NATURAL HIGH FOREST REHABILITATION PROJECT ON DEGRADED LAND OF KIBALE NATIONAL PARK.

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1 PROJECT DETAILS

1.1 Summary Description of Project

The project is rehabilitating a natural high forest in Kibale National Park. Kibale National Park is located in the western part of Uganda and project activities are implemented by Uganda Wildlife Authority (UWA) in cooperation with Face the Future (FtF) of the Netherlands. The project takes place on lands within the national park that have previously been subjected to severe degradation from human encroachment into the park. Rehabilitating the area with native tree species contributes to climate change mitigation by sequestering GHGs in sinks through assisted natural regeneration activities as well as to the realization of multiple socio-economic and environmental benefits such as employment, local nursery production, biodiversity conservation and soil erosion control.

1.2 Sectoral Scope and Project Type

The project is a Voluntary Carbon Standard (VCS) Afforestation/Reforestation (ARR) Project which falls under the AFOLU category of eligible project activities. Additionally, the project applies a Clean Development Mechanism (CDM) methodology called *"Approved consolidated afforestation and reforestation baseline and monitoring methodology AR-ACM0001: Afforestation and reforestation of degraded land", Version 05.0.0*.

This Monitoring Report describes the results of project monitoring carried out from 2009 to 2011 for the purpose of verification of the GHG emission reductions resulting from project implementation. The report is based on the monitoring plan provided in the VCS Project Document (PD) for Kibale version 2007.1 and therefore serves as Annex 4 of the PD.

1.3 Project Proponent

The implementation of the project is achieved through a partnership between UWA and Face the Future. Table 1.3.1 contains the contact information of project proponents for the ARR VCS Project activity.

Table 1.3.1. Contact information of Project Proponents.

Organization:	Face the Future
Street/P.O.Box:	Pieter de Hoochweg 108,
Building:	
City:	Rotterdam
State/Region:	Rotterdam
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Represented by:	Denis Slieker
Title:	Managing Director
Salutation:	Mr.
Last Name:	Slieker
Middle Name:	
First Name:	Denis
Department:	
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Direct tel:	+31 1075 42051
Personal e-Mail:	

Organization:	Uganda Wildlife Authority
Street/P.O.Box:	Plot 7 Kira Road, Kammwokya/P.O. Box 3530
Building:	
City:	Kampala
State/Region:	
Postfix/ZIP:	
Country:	Uganda
Telephone:	+256 414 355 000
FAX:	+256 414 346 291
E-Mail:	Andrew.seguya@ugandawildlife.org
Website URL:	www.ugandawildlife.org
Represented by:	Andre Seguya
Title:	Ag. Executive Director
Salutation:	Dr.
Last Name:	Seguya
Middle Name:	
First Name:	Andrew
Department:	
Mobile phone:	+256 772 722 210
Direct FAX:	
Direct tel:	
Personal e-Mail:	seguya@gmail.com

Face the Future is an organization that develops forest projects in order to sequester carbon dioxide to mitigate climate change whilst facilitating socio-economic and biodiversity benefits. Face the Future's projects are partly funded through the marketing of carbon credits generated by the projects themselves. In addition to the development of forest projects, Face also provides consultancy services with regards to carbon certification of forest projects, project implementation as well as funding of projects.

The Uganda Wildlife Authority (UWA) was established in August 1996 by the Uganda Wildlife Statute, which merged the Uganda National Parks and the Game Department. It is governed by a Board of Trustees appointed by minister responsible for wildlife. UWA is in charge of management of 10 National Parks, 12 Wildlife Reserves, 14 Wildlife Sanctuaries and provides guidance for 5 Community Wildlife Areas. UWA's vision is to be a leading self-sustaining wildlife conservation agency that transforms Uganda into one of the best eco-tourist destinations in Africa. Its mission is to conserve, economically develop and sustainably manage the wildlife and Protected Areas of Uganda in partnership with neighbouring communities and other stakeholders for the benefit of the people of Uganda and the global community.

Face the Future and Uganda Wildlife Authority have successfully cooperated on the restoration of former encroached areas in Kibale National Park. Since the start of cooperation in 1994, approximately 3.407 hectares have been replanted and 2600 hectares have naturally regenerated.

The role of Face the Future has been to provide carbon development expertise and funding while the role of UWA has been has been to carry out all project implementation activities. Since 1994, Face has been providing significant amounts of funding from which the project implementation activities have been paid.

1.4 Other Entities Involved in the Project

IFER – Institute of Forest Ecosystem Research, Jílové u Prahy, Czech Republic is an independent research institute conducting ecosystem research, developing and applying modern forest monitoring techniques. IFER was contracted by Face the Future in 2002, 2008 and 2011 to conduct carbon monitoring campaigns.

Table 1.4.1. Contact information for Institute of Forest Ecosystem Research.

Organization:	Institute of Forest Ecosystem Research
Street/P.O.Box:	Areál 1. Jílovské a.s
Building:	
City:	Jílové u Prahy
State/Region:	
Postfix/ZIP:	254 01
Country:	Czech Republic
Telephone:	+420 2 4195 0607
FAX:	+420 2 4195 1205
E-Mail:	martin.cerny@ifer.cz
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Represented by:	Martin Černý
Title:	C.E.O
Salutation:	Dr.
Last Name:	Černý
Middle Name:	
First Name:	Martin
Department:	
Mobile phone:	
Direct FAX:	
Direct tel:	
Personal e-Mail:	

1.5 Project Start Date

The project activity start date is 15th May 1994; however, the crediting period start date under VCS is 1st January 2009.

1.6 Project Crediting Period

The proposed project activity will use a fixed crediting period of 60 years, starting from 1st of January 2009 and ending on 31st of December 2068.

1.7 Project Location

The project activity is located in western Uganda, near the base of the Rwenzori Mountains and about 200 km north of the equator (**Figure 1.7.1**). It falls into Kabarole district and is within half an hour's drive from Fort Portal town.

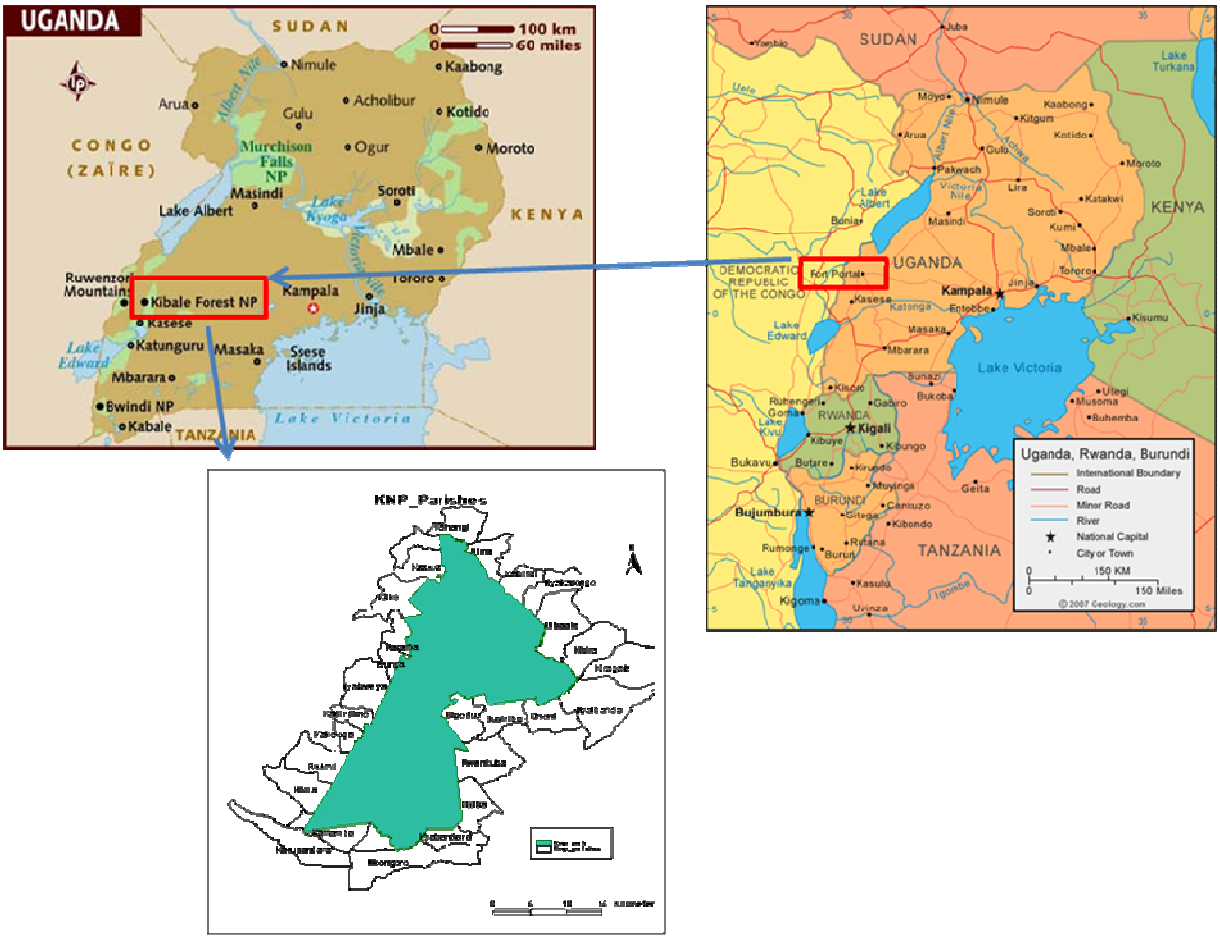

Figure 1.7.1. Location of Fort Portal town and communities surrounding proposed ARR VCS project activity.

1.8 Title and Reference of Methodology

This project activity uses the approved baseline methodology called *"Approved consolidated afforestation and reforestation baseline and monitoring methodology AR-ACM0001: Afforestation and reforestation of degraded land", Version 05.0.0.*

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

Since the start of the ARR project activities in 1994, more than 3.400 hectares have been replanted and almost 2.600 hectares have naturally regenerated (Figure 2.1.1).

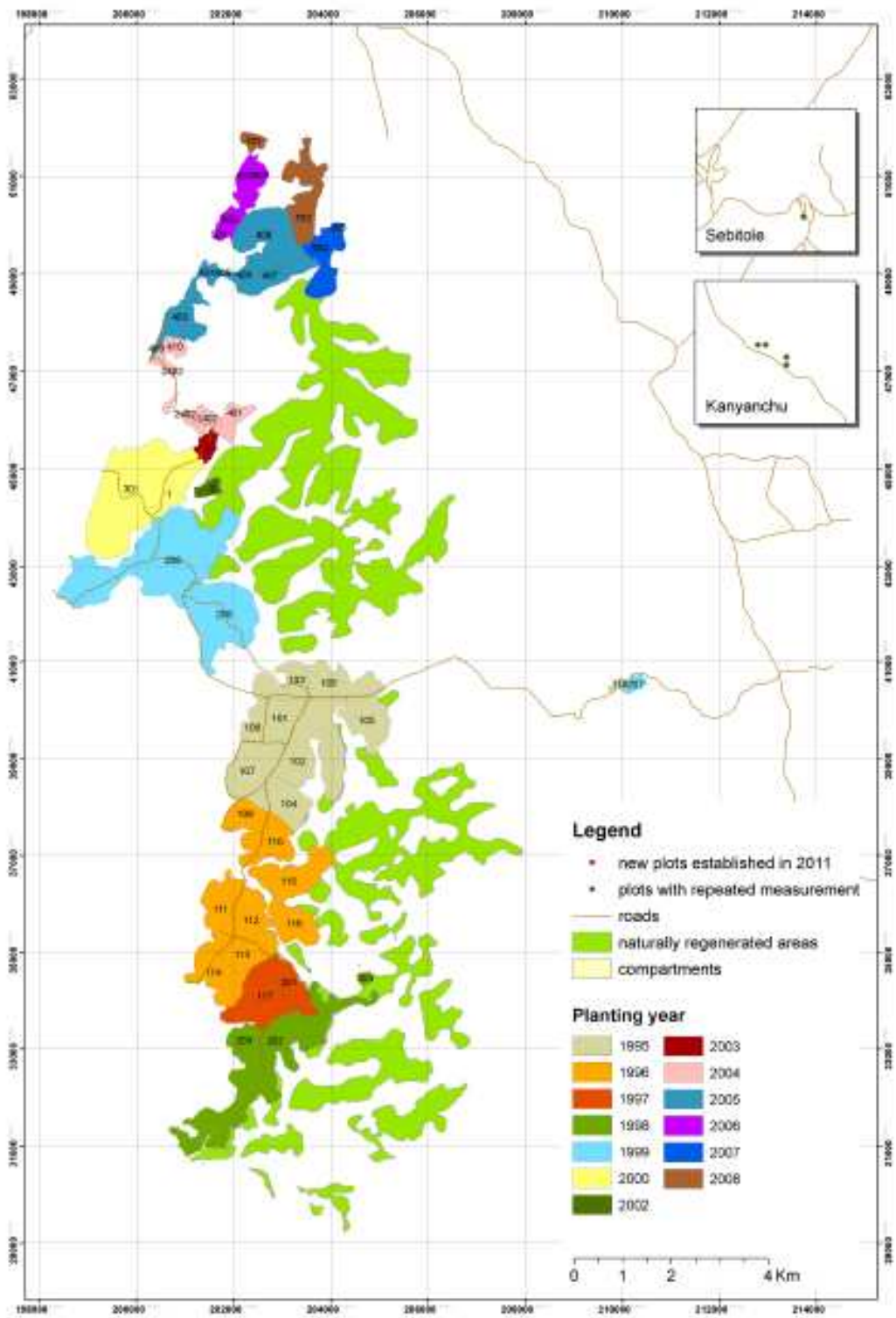

Figure 2.1.1. Showing an outline of planted and natural regeneration areas within the project boundary.

Table 2.1.1 outlines the areas (ha) that have been planted since 1995 and those that have naturally regenerated.

Planting Year	Area (ha)
1995	688,76
1996	591,70
1997	168,55
1998	359,68
1999	565,13
2000	339,28
2002	15,55
2003	20,85
2004	98,21
2005	284,78
2006	79,69
2007	89,92
2008	115,52
2009	105,00
2010	97,00
Natural Regeneration	2.592,92
Total	6.212,54

The AAR project activities in Kibale involved rehabilitation of degraded areas with native tree species comprising pioneers, intermediate, and climax species listed in Table 1.

Table 1. List of species selected for the ARR VCS project activity

Genus	Species
Albizzia	*qummifera*
Bridelia	*micrantha*
Celtis	*durandii*
Chrysophyllum	*albidum*
Cordia	*africana/abyssinica*
Cordia	*mellenii/ugandensis*
Croton	*macrostachys*
Croton	*megalocarpus*
Diospyros	*mespiliformis*
Erythrina	*abyssinica*
Ficus	*natalensis*
Funtumia	*elastic*
Lovoa	*trichiliodes/L. brownii*
Markhamia	*Platycalyx*
Mimusops	*bagshawei*
Prunus	*african/Pygeum africana*
Sapium	*ellipticum*
Spathodea	*campanulata / similotica*
Trichilia	*drageana / splendida*
Uvariopsis	*congensis*
Warbugia	*ugandensis*

The project does not anticipate any significant emissions from the project implementation activities because:

1. All labor force used for the proposed ARR VCS project activity is from local villages; hence transportation for workers is not needed.
2. All seedlings are raised on or near the site and will be transported to the project sites by manpower and project vehicles, whose emissions are insignificant.
3. No harvesting or thinning of the forest expected to take place as the project area wholly contained within the National park.

Non-permanence risk assessment was carried out using the VCS' "*AFOLU Non-Permanence Risk Tool*" version 3 of 8 March 2011. According to this tool, the project activity was rated at a low risk after yielding a 8.5% of buffer requirement. According to this tool, the project activity was rated at a low risk. The project has a system in place to identify risks and established targets to reduce any non-permanent risks. Procedures have been developed and responsibilities are well assigned with internal auditing, reviews and training in place. The project also has a well qualified, experienced local management team in place to ensure that the project activities are implemented effectively. Additionally, the project will hold a 10% VCS buffer in reserve for use in case of any loss of permanence. Reference is hereby made to the detailed VCS report called "*Non-Permanence Risk Report: Natural High Forest Rehabilitation Project on degraded land of Kibale National Park*" for more information.

2.2 Deviations from the Monitoring Plan

There have been no deviations to the monitoring plan so far.

2.3 Grouped Project

This is not a grouped project activity.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

3.1.1 Determination of Carbon stocks in trees:

$$C_{TREE,j,p,i} = f_j(DBH, H) * (1 + R_j) * CF_j$$

Data Unit / Parameter:	$C_{TREE,j,p,i}$
Data unit:	t C
Description:	Total carbon stock in trees of species j in sample plot p in stratum i.
Source of data:	Calculated from formula above
Value applied:	Varied according to area planted
Purpose of the data:	To calculate carbon stock in tree biomass for each stratum
Any comment:	

Data Unit / Parameter:	*DBH*
Data unit:	m
Description:	Diameter measured at 1.3m height
Source of data:	Measured in the field
Value applied:	Dependant on the size of tree.
Purpose of the data:	Calculation of carbon stock in trees
Any comment:	

Data Unit / Parameter:	*H*
Data unit:	m
Description:	Measured in the field by either a laser impulse or criterion

Source of data:	Measured in the field
Value applied:	Dependant on the height of tree.
Purpose of the data:	Calculation of carbon stock in trees
Any comment:	The heights of bend or slanted trees were modeled using exponential model H=(1.3+exp(P1+P2/DBH)). Where P1 and P2 are parameters. The model was parameterized on the level of single inventory plot (if there were more then 3 samples of the same species measured) or species level (all trees of the same species in case there were not enough samples in the single inventory plot). Crown width of bend or slanted trees were modeled using equation CW=a*DBH^b*Height^c. where a, b and c are parameters developed by the National Biomass Study in Uganda. The model was parameterized using general model (all samples with measured crown width).

Data Unit / Parameter:	*CR*
Data unit:	m
Description:	Measured in the field by either a laser impulse or criterion
Source of data:	Measured in the field
Value applied:	Dependant on the width of tree.
Purpose of the data:	Calculation of carbon stock in trees
Any comment:	Crown width was measured directly in the field. Field-Map provides functionality for mapping the horizontal crown projection. If projection was circular then only one point was measured (x, y co-ordinates in relation to the tree stem center), if horizontal projection was irregular then two points were taken to map the shortest and longest distance of crown circumference.

Data Unit / Parameter:	*a*
Data unit:	Dimensionless
Description:	Established for tree size classes based on data obtained in Uganda.
Source of data:	NBS, Kampala, Uganda based on Velle (1997) and

	Begumana (2000)
Value applied:	-0.85989 for DBH <20cm ; -1.75089 for DBH 20-60cm; -2.16650 for DBH >60cm.
Purpose of the data:	To calculate the fresh weight of carbon stock held in trees
Any comment:	

Data Unit / Parameter:	*b*
Data unit:	Dimensionless
Description:	Established for tree size classes based on data obtained in Uganda.
Source of data:	NBS, Kampala, Uganda based on Velle (1997) and Begumana (2000)
Value applied:	1.54456 for DBH <20cm ; 1.94391 for DBH 20-60cm; -2.03293 for DBH >60cm.
Purpose of the data:	To calculate the fresh weight of carbon stock held in trees
Any comment:	

Data Unit / Parameter:	*c*
Data unit:	Dimensionless
Description:	Established for tree size classes based on data obtained in Uganda.
Source of data:	NBS, Kampala, Uganda based on Velle (1997) and Begumana (2000)
Value applied:	0.50663 for DBH <20cm ; 0.47373 for DBH 20-60cm; -0.31292 for DBH >60cm.
Purpose of the data:	To calculate the fresh weight of carbon stock held in trees
Any comment:	

Data Unit / Parameter:	*d*
Data unit:	Dimensionless
Description:	Established for tree size classes based on data obtained in Uganda.
Source of data:	NBS, Kampala, Uganda based on Velle (1997) and Begumana (2000)

Value applied:	0.33335 for DBH <20cm ; 0.24578 for DBH 20-60cm; -0.43634 for DBH >60cm.
Purpose of the data:	To calculate the fresh weight of carbon stock held in trees
Any comment:	

Data Unit / Parameter:	MP_{TREE}
Data unit:	Dimensionless
Description:	Conversion factor wet to air-dry weight biomass
Source of data:	NBS, Kampala, Uganda
Value applied:	Ranged from 0.5 – 0.75 for known species, a value of 0.56 was applied to all unknown species.
Purpose of the data:	To convert from wet to air-dry weight biomass
Any comment:	Species specific.

Data Unit / Parameter:	*CF*
Data unit:	t C t^{-1} d.m.
Description:	Carbon Fraction for dry matter in biomass
Source of data:	IPCC default value
Value applied:	0.5
Purpose of the data:	To convert from wet to air-dry weight biomass
Any comment:	Species specific.

Data Unit / Parameter:	*R*
Data unit:	Dimensionless
Description:	Below ground biomass determination
Source of data:	Nabuurs and Mohren, 1993
Value applied:	Dependant on the size of tree, ranged from 0.32 for smallest to 0.08 for largest trees.
Purpose of the data:	Estimation of below-ground biomass based on the above-ground biomass values.
Any comment:	

3.1.2 Determination of Carbon stocks in tree biomass for each stratum:

$$C_{TREE,i} = \frac{A_i}{A_{p,i}} \sum_{p=1}^{P_i} \sum_{j=1}^{J_i} C_{TREE,j,p,i}$$

Data Unit / Parameter:	$C_{TREE,i}$
Data unit:	t C
Description:	Carbon stock in trees in stratum
Source of data:	Calculated from formula above
Value applied:	Varied according to area planted
Purpose of the data:	To calculate the total carbon stock in tree biomass for each stratum
Any comment:	

Data Unit / Parameter:	A_i
Data unit:	ha
Description:	Total area of stratum
Source of data:	GPS coordinates
Value applied:	Varied according to area planted
Purpose of the data:	To calculate the total carbon stock in tree biomass for each stratum
Any comment:	

Data Unit / Parameter:	$A_{p,i}$
Data unit:	ha
Description:	Total area of sample plots in stratum
Source of data:	GPS coordinates
Value applied:	Dependant on the size of strata.
Purpose of the data:	To calculate the total carbon stock in tree biomass for each stratum
Any comment:	

Data Unit / Parameter:	$C_{TREE,\,j,p,i}$
Data unit:	t C
Description:	Carbon stock in trees of species or group of species *j* in plot *p* of stratum *i*.
Source of data:	Calculated from formula above
Value applied:	Varied according to area planted
Purpose of the data:	To calculate the total carbon stock in tree biomass for each stratum
Any comment:	

Data Unit / Parameter:	*j*
Data unit:	Count
Description:	1,2,3,… J_i species or group of species in stratum *i*.
Source of data:	Measured in the field
Value applied:	
Purpose of the data:	To calculate the total carbon stock in tree biomass for each stratum
Any comment:	

Data Unit / Parameter:	*p*
Data unit:	Count
Description:	1,2,3,… p_i sample plots in stratum i in the project scenario.
Source of data:	Measured in the field
Value applied:	
Purpose of the data:	To calculate the total carbon stock in tree biomass for each stratum
Any comment:	

Data Unit / Parameter:	*i*
Data unit:	Count
Description:	1,2,3,… M_{ps} strata in the project scenario.
Source of data:	Measured in the field
Value applied:	

Purpose of the data:	To calculate the total carbon stock in tree biomass for each stratum
Any comment:	

3.1.3 Estimation of change in carbon stock in tree biomass:

$$dC_{TREE,i,(t_1,t_2)} = \frac{C_{TREE,i,t_2} - C_{TREE,i,t_1}}{T}$$

Data Unit / Parameter:	$dC_{TREE,\,i,\,(t1,t2)}$
Data unit:	t C yr^{-1}
Description:	Rate of change in carbon stock in above-ground and below-ground biomass of trees in stratum *i* for a period between year t_1, and year t_2.
Source of data:	Calculated from formula above
Value applied:	Varied according to area planted
Purpose of the data:	To estimate change in carbon stock in tree biomass
Any comment:	

Data Unit / Parameter:	$C_{TREE,\,i,\,t2}$
Data unit:	t C
Description:	Carbon stock in trees in stratum i at a point of time in year t2.
Source of data:	Calculated in 3.1.2
Value applied:	Varied according to area planted
Purpose of the data:	To estimate change in carbon stock in tree biomass
Any comment:	

Data Unit / Parameter:	$C_{TREE,\,i,\,t1}$
Data unit:	t C
Description:	Carbon stock in trees in stratum i at a point of time in year t1.
Source of data:	Calculated in 3.1.2
Value applied:	Varied according to area planted

Purpose of the data:	To estimate change in carbon stock in tree biomass
Any comment:	

Data Unit / Parameter:	*T*
Data unit:	years
Description:	T_2 is 2011 and T_1 is 2008
Source of data:	Record time
Value applied:	3
Purpose of the data:	To calculate rate of change of carbon stocks.
Any comment:	

Data Unit / Parameter:	*Plot positions*
Data unit:	Coordinates
Description:	
Source of data:	Field measurement
Value applied:	Varied per location
Purpose of the data:	
Any comment:	

3.1.4 Actual Net GHG removals by sinks:

Since only tree biomass is considered for this purpose in the ARR project activity in Kibale, then

$$\Delta C_t = \sum_{i=1}^{M_{PS}} (\Delta C_{TREE,i,t} + \Delta C_{DW,i,t} + \Delta C_{LI,i,t} + \Delta C_{SOC,i,t})$$

is equal to:

$$dC_{TREE,i,(t_1,t_2)} = \frac{C_{TREE,i,t_2} - C_{TREE,i,t_1}}{T}$$

presented above. Therefore, the actual net GHG removals are determined by:

$$\Delta C_P = \frac{44}{12} * \sum_{t=1}^{t^*} \Delta C_t$$

Data Unit / Parameter:	ΔC_p
Data unit:	tCO_{2-e}
Description:	Sum of the changes in carbon stock in all selected carbon pools in stratum I, since start of the project
Source of data:	Calculated
Value applied:	
Purpose of the data:	To estimate verifiable changes in the carbon stock within the project boundary.
Any comment:	

Data Unit / Parameter:	$\frac{44}{12}$
Data unit:	diamensionless
Description:	Ratio of molecular weights of CO_2 and carbon
Source of data:	IPCC
Value applied:	
Purpose of the data:	To estimate verifiable changes in the carbon stock within the project boundary.
Any comment:	

3.2 Data and Parameters Monitored

Data Unit / Parameter:	A_i
Data unit:	ha
Description:	Area of tree biomass stratum *i*.
Source of data:	
Description of measurement methods and procedures to be applied:	See SOP
Frequency of monitoring/recording:	Every 5 years after initial verification
Value monitored:	Original size of stratum
Monitoring equipment:	*GPS*
QA/QC procedures to be applied:	See QA/QC Procedures and Section 3.21 below.
Calculation method:	
Any comment:	

Data Unit / Parameter:	$a_{i,p}$
Data unit:	m^2
Description:	Area of sampling frame for plot *p* in stratum *i*
Source of data:	Predetermined by IFER
Description of measurement methods and procedures to be applied:	See SOP
Frequency of monitoring/recording:	Every 5 years after initial verification
Value monitored:	Original size of plot
Monitoring equipment:	*GPS*
QA/QC procedures to be applied:	See QA/QC Procedures and Section 3.21 below.
Calculation method:	
Any comment:	

Data Unit / Parameter:	$A_{p,i}$
Data unit:	ha
Description:	Total area of all sample plots in stratum *i*
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	See SOP
Frequency of monitoring/recording:	Every 5 years after initial verification
Value monitored:	
Monitoring equipment:	*GPS*
QA/QC procedures to be applied:	See QA/QC Procedures and Section 3.21 below.
Calculation method:	
Any comment:	

Data Unit / Parameter:	*DBH*
Data unit:	m
Description:	Diameter at breast height of tree
Source of data:	Measured in the field
Description of measurement methods and procedures to be applied:	Following the SOP for carbon monitoring.
Frequency of monitoring/recording:	Every 5 years after initial verification

Value monitored:	
Monitoring equipment:	Tape measure
QA/QC procedures to be applied:	Following the QA/QC OP for carbon monitoring
Calculation method:	N/A
Any comment:	

Data Unit / Parameter:	*H*
Data unit:	m
Description:	Height of tree
Source of data:	Measured in the field
Description of measurement methods and procedures to be applied:	Following the SOP for carbon monitoring.
Frequency of monitoring/recording:	Every 5 years after initial verification
Value monitored:	
Monitoring equipment:	Laser Impulse or Criterion
QA/QC procedures to be applied:	Following the QA/QC OP for carbon monitoring
Calculation method:	N/A
Any comment:	

Data Unit / Parameter:	*T*
Data unit:	Year
Description:	Time period elapsed between two successive estimations of carbon stock in a carbon pool/ Year
Source of data:	Record time
Description of measurement methods and procedures to be applied:	N/A.
Frequency of monitoring/recording:	Every 5 years after initial verification
Value monitored:	5 years
Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Calculation method:	N/A

Any comment:	T_2 and T_1 represent the successive times of estimations of carbon stocks in a carbon pool

3.2.1 Monitoring equipment

Field-Map technology is composed of software and hardware parts. For more information see www.fieldmap.cz. The set is composed of laser rangefinder, electronic compass, GPS, field computer and other accessories. Three sets have been used in Kibale. Table 3.2.1. below shows the main hardware parts.

Table 3.2.1.1: List of main equipment used in during monitoring.

Description	Manufacturer	SN	Note
Hammerhead HH3 monochrome	DRS	29236	water resistant (IP66), 10 inch display
Hammerhead	DRS	H154H10XM002N02DN	water resistant (IP66), 10 inch display
Hammerhead HH3 monochrome	DRS	29235	water resistant (IP66), 10 inch display
Laser Rangefinder Impulse 200 LR	LaserTech	i07524	waterproof (IP67), typical distance accuracy 3-5cm, inclination accuracy 1°, range up to 575 m
Laser rangefinder and compass Criterion	LaserTech	10281	typical distance accuracy 9cm, compass accuracy 0.3°, range up to 457 m
Laser Rangefinder Impulse 200 LR	LaserTech	i07523	waterproof (IP67), typical distance accuracy 3-5cm, inclination accuracy 1°, range up to 575 m
Electronic compass MapStar	LaserTech	C001545	water resistant (IP54), azimuth accuracy 0.3°
Electronic compass MapStar	LaserTech	C001552	water resistant (IP54), azimuth accuracy 0.3°

GPS Pathfinder Power	Trimble	224048548	water resistant
GPS Pathfinder Power	Garmin	224048532	water resistant
GPS Garmin 60CSx	Garmin		waterproof (IPX7)

In addition to the main equipment, a number of accessories were also utilized and are listed in the table below.

Table 3.2.1.2: Hardware accessories

Description
Carrying cases for computers, laser rangefinders and compasses
Telescopic poles 4.5 m
Poles 2 m
Poles 1.3 m
Cylindrical reflectors
Circular reflectors
Reflective prism
Measuring tapes
Cables (connecting lasers, compasses, computers and GPS)
Port replicators for Hammerhead computer
Chargers for AA batteries
Chargers for external Li-on batteries
Chargers for external Lead batteries
External batteries Li-on

External batteries Lead
Rechargeable AA batteries
Telescopic monopode
Aluminum frame for computer
MapStar Field Degausser
Other accessories

3.2.2 Calibrations

An electronic compass is the most sensitive hardware part as far as calibration is concerned. Electronic compasses were demagnetized prior the field campaign using Map-Star Field Degausser. Compasses were calibrated every day by Field-Map operators on the location where the navigation to the plots started. The procedure of compass calibration was explained to Field-Map operators during the training. Other electronic devices were calibrated from the respective manufacturers and needed no further calibration in the field.

3.3 Description of the Monitoring Plan

The monitoring involves the monitoring of the project boundary, forest establishment, forest management, instrumentation and sampling information as described below:

3.3.1 Monitoring of project boundary

The project boundary is used to delineate the project area. The location of each node of the project boundary is measured during fieldwork and archived in the database. The project boundary is monitored during events such as site preparation, planting, permanent sampling operations, fire monitoring events, carbon monitoring campaign, etc., during which compartment IDs and compartment areas are required to be entered.

Table 3.3.1. Unique identification of the planting compartments for the KNP project (coordinates in UTM ARC 1960 Zone 36N).

Compartment ID	Grid Coordinates	
	Eastings	Northings
1	200707	44462
2	201537	44553
3	201445	45466
101	202919	39805
102	203380	39166
103	203196	40444
104	203103	38162
105	204763	39896
106	202458	39714
107	202365	38710
108	204026	40535
109	202365	37705
110	202826	37431
111	201719	35788
112	202364	35606
113	202088	35058
114	201719	34419
115	203194	36518
116	203102	35605
117	202548	33962
118	209927	40533
201	203286	34145
202	203101	33323
203	202271	32319

Compartment ID	Grid Coordinates	
	Eastings	Northings
204	204669	34418
205	201628	41997
206	200707	43275
207	210204	40533
301	199877	44554
403	200893	48114
404	201446	49027
405	201723	49026
406	202184	48935
407	202737	49026
408	202830	49848
409	200431	47566
401	201906	46014
410	200800	47475
501	201723	49848
502	201908	50122
503	202185	50944
504	202554	51035
602	203844	49482
603	204121	49939
701	202462	51765
702	203476	50395
1402	201445	45922
2402	200431	47201

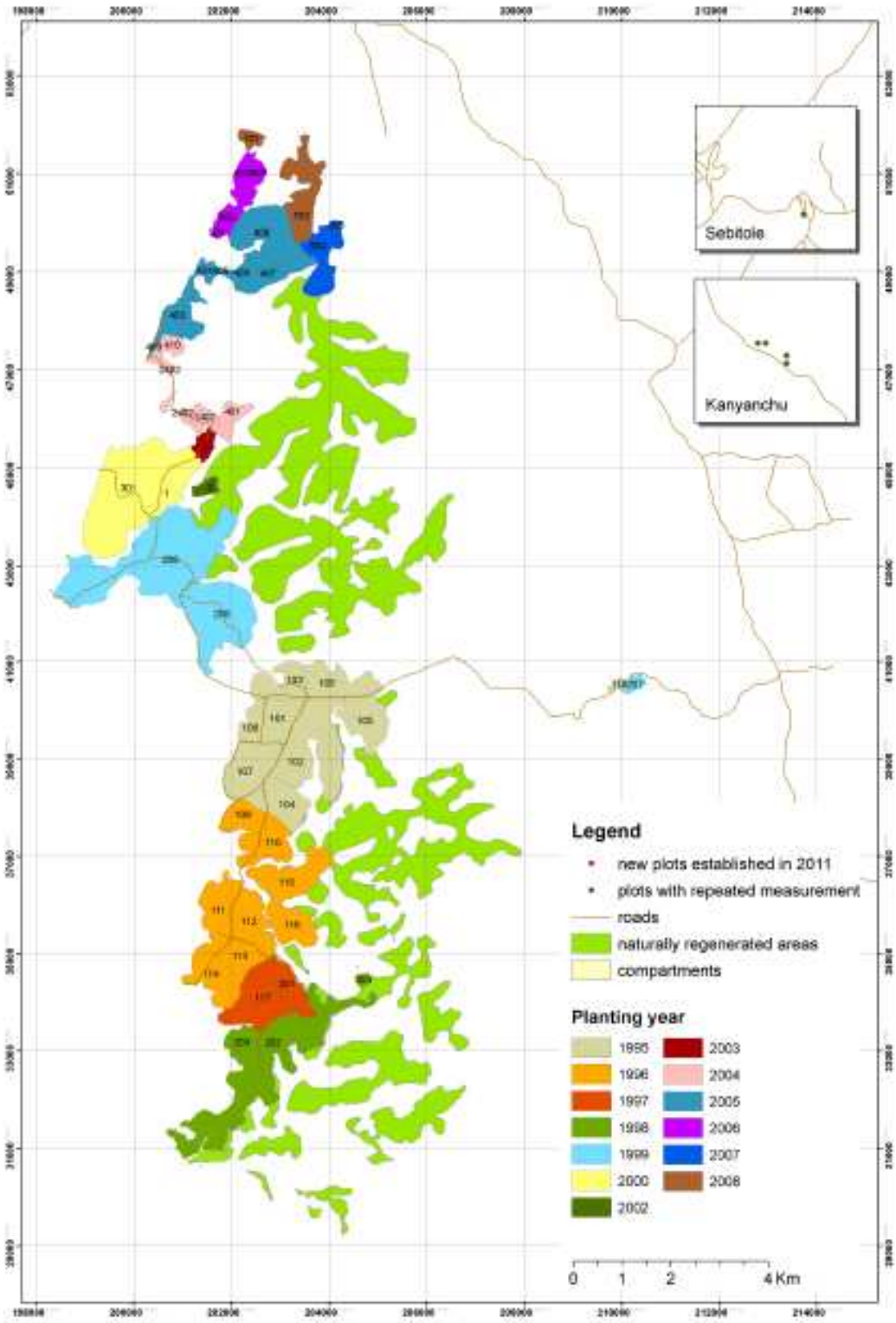

Figure 3.3.1. Showing an outline of planted and natural regeneration areas within the project boundary.

The project boundary is monitored through two different activities:

1. Through a computer program called **MONIS** (Monitoring and Information System) which was developed with the specific aim to monitor the progress of the project over the lifetime of the contract. The program makes use of satellite images, ground photographs and topographic maps of the region. In addition to this program, Geographic Positioning System (GPS) is utilized in order to locate the specific boundaries of the project area and the national park at large. An in-house training program was developed and implemented for relevant staff members to utilize GPS technology for these activities. In order to store basic data in a logical order, data entry into MONIS is carried out on a monthly basis after the monthly reports have been submitted from the field.

2. Through mapping activities of planted compartment boundaries using a hand-held GPS. Coordinates at each turning point on the compartment boundary are recorded in order to show proper boundaries of planted areas and to determine the actual planted areas. Mapping is carried out every year after planting targets have been achieved. The end product of the mapping exercises are maps of the rehabilitated areas.

Table 3.3.2. Data used for monitoring project boundary

Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of data points / Other measure of number of collected data.	Comment
Project ID	Alpha numeric	d	Before the start of the project	100%	Named before the project start.
Project location	Alpha	m	Before the	100%	Using GPS to locate

	numeric		start of the project		geographical coordinates of the project boundary before start of the project
Compartment ID	Alpha numeric	d	Annually	100%	Each compartment has a particular combination of tree species and year planted. Numeric series ID will be assigned to each compartment
Compartment Area	Alpha numeric	c	5 years	100%	Spatial extent of actual area of compartment (spatial size) determined by the use of GPS

3.3.2 Monitoring of Carbon Stocks

The carbon monitoring campaign in Kibale NP used the same plot design and methodology as were applied in Kibale NP during previous campaigns in 2002 and 2008. For details about the general methodology see Methodology for Carbon Stock Monitoring (Černý et al., 2002).

3.3.2.1 Sampling Scheme

A regular sampling grid was applied to all the compartment areas using clusters of four permanent sampling plots at a spacing of 500 x 500 meters. In the naturally regenerated areas, the same grid was employed, however, clusters of three permanent sampling plots were randomly spread throughout the entire area. This design allowed adding new clusters when needed (see Figure 3.3.2.1.).

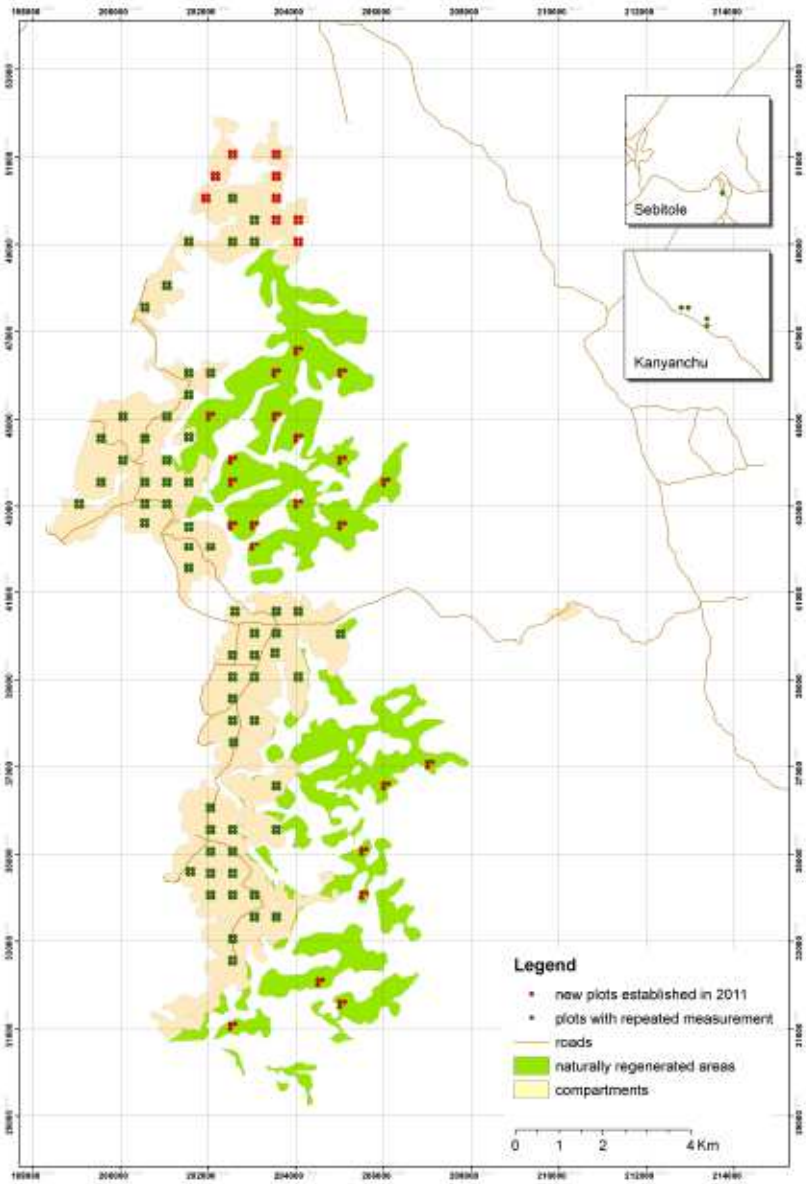

Figure 3.3.2.1. Overview of carbon monitoring sampling grid in Kibale.

In total there were 283 plots in 71 clusters established or re-measured in compartment areas. Of this number, 9 were newly established clusters with 36 inventory plots. The naturally regenerated areas comprised of 66 plots in 22 clusters. The number of sampling plots and the targeted precision

level for the biomass estimation is ± 10% of the mean at a 90% confidence level and was determined using the approved CDM tool for "*Calculation of the number of sample plots for measurements within A/R CDM project activities*" version 02.1.0 as required by the CDM methodology AR-ACM0001, version 05.0.0. Tables 3.3.2.1 and 3.3.2.2 below outline the precision level of 5.7% in the planted areas and 10.5% in the natural regeneration area.

Table 3.3.2.1. Outlining the precision level for biomass estimation in planted areas.

Mean carbon stock in whole tree biomass by planting year (DBH>49 mm)				
Planting year	**Carbon/whole-tree biomass**			
	t/ha	**lower conf. limit**	**upper conf. limit**	**Precision, %**
1995	23,66	20,36	26,96	13,9
1996	46,31	40,48	52,14	12,6
1997	60,8	48,61	72,99	20
1998	42,47	34,29	50,64	19,2
1999	34,52	30,5	38,55	11,7
2000	31,01	24,74	37,28	20,2
2002	25,78	10,55	41,02	59,1
2003	26,41	6,24	46,58	76,4
2004	14,41	7,91	20,91	45,1
2005	17,23	12,09	22,38	29,9
2006	24,69	15,68	33,71	36,5
2007	10,09	6,39	13,8	36,8
2008	14,96	7,3	22,61	51,1
All	32,59	30,73	34,46	**5,7**

Table 3.3.2.1. Outlining the precision level for biomass estimation in natural regeneration area.

Mean carbon stock in whole tree biomass by tree type (DBH>49 mm)				
Tree type	**Carbon/whole-tree biomass**			
	t/ha	**lower conf. limit**	**upper conf. limit**	**Precision, %**
native species	38,42	34,13	42,72	
introduced species (Eucalyptus&Cassia)	4,49	2,63	6,36	
All	42,92	38,41	47,43	**10,5**

3.3.2.2 Cluster Design

The inventory plots were aggregated in clusters. It was planned that one field group would manage one cluster per day on average. The cluster design is described in Figure 3.3.4.2 below.

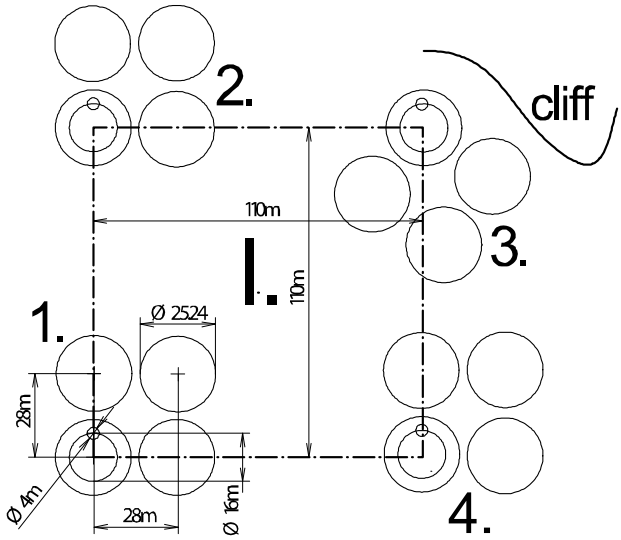

Figure 3.3.4.2 . The monitoring cluster (I.) consists of four plots (in compartments) or three plots (in naturally regenerated areas). Each sampling plot is composed of four circles 500 m^2 each. Plot 3 was rotated because of the obstacle. The obstacle can be road, cliff, river, etc.

3.3.2.3 Plot Design

Each inventory plot (Figure 3.3.4.3.) was composed of four circles with an area of 500 m^2 each (i.e. 2 000 m^2 altogether). The key circle contained two additional circles: a concentric internal subplot to measure smaller trees; and, a small eccentric circle for the assessment of tree regeneration. The applied limits for sub-circles and tree size specified for the carbon monitoring project in Uganda are shown in Table 3.3.4.3.

Table3.3.4.3: Applied limits for trees given by diameter at breast height (DBH) for particular sub-plots within an inventory plot.

Circle radius	Tree DBH limit
Eccentric 2 m "regeneration circle"	Bellow 50 mm
Up to 8 m of the key plot centre	50 mm and more
Up to 12,62 m of the key plot centre (its entire area)	150 mm and more
Remaining three large circles of the plot	300 mm and more

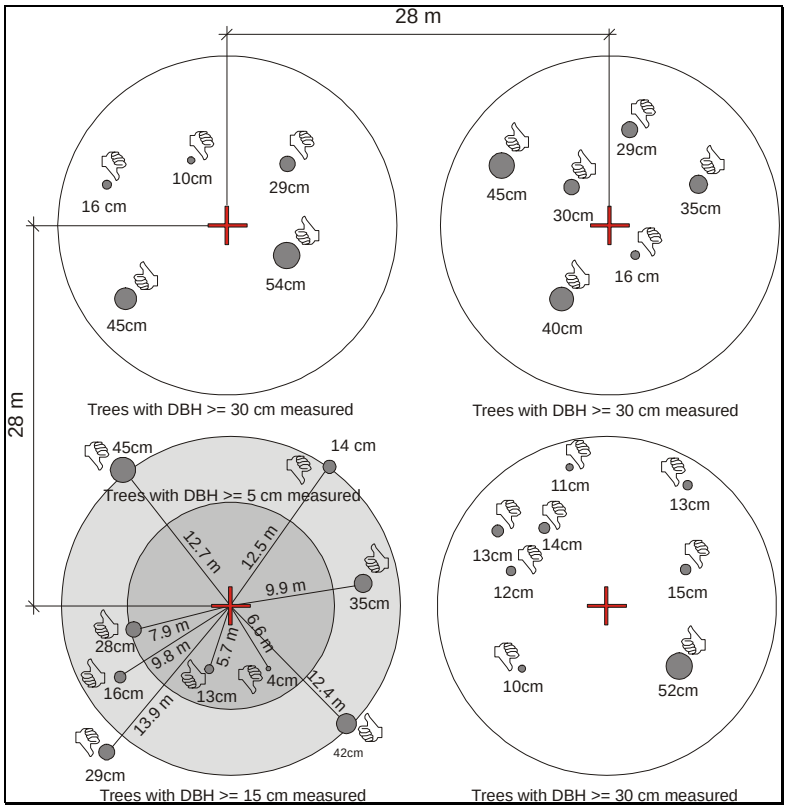

Figure 3.3.4.3. Trees equal or greater than 30 cm of DBH are measured in the entire plot. Trees equal or greater than 15 cm of DBH are measured in the light gray circle. Trees equal or greater than 5 cm of DBH are measured in the inner dark gray circle.

Tree regeneration was only surveyed in the regeneration circle (2 m radius), located 8 m to the North from plot centre. If regeneration was present within this circle, height description and species determination was also performed. A tree was classified as regeneration only if the DBH was less than 50 mm and height was more than 10 cm.

Additionally, deadwood and stumps were described in the key circle of each plot. Only deadwood with a diameter larger than 20 cm and stumps with a surface diameter larger than 30 cm were recorded.

3.3.2.4 Database Structure

The components that were subject to measurement and/or description in this project are represented as layers in the database structure. They are shown in Table 3.3.5.

Table 3.3.5: List of measured or described components

Layer	Description
Plots	Basic description of the plot
Trees	Standing trees and dead trees; DBH ≥ 50 mm
Deadwood	Lying wooden debris; length ≥ 1 m; center diameter ≥ 20 cm
Regeneration	Planted tree and natural regeneration; Height ≥ 0.1 m; DBH < 50 mm
Stumps	Rest of tree; ground level diameter ≥ 30 cm
Shrubs	Shrub layer

3.3.2.5 Measurement technology

Field-Map technology (www.field-mapping.com) was used for data collection and mapping in this monitoring campaign. Field-Map (© IFER-Monitoring and Mapping Solutions, Inc.) is an advanced computer aided field data collection technology based on modern electronic devices and user-friendly software. The complete Field-map solution includes specific features and utilities that are specifically important for the demanding field conditions of tropical regions. They include efficient field navigation, support for concentric sample plot circles, continuous georeferencing, remote diameter measurement allowing measuring trees with buttresses, several height measurement modes etc.

List of main parts of Field-Map equipment used in Kibale:

- GPS
- Calliper
- Field computer
- Laser rangefinder
- Electronic compass
- Reference poles with reflectors
- Telescopic monopod
- Telescopic main pole
- Battery charger
- Accessories

Figure 3.3.6. Field-Map set

3.3.2.6 Organizational structure , roles, responsibilities and competencies.

Many people were involved in the monitoring campaign on different levels. Majority of them were workers doing the actual fieldwork. There were 3 field teams involved in the 2011 field campaign. For easy orientation these were called Red, Blue and Green Teams. The team members are trained on using the monitoring equipment and on the procedures for monitoring. In the selection procedure of the team members, prior experience with monitoring is a very important criterion. All supervisory staff (managers, leaders and supervisors) have forestry background and have multiple years of experience in forest inventories.

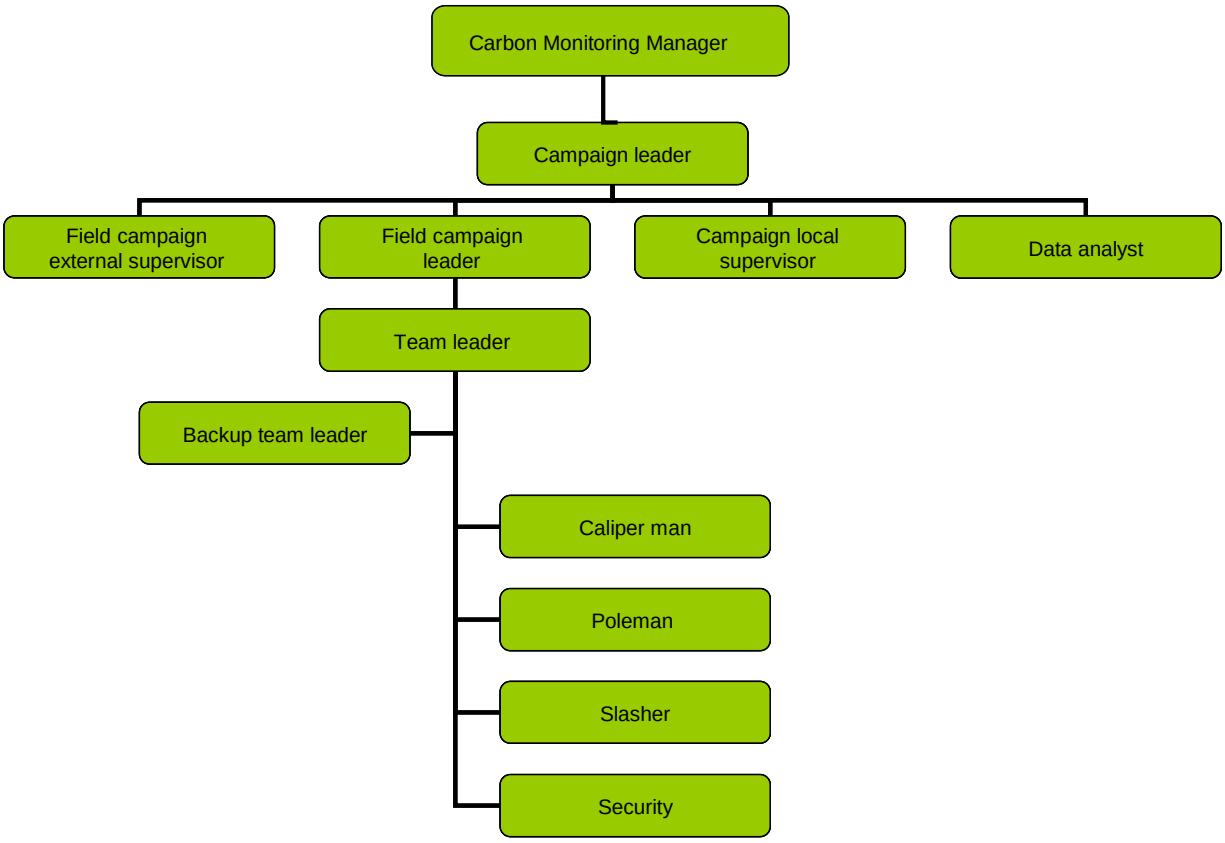

Figure 3.3.7: Organizational Structure

Carbon Monitoring Manager
The carbon monitoring manager is responsible for planning and coordinating the monitoring campaign activities and contracting staff for implementing the campaign. The manager is also responsible for writing the monitoring report.

Campaign leader
The leader of the campaign is responsible for the methodology of the campaign. He designs the project structure and supervises the data evaluation.

Field campaign leader
Leader is responsible for the operations on the ground. The main tasks of the leader are to select and hire local staff capable of works related to computer aided field data collection, manage monitoring teams in the training phase and also later in the field, organize repairs of broken equipment and assigned other responsibilities to team leaders.

Field campaign external supervisor
External supervisor is responsible for teaching the correct methodological approach to the local workers. He is present in the beginning of the campaign to ensure that all problems related to equipment and project database structure are solved and all questions regarding the methodology of data collection are answered. He leads the training of local staff. He is also present at the end of the campaign to check data quality and to check the quality of field work by revisiting random selection of inventory plots and re-measuring them.

Data analyst
Data analyst is responsible for data check and data evaluation. He carries out the statistical computations and produces the final results.

Campaign local supervisor
Local supervisor is responsible for transportation in the field, supply of local workers and for other administrative tasks and logistics.

Team leader
Team leader is responsible for managing local workers in the field and is operating the technology in the field and therefore must be familiar with it. He is also responsible for daily backup of collected data.

Backup team leader
Backup team leader acts as team leader in case that team leader is not able to participate in the field work on particular day. Otherwise he is regular member of the field crew.

Caliper man
Works with caliper. He needs to follow the methodology for dbh measurement and measure diameters responsibly.

Poleman
Poleman is operating measuring pole. He is familiar with the correct procedures for measuring positions of the trees and also procedure for navigation to the plot.
Slasher
Slasher helps to clear the way to the other team members. He must make sure that no excessive cutting takes place during the survey.

Security
Security man is armed and ensures safety of the team in the field.

Table 3.3.7: List of people involved in the 2011 carbon monitoring campaign.

Team member	Team	Role
Tasila Banda	-	Carbon Monitoring Manager
Martin Černý	-	Campaign leader
Frederick Wanyama	-	Field campaign leader ******
Petr Vopěnka	-	Field campaign external supervisor
Radek Russ	-	Field campaign external supervisor and Data analyst
Chemutai Wilfred	-	Field campaign local supervisor *******
Richard Kigenyi	Red	Team leader *****
Nelson Enyagu	Green	Team leader ****
Richard Muhabwe	Blue	Team leader ******
Wasike Joseph	Blue	Backup Team leader ***
Chebet Jamada	Red	Backup team leader *****
Megezi Sunlight	Green	Backup team leader ****
Bitaka Juma	Green	Slasher **
Bigabomwe Garas	Blue	Slasher **
Alibonoha Isaac	Green	Slasher *
Basaliza Patrick	Blue	Caliper man *
Amanya Augustine	Green	Poleman *

Team member	Team	Role
Rwabuguli Lawrence	Red	Poleman *
Byamulcama Rashid	Red	Caliper man **
Mugarra Wilson	Red	Slasher **
Kiiza Gregory	Blue	Slasher **
Turyahabwa Monday	Red	Slasher **
Alinaitwe Velentino	Green	Caliper man *
Baita Mary	Green	Security ****
Okumu	Red	Security ****
Ocaya Robert	Blue	Security ***
Owoyesisgire Hamada	Blue	Poleman **
******* *UWA-FACE Warden*, ****** *Monitoring and Research Warden*, ***** *Forest Clerk*, **** *Ranger*, ***Head Ranger*, **UWA_FACE worker*, **Headman*		

3.3.2.7 Training and support

The training at Kibale was scheduled for early February 2011. IFER, represented by Petr Vopěnka, led the training of the data collection using Field-Map technology. Three field teams were trained in the hardware maintenance and software operation. Team leaders were also trained in backing up of the data. Standard Operating Procedures document was prepared containing step-by-step description of the procedures including screenshots of the Field-Map software.

3.3.2.8 Standard of Operating Procedures

Standard Operation Procedures (SOP) for the carbon monitoring campaign was written in 2011 by IFER in cooperation with Face the Future. The content of the SOP is in line with the content of the monitoring training sessions. The SOP includes procedures for all monitoring steps. Specific procedures are provided for plots that are measured for the first time and for plots that are re-measured. The main items include procedure for:

- Navigating to the plot centre
- Fixing (first measurement) or finding (re-measurement) the plot centre
- Measuring and describing trees
- Describing other parameters of the plot
- Checking the database
- Creating data back-up

3.3.2.9 Standard of Quality Assurance and Quality Control Procedures

Standard of Quality Assurance and Quality Control Procedures (QA/QC) for the carbon monitoring campaign was also written in 2011 by IFER in cooperation with Face the Future. The contents of the Standard of Quality Assurance and Quality Control Procedures are in line with the content of the QA/QC training sessions. The Standard of Quality Assurance and Quality Control Procedures includes procedures for all monitoring steps. Specific procedures are provided for plots that are measured for the first time and for plots that are re-measured.

The Field-Map software includes a number of automatic data checks. In addition, the build-in checking routines were amended by scripts written specifically for this monitoring campaign. Thus the data could be checked online in the field. The checking routines included:

- empty values (where database fields are defined as required, the data checking routine warns the user about empty values).
- values out of bounds (e.g. since the trees are measured for the second time the DBH should be larger and therefore a warning message pops up every time the new DBH is smaller then old DBH).
- dependency checks (conditional lookup lists shorten the choice for subordinate variable, e.g. selecting certain species group shortens list of individual species).
- SQL queries (final checking of the database performed by IFER is through the SQL queries. These checks are designed specifically for the purpose of this project at the time of data checking and validation at the end of the campaign).

The final checks of the database revealed some discrepancies, but there were not many since most of the potential mistakes were captured by automatic checks.
These errors were mainly concerning proper categorization of tree regeneration into height classes. The errors were corrected by moving the individual trees into proper classes.
QA/QC checks were performed during the campaign. A total 48 plots were re-measured, which equals to 10% of the total number of plots. The field checks were conducted jointly by IFER and Face the Future. The difference between data collected by field teams and QA/QC teams expressed in tons of carbon per plot ranged from -24% up to +21% (checking data are considered to be 100%). Mean difference is 0.26 t/plot and mean relative difference then being 2.7%.

3.3.2.10 Corrective and preventive measures

The Field-Map software contains a measurement assistant. The assistant is a software wizard, which guides the user through the field measurement process. The assistant can be switched on for beginners and switched off for advanced users. The user interface is build for the project and contains lookup list populated with project specific values (e.g. species list contains only species occurring in the project area). This prevents the mistyping the names and values which is crucial for database consistency and further data processing.

For every numeric field in the data collection forms it is possible to define minimum and maximum accepted values. If smaller or larger value is entered, the software warns the user and the user needs to enter valid value.
The main window of the data collection software contains a map of the inventory plot showing the plot boundary, boundary of concentric circles, location of measured trees and circles showing DBH for every tree. Any time the measured tree location falls outside the plot, the user is warned. As soon as DBH of the tree is entered, the location of the tree is checked and compared to allowed DBH value in particular concentric circle. If there is a discrepancy, the user is warned and asked to either delete the tree or correct the DBH value.
The aim of the 2011 monitoring campaign was to find existing trees in the field that have been measured in previous campaigns. The software has functions for searching the trees and comparing the new measured values with the old ones. More details on the functionality of Field-Map software are located at www.fieldmap.cz.

3.3.2.11 Management of monitoring data and archiving of documentation

Data are stored in the database called Field-Map project. Field-Map project is a folder containing database tables in Paradox or MS Access format, ESRI Shapefiles, XML configuration files and other necessary files. The structure of the Field-Map project is managed through Field-Map Project Manager application.

Field-Map is designed to work with distributed databases, which in practice means that many field teams can work on the same project at the same time and the results of the data collection can be easily combined together and stored in common database on daily basis.
The database was backed up on several locations and intervals during the field campaign:

- Field computers (Field teams stored their work on their computers.)
- USB drives of the field team leaders (Every day the teams backed up the work to computer in the office through USB stick. The data stayed on the USB stick as well.)
- Office computer (The data was combined together from all three groups and stored at UWA-Face office computer on daily bases).
- Computer at IFER (At the beginning and at the end of the campaign, when IFER supervisor was present Kibale, the backups were done to the IFER computer as well. During the campaign IFER received data sets via email and stored these as back up.)

Since the entire data collection process is electronic, there is no need to store any paper forms.

3.3.2.12 Technology for data processing

Advanced technology Field-Map was used also for data processing. The advantage of the Field-Map technology is implementation of the field computers in data collection process. Therefore the data collected in the field are digitized instantly in the field and are stored in industry standard formats (maps in ESRI shape files, tables in Paradox or MS Access).
Field-Map Data Processing Tools are used for further processing (i.e. calculation of missing variables, data classifications/re-classifications, data aggregation), while Field-Map

Inventory Analyst (© IFER-Monitoring and Mapping Solutions, Inc.) is used for statistical analyses.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

There is no quantification of baseline emissions for this project activity. However, baseline removals have been quantified through the estimation based on existing data as recommended in the Methodology AR-ACM0001/Version 05.0.0 Section 4.2.1. as follows:

$$B_{TREE_BSL} = BD_{TREE_BSL} * A_{TREE_BSL}$$

The carbon stocks in living trees at the start of project activity in planted (in planting years 2009 and 2010) and natural regeneration area was calculated as follows:

$$C_{TREE_BSL} = \frac{44}{12} * B_{TREE_BSL} * CF_{TREE_BSL}$$

The baseline net GHG removals for 2009 and 2010 are equal to the sum of the carbon stock changes in the above-ground and below-ground biomass of trees in the baseline which is equal to zero.

4.2 Project Emissions

There is no quantification of emissions because all the labor force used for the proposed ARR VCS project activity is from local villages; hence transportation for workers is not needed. All seedlings will be raised on or near the site and will be transported to the project sites by manpower and project vehicles, whose emissions are insignificant. No harvesting or thinning of the forest expected to take place as the project area wholly contained within the National park.

The quantification of carbon stock in the above-ground and below-ground tree biomass ($C_{TREE,i,t}$) is estimated using the allometric equation method with the data collected from sample plots measured during the 2008 and 2011 carbon monitoring campaigns.

The allometric equations were formed as:

$$\ln(W_{wet}) = a + b * \ln(D) + c * \ln(HT) + d * \ln(CR)$$

Where, W_{wet} is the calculated tree fresh weight (all above-ground components). The parameters a, b, c were established for three tree size classes based on a wealth of destructively obtained data in Uganda (Velle 1997, Begumana 2000, IFER 2002). The parameters a, b, c that were applied in the calculation of W_{wet}: are shown in Table 3 (after Velle 1997 adjusted by Begumana 2000).

Table 4.2.1: The set of parameters for allometric equation estimated by NBS, Kampala, Uganda.

Diameter range	Parameters			
	a	b	c	d
DBH<20 cm	-0.85989	1.54456	0.50663	0.33335
DBH 20-60 cm	-1.75089	1.94391	0.47373	0.24578
DBH>60 cm	-2.16650	2.03293	0.31292	0.43634

Conversion of W_{wet} to air-dry weight was performed by applying conversion factors that were locally available at NBS, Kampala, Uganda. These conversion factors were species-specific and ranged between 0.32 and 0.75. If a factor for particular species was unknown, a default value of 0.54 was applied. This corresponds to a mean value of the available factors for common tree species in Uganda. The list of conversion factors is in Appendix I.

An additional factor of 0.853 was used to account for differences between air-dry weight and oven-dry weight. This corresponds to a moisture content of 14.7 % in air-dry matter. This is the average value found in the local experiments (NBS, unpublished material).

Oven-dry matter was converted to carbon stock using a factor of 0.50, which is a commonly used value elsewhere (Matthews ,1993; Schelhaas, 2002; Kort, 1999) and also recommended by the IPCC (1995 a, b).

Finally, the below-ground biomass component (root system) was accounted for by multiplying the above-ground carbon stock by a specific root factor of 1.16.

As earlier stated, the change in the carbon stock in tree biomass was estimated on the basis of the field measurements in the permanent sample plots collected during the 2008 and 2011 carbon monitoring campaigns. The rate of change of carbon stock in trees was calculated as:

$$dC_{TREE,i,(t_1,t_2)} = \frac{C_{TREE,i,t_2} - C_{TREE,i,t_1}}{T}$$

Because no other carbon pools such as deadwood, litter and soil where considered in this project activity, only the above-ground and below-ground pools where included in the estimation of the changes in carbon stocks. And because of this,

$$\Delta C_t = \Delta C_{TREE,I,t}$$

Verifiable changes in the carbon stock in the selected above-ground and below-ground carbon carbon pools within the project boundary were estimated using the following equation:

$$\Delta C_P = \frac{44}{12} * \sum_{t=1}^{t^*} \Delta C_t$$

Table 4.2.2. below outlines the calculations described above.

Table 4.2.2. Estimation of changes in the carbon stocks per strata (DBH>49 mm)								
Planting year		Carbon/whole-tree biomass in ton carbon						
	Area	$C_{TREE\,t1}$	$C_{TREE\,t2}$	$\Delta C_{TREE,i,t}$	ΔC_t	$\Sigma\Delta C_t$	Molecular Ratio	ΔC_P
1995	688,76	13.065,00	16.297,00	1.077,33	1.077,33	10.029,71	3,67	73.551,22
1996	591,7	21.103,00	27.402,00	2.099,67	2.099,67			
1997	168,55	9.701,00	10.248,00	182,33	182,33			
1998	359,68	10.226,00	15.275,00	1.683,00	1.683,00			
1999	565,13	13.857,00	19.511,00	1.884,67	1.884,67			
2000	339,28	7.351,00	10.535,00	1.061,33	1.061,33			
2002	15,55	198,00	401,00	67,67	67,67			
2003	20,85	284,00	552,00	89,33	89,33			
2004	98,21	644,00	1.416,00	257,33	257,33			
2005	284,78	3.057,00	4.909,00	617,33	617,33			
2006**	79,69	408,01	1.969,00	520,33	520,33			
2007**	89,92	460,39	790,00	109,87	109,87			
2008**	115,52	591,46	1.730,00	379,51	379,51			
Natural Regeneration***	2.592,92	13.511,71	108.821,00	5.606,43	5.606,43	5.606,43		349.467,41
** Initial carbon stock		5,12						
***$C_{TREE\,t1}$ value for Natural Regeneration is from the start of project activity in 1995.								

For the calendar years 2009 and 2010 the total verifiable carbon stocks are determined to be 73,551.22 tons of CO2 in the planted area. However, this value need to be corrected for dead wood carbon stocks that was included in the monitoring results. The parameters $C_{tree,t1}$ and $C_{tree,t2}$ contain dead wood carbon stocks for each planting year (this is not the case for the Natural Regeneration area). The total value of the dead wood carbon pool is known for *t1* (2008) and *t2* (2011), which is 10.806 tCO2 and 20.068 tCO2 respectively. The change in the dead wood carbon pool (*t2* – *t1*) is 9.262 tCO2, and this needs to be subtracted from the 73,551.22 tons of CO2. The real value of ΔC_p for the planted area is therefore 64,289.22 tCO2.

For the natural regeneration area, the total verifiable carbon stocks are determined to be 349.467.41 tons of CO2. Adding this to the total value of the planted area (67.858) gives a total of 413,756.63 tons of CO2.

4.3 Leakage

There is no quantification of leakage because all the proposed ARR VCS project activities are taking place within the boundary of a well protected national park of Kibale. The selected methodology requires assessing and accounting leakage resulting from displacement of agricultural activities. Local communities already have their fields outside the boundary of the national park and will therefore not be displaced by the project activity. Therefore,

$$LK = \sum_{t=1}^{t^*} LK_{AGRIC,t}$$

is equal to zero.

4.4 Summary of GHG Emission Reductions and Removals

The net anthropogenic GHG removals by sinks of this A/R CDM project activity in Kibale is equal to the actual net GHG removals by sinks because leakage was determined to be zero. Therefore, the following equation was applied:

$$C_{AR-CDM} = \Delta C_{ACTUAL} - \Delta C_{BSL}$$

C_{AR-CDM} = 413,757 – 0 = 413,757

C_{AR-CDM} = VCUs = 413,757

The AFOLU buffer withholding percentage is **10%.**

The number of VCU's to be retained in the buffer are: 41,376

The amount of VCU's to be issued after subtraction of the buffer are: 372,381.

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