need to get it. Finally my question is can you please arrange a sort of capacity building training for experts like me who lacks this skill and could not really get it anywhere. Merga FARM Africa GIS Specialist. Finally my comment on the tool, It would be much better to be prepared with technical steps to be used for RS software that would help the experts on this field to produce their own estimated Biomass map.

***Response MED proponent**:*

The intent of the tool is to provide a fundamental framework for the measurement of biomass. Software-specific tutorials are beyond the scope of the intent.

DNV GL:

DNV GL confirmed that none of the listed comments require any action by the MED proponent.

Comment by: Merga Diyessa; FARM Africa; Ethiopia; merga2840@yahoo.com

Comment:

Finally my comment on the tool, It would be much better to be prepared with technical steps to be used for RS software that would help the experts on this field to produce their own estimated Biomass map

***Response MED proponent**:*

No response.

DNV GL:

DNV GL raised a number of CARs and CLs (e.g. CAR4) requiring to improve the structure of the tool in order to allow its implementation to a specific project. DNV GL is able to confirm that this was addressed by the MED proponent.

It is worth noting that the reference made by the stakeholder regarding the RS Software has not been taken into account as different softwares are available in the market and could be used for this purpose.

Moreover, DNV GL would like to note that the primary intention of the MED is not to produce a biomass map as indicated by the stakeholder, but to estimate average biomass within an AOI. This was raised by DNV GL through CAR3 and it clarified in the last version of the MED.

Comment by: Inga P. La Puma; Forest Landscape Ecology Lab - University of Wisconsin-Madison; USA; lapuma@wisc.edu

Comment:

Check the old growth definition: Should it be >10cm for old growth in the diameter at breast height instead of <10cm? How you will take into account areas of recent disturbance, such as wildfire or wind-throw in your protocol. Will these areas necessarily be stratified out of the one time AGLB estimation via LULC for a given analysis region? In areas prone to forest disturbance the LULC stratification step should be mandatory given the inherent variability in most forested regions.

Response MED proponent:

a) Notation has been changed per the suggestion.

b) Any measurement can be expected to be reflective of the conditions at the time of data collection. Disturbance must be accounted for in MRV exercises.

c) The tool is intended for a single point in time measurement. The tool can be can be used at a point in the future as a part of MRV to detect disturbance.

DNV GL:

a) DNV GL raised CL2 requesting a clarification on the definition of the minimum diameter. The MED was revised accordingly by leaving open the tree definition. The project proponent is free to define Above ground Live Tree Biomass.

b) c) DNV GL raised CAR4 requesting the MED proponent to clarify in the MED the objective of the tool: to produce average estimates for one point of time. The MED was revised accordingly and the applicability conditions now clearly state that the objective of the tool is to obtain an average estimate of AFLB in one point of time. Therefore, any future disturbance is not required to be taken into consideration as this would be accounted for in any new inventory.

Comment by: Rutishauser Ervan; CarboForExpert; Switzerland; er.rutishauser@gmail.com

Comment:

This is a very standard approach that is currently used in both REDD+ and AFOLU projects. Calibrating RS data with field based inventories has been done since the 90's, with now good results with LiDAR/radar data. To enhance remotely-sensed prediction of AGB, I suggest to follow Vincent et al. 2014 (Oecologia) rather than Asner et al. 2013. Moreover, you should include a paragraph on error propagation, as proposed in Pearson et al. 2005, to assess uncertainties on field-based AGB estimates.

Response MED proponent:

Have added a reference to Vincent et. al.

DNV GL:

a) DNV GL confirmed that the reference to Vincent et al. (2014) was added in the MED. DNV GL did not raise any finding as the reference to this or to any other author does not contravene the VCS requirements.

b) DNV GL raised CAR9 as the MED did not provide any means to estimate the 90 or 95 confidence interval as required by Section 4.1.4 of the VCS Standard, and any discounting mechanisms if applicable. The MED proponent addressed this issue by revising the MED and providing procedures to propagate errors from the RS-biomass prediction and from the statistical sampling with RS. Hence, the MED is now in compliance with Section 4.1.4 of the VCS Standard.

Comment by: Peter Schlesinger; University of Idaho/Moscow; pschles@gmail.com; USA

Comment:

Dear Secretariat,

This tool is not yet ready for release. There are a goodly number of issues that need to be checked out further:

1) First off, the text needs a good edit: there are a number of English language typos, grammatical issues, sentences that are really run-on phrases.

2) It says strata are optional in 5.1 and 5.2.1 but then requires strata for the equations in 5.2.2.2 and subsequent equations. There are no equations that specify what to use if stratification was not used.

3) The equation in 5.2.2.3 is faulty. The text says this is going to be "Mean ALFB and variance of ALFB per hectare in the stratum", the first equation is NOT Mean AFLB per hectare, but mean / plot, because n sub i is the number of plots in stratum i, not the number of hectares. AND in the same section "Mean ALFB per hectare within the project area" is also incorrect too because it is calculating number of tons per plot (n sub i) NOT tons/hectare.

4) in the same section 5.2.2.3, ATB UNIT,p,i is undefined. One might be able to guess that it is Aboveground Tree Biomass, but UNIT is undefined, and UNITs are tons in one case and hectares in another, so it is unclear what this is.

5) In the same section 5.2.2.3, there is a ATFL defined, but there is no ATFL used in the equations in this part.

6) The nomenclature in the units is not consistent. in two places in the definitions for section 5.2.2.3 it uses tons/ha and in two other places it uses "tons ha-1" which means the same thing as tons/ha, but this could be made to be consistent. Likewise in 5.2.3, it uses "t ha-1".

7) to follow on in the same section the nomenclature for the standard deviation and the error is either not correct or not consistent because, the definitions prior indicate that ALFB is the mean tree biomass per hectare within the stratum, where as here both s and e refer to the mean tree biomass per hectare within the project boundary.

8) in the definitions for the same section describing "t val" it says in subsection "(i) Degrees of freedom equal to n − M", but M is never defined.

9) In the same section 5,2,2,3 it says in the last paragraph "prescribed in the methodology" but it does not specify whether this means the methodology of the tool or the methodology applying the tool (e.g.VM006 or VM0015).

10) Across the tool it uses the phrase "RS metric(s)" but never states what this means. this should be dictated for a list of examples should be stated, so the used can know what is being suggested.

11) Page 8, 11, 12 uses the acronym PSP and PSPs but this is never defined in the entire methodology.

12) There are no clear steps showing calibration, validation, nor sensitivity analysis.

13) In section 5.2.3.1 There is "E sub int" but "int" is never defined. I presume it means the Error of the intermediate RS data set, but it does not specify this nor specify what this means nor how to calculate that to be in compliance with the terms of the tool's requirements.

14) There are no or no useful QA/QCs recommended to follow in this tool, though the term QAQC is in Part 6 listing of Data and Parameters. It only says to use "Utilize industry standard techniques for measurement". This is insufficient because there are many ways to calculate many of the parameters. For example, one can use an clinometer, laser rangefinder, hysometer, or use LIDAR, all of which would be industry standards but would give four different estimates of tree height. The purpose of the QAQC is to give clear advice on how and what to do to avoid discrepancies in estimation.

15) The reference for Asner 2013, page 5, dictates that there are applicability conditions for the methodology that they describe, sating that their "LiDAR approaches can stand in for field plots, both in humid tropical forests and among drier tropical vegetation types". but these conditions are not listed in section 4 of the Tool's methodology. Perhaps the methodology should be amended to ask that the developer prove that his application is within the area applicable by the Asner document if using LiDAR as the intermediate RS method.

I hope this helps.

Best regards,

Response MED proponent:

1) -

2) no equations in the current version require stratification

3) section has been removed

4) section has been removed

5) section has been removed

6) notation has been made consistent

7) section has been removed

8) section has been removed

9) section has been removed

10) A description and examples of RS metrics has been added to the definition of Remote Sensing.

11) fixed

12) the tool gives sufficient instruction for conducting calibration validation and error estimation.

13) section has been modified. no E_int in current draft.

14) -

15) there are no applicability conditions necessarily implicated in citing the Asner paper

DNV GL:

1) DNV GL raised CAR1 requesting the MED proponent to ensure compliance of the MED with the VCS tool/module template. DNV GL reviewed the MED and confirmed that the issue was addressed and that the MED does not have any typos or errors.

2) DNV GL raised CAR6 as it was not clear the actual procedure for using RS data in order to estimate the average ALFB. This issue was addressed by the project proponent by the clarifying specifically the procedure to be applied, i.e. estimation of a RS-biomass predictor, and its application to RS sampling units which are used to estimate the aboveground biomass through a stratified or simple random sampling scheme.

3) 4) DNV GL raised CAR6 as it was not clear the actual procedure for using RS data in order to estimate the average ALFB. The equation provided to estimate the average ALFB out from the calibration plots was not clear. This was addressed by the project proponent by deleting those equations and clarifying specifically the use of the calibration plots.

5) DNV GL raised CAR2 as the definition of ATFL was not provided and ALFB was referred in some cases to tree biomass and to others to live biomass. The issue was addressed by the MED proponent by revising the MED and using consistently ALFB throughout.

6) 7) 8) 9) DNV GL raised CAR6 as it was not clear the actual procedure for using RS data in order to estimate the average ALFB, so it was not clear whether the equations were applicable. DNV GL is able to confirm that the mistakes pointed out in these comments were addressed and that the equations provided are correct.

10) DNV GL confirmed that the phrase "RS metric" is now defined and clear. This issue did not require to raise any finding.

11) DNV GL raised CAR2 requesting the MED proponent to clarify the meaning of PSPs. Now this abbreviation has been deleted as it is no longer applicable as it refers to Permanent Sampling Plots.

12) DNV GL raised CL9 as the steps for calibration and validation were not clear in the MED. DNV GL confirmed that the MED is now clear with this regard as it provides clear procedures to validate the RS-Biomass relationship.

13) DNV GL confirmed that the phrase "E sub int" has been removed. This issue did not require to raise any finding.

14) DNV GL raised CAR10 requesting the MED proponent to refer to the specific procedures provided in the overarching methodology regarding the collection of data in the biomass in-situ plots. DNV GL confirmed that this finding was addressed and that now the MED states clearly that the procedures provided in the applicable methodology must be followed.

15) DNV GL confirms that the Anser et al. (2013) provides an example of methods that could be applied elsewhere and that it does not provide any applicability conditions. This reference is referred to in the paper as a possible example, not as a specific methodology to be followed. Hence, DNV GL agrees that the MED does not need any revision with this regard.

Comment by: Donald E. Strebel; Versar, Inc.; USA; dstrebel@versar.com

Comment:

Comments on VCS Tool for Remote Sensing Biomass Measurement

This conceptual framework still needs a lot of work to be forged into a practical tool. The conditions under which the tool is applicable are vague, and the most critical part of a remote sensing based biomass measurement procedure (the prediction method) is not fully addressed. There are some very muddled,

and occasionally conflicting, discussions of statistical concepts important to implementing the procedure. In addition, there are numerous errors in the text and inconsistencies in the statistical formulas. In some places slang or jargon is used instead of precise English, and some of the units are ambiguous or not properly defined. It appears that this proposed module has not been subjected to a thorough quality assurance review or a field test.

Some specific notes:

1. Definitions (Section 3). Validation Plot definition is circular. "VPs" should be "CPs"?

2. Applicability Conditions (Section 4). What is meant by requiring that remotely sensed data must be available "for the time period required"? Remote sensing instruments and technology change rapidly while biomass offset project monitoring must be repeated periodically and consistently for decades. It is very unlikely that a consistent set of remotely sensed data will be available throughout the lifetime of a biomass project. If the same type and quality of remotely sensed data has to be available at every monitoring event, then this is a useless module for VCS – the condition will never be met. To be useful, the module must address the effects of using different remotely sensed data sets (including a gap in data availability) at different monitoring events.

3. Estimation (Section 5.2, page 6). The expression f(x) = ALFB is mathematically incorrect. The function definition is always on the right, with the result on the left. Thus, ALFB = f(x). Technically, you should write f(x1, x2, …xn) to indicate that there are n metrics that contribute to the function, or state that "x" is a vector of n metrics. It would be appropriate to use the same level of mathematical rigor in describing the remote sensing estimation/prediction methods as is used in describing the statistics.

4. Stratification (Section 5.2.1, p. 7). The concepts of stratification, estimation, and independence are muddled in the second paragraph of this section. There is no inherent loss of independence in using data from the same sensor in both stratification and biomass estimation, as long as independent calibration data are used to develop the predictor algorithm. In fact, the main purpose of stratification is to increase the precision of a parameter estimate within a specific range of the data, which is normally achieved simply by placing more calibration samples within a stratum than might occur randomly. This has no bearing on the independence of the strata or estimates, and two or more strata can be recombined using pooled calibration data if desired. An unbiased estimate of the parameter for the whole population can always be recovered by appropriately weighting the stratum estimates.

5. Sampling Design (Sections 5.2.2.1.1 and 5.2.2.1.2, p. 8). These two sections need to be much more specific and less speculative. For example, there is a conflict between the sections that indicates some fundamental confusion about the purpose and nature of geostatistical sampling design. The first section ascribes large errors from in‐situ measurement plots as due to locations that create "an statistically unsystematic sampling." The second section says that sample plots "must be established at random" across an area. Random placement is by definition "unsystematic", and is known to provide unbiased area estimates with the least error, given no other knowledge about the system. Systematic sampling, on the other hand, is known to be biased by the starting location and the length of the sampling interval, and to be subject to missing entire classes of data if there is underlying periodicity.

Systematic sampling designs must be used with caution, after careful evaluation of the problem to be studied and the available knowledge about the nature of the system. A further complication arises where remote sensing data is concerned because spatial autocorrelation may significantly compromise the value of systematic sampling designs unless the entire area of interest is sampled (exhaustive sampling). All of the sampling design options need to be clearly described and appropriate procedures discussed for these sections to be useful.

6. Plot estimation (Section 5.2.2.2, pages 9 - 10). This section should be re - written by someone familiar with physical and mathematical conventions and text. It is confusing for the same symbol (D) to be used for both tree diameter and wood density. It is conventional to use "rho" (p) for density, which would eliminate this confusion. Further, the symbols defined for various biomass quantities are not used consistently in the formulas. The formulas use ALFB where the defined quantities ATB should appear. It would also be clearer if subscripts did not include both sub - labels (TREE, PLOT, UNIT) and enumeration indices (i, j, p).

7. Error Estimates (Section 5.2.2.3, pages 10 - 11). This section continues the problems with symbol usages and definitions found in the previous section. Some parameters are used that are not defined, and some parameters are defined that are not used. There are also some statistical terminology problems. While s2 i can properly be called a variance, the computation of s2 AFLB includes an additional division by ni. Instead of reflecting the variability of the mean (should it be recalculated with different samples), that makes sAFLB the error of the estimate of the true mean (the Standard Error). Normally

sAFLB would be used to estimate statistical confidence intervals for the probability that the true mean is different from the computed value by a specific amount; however, here it is related to an undefined quantity called the "margin of error". The definition of margin of error should be given and its usage clearly explained.

8. Units (Section 5.2.2.2, pages 9 - 10, Section 5.2.2.3, pages 10 - 11, and Section 6, pages 13 - 17). If "tons" are to be the measurement unit, it is extremely important to specify whether they are to be

English tons or metric tons. The defaults are different in engineering and scientific literature, as well as among countries, and confusion between them has caused a great deal of misunderstanding and inaccuracy. It would be better to stick to standard multiples of grams (kg, Mg) and avoid tons. Note, too, that RMSE (Root Mean Square Error) is not "unitless" as stated on p.16; it must have the same units as the parameter to which it applies or the measurements from which it is calculated.

9. "Upscale" (Section 5.2.2.4) is not a verb. In fact, "upscale" isn't even a proper English word, just loose and imprecise slang sometimes used as an adjective to describe luxury life styles. A better description is required, preferably by explaining (mathematically) how RS area or transect data are calibrated using ground sample plot data, and illustrating how errors will be propagated. At least outline some of the major methods, such as regressions, vegetation indices, or inversion algorithms.

There is, too, a large amount of literature on the methods and accuracy of supervised classification which should be consulted.

10. The essence of a remote sensing - based biomass measurement tool is the prediction of biomass.

Instead of precisely defining a viable certification protocol for handling predictions from at least one remote sensing technology – which would make this module useful for VCS applications – this section discusses prediction in the broadest generalities. The discussion describes a completely empirical approach in which "metrics" are "mined" for predictors of biomass. That generic approach fails (and has failed repeatedly for 40 years) to produce a quantitative and complete predictor that can give consistent results with known errors from place to place and time to time. No such prediction method would be likely to achieve certification at the level required to perform accurate and repeatable carbon inventories, which makes this module/tool, as it stands, a completely theoretical exercise with no practical use.

Remote sensing science has more to offer than this, and that should be reflected in the module in terms of specific instrument types and prediction techniques that can be certified for practical use.

Radar responds directly to physical parameters of trees, including water content, that are functionally linked to biomass. LiDAR can measure height and other structural characteristics that are allometrically

related to biomass. Indices constructed from multispectral visible/near - IR sensors measure canopy reflectance, which is driven by vegetation type, composition, density, and other features that correlate with biomass. These are the kind of measurement relations that the tool should address, specifically with respect to the propagation of the errors from the ground measurements of the calibration data, the effects of spatial resolution of the sensors employed, the repeatability under different atmospheric conditions, and the use of different predictors/instruments at different measuring events.

To be complete, a section that describes how to propose and certify new instruments and the associated predictive techniques is also required.

Response MED proponent:

1. not circular, clarified VP definition'

2. changed terminology

3. fixed notation per the suggestion

4. Text has been modified per the suggestion

5. Text has been modified per the suggestion. expanded the section on RS sampling to emphasize the importance of maintaining randomness in sampling with RS platforms

6. this section has been substantially changed. The nomencalture is analogous to that used in many other UNFCC and VCS methodologies. I agree its a little verbose, however it makes equations somewhat more accessible to an audience not well versed in such nomencalture conventions.

7. section removed. section removed

8. section removed. RMSE and ton notation changed

9. term modified

10. I believe there are many prominent scholars who would disagree with the statement discredinting the empirical approach. suggestions are welcome

DNV GL:

1. DNV GL raised CAR2 requesting the MED proponent to provide a definition of all abbreviations. It was confirmed that the MED now provides a clear definition of calibration plot (CP) and validation plot (VP).

2. DNV GL raised CAR4 and CL8 as the purpose of the MED was not clear. The purpose is to provide average estimates of ALFB at a stratum or AOI level based on current information, so it is only valid for one time, not for a series of time. If it is applied in a series, estimates will be independent. Hence DNV GL, deems that by addressing CAR4 and CL8, this comment has been addressed.

3. DNV GL confirmed that the MED has been revised. Now the notation is in accordance to the comment made by the stakeholder.

4. DNV GL raised CL4 requesting the MED proponent to clarify why the same RS data cannot used for stratification and to produce the RS-biomass relationships. The MED addressed this finding by revising the MED and stating that the same data may be used for both, yet independence is ensured by using separate and distinct calibration/validation data.

5. DNV GL raised CAR4 and CL8 as the MED did not clarify the real purpose of the tool or the specific method for this purpose, i.e. estimate average ALFB at a stratum level or at a level of the AOI. The MED was revised clarifying now the real purpose of the tool, and specific procedures were provided in the tool: use of LiDAR sampling data in order to estimate the average ALFB at a stratum or AOI level.

6. DNV GL confirmed that this comment is no longer applicable as the equation was removed from the latest version of the MED. In any case, the nomenclature used was in accordance to other CDM tools and is consistent with nomenclature commonly used.

7. DNV GL raised CAR8, CAR9, CL1, CL8 and CL9 regarding the uncertainty in the estimate of the average ALFB, and the propagation of errors for all applicable error sources. The MED was revised accordingly and it now provides clear procedures to estimate the uncertainty and propagate the different errors.

8. DNV GL raised CAR2 as the RMSE was not defined in the MED. The MED was revised accordingly and now it provides a clear definition of RMSE.

9. DNV GL checked the revised MED and confirmed that this issue has been addressed by the MED proponent.

10. DNV GL raised CAR4 and CL8 as the MED did not clarify the real purpose of the tool or the specific method for this purpose, i.e. estimate average ALFB at a stratum level or at a level of the AOI. The MED was revised clarifying now the real purpose of the tool, and specific procedures were provided in the tool: use of LiDAR sampling data in order to estimate the average ALFB at a stratum or AOI level. This makes the tool much more applicable.

3.3 Structure and Clarity of Methodology

DNV GL is able to confirm that the MED is written in a clear, logical, concise and precise manner. Moreover, DNV GL confirms that the structure of the methodology allows the reader to follow exactly the procedures to be applied for the estimation of each emission source and sink. Moreover it is able to confirm that:

- The MED proponent has followed the instructions in the tool/module template and ensured that the tools' various criteria and procedures are documented in the appropriate sections of the template;
- The terminology used in the tool is consistent with that used in the VCS Program, and GHG accounting generally;
- Key words must, should and may have been used appropriately and consistently to denote firm requirements, recommendations and permissible or allowable options, respectively;
- Criteria and procedures are written in a manner that can be understood and applied readily and consistently by project proponents;
- Criteria and procedures are written in a manner that allows projects to be unambiguously audited against them.

3.4 Definitions

The audit team confirmed that terms listed in the MED are in alphabetical order, and terms already defined under the VCS have not been repeated. Moreover, the audit team confirmed that the Definitions section includes a list of the key acronyms used in the tool.

3.5 Applicability Conditions

An assessment of how the applicability conditions are appropriate, adequate and in compliance with the VCS rules follows. Below are assessed the conditions where the MED is applicable:

Applicability Condition	Assessor comments
1. The tool is applicable in conjunction with AFOLU methodologies in which estimation of ALFB is required.	This serves to define the cases where the tool is applicable, and where the provided procedures can be applied instead of those defined in the overarching methodology. This condition is written in a sufficiently clear and precise manner, such that it can be determined whether a project activity meets with the condition. Furthermore, conformance with the applicability condition can be demonstrated at the time of project validation and it obviously will not change during the project's crediting period or lifetime as this tool is to estimate the average biomass within an AOI or stratum for one point in time.
2. The remotely sensed data necessary to estimate ALFB is accessible for the time period desired.	The applicability condition serves to define the temporal boundary of the applicability of the tool. This condition is written in a sufficiently clear and precise manner, such that it can be determined whether a project activity meets with the condition. Furthermore, conformance with the applicability condition can be demonstrated at the time of project validation and it obviously will not change during the project's crediting period or lifetime as this tool is to estimate the average biomass within an AOI or stratum for one point in time.
3. Predictive model (PM) relating RS metrics to ALFB is parametric (eg $, \mathrm{ALFB} = \mathrm{f}(\mathrm{x}, \alpha, \varepsilon)$)	This serves to ensure that the formulae provided in the tool are applicable to the project. The reason is that non-parametric methods may be used for the PM; case in which the applicable equations to determine the uncertainty of the estimates would not be applicable. This condition is written in a sufficiently clear and precise manner, such that it can be determined whether a project activity meets with the condition. Furthermore, conformance with the applicability condition can be demonstrated at the time of project validation and it obviously will not change during the project's crediting period or lifetime as this tool is to estimate the average biomass within an AOI or stratum for one point in time.

Below are assessed the conditions where the MED is not applicable:

Non-Applicability Condition	Assessor comments
4. The overarching methodology requires specific method for determining change in biomass density over time. This tool does not provide methods for temporal change in ALFB	This is a non-applicability condition in order to clarify that the MED is not applicable to determine detection of change in ALFB. This is necessary as the MED does not provide procedures in order to estimate change detection or estimate its uncertainty. This condition is written in a sufficiently clear and precise

Non-Applicability Condition	Assessor comments
density. However, the tool can be repeated at distinct points in time to determine an ALFB delta.	manner, such that it can be determined whether a project activity meets with the condition. Furthermore, conformance with the applicability condition can be demonstrated at the time of project validation and it obviously will not change during the project's crediting period or lifetime as this tool is to estimate the average biomass within an AOI or stratum for one point in time.

In view of the above, the applicability conditions include conditions regarding the project activities that are eligible and those that are not, so the scope of application is sufficiently clear. Hence, the audit team is able to confirm that the applicability conditions as a whole are sufficiently clear for determining which project activities are eligible under the methodology, and which are not.

In summary, the applicability conditions are appropriate, adequate and in compliance with the VCS requirements.

3.6 Project Boundary

Not applicable.

3.7 Baseline Scenario

Not applicable.

3.8 Additionality

Not applicable.

3.9 Quantification of GHG Emission Reductions and Removals

Not applicable.

3.9.1 Baseline Emissions

Not applicable.

3.9.2 Project Emissions

Not applicable.

3.9.3 Leakage

Not applicable.

3.9.4 Net GHG Emission Reductions and Removals

Not applicable.

3.10 Monitoring

As explained in the MED, it may be applied to obtain carbon estimates of the AFLB at the time of validation or individually at each monitoring event. Therefore, it may be used by project proponents at the time of validation or at a time of verification, so each parameter may appear in Section 4.1 or Section 4.2 of the PD. Hence, all parameters have been reported in Section 6.1 of the MED.

Moreover, the MED may be applied under different circumstances and different overarching methodologies, which require different parameters. In order to avoid overlapping with the requirements of overarching methodology or being to specific, the MED does not list those parameters.

The only parameters that are reported, are those related to the cross-validation results and the final estimates per stratum. They are described hereunder:

- E - Accepted margin of error (i.e. one-half of the confidence interval) in estimation of carbon density or ALFB at each stratum or AOI. The unit is t ha^{-1};
- t^{∞}_{val}- Two-sided Student's t-value at infinite degrees of freedom for the required confidence level. This is unitless;.
- r -. Range from semivariogram estimating the spatial correlation of errors associated within cluster samples in RSSU. See below (this section) for a discussion of semivariogram analysis. The unit is number of pixels;
- d - Distance between pixels within the stratum and all other pixels within the stratum. The unit is number of pixels;
- c - Parameter of fit for exponential spatial correlation function derived from semivariogram analysis. This is unitless;
- m - A dummy large number representing pixels in RSSU. The number can be arbitrarily large or at least twice the default value of range (*r*). The unit is number of pixels;;
- $\widehat{ALFB}_p$- Average ALFB density for the AOI or stratum from previous study or relevant literature. The units are Tonnes (metric) ha^{-1};
- K - Number of validation rounds used in cross validation of predictive RS model. The unit is an integer;
- γ' - Predicted ALFB density. The unit is Tons (metric) ha^{-1};
- γ − Observed ALFB density in SPs. The unit is Tons (metric) ha^{-1};
- n - Number of VPs used validating the PM. The unit is a count of number of plots;
- t_{val}- Two-sided Student's t-value for a confidence level of 90 or 95 per cent as required by the overarching methodology and degrees of freedom equal to the total number of sample plots within the ALFB estimation strata minus the total number of ALFB estimation strata. It is unitless;
- A_j- Area of stratum *j* or the area of the entire AOI if stratification is not employed. Units are ha;
- A- Total area of AOI consisting of j strata. Units are ha;
- N - The number of strata *j* in AOI;

DNV GL deems that the list of parameters is complete.

4 ASSESSMENT CONCLUSION

Det Norske Veritas (U.S.A.), Inc (DNV GL) has performed a validation of the "1st Assessment - Tool for measuring aboveground live forest biomass using remote sensing". The validation was performed on the basis of VCSA criteria for methodologies as well as criteria given to provide for consistent project operations, monitoring and reporting.

The review of the MED and the subsequent follow-up interviews have provided DNV GL with sufficient evidence to determine the fulfillment of stated criteria.

It is DNV GL's opinion that the MED "Tool for measuring aboveground live forest biomass using remote sensing", Version DRAFT 3.4.4 as described therein, complies with the methodological requirements set in AFOLU requirements: VCS Version 3.4 and VCS Version 3.4. Hence, DNV GL recommends the approval of the proposed MED.

5 REPORT RECONCILIATION

As part of the report reconciliation the team reviewed the revised MED and the second assessor's report. Although the team agreed with most of the changes made to the MED and with the findings of the second assessor, some issues were identified that were not present in the MED version assessed initially. As a result additional findings were open (CAR11, CAR12, CL10, and OBS2) and these were addressed by the MED proponent by revising the MED.

The final version validated by the team is the DRAFT version 3.4.4 dated 27 February 2015.

6 EVIDENCE OF FULFILMENT OF VVB ELIGIBILITY REQUIREMENTS

Det Norske Veritas (U.S.A.), Inc holds accreditation to perform validation for projects under sectorial scopes 3 (agriculture, forestry, other land use) under the American National Standards Institute (ANSI). DNV GL, therefore, is eligible under the VCS Program to perform assessments for the MED, which falls under the sectorial scope 3.

7 SIGNATURE

Signed for and on behalf of:

Name of entity: Det Norske Veritas (U.S.A.), Inc

Signature: 

Name of signatory: David Knight

Date: 3rd March 2015

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APPENDIX A

RESOLUTION OF CORRECTIVE ACTION AND CLARIFICATION REQUESTS, AND OBSERVATIONS

Corrective action requests

CAR ID	Corrective action request	Response by project proponents	DNV GL's assessment of response by project proponents
CAR1	**Element of MED** General **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template **Evidence** MED Version 1.4 **Corrective Action Request** According to the applicable criteria, the MED has to be completed following the VCS template and considering any guidance provided in the same. The assessment team identified the following issues: a) According to the template, the font shall be Arial 10 black, regular (non-italic) font. However, some sections of the MED uses a different font (e.g. cover page, table of contents, etc.). b) The header and footer is not in accordance with the template. c) Sections 6.1 and 6.2 have been deleted. Please note that according to the template "*Where a section is not applicable, same must be stated under the section (the section must not be deleted from the final document)*"	**Response #1** (MED Version Draft 2.0) a) Font size and type has been modified where appropriate. There is no clear indication from VSC as to font or style for section headings below level 2. b) Header and footer have been modified to match the template. c) The version of the template used to draft the tool did not have sections 6.1, 6.2. Sections have been added **Response #2** (MED Version Draft 2.2) a) PWT Fixed **Response #3** (MED Version Draft 2.2.6) a) Tool revised.	**Assessment #1** (MED Version Draft 2.0) a) It was confirmed that the font size of the revised MED is in accordance to the VCS Module/Tool template. However, there are still some issues regarding the headings used (i.e. Step 2b: Estimation of ALFB in Plots is not formatted as a header, from Step 2b it jumps directly to Step 2d) – NOT OK. b) It was confirmed that the header and footer of the revised MED are in accordance to the VCS Module / Tool template – OK. c) It was confirmed that now Sections 6.1 and 6.2 appear in the revised MED – OK. **Assessment #2** (MED Version Draft 2.2) a) There are still some parts of the MED that are not in accordance with the latest template – NOT OK. **Assessment #3** (MED Version Draft 2.2.6) a) The tool is now in compliance with the latest version of the VCS template. **CAR1 is closed**
CAR2	**Element of MED** 3. Definitions **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template **Evidence** MED Version 1.4 **Corrective Action Request** According to Section 3 of the template, using the format provided, "*provide, in alphabetical order, definitions of key terms and acronyms that are used in the module. Ensure all defined terms are used, and consistently applied, in the module"*. The assessment team identified the following issues: a) Some acronyms are missing in section 3 (e.g. MRV, LULC, AGB, RMSE, PSP, etc.); b) The list is not in the required format;	**Response #1** (MED Version Draft 2.0) a) Resolved missing acronyms. LULC is listed in the submitted document. b) Changed list format to match specification c) Alphabetized list d) Removed items not used in text e) Resolved text in §2 **Response #2** (MED Version Draft 2.0) PWT Fixed (added equation)	**Assessment #1** (MED Version Draft 2.0) a) It was confirmed that the revised MED includes all missing acronyms. However, the definition of RMSE is not complete – NOT OK. b) It was confirmed that the list of the revised MED is now in accordance to the required format – OK. c) It was confirmed that the list of the revised MED is now in alphabetical order – OK. d) The assessment team confirmed that the inconsistency has been corrected. The MED refers now to Aboveground Live Forest Biomass (ALFB) – OK. **Assessment #2** (MED Version Draft 2.0) a) It was confirmed that the revised MED now includes the definition of RMSE – OK. **CAR2 is closed**.

CAR ID	Corrective action request	Response by project proponents	DNV GL's assessment of response by project proponents
	c) The list is not in alphabetical order; d) The list provides terms which are not used in the document such as FIA, ANR or NER; e) It provides a definition for Aboveground Live Forest Biomass (ALFB), yet in §2 it refers to Aboveground Live **Tree** Biomass (ALFB);		
CAR3	**Element of MED** 4. Applicability conditions **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template **Evidence** MED Version 1.4 **Corrective Action Request** According to §4 of the template, it should be firstly described, "*the project activity(s) and/or circumstances under which the module applies. Second, set out specific conditions under which the module can be used such as geographic location, technology type, methodology type and any other conditions that determine the applicability of the module*". However: a) The tool does not provide a description under which the MED applies and under which methodology it may be applied. Please provide a description of the circumstances under the MED can be applied;	**Response #1** (MED Version Draft 2.0) a) Expanded applicability conditions per suggestion **Response #2** (MED Version Draft 2.2) -- PWT This has been clarified, see Section 2 (Summary Description). Added text to applicability conditions **Response #3** (MED Version Draft 2.2.6) -- PWT This has been clarified, see Section 2 (Summary Description). Added text to applicability conditions	**Assessment #1** (MED Version Draft 2.0) After discussing with the MED proponent it has been clarified that the objective is not to use this tool for change detection, and that the objective is to provide estimates of average carbon density for different Strata and LULC classes within the AOI (or the whole AOI if no differentiation is made) in order to derive emission factors which will be used to estimate baseline and project emissions. The MED should be improved in order to clearly explain the purpose of the tool which is to derive average estimates of carbon densities at an AOI level or stratum level, not for change detection or for the production of carbon density maps- NOT OK. **Assessment #2** (MED Version Draft 2.2) It was confirmed that the new version of the MED now clearly specifies the cases where and where not the methodology is applied. However, the MED does not provide applicability conditions that specify the cases where the MED accounting is applicable (i.e. schema in Figure 1 and using RS samples). This is important as in other cases the assumptions made would not be applicable – NOT OK. **Assessment #3** (MED Version Draft 2.2.6) It was confirmed that the new version of the MED now clearly specifies the cases where and where not the methodology is applied. It now includes the requirement that the predictive model has to be parametric in order to ensure that non-parametric models are not applied, as there is no formulae for these models – OK. **CAR3 is closed.**
CAR4	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4	**Response #1** (MED Version Draft 2.0) a) Stratification is not a requirement for this methodology. Clarification of the statement referencing the use classification has been made. b) The intent of the methodology is to present a method for the use of Remote Sensing as a tool for measurement of above ground live forest biomass. As such, we deal with the issue of classification based on its relevance to that exercise. It is recognized that this tool will be used predominantly in the context of emissions reduction projects requiring demonstration of a historical baseline and this we	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and confirmed that it now provides a better description – OK. b) After discussing with the MED proponent it has been clarified that the objective is not to use this tool for change detection, and that the objective is to provide estimates of average carbon density for different Strata and LULC classes within the AOI (or the whole AOI if no differentiation is made) in order to derive emission factors which will be used to estimate baseline and project emissions. The MED should be improved in order to clearly explain the purpose of the stratification – NOT OK.

CAR ID	Corrective action request	Response by project proponents	DNV GL's assessment of response by project proponents
	Corrective Action Request Section 5.2.1 states that "*it is not essential to stratify the AOI if the proponent: a) accepts increased uncertainty in the estimate, or b) employs a method that can achieve sufficient accuracy without the use of stratification*". Later it states "*If this tool is being used the context of emissions reductions projects (REDD+, CDM, etc.), the project proponent should consider use of the LULC classification scheme developed for establishing the historical emissions baseline*". However, the assessment team would like to note the following issues: a) The MED is not clear enough on what is the objective of stratification. It is not clear if it to ensure allocation of enough SPs in each stratum, is it to allow the calibration of a specific model per stratum, or is it a way to derive average carbon estimates for each LULC class or stratum (in some cases a single model may be applied and the results might be clipped per stratum or LULC class). This should be clarified. b) According to the MED, stratification is not essential but it should be considered in the context of AFOLU projects. Please note that the primary objective of the tool should be to derive average carbon estimates and their associated uncertainties for each of the LULC classes defined in a project in accordance to the applicable methodology. In the context of REDD project categories, most of the methodologies that apply an IPCC Approach 3 (wall-to-wall activity data) provide procedures to define LULC classes (VM0006, VM0007 and VM00015). These LULC classes will be used then to produce transition matrices for the baseline and the project scenario. It is important to note that in the definition of these classes the availability and quality of historical data is a constraint. It is true that with the availability of new data such as LiDAR and RADAR it would be possible nowadays to define many more LULC classes, but this would cause a consistency issue if used together with data available historically (e.g. the historical transitions are estimated with Landsat TM/ETM while the future transitions are estimated using RADAR). Now, in all	explicitly recognize the case in which stratification is a component of other methodologies being deployed. Landscape stratification while useful to reduce uncertainty in the context of a stratified sampling is not critical to estimating biomass density using RS. There is sufficient detail in methodologies such as VM0006 dealing LULC classification and determination of historical baseline. **Response #2** (MED Version Draft 2.2) PWT Nowhere in this document is there an implication that this tool should be used for change detection or creation of a wall-to-wall map. I have added some clarification to section 5.2. Other than the reader's pre-conceived expectation, I don't see where in the document there is a need to further clarify the objectives of the tool.	**Assessment #2** (MED Version Draft 2.2) The new version of the MED was assessed and it was confirmed that the stratification and the objective of the tool is clear, i.e. provide an estimate of carbon density in the AOI or each Stratum – OK. **CAR4 is closed.**

CAR ID	Corrective action request	Response by project proponents	DNV GL's assessment of response by project proponents
	methodologies, since there is no past inventory information, current estimates are used in order to derive emission factors for each of the LULC classes. In order to obtain such estimate you may use auxiliary information to stratify or to apply hierarchical sampling method, or both (i.e. the proposed MED). However, what it is important is that in the final output is an average estimate (and its uncertainty) for each of the defined LULC classes in the case of REDD projects. This could change in the baseline renewal where new information would become available and new LULC classes could be defined. The MED needs some revisions in order to bring some clarity on what is the purpose of stratification and how the LULC classes defined by a REDD project would be taken into consideration.		
CAR5	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4 **Corrective Action Request** Section 5.1 states "*If this tool is being deployed in the context of an emissions reduction project in which a historical baseline of emissions is established for LULC classes within the AOI, the LULC classification map should be used as the basis for sampling design to ensure sufficient sampling density for each LULC type*". According to Section 5.2.1, the "*LULC classification and forest stratification procedures must follow the guidelines similar to the one set forth in Section 8.1.2 of VCS Methodology VM0006 or the appropriate guidelines listed in any other approved VCS methodologies for which this methodological tool (Remote Sensing Biomass Measurement) is being applied*". Please note that the procedures defined in the	**Response #1** (MED Version Draft 2.0) It's not clear to me what is requested here. Should we reference other methodological tools than VM0006? we already state "LULC classification and forest stratification procedures must follow the guidelines similar to the one set forth in Section 8.1.2 of VCS Methodology VM0006 or the appropriate guidelines listed in any other approved VCS methodologies for which this methodological tool (Remote Sensing Biomass Measurement) is being applied" **Response #2** (MED Version Draft 2.2) --- PWT Still not clear to me what needs to be changed, I've attempted to improve the language.	**Assessment #1** (MED Version Draft 2.0) Please note that we are saying that the procedures for defining the LULC classes provided in the applicable methodology must prevail. VM006 provides procedures, but VM0015 provides other procedures, VM0011 other procedures, etc… **Assessment #2** (MED Version Draft 2.2) The MED is clear now that the LULC classification system of the MED must prevail. **CAR5 is closed.**

CAR ID	Corrective action request	Response by project proponents	DNV GL's assessment of response by project proponents
	applied methodology for defining LULC classes shall prevail over VM0006. Leaving this option open would leave the chance to change the procedures of the methodology which in some cases it would lead to undesirable situations.		
CAR6	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4 **Corrective Action Request** The assessment team checked the information in step 2 and would like to make the following comments: a) According to section 5.2.2 Step 2 Sampling "*sampling can be conducted via in situ ground-based plots or by a remote sensing platform. Sampling should be conducted to an extent to sufficiently reduce the variance around the mean area-normalized biomass estimate within the desired confidence interval (α)*". Please note that this is true if stratified or simple random sampling is applied, but not necessarily true if other methods are applied, which are covered under Step 2. b) According to section 5.2.2.1.2 "*In-situ measurement plots, or Sample Plots (SPs) are used to develop and validate statistical relationships between RS metrics and ALFB*" with refers to the use of calibration SPs. However, further down it is stated that "*In-situ measurement plots, "A/R Methodological Tool 03 may be used for guidance to estimate the number and size of necessary PSPs*". Please note that this tool is only applicable if stratified or simple random sampling is applied. The use of RS would require fewer SPs. c) Section 5.2.2.1.2 states that "*Plot design should follow established guidelines for the forest type being sampled (RAINFOR, FAO,*	**Response #1** (MED Version Draft 2.0) a) Text has been modified based upon the suggestion. b) The number of sample plots should adhere to the A/R Methodological Tool 03 for developing the statistical relationship between plot measures and intermediate RS. Simple or stratified random sampling within the RS flighline is necessary to develop a rigorous relationship. A reduction in the number of SP's is still achieved as sampling is ONLY needed with the RS flighline, not across the entire AOI. c) Reference to problematic plot designs for RS methods has been removed and replaced with a specification for plot size and shape. Threshold criteria for the positional accuracy of plots has been specified as well.	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and confirmed that now Section 5.1.2 (5.2.2 in previous version) does not include the referred statement – OK. b) The assessment team checked the revised MED and confirmed that that Section 5.1.2.1.2 (5.2.2.1.2 in previous version) now includes the following statement "To estimate the number of plots, refer to the UNFCC A/R Methodological Tool 03 "Calculation of the number of sample plots for measurements within A/R CDM project activities" . The total number of sample plots should be 2x the number of plots estimated by the above tool to ensure sufficient samples for model testing and validation". Please note that the referred tool serves to determine the number of samples when the sampling is through a simple or stratified random sampling for the estimation of a sample average. It is not clear how this tool could be applied to define the number of samples required for developing a rigorous relationship between a RS parameter and the carbon density (i.e. which is the variable of interest?); for instance the number of samples required for a SRS is not the same as the number of samples required in the case of a regression estimator (which requires less samples) – NOT OK. c) The assessment team checked the revised MED and confirmed that Section 5.1.2.1.2 (5.2.2.1.2 in previous version) now includes clear procedures regarding the plot size and the geolocation accuracy. .However, it is stated that Sample plots must be large enough to avoid edge effects and provide unbiased relationship with RS height metrics ", so it refers to a specific RS parameter. It is not clear why it refers to this specific relationship; it seems that the MED proponent has in mind a specific method but it is not clear in the MED – NOT OK. NOTE applicable to sections 5.1.1 to 5.1.3. Please kindly note that for the reader (as expressed by various stakeholders during the comment period) it is not clear the difference between the RS sampling and the in-situ sampling and how this information is used to extrapolate to the rest of the AOI/Stratum. It seems that there are various levels of sampling, but it is not clear, and the tool does not provide any information on procedures to extrapolate to the AOI/stratum or criteria for defining acceptable approaches or a list of valid methods. Please refer to the drawing below:

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	others)". However, please note that these guidelines are applicable for "traditional" inventories. SPs used for calibrating RS models are quite different to "traditional" SPs: They are often larger in order to dilute any positional error or the inclusion or exclusion of border trees; the positional accuracy has to be in any case very high in order; the SPs locations should be random but should try to cover as much as variability in order to maximize the range of validity of the model (please refer to Maltamo et al., 2012); etc.		According to this drawing, there would be various levels of information which will define various options. The MED is unclear of which of these options it is referring to or if it refers to all these options. • **1 or 4**: in-situ AFLB →RS relationship. This relationship could occur from in-situ biomass data to RS data. RS data could be wall-to-wall information (c.f. 4) or could be RS samples (c.f. 1). These relationships could be built for the whole AOI (with or without further clipping per stratum) or for each Stratum. • **2**: RS-sample AFLB →RS relationship. There could be two options, existing allometric relationships between RS parameters and AFLB could be used in order to express the RS samples as AFLB samples (e.g. Vincent et al. (2014)) or the relationship obtained from in-situ AFLB could be used in order to express the RS samples as AFLB. With this data it would then be possible to obtain an additional relationship between the AFLB estimates of the RS samples with wall-to-wall RS data. These relationships could be built for the whole AOI (with or without further clipping per stratum) or for each Stratum. • **3**: RS-sample → AOI/Stratum statistical inference: Another option would be to use the AFLB estimates of the RS samples in order to estimate the average AFLB of the AOI or stratum using statistical inference. This inference could be applied at a stratum level or AOI level. The MED is not clear on whether all the above options are applicable. If these are applicable the MED must provide specific procedures and criteria to apply each of them in order to ensure that no major biases exist and in order to ensure that methods that are in compliance with the VCS Requirements are used (i.e. 4.1.6 and 4.1.7 of the VCS Standard) **Assessment #2** (MED Version Draft 2.2)

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		Response #2 (MED Version Draft 2.0) b) --- PWT reference to the A/R tool has been removed base upon conversation with ABE. An arbitrary minimum (30) number of SP, has been specified. c) The term height metric has been removed for consistency. – PWT d)	b) Now the MED provides clear indication that a total of 60 plots should be used, 30 Calibration Plots and 30 Validation Plots within each RSP. The assessment team agrees with the number of plots, however, it should be clear that there are no 30 CP and 30 VP, but that a 2-fold cross-validation will be applied (the 60 plots will be divided in 2 groups iteratively) and it is not clear why there should be 60 plots in each RSP. If there are 30 other RSPs this would mean 1800 plots in total, which seems unreasonable – NOT OK. c) The reference to height metrics has been deleted – OK. d) Section 5.1.2.1.1 Sampling with RS data requires that RSP are located randomly and that are located in order to capture the maximum range of the values in RS metrics which is correct, however, no indication of the number of samples is indicated – NOT OK.
		Response #3 (MED Version Draft 2.2.6) Tool has been revised.	**Assessment #3** (MED Version Draft 2.2.6) b) The MED has been revised. Now it requires that a minimum of 45 SPs should be established, using 30 for the calibration of the model and 15 for the validation. It is now clear that the 15 SPs are independent, but that an iterative cross-validation procedure is required – OK. d) Now the MED provides procedures in order to specify the number of SPs and the number of RSSUs. In order to determine the RSSU a specific equation that takes into account the correlation within each RSSU is provided. DNV GL deems that the procedure is correct and reasonable – OK. **CAR6 is closed.**
CAR7	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4 **Corrective Action Request** The assessment team checked Section 5.2.2.2 Step 2b: Estimation of ALFB in Plots and would like to point out the following issues: a) The MED states "*if wood density (D) for each species is not collected in field sampling, values should be taken from Table GPG-LULUCF 3A.1"*. However: i) The procedures indicated in	**Response #1** (MED Version Draft 2.0) a) Reference to the Table GPG-LULUCF 3A.1 has been replaced with reference to the Global Wood Density Database. Appropriate citations have been included. b) Text has been modified to clarify that if the tools is being deployed to comply with and overarching methodology that specifies allometric equation selection, it must guidelines therein.	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and confirmed that reference to Zane and Chave have been included which is an acceptable source according to the VCS Standard requirements regarding default values – OK. b) The assessment team checked the revised MED and confirmed that Step 2b: Estimation of ALFB in Plots (Section 5.2.2.2 in previous version) now states "*If this methodology is being conducted to comply with REDD+, ARR, or IFM methodologies that specify allometric equations, selection and use of allometric equations must follow the guidelines therein*", therefore, ensuring that the selected allometry will be in compliance with the applicable methodology. However, that same paragraph states "If species-specific biomass data has been measured via destructive sampling methods for forests similar to those found in the AOI, the project proponent may derive equation coefficients using the collected data and replace the default values. If permitted in the overarching methodology. Allometric equations specified in GPG-LULUCF Annex 4A.2 Table 4.A.1 may be used", which contradicts the previous statement. This last statement leaves the door open to use different procedures as those set in the applicable methodology – NOT OK. c) The MED does not provide any procedures for the establishment of in-situ plots (i.e. not biased location, size, type, etc.). The MED should refer to the procedures

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	the methodology to obtain the basic density shall prevail over the tool; ii) The database provided is not complete and it provide erroneous values as pointed out by Zanne et al. (2009) and Chave et al. (2006); iii) The above authors provide better estimates and more complete databases which have been peer-reviewed. b) The MED states "*If species-specific biomass data has been measured via destructive sampling methods for forests similar to those found in the AOI, the project proponent may derive equation coefficients using the collected data and replace the default values. Allometric equations specified in GPG-LULUCF Annex 4A.2 Table 4.A.1 may be used. See additional guidance on selection and use of allometric equations for ALFB in Picard et al. (2012) and Chave (2005)*". However: i) REDD, ARR and IFM methodologies provide their own procedures for selecting and validating allometric equations for the estimation of aboveground biomass. These procedures must prevail over the ones indicated in the tool;	**Response #2** (MED Version Draft 2.0) b) – PWT Language has been modified to ensure that IF an overarching methodology provides guidance on allometric relationships it must be used c) PWT Section 5.1.2.1.2 details in-situ sampling procedures. **Response #3** (MED Version Draft 2.2.6) Tool has been revised.	provided in the applicable methodology or to the GPG-LULUCF if no procedures are provided – NOT OK. **Assessment #2** (MED Version Draft 2.0) b) The MED is now clear. The procedures and guidance of the MED prevails – OK. c) It is OK, but we would suggest referring to the GPG-LULUCF and the applicable methodology on aspects regarding SOPs, QA/QC, measurement procedures (biometrics), etc. – NOT OK. **Assessment #3** (MED Version Draft 2.2.6) c) Now the MED specifies clearly that the procedures of the overarching methodology must be followed by the proponent. Moreover, QA/QC procedures of the 2003 LULUCF GPG or the overarching methodology- OK. **CAR7 is closed.**
CAR8	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4 **Corrective Action Request** The assessment team checked Section 5.2.3 Step 3: Prediction and would like to point out the following issues: a) The whole section refers to project area. It is not clear how this relates to the strata or the AOI. b) The MED does not provide metrics which are common in the use of these models: i) bias; ii) the R2 of the model; iii) an analysis of the residuals vs fitted values in order to understand	**Response #1** (MED Version Draft 2.0) a) All references to project area have been changed to AOI for clarity b) Requirements have been added to include a plot of regression residuals and the coefficient of determination (R2). **Response #2** (MED Version Draft 2.0) a) – PWT Could not find this. No reference to 'project' in 5.2 b) – PWT language has been revised and bias added.	**Assessment #1** (MED Version Draft 2.0) a) The MED still refers to "project" in the first paragraph – NOT OK. b) Please note the following issue: i) Bias is missing; ii) The same language is not being used, for the RMSE it is stated "of the RS-based biomass estimate compared with field data", in the following points it refers to "for the regression relationship between modeled and measured AFLB density estimates" which is not exactly the same – NOT OK. **Assessment #2** (MED Version Draft 2.0) a) This error has been corrected – OK. b) Language has been revised and corrected– OK. **CAR8 is closed.**

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	the existence of any local bias of the model; iv) the range of validity of the model in order to confirm that there are no large areas where the model may not be valid (NOTE: may not be possible with non-parametric models; this requires a discussion).		
CAR9	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that "*methodology elements shall provide a means to estimate a 90 or 95 percent confidence interval. Where a methodology applies a 90 percent confidence interval and the width of the confidence interval exceeds 20 percent of the estimated value or where a methodology applies a 95 percent confidence interval and the width of the confidence interval exceeds 30 percent of the estimated value, an appropriate confidence deduction shall be applied*". **Evidence** MED Version 1.4 **Corrective Action Request** a) According to the MED section 5.2.3 Step 3 "*Estimates of carbon in ALFB must be discounted based upon the accuracy of the estimate. Review the appropriate discounting mechanism from the methodology or the VCS guidance documents"*. However, methodologies and the VCS guidance have discounting mechanisms that apply when the relative margin error is above 15% at 95% of confidence. It is not clear how this RMSE relates to a relative margin error of an average of a random variable. b) The MED Section 5.2.3.1 Step 3b (optional): Intermediate RS Sampling does not provide any procedure for estimating the uncertainty of the carbon estimates and the discounting mechanisms in the case the relative margin is above permissible thresholds.	**Response #1** (MED Version Draft 2.0) a) Error reporting and discounting has been revised per the comment. A section on discounting procedures has been added. b) This section has been removed from the document.	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and confirmed that Section 5.1.3 (5.2.3 in the previous version) provides revised procedures. According to the revised procedures the accuracy of the predictive model is estimated as RMSE calculated through cross-validation. Moreover, the revised MED provides now Section 5.2.3 with procedures for discounting. However, the assessment team identified the following issues: i) The equation provided gives the RMSE for all validation plots in one iteration. However, in the procedures of Section 5.1.3 it is stated that the cross-validation "process can be conducted iteratively preserving the ratio of CP to VP to improve the strength of the predictor". Therefore, it is not clear if an average RMSE is calculated for all iterations or it is expected that only one iteration is applied. - NOT OK. ii) The RMSE will give an idea of the predictive power of the model (i.e. estimate of random error at a local level). However, it is not clear how this can be determine to estimate the uncertainty of the average carbon density in the AOI or a specific stratum (i.e. at 95%) in order to confirm if it is in compliance with the VCS requirements regarding uncertainties – NOT OK iii) It is not clear how errors from the different levels are propagated. As an example, please note, that if you apply LiDAR samples as a stratified sample (c.f. case 1+3 below) you would have to consider the propagation of 2 different errors, the prediction error (ALFB → RS) and the sampling error (relative margin error of the sampling). If you have a wall-to-wall RS information which relates directly to in-situ AFLB data (c.f. case 4 below), the only error would be the prediction error (assuming that the biomass measurement is exact). If you have two different ALFB→RS relationships (c.f. 1+2 below), you would have errors for both relationships. The assessment team acknowledges that by using as validation set a part of the in-situ plots to assess the final product, the propagation of errors would be already considered, except where the RA samples are applied to obtain an unbiased estimate assuming a SRS. However, the MED does not provide clear procedures in order to account for all these sources of errors, especially in the case 1+3 below – NOT OK

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			iv) REDD/AR/IFM methodologies provide already discount mechanisms if the 15/95 of the estimate is not reached. Hence, the MED should rely on these discount mechanisms, and as said before, in order to be able to apply these mechanisms the confidence interval of the estimate at 95% of confidence level needs to be estimated, otherwise it is not possible. An option could be to bootstrap the method applied in order to derive confidence intervals, yet this is an example and should not be considered as a recommendation made by the team. Please refer to Ryan et al. (2011) for an example of a technique to estimate confidence intervals of average estimates – OK b) Information in Step 3b has been deleted. Therefore, this non-conformity is no longer applicable – OK.
		Response #2 (MED Version Draft 2.0) a) i) Average of all RMSE values for all cross validation iterations should be used. Text modified a) ii) .—PWT The SPs are used to calibrate a regression model for the RSP (Intersection of the stratum and RS flighline). Once the model is tested and validated, each pixel from the RSP is considered a plot sample for the stratum. Thus the pixels from the RSP can be used to generate the average and confidence interval for the stratum. a) iii) .—PWT Discounting section has been revised to ensure error is discounted appropriately at each step. a) iv) . – PWT See revised graphic for clarification of steps.	**Assessment #2** (MED Version Draft 2.0) a) The assessment team checked the MED and confirmed whether the findings were resolved: i) The MED provides now clear equations to estimate the average RMSE and Bias across iterations. This is now correct – OK. ii) The MED states that "For use in subsequent steps, the RMSE reported by the PM must be subjected to the discounting regime in Appendix 2 of the UNFCC AR-TOOL14 (UNFCC 2013)." It is not clear how the RMSE can be used with the table in Appendix 2 to apply the discounting. The table requires the use of uncertainties at 90% confidence level, while the RMSE is not exactly this. Besides, please note that the discounting should be applied to the propagated error, apply it separately is not correct as you might have acceptable uncertainties for the PM and the sampling but the propagated is not acceptable – NOT OK. iii) It Is now clear that once the PM is adjusted, the RS samples will be used to estimate the average carbon at a stratum level or at an AOI level. Section "5.1.3.2 (2) Estimation of ALFB at the Stratum/AOI" provides equation to estimate the

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			average ALFB and the variance, where the pixel is the sampling unit. However, if Figure 2 is regarded, it can be seen that if pixels are considered as sampling units there would be spatial correlation linked to the fact that they are all very close, and in this case equations to estimate average and variance of a SRS would not be applicable as the group of pixels are in reality clusters of pixels. The sampling unit should be the cluster of pixels and the value should be the average of pixels in that cluster, while the average estimate should be the average of all cluster in that stratum. Moreover, please note that there is no equation to estimate the relative margin of error at 90 or 95% confidence level – NOT OK. iv) It is still not clear how the errors are propagated. The confidence interval at 95% should be estimated for the PM and the sampling design and propagated or all together, and the discounting of the overarching methodology should be applied to the resulting value – NOT OK.
		Response #3 (MED Version Draft 2.2.6) Tool has been revised.	**Assessment #3** (MED Version Draft 2.2.6) a) The assessment team checked the MED and confirmed whether the findings were resolved. The MED now provides specific formulae for determining the uncertainty at stratum level and the overall uncertainty which can be employed for discounting as specified in the overarching methodology – OK. **CAR9 is closed.**
CAR10	**Element of MED** 6. Data and parameters **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template. **Evidence** MED Version 1.4 **Corrective Action Request** The assessment team checked section 6. Data and Parameters and would like to point out the following issues: a) According to the template "*Parameters that are not directly monitored themselves (i.e., are calculated, using monitored data/parameters and the equations provided in the module) do not need to be included in this section*". However, the parameter RMSE has been included which is estimated following equations provided in the MED. b) According to the template the table in section 6 should be completed for "*all data and*	**Response #1** (MED Version Draft 2.0) a) RMSE has been removed from the parameters section and incuded in the Definition of Terms b) All parameters not used in equations have been removed from the parameters table. **Response #2** (MED Version Draft 2.0) c) –PWT There is not a validation period. Several parameters have been added to 6.1.	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and confirmed that Section 6.1 no longer includes the parameter RMSE. Therefore, the MED is now in compliance with the applicable criteria – OK. b) The assessment team checked the revised MED and confirmed that Section 6.1 no longer includes the parameter D. Therefore, the MED is now in compliance with the applicable criteria – OK. c) The assessment team checked the revised MED and confirmed that Section 6.1 no longer includes the parameter Dref and H. Therefore, the MED is now in compliance with the applicable criteria – OK. d) The assessment team checked the revised MED, and it confirmed that it does not provide any additional parameter in section 6.1 and 6.2 (not even generic parameter). However, it is expected that other parameters will be required to be measured in order to apply the tool. Although some of these parameters are probably generic, the tool must include these parameters and provide procedures for measurement or refer to procedures of applicable methodologies – NOT OK **Assessment #2** (MED Version Draft 2.0) d) The MED now provides parameter "Biomass in specific tree t of species j in plot p, stratum i" which is a calculated parameter. The parameter provided should be a generic biometric parameter required by the overarching methodology. Moreover, there should be an indication that other parameters required by the methodology to

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	parameters that will be monitored during the project crediting period". The basic wood density D_j has been included in the list of parameters, however, this parameter is not used in any equation of the MED. Please note that it will depend on the allometric equation employed by the project proponent. c) Variables D_{ref} and H, however, please note that depending on the allometric equation other variables might be measured instead.	**Response #3** (MED Version Draft 2.2.6) Tool has been revised.	estimate carbon stocks should be included – NOT OK. **Assessment #3** (MED Version Draft 2.2.6) a) The assessment team checked the MED and confirmed whether the findings were resolved. The issue is that this tool may be used at the time of validation or for monitoring purposes, so the same parameters may be reported at the time of validation or may be subject to changes. Hence, the assessment team will wait till the VCSA reviews the tool and provides its opinion. Moreover, the assessment team deems that the parameters reported are enough – OK. **CAR10 is closed.**
CAR11	**Element of MED** Section "Sampling with RS data". **Requirement** §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 3.4 **Corrective Action Request** The tool states that "The pixel resolution of the data produced from the RS platform must not exceed the size of the SP". However, this is a bit contradictory with the fact that the RSP has been fixed to 1 ha, while in Section "In-situ measurement plots" it is prescribed a minimum area of 0.25 ha. Therefore, the MED is not internally consistent.	**Response #1** (MED Version 3.4.1) We have changed the definition of the RSP per the inconsistency identified here. **Response #2** (MED Version 3.4.2) I've fixed the indexing in 13. Thanks for catching this.	**Assessment #1** (MED Version 3.4.1) I see that now a pixel size >0.25 ha may be used. However, please note that if the RSP is no longer equal to 1 ha, some equations no longer provide a correct estimate. For instance, if a pixel size different to 1 ha is assumed, equation (13) would provide an average estimate per pixel and not per ha. Therefore, it seems that ηij in equation (13) shouldn't be the "number of RSPs within RSSU i, stratum j", but the "size of the RSSU I, stratum j in ha". Please note that this is just an example and I haven't reviewed all the formulae; so a full review of all formulae would be necessary to ensure that there are no issues. After reviewing again Stahl et al, I see that equation (13) might need some really minor changes. It seems that "T" should be "Ti" as T can differ in each RSSU, and it seems that "ni" should be "nj" **Assessment #2** (MED Version 3.4.2) Thank you for the changes. However, there seems to be some issues with the latest changes: 1. Equation 15: With the change in Equation 13, $ALFB_j$is now expressed in t/ha. This change has now an impact in the product $ALFB_j\eta_{ij}$ of this first term of equation 15 (now it is a product of t/ha x number of RSPs), so equation 15 no longer makes sense. 2. Equation 13 and 16: The summation in these equations are for **i**=1….nj not **j**=1….nj (e.g. $\sum_{j=1}^{n_j} F_{ij}(\alpha_j)$ should be $\sum_{i=1}^{n_j} F_{ij}(\alpha_j)$. Please confirm. 3. Equation 15: My understanding is that you have to multiply by A_x^{-2} in order to convert to (t/ha)^2. Please confirm. 4. Equation 17: My understanding is that $\sum_{j=1}^{n_j}\sum_{i=1}^{T_i}\frac{\partial f(x_{ijt},\alpha_{k_1})}{\partial \alpha_{k_1}}$ should be $\sum_{\boldsymbol{i}=1}^{n_j}\sum_{\boldsymbol{t}=1}^{T_i}\frac{\partial f(x_{ijt},\alpha_{k_1})}{\partial \alpha_{k_1}}$. Please confirm. 5. Equation 8, 10, 11, 12: Now there is a new index "*o*". My understanding is that it should be "k". So $\sqrt{\frac{1}{n\times K}\sum_{o=1}^{n}\sum_{l=1}^{K}(\gamma'_{kl}-\gamma_{kl})^2}$ should be $\sqrt{\frac{1}{n\times K}\sum_{k=1}^{n}\sum_{l=1}^{K}(\gamma'_{kl}-\gamma_{kl})^2}$. The reference "*The index k is used for this parameter*" should be deleted as the number of rounds is defined by index l.

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		Response #3 (MED Version 3.4.3) 1. The change in equation 13 was not correct. The division by A changes the units of ALFB. ALFB is always in units of carbon density t/ha regardless of plot size of pixel size. ALFB is estimated using a function that relates lidar height metrics to biomass (t/ha) estimated in calibration plots. Therefore, the unit of ALFB always stays the unit of biomass, which is t/ha. The original equation without the division by A is correct. 2. Changed and confirmed. 3. Again, division by pixel area has been removed. 4. Changed and confirmed. 5. Division by pixel area has been removed. 6. Division by pixel area has been removed. **Response #3** (MED Version 3.4.4) 1. We have changed the definition of Fij to reflect that units will be t/ha. Hopefully this resolves the last issue	6. Equation 3: You have included "A_x^{-1}" but it seems that it is not necessary to apply this as the parameter $\sigma^2_{ui,j}$ is already expressed in (t ha-1)^2. **Assessment #2** (MED Version 3.4.3) Thank you for the changes. However, there seems to be some issues with the latest changes: 1. Equation 15: Thank you for the clarification. It is noted that Equation 13 should provide estimates in t/ha and that the original notation was correct. However, according to the description provided F_ij means "Sum of all of RSP ALFB estimates derived from the PM in each RSSU i and stratum j (t)", so it seems that it should be written t/ha instead of t. 2. Equation 13 and 16: The index of the summation is now correct as confirmed by the audit team. Therefore, the MED is now correct. 3. Equation 15: The audit team agrees that the parameter A must be deleted as the estimates provided by F are already in t/ha. Therefore, the MED is now correct. 4. Equation 17: The index of the summation is now correct as confirmed by the audit team. Therefore, the MED is now correct. 5. Equation 8, 10, 11, 12: The index of the summation is now correct as confirmed by the audit team. Therefore, the MED is now correct. 6. Equation 3: The audit team agrees that the parameter A must be deleted as the estimates provided by F are already in t/ha. Therefore, the MED is now correct. **Assessment #2** (MED Version 3.4.3) 1. Equation 15: The units of F have been now set to t/ha which makes all equations from 13-through 17 to provide accurate estimates. Therefore, the MED is now correct. **CAR is closed.**
CAR12	**Element of MED** Section "Estimation using RS predictor" **Requirement** §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 3.4 **Corrective Action Request** The notation "m" in Equations 8,11 and 12 is not defined; it seems that this is equal to K (number of cross-validations). If this is the case, it seems	**Response #1** (MED Version 3.4.1) Thanks for catching this. The notation was quite confusing in these equations, I have modified for consistency. **Response #2** (MED Version 3.4.2) [Changes were made to the MED but no response was given]	**Assessment #1** (MED Version 3.4.1) Thanks for the changes. However, it seems that equation (12) needs a revision in the denominator. **Assessment #2** (MED Version 3.4.2) The team checked the revised MED and confirmed that the index and denominators of Equations. Therefore, the MED is now correct. **CAR is closed.**

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	that the denominator of these equations is not accurate as they don't represent m (or k) cross-validations of n samples each.		

Clarification requests

CL ID	Clarification request	Response by project proponents	DNV GL's assessment of response by project proponents
CL1	**Element of MED** 1. Sources **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template **Evidence** MED Version 1.4 **Clarification request** According to the template, §1 should specify clearly the tools/modules/documents upon which the tool is based, tools/modules/documents referred to and used by the MED. However: a) It is not clear if the list of methodologies / tools / documents provided are used by the MED or are those upon which the MED is based. b) The list includes versions of methodologies/tools which are not correct (e.g. VM0006) or are not the latest one (e.g. "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" is no in the 4.1 version). Please clarify; c) The list includes AR-AM0002 "Restoration of degraded lands through afforestation/reforestation" (Version 03). Please clarify why the MED refers to this tool considering that it has been withdrawn and considering that, any method is already described in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities". d) Page 6 includes a reference to CDM Meth Panel. (2008). Guidance on addressing uncertainty in the estimation of emissions reductions for CDM project activities. In Report	**Response #1** (MED Version Draft 2.0) a) Removed all sources which do not directly bear on this methodology b) Removed reference to VM0006 and revised reference to CDM to refer to most recent version c) removed reference to this document d) Unnecessary source documents have been removed and citations updated	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and confirmed that many tools or methodologies that were referred to have been deleted – OK. b) The assessment team confirmed that the revised MED now refers to the latest versions of applicable tools and methodologies – OK. c) Reference to methodology AR-AM0002 has been deleted – OK. d) Reference to the CDM Meth Panel (2008) has been deleted – OK. **CL is closed.**

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	of the thirty-second meeting of the methodologies panel (pp. 1–3). Bonn: UNFCC. Please clarify why this document is being referred to considering that it is an old document (2008) which has been replaced by more recent guidance on the treatment of uncertainty (i.e. please refer to the latest version of the tool for "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities").		
CL2	**Element of MED** 3. Definitions **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template and §4.3.1 AFOLU requirements: VCS Version 3.4 **Evidence** MED Version 1.4 **Clarification request** Section 3 Definitions provides the following definition of Aboveground Live Forest Biomass (ALFB): "Live forest biomass above the soil, including the stem, stump, branches, bark, seeds and foliage for vegetation with a diameter Dref (<10cm old growth , >5cm for secondary and degraded)". a) Please clarify if this refers only to the tree or the non-tree carbon pool for non-ARR activates as described in §4.3.1 AFOLU requirements: VCS Version 3.4; b) Please clarify if this refers to the woody or non-woody biomass for ARR project activities as described in §4.3.1 AFOLU requirements: VCS Version 3.4; c) Please clarify why it includes such a limitation in the minimum diameter considering that this should be based on the range of validity of the allometric equation to be used or/and the minimum diameter defined by the project developer. Besides, please note that, defining these limits for old and secondary/degraded forest would require to do a stratification beforehand; d) Please clarify why it is <10 cm. It seems a typo;	**Response #1** (MED Version Draft 2.0) a) There is no reference to tree or non-tree carbon pools in §4.3.1 AFOLU requirements: VCS Standard Version 3.4; b) There is no reference to woody or non-woody carbon pools in §4.3.1 AFOLU requirements: VCS Standard Version 3.4; c) Reference to minimum stem diameter and stem diameter classes has been removed and replaces with reference to superseding methodology. d) typo, fixed **Response #2** (MED Version Draft 2.2) PWT I've revised the text in the definition of ALFB to ensure that the proponent harmonizes the definition of ALFB in this tool with the relevant reporting carbon pool in a superseding methodology.	**Assessment #1** (MED Version Draft 2.0) a) Please note that §4.3.1 AFOLU requirements: VCS Standard Version 3.4 (c.f. Table 2) includes a list of carbon pools that are eligible or not for each eligible activity. For non-ARR, ALM and ACoGS projects, there are two carbon pools: Above-ground tree biomass Above-ground non-tree biomass, while for ARR, ALM and ACoGS projects, these two carbon pools are called "Aboveground woody" and "Aboveground non-woody". According to the same table the non-tree and non-woody carbon pools are not eligible in some activities, however the tool seems to aggregate both carbon pools in one, i.e. ALFB. The assessment team acknowledges that this depends in the end of what you measure in the in-situ plots, so if you measure only trees your model will predict only tree biomass. However, this is not clear in the MED and it needs a clear indication on how these different carbon pools are handled, etc. – NOT OK. – b) Please refer to a) –OK. c) The assessment team confirmed that reference to minimum stem diameter has been replaced in the revised MED and that it now includes reference to the applicable methodology – OK. d) The assessment team confirmed that the typo has been corrected – OK. **Assessment #2** (MED Version Draft 2.2) a) The MED provides now clear indication that the carbon pools required by the overarching methodology should be included – OK. **CL is closed.**

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CL3	**Element of MED** 4. Applicability conditions **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template **Evidence** MED Version 1.4 **Clarification request** The list of applicability conditions provides the following criterion "Inventory plot locations are loca a) It is not clear if this condition is to ensure that external models are not used Please clarify the rationale of this condition. b) It is not clear how the project and/or reference area matches with the AOI. Please note that the AOI could be larger than the project and reference area and these could be enclosed by the AOI (e.g. it could include the leakage area, or areas out of those). Besides, in ARR projects the AOI would be initially the project and the leakage area (to estimate pre-project stocks) and then the project area (only the carbon stocks in the project area are monitored). c) Please note that there is not a definition of project and reference area in the MED and that this concept is mainly applicable to REDD methodologies, not to methodologies of other categories. Besides, the reference area has different definitions depending on the methodology. (Please note that throughout the MED reference area and project area are used, while our understanding is that it should be stratum or AOI).	**Response #1** (MED Version Draft 2.0) a) There is no need to have pre-existing plot locations within the AOI. This condition has been removed. b) Reference to reference region and project area have been changed to AOI throughout except in the definition of AOI.	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and confirmed that the condition "Inventory plot locations are located within the project and/or reference area" has been removed. Therefore this clarification request is no longer applicable – OK. b) The assessment team checked the revised MED and confirmed reference to the reference area and project area has been removed. Therefore this clarification request is no longer applicable – OK. b) The assessment team checked the revised MED and confirmed reference to the reference area and project area has been removed. Therefore this clarification request is no longer applicable – OK. **CL is closed.**
CL4	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness.	**Response #1** (MED Version Draft 2.0) a) Reference to forest stratification has been changed to AOI stratification throughout b) Clarification of the use of RS metrics for stratification and biomass estimation has been made. Independence is ensured by using separate and distinct calibration/validation data.	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and it confirmed that it now refers exclusively to the stratification within the AOI. Therefore this clarification request is no longer applicable – OK. b) The assessment team checked the revised MED and confirmed that it now states that the same data can be used but independence has to be ensured by not using the calibration data for the stratification – OK.

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	Evidence MED Version 1.4 **Clarification request** a) Section 5.1 provides procedures for the stratification of the AOI and Section 5.2.1 provides procedures for the stratification of forest. In Section 5.2.1 it keeps referring to the stratification of the AOI. Please clarify why there is such distinction. b) Section 5.2 of the tool in its subsection 5.2.1 states that "*To ensure independence metrics used in ALFB estimation using RS data, data used in the stratification step may be used as long as the errors are propagated correctly to predict ALFB from sampled data. In the case of a multi-sensor (multi-spectral, etc.) RS platform it is justifiable to use data collected synchronously as long as data from the same sensor are not employed in both stratification and biomass estimation methods*". Please clarify when the same data can be used for stratification and when not as the procedure is not very clear. Moreover, it is not clear the consequence of using the same data for both.		**CL is closed.**
CL5	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4 **Clarification request** Section 5.2.1 states that "*If this tool is being used the context of emissions reductions projects (REDD+, CDM, etc.) the project proponent should consider use of the LULC classification scheme developed for establishing the historical emissions baseline and MRV as the basis for stratification*". Please note that historical emission baseline is mainly applicable for REDD, ACoG or WRC, not for ARR project. AR projects are the only eligible activities in the	**Response #1** (MED Version Draft 2.0) text has been modified per the suggestion	**Assessment #1** (MED Version Draft 2.0) The assessment team checked the revised MED and it confirmed that no mention of CDM in the context of REDD is provided. Therefore, this clarification request has been resolved – OK. **CL is closed.**

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	CDM.		
CL6	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4 **Clarification Request** The assessment team checked Section 5.2.2.2 Step 2b: Estimation of ALFB in Plots and would like to ask for the following clarifications: a) The MED states "*Sampling techniques such as field-based direct volume measurement that can be demonstrated to meet or improve accuracy of the above allometric equation may be accepted if evidence is provided*". Please clarify what does it mean "*field-based direct volume measurement*" and how this would relate to an AGB allometric equation.	**Response #1** (MED Version Draft 2.0) a) The use of terrestrial LiDAR scanners can produce 3-dimensional volumes of tree boles and branches. This text reflects that allometric equations are subject to statistical error and leaves the option open to use LiDAR or, as yet undeveloped technology for direct measurement.	**Assessment #1** (MED Version Draft 2.0) a) The assessment team confirms that it is an acceptable clarification. Although, it is an undeveloped technology and it does not worth any mention of it in the MED (procedures would have to be provided), the assessment team accepts the response – OK. **CL is closed.**
CL7	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4 **Clarification Request** The assessment team checked Section 5.2.2.3 Ste a) The MED provides equations for estimating the average and the variance when a stratified random sampling is used. It is not clear if these equations have to be used with in-situ measurement plots (which does not seem within the scope of the tool), or if they have to be used with RS "plots" or samples (e.g. random located	**Response #1** (MED Version Draft 2.0) a) The section inwhihc average and variance of plot data are estimated has been removed. The observation is correct that it is not relevant to this tool. **Response #2** (MED Version Draft 2.2) equations for calculating mean ALFB and variance at the stratum level have been included in 5.1.3.2--PWT Average and variance equations for stratum-level estimation has been included in section 5.1.3.2	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked the revised MED and confirmed that Section 5.2.2.3 has been removed. However, it is not entirely clear why this has been removed. According to Section 5.1.2.1.1 sampling can be done with RS data to achieve an unbiased estimate of ALFB, therefore, it seems that an option of the MED is to allow to use RS samples in order to obtain unbiased estimates of the variable of interest. Hence, the removal of that section or specific reference to the procedures of the methodology regarding SRS techniques seems to be missing – NOT OK **Assessment #2** (MED Version Draft 2.2) It Is now clear that once the PM is adjusted, the RS samples will be used to estimate the average carbon at a stratum level or at an AOI level. Section "5.1.3.2 (2) Estimation of ALFB at the Stratum/AOI" provides equation to estimate the average ALFB and the variance, where the pixel is the sampling unit. However, if Figure 2 is regarded, it can be seen that if pixels are considered as sampling units there would be spatial correlation linked to the fact that they are all very close, and in this case equations to estimate average and variance of a SRS would not be applicable as the group of pixels are in reality clusters of pixels. The sampling unit should be the cluster of pixels and the value should be the average of pixels in that cluster, while the

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	areas are sampled with LiDAR and the carbon estimates obtained through regression, for instance, are used to estimate the average carbon stocks using the referred formulae). Please clarify.	**Response #3** (MED Version Draft 2.2.6) Tool has been revised. .	average estimate should be the average of all cluster in that stratum. Moreover, please note that there is no equation to estimate the relative margin of error at 90 or 95% confidence level – NOT OK. **Assessment #3** (MED Version Draft 2.2.6) The MED is provides now clear procedures for estimating the aboveground living biomass at a stratum level. Now the two different phases are described and procedures to determine the uncertainty of both phases is included in the MED. Hence, this CL may be closed – OK. **CL is closed.**
CL8	**Element of MED** 5.2. Estimation using RS predictor **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template **Evidence** MED Version 1.4 **Clarification Request** According to Section 5 procedures of the template, the MED proponent shall "*describe, in detail, the procedures established by the module*". a) According to the MED Section 5.2.2.4 Step 2d (optional): Intermediate RS sampling "*In cases where it is difficult to accurately predict project-wide ALFB based on the extrapolation of field plots to forest strata or project area (i.e. very large and remote project areas), an intermediate RS step may be used to increase the sampling accuracy*". Please clarify how this intermediate RS step is applied (sample location and selection, etc.). b) According to the MED Section 5.2.3 Step 3: Pre	**Response #1** (MED Version Draft 2.0) a) RS sampling is detailed in section 5.2.1.1 and has been expanded for clarity b) Yes, project area has been changed to AOI. **Response #2** (MED Version Draft 2.2) a) . – PWT Resolved --b) -PWT Resolved.	**Assessment #1** (MED Version Draft 2.0) a) The assessment team checked Section 5.1.2.2 (Section 5.2.2.4 in the previous version) of the MED and found that reference to intermediate sampling has been deleted. However, it is not clear why such section is provided as it does not provide additional information on procedures to follow and there is another section with a similar name in Section 5.1.2.1.1 – NOT OK b) The assessment team checked Section 5.1.3 (Section 5.2.3 in previous version) of the MED and confirmed that it provides the statement "To estimate carbon in ALFB, field or RS data must be extrapolated to the extent of the strata or AOI". However, it does not provide any procedure for extrapolating to the strata or the AOI as required by the applicable criterion – NOT OK- **Assessment #2** (MED Version Draft 2.2) A) This finding has been resolved-OK. b) Procedures to extrapolate are now applied – OK. **CL is closed.**
CL9	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 sets that methodologies shall be guided by the principles set out in §2.4.1 of VCS Version 3.4. Which includes the principle of accuracy and conservativeness. **Evidence** MED Version 1.4	**Response #1** (MED Version Draft 2.0) Some text has been added to clarify here. The CPs and VPs are distinct and non-overlapping sets of the SPs. CP's are used only for calibration of the model and VPs are used only for assessing the accuracy of the model.	**Assessment #1** (MED Version Draft 2.0) The assessment team checked the revised MED and it confirmed that it now provides a description of the cross-validation procedure which is an acceptable procedure. **CL is closed.**

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	Clarification request Section 5.2.3 Step 3: Prediction According to the MED "*Once a predictor is selected, it is used to estimate ALFB for the remainder of CPs constituting the Validation Plots (VP) within the strata. Cross validation should be employed and results reported to assess the accuracy of the predictive model*". It is not clear which is the applicable method of validation since the MED mentions the use of validation plots. It seems that the term validation plots is a way to refer generically to the part of the sample that is set aside as part of the cross validation. However, please note that Asner et al. (2013) applied a more recommendable approach consisting in using an independent validation sets for each of the phases ("*In each case, the data used to estimate errors were completely excluded from the project until the validation phase*"). Please clarify what is the exact validation procedure to be applied.		
CL10	**Element of MED** 4. Applicability conditions **Requirement** §4.1.3 VCS Version 3.4 referring to VCS Module/Tool template **Evidence** MED Version 3.4 **Clarification request** According to the second applicability condition of the revised tool, "The AOI qualifies as forest". It is not clear why such applicability condition has been added from the previous version, considering that the same methods could be applied to estimate carbon densities in non-forest areas (e.g. baseline surveys in AR projects, or carbon densities of non-forest areas to estimate net GHG emission factors).	**Response #1** (MED Version 3.4.1) [The tool was revised by the MED proponent. The applicability condition was removed]	**Assessment #1** (MED Version 3.4.1) The assessment team checked the revised MED and it confirmed that it no longer includes the applicability condition that refers to the qualification as forest. Therefore, this finding may be closed. **CL is closed.**

Observations

OBS ID	Observation	Response by project proponents	DNV GL's assessment of response by project proponents

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OBS1	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 **Evidence** MED Version 1.4 **Observation** One of the methods commonly employed in the estimation of aboveground biomass using RS auxiliary data is through double sampling. The interest of this method is that it provides explicit equations to estimate the model parameters and enables to estimate the confidence interval of the estimate. Although it is not as sophisticated as other options (non-parametric methods) it can be a valid option in many cases. The assessment team would like to point out that a possible area of improvement could be to include procedures to apply the double sampling method. Please note that the latest version of the "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in AR CDM project activities" allows now the use of double sampling to estimate the average biomass at stratum level and to combine this with other methods.	**Response #1** (MED Version Draft 2.0) **Response #2** (MED Version Draft 2.2) PWT The method employed here is very similar to a double sampling regime and can be used with non-parametric PMs.	**Assessment #1** (MED Version Draft 2.0) No response has been provided. – **Assessment #2** (MED Version Draft 2.2) This finding is an area of improvement and it is not compulsory to change the MED in order to address it. **OBS1 is closed.**
OBS2	**Element of MED** 5.2. Estimation using RS predictor **Requirement** Section §4.1.4 VCS Version 3.4 **Evidence** MED Version 3.4 **Observation** The phrase "Sampling plots …. must represent to the greatest extent possible, the full range and variability of biomass density within the stratum or AOI" has been deleted. Please note, that although removing this requirement will not affect any VCS requirement, the team would like to note that it is important that the predictive model cover the range of variation of the main parameters, otherwise large areas might be	**Response #1** (MED Version 3.4.1) This was removed because the second review felt that the text was not precise enough. The 'to the greatest extent possible' phrase was perceived to not be sufficiently descriptive of the requirement. The tool requires that in situ sampling to develop the predictive model be done randomly without replacement or systematically and specifies a number/size of plots. I and the second validator consider this to be sufficient but am open to considering alternative perspectives. **Response #2** (MED Version 3.4.2) We have added some descriptive language in the description of in-situ sampling (5.1) and inserted references to the papers you sent, thanks for those. Our sampling approach for SPs is consistent with the methods in the papers you sent. Systematic or random sampling with a defined number of samples will not bias the estimator. I'f you'd like to discuss this point further please let us know. Sassan, if you'd like to provide more clarity here, feel free.	**Assessment #1** (MED Version 3.4.1) Please note that the tool requires as part of Step 3b to discuss the range of applicability of the PM ("The range of applicability of the PM must be described in terms of the range of biomass densities in measured SPs and the range of RS metrics used in the PM"), so if your in-situ sampling does not take the range of RS metrics the project developer could encounter undesirable situations where your regression is not applicable to large areas of your AOI. In order to avoid further iterations and since you indicated that you are open for recommendations, I would suggest leaving the plot location selection strategies more open to developers; I send you two papers where different sampling strategies are discussed and that could be used as reference/guidance. **Assessment #2** (MED Version 3.4.2) The audit team checked the revised tool and confirms that it now considers other methods that are prescribed by peer reviewed papers for sampling in order to enhance the performance of the predictive model.

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	present where the model is applied out of the range of validity of the mode.		**OBS2 is closed.**