Project Name:	Laguna Seca Forest Carbon Project
Project Location:	Belize, Orange Walk District
Project Proponent:	The Forestland Group LLC, Kaarsten Turner Dalby, kaarsten@forestlandgroup.com, (303) 838-2512
Auditor:	Environmental Services Inc., Shawn McMahon, smcmahon@ESINC.CC, 330-833-9941
Project start date:	January 1, 2011
GHG accounting period:	January 1, 2011 through December 31, 2040
Lifetime:	30 years
Full validation or a gap validation:	full validation

History of CCB Status, where appropriate, including issuance date(s) of earlier Validation/Verification Statements: not applicable

Edition of the CCB Standards being used for this validation: Third Edition

Brief summary of the project's expected climate, community and biodiversity benefits:

This project intends to protect 8,432 ha of mature tropical forest in Belize at imminent threat of conversion to sugarcane at project start. This area is a rare example of protected forest with complete neotropical biodiversity. The project will provide climate benefits by avoiding emissions associated with land clearing and agriculture, gold level biodiversity benefits by protecting habitat for multiple species on the IUCN Endangered list, and community benefits by committing to annual support of a scholarship fund for community members to attend high school.

Optional Gold Level criteria are being used and a brief description of the attributes that enable the project to qualify for each relevant Gold Level:

Gold Level based on exceptional biodiversity benefits including multiple IUCN Endangered species

Date of completion of this version of the PDD, and version number, as appropriate:

Version 1. 17 March 2016

Expected schedule for verification, if known: Verification planned in 2017, 2021, 2026, 2031, 2036, 2040, and 2041.

LAGUNA SECA FOREST CARBON PROJECT

Document Prepared By Forest Carbon Offsets LLC

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Project Title	Laguna Seca Forest Carbon Project
Version	1.7
Date of Issue	17/03/16
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1 GENERAL

1.1 Summary Description of the Project (G3)

The goal of the project is to protect the property as a carbon sink, maintain the biodiversity values of the property, and provide net positive community benefits through support for the local high school scholarship fund. The climate objective is to avoid emissions from deforestation during the project timeframe. The project area was slated for conversion to sugarcane agriculture.

The project consists of protection of the property through 2040 (30 years) through patrols. Gallon Jug Agroindustry Ltd. (GJA) owned and managed the property prior to implementation of the project. Gallon Jug Agroindustries implemented the project, and then sold the property to The Forestland Group (TFG). Forest Carbon Offsets LLC (FCO) was an agent of GJA to develop the carbon finance project, and continues to serve in that capacity for TFG. The Conservation Management Institute at Virginia Tech (CMI) was the subcontractor originally hired to conduct technical analyses on behalf of FCO in 2011. A more recent update to the inventory data plus additional community input data was developed by ERA/Offsetters/NatureBank of Vancouver, Canada. CMI updated remote sensing and mapping data in 2015.

This project started in 2011 to protect 8,432 ha of tropical forests in Belize, Central America. The entire property owned by GJA originally consisted of 53,882 ha. Near the center of the property, 1,214 ha is managed as a cattle and coffee farm. An exceptional ecotourism lodge (Chan Chich Lodge) is on the property as well. The property was selectively logged multiple times through the 1960's when it was purchased (fee simple) in the 1980's by Sir Barry Bowen, a well-known businessman and former Belizean Senator. The property was managed for conservation with the exception of the farm. Due to the untimely death of the owner and the global economic recession, a portion of the property was proposed for development and conversion to sugarcane for a new sugar/electricity facility. Expected carbon finance allowed the owners to avoid going forward with the sugarcane project, and instead sell a large portion of the property (~41,152 ha) including the entire project area, to The Forestland Group, LLC of Chapel Hill, NC.

Biodiversity at Gallon Jug is well documented and world-renowned. The densest population of large cats in Central America has been documented on the property primarily due to superb habitat and a rigorous prohibition on hunting. In addition to large cats, there are notable populations of Baird's Tapir (*Tapirus bairdii*), Yucatan Black Howler Monkeys (*Alouatta pigra*), and Geoffroy's Spider Monkeys (*Ateles geoffroyi*) all of which are listed as endangered by the International Union for the Conservation of Nature. Many other rare species are commonly found at the project site and 24 species are listed by IUCN above "least concern". The property has been identified as a key biodiversity area (KBA) in Belize and Central America (Meerman 2007) and is contiguous with two other protected areas, the Rio Bravo Conservation and Management Area, and the Maya Biosphere Reserve in Guatemala. The project proponents will support the community through contributions to the Gallon Jug-Chan Chich High School Scholarship Fund, a scholarship fund to defray the cost of high school tuition for children in the community.

The "without project" baseline scenario for this project is conversion to agricultural for sugarcane. Additionality is proven by virtue of the financial statements of the former owner and written plans for conversion. Road access is adequate. Topography is minimal. Soils are good as evidenced by the existing cattle operation already on the property and past efforts to evaluate sugarcane. Impacts to biodiversity and the local community would be drastic, largely negative and potentially impact the surrounding properties.

The "with project" scenario would maintain the current management regime which consists of very low impact timber harvesting and conservation of the property. FSC certification will be achieved in 2016. The hunting prohibition will be maintained and patrols increased. Support for the community will be maintained and increased by virtue of contributions to a scholarship program for members of the community to attend high school. Climate, biodiversity and community value monitoring would commence.

Climate, Community, and Biodiversity Standard Gold Level is achieved by virtue of the significant biodiversity resources conserved on the property including habitat for multiple IUCN listed species and most notably IUCN-Endangered Baird's tapir (*Tapirus bairdii*), Yucatan black howler monkey (*Alouatta pigra*) and Geoffroy's spider monkey (*Ateles geoffroyi*).

Forest Carbon Offsets LLC (FCO) is the project developer. The Forestland Group LLC is the project proponent. The Project follows the carbon accounting principles of conservatism, accuracy, completeness, transparency, consistency, and relevance. Validation under the Verified Carbon Standard and the Climate, Community, and Biodiversity Alliance Standard is sought. After validation, registration of voluntary emission reduction credits will be conducted with the APX Environmental Registry.

1.2 Project Location (G1 & G3)

The Project area is located at Latitude 17°34'15.65" N and Longitude 89°03'06.30" W in the Orange Walk District, Belize 47.5 km northwest of Belmopan, Belize. The Project boundary encompasses 8,432 ha of which 8240 ha are available and suitable for conversion to agricultural uses in the absence of finance from a carbon trade program.

Belize is a neotropical country that experiences a pronounced dry and wet season. Rainfall average annual totals from 1339.0-1546.6 mm per year (Tench 2013). Rainy season typically begins in late May and continues through November. Temperatures throughout Belize vary across different districts with mean annual temperatures ranging from 27°C along the coast to 21°C in the hills. Hurricanes and tropical storms peak in September and can have a significant effect on rainfall totals (Belize National Meteorological Service 2011).

Soils in the project area consist of the Yaxa Suite and specifically soils that are formed under constant lime enrichment (Baillie et. al. 1993). Elevation ranges from 10-20 m (Miller and Miller 2011).

Due to the remote nature of the property, and the fact that only two other landowners, Rio Bravo Conservation and Management Area and the Yalbac Ranch, have common boundaries, the project zone for this project consists of the original property owned by Gallon Jug Agroindustries plus the Rio Bravo Conservation and Management Area and the Yalbac Ranch property. The Rio Bravo Conservation and Management Area is managed by the Programme for Belize[1] a nonprofit established for that purpose. The Yalbac Ranch is owned and operated for timber production by the Forestland Group LLC[2] , a US-based timber company.

[1] Programme for Belize http://www.pfbelize.org/
[2] Forestland Group LLC http://www.forestlandgroup.com

Figure 1: Project location map.

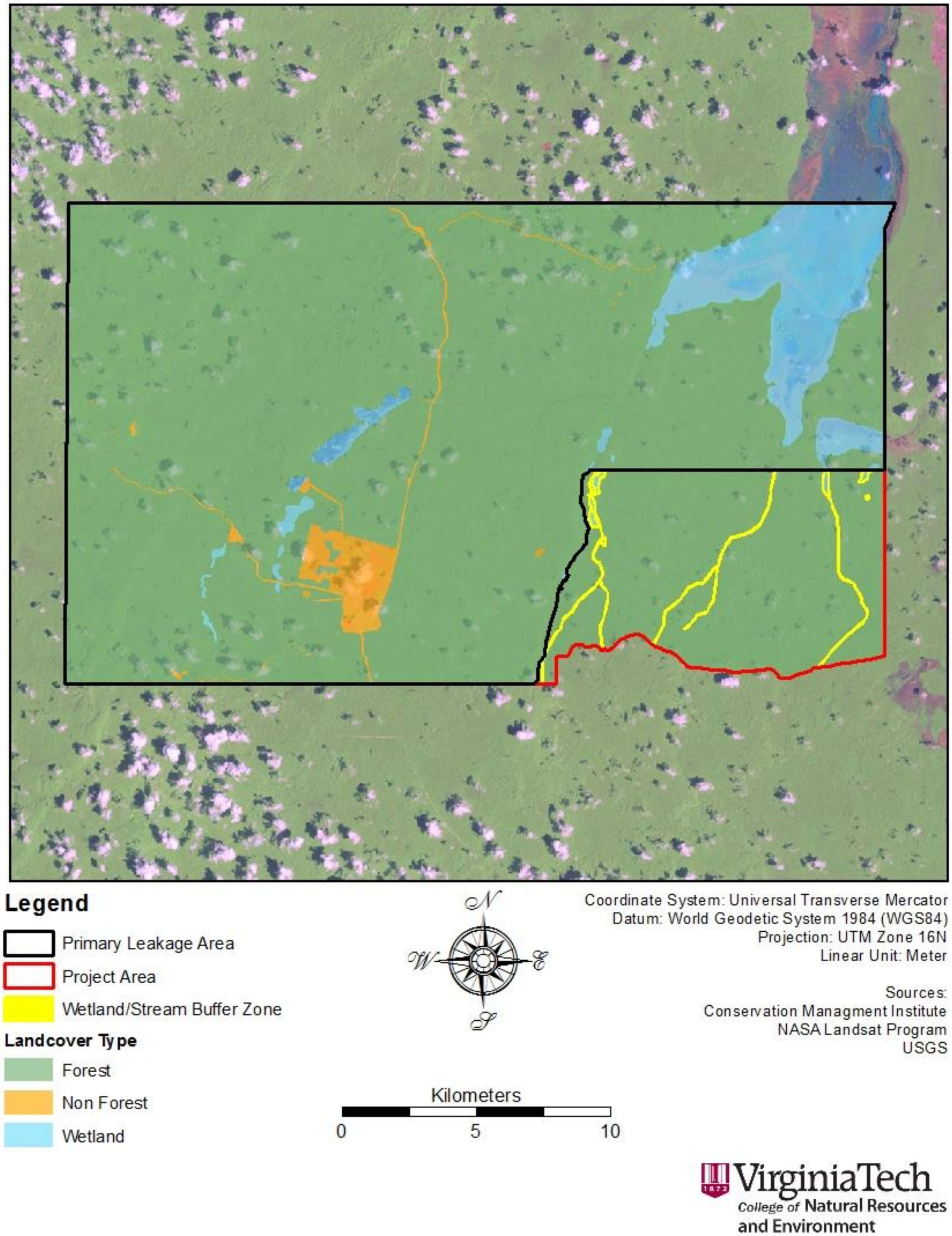

Figure 2: Project Area and Leakage Area

1.3 Conditions Prior to Project Initiation (G1)

In the 1960's, the property was owned by the Belize Estates Company. Belize Estates harvested timber using selective harvesting. Gallon Jug was a Belize Estates logging camp. The property was purchased by Sir Barry Bowen of Bowen and Bowen Ltd. in the 1980's. The property was divided into four parcels, approximately 400,000 acres became the Rio Bravo Conservation and Management Area to the north and east. Bowen & Bowen Ltd. retained 133,000 acres at Gallon Jug and cleared 3,000 acres for farming. The remainder, Yalbac Ranch, was sold to private owners.

Farming at Gallon Jug has focused on cattle and coffee and test plots and planning for sugarcane began as early as 1999 but became a high priority in 2010-2011. Selective harvesting of timber has occurred historically. A small mill was built on site and products are sold primarily for the domestic market with small lots of export grade mahogany sold internationally. Chan Chich Lodge, an ecotourism operation, was built in the late 1980's and has been recognized as a top-tier international destination for birdwatching and nature tourism.

Due to the vigorous prohibition on hunting and the large unbroken tract of nearly mature forest, the biodiversity of the project area is exceptional. GJA supported a biodiversity research effort on the property starting in the 1980's through 2012. For a large part of that time, support was provided by the Wildlife Conservation Society. Important publications have been produced on neotropical biodiversity as a result of this work.

The forest consists of tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-western Variant, locally known as "high forest" and tropical evergreen seasonal broadleaf lowland swamp forest: High Variant locally known as bajo forest (Meerman and Sabido 2001). High forest is typical of Central America with a very diverse species assemblage. Bajo forest consists of the same tree species, but due to periodic flooding, slower growth characteristics are prevalent.

Periodic storms (hurricanes and the remnants of hurricanes) impact the forest causing small scale blowdowns. Very infrequent large hurricane events can cause wider damage. The last hurricane to cause widespread damage was Hurricane Hattie in 1961. Minor damage occurs more frequently, e.g. Hurricane Richard in the fall of 2010, which is quickly recovered by fast growing plant colonizers and the natural ecological response to canopy gaps in this sort of forest system (Bridgewater 2011). Rainfall average annual totals from 1339.0-1546.6 mm per year (Tench 2013).

In 2010, the CEO and a strong advocate for conservation of the property, Sir Barry Bowen passed suddenly in a small airplane accident. Leadership of Bowen & Bowen Ltd., the holding company that owns Gallon Jug Agroindustries, transferred to Michael Bowen ably assisted by Alexander Bowen, Manager for Gallon Jug Agroindustries Ltd. GJA had instituted several agricultural initiatives in an attempt to find an agronomic practice that would support the property and the community. One strategy that was evaluated extensively and at considerable expense was sugarcane agriculture. By 2010 a decision was needed to either go ahead with the sugarcane project, or find an alternative. Before he passed, Sir Barry Bowen made the decision to set aside the planned sugarcane project and instead contract with FCO to develop a carbon sequestration project thereby conserving the forest and the biodiversity found there. After Sir Barry's passing, Bowen & Bowen Ltd. sold a large portion of the property, including the designated sugarcane project area, to The Forestland Group (TFG). TFG pledged to maintain the carbon project while conducting low intensity selective harvesting.

Project Area Basic Ecotypes

There are several classification systems that can be used to map the vegetative communities within the Project area. The most useful is the basic ecotype classification described in Meerman and Sabido (2001) which identifies two distinct ecosystems within the Project area (Figure 2).

1. Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Central-western variant (hereafter referred to as "high forest")

This type is found at an elevation under 100 m on mostly well-drained soils over calcareous rock where average rainfall is less than 2000 mm/year with a pronounced dry season. Forest to 25 m tall on mostly well-drained limestone soils.

2. Tropical evergreen season broadleaf lowland swamp forest: High variant (hereafter referred to as "bajo")

This type at an elevation under 250m on ill-drained soils over calcareous rock where average rainfall is less than 2000 mm/year with a pronounced dry season. This forest type is low in stature with a broken canopy with a distinct deciduous element.

Based on inventory data, the carbon sequestration of these two types was determined to be insignificantly different, so the two types were merged and treated as one strata.

Carbon Stocks within the Project Area

The approach to measuring carbon stocks in the Project area is based upon the *Sourcebook for Land Use, Land-Use Change and Forestry Projects* (Pearson et. al. 2005). These methods comply with the Intergovernmental Panel on Climate Change's 2006 Guidelines for National GHG Inventories for Agriculture, Forestry and Other Land Use. The overarching methodology for determining climate benefits is VDM0007 REDD Methodology Modules (REDD-MF), v1.5[3].

Carbon Pools

The carbon pools selected for measurements are the aboveground tree ≥ 5 cm DBH, palms from .3 m to 15.7 m in height varying by species, and belowground biomass. Soil carbon, down or standing dead wood, and leaf litter were not measured, which resulted in a conservative estimation of carbon stocks.

Table 1: Selected Carbon Pools and Sources of Greenhouse Gas Emissions

Carbon pools	Included / excluded	Justification / explanation of choice
Aboveground tree biomass	Included	A major component of project. Three species of palms are included.
Aboveground nontree biomass	Included	Included based on Dewalt and Chave (2004).

[3] See Verified Carbon Standard Methodologies http://www.v-c-s.org/methodologies/VM0007

Belowground tree biomass	Included	A component of the project calculated as a ratio of aboveground tree biomass.
Belowground nontree biomass	Included	A component of the project calculated as a ratio of aboveground nontree biomass.
Dead-wood	Excluded	More deadwood is conservatively assumed to be present in the project case than the baseline case. Conservatively excluded.
Harvested wood products	Included	The standard practice in Belize for conversion of forest to agricultural lands is to remove valuable timber species and then bulldoze and burn the remaining trees. This pool is the same in the baseline and project scenarios. The long term wood products in the project case is summed with an estimation of overall degradation which was found to be de minimis.
Litter	Excluded	Conservatively excluded.
Soil organic carbon	Excluded	Conservatively excluded.

Sources	**Gas**	**Included / excluded**	**Justification / explanation**
Biomass burning	CO_2	Excluded	CO_2 emissions are accounted for by biomass changes in the aboveground and belowground biomass pools.
	CH_4	Included	Calculated based on methodology component "Approved VCS Module VMD0013, Version 1.0, REDD Methodological Module: Estimation of greenhouse gas emissions from biomass burning (E-BPB) "
	N_2O	Included	
Combustion of fossil fuels	CO_2	Excluded	Conservatively omitted from the baseline and project scenarios.
	CH_4	Excluded	Conservatively omitted from the baseline and project scenarios.
	N_2O	Excluded	Conservatively omitted from the baseline and project scenarios.
Use of fertilizers	CO_2	Excluded	Conservatively omitted from the baseline and project scenarios.
	CH_4	Excluded	Conservatively omitted from the baseline and project scenarios.
	N_2O	Excluded	Conservatively omitted from the baseline and project scenarios.

Field Measurements

Using a digital map of the project area, 40 plots were randomly allocated. The methods for measuring the carbon pools at TFG were based on the *Sourcebook for Land Use, Land-Use Change and Forestry Projects* (Pearson et al 2005). Because destructive sampling was not practical to measure aboveground carbon stocks, published allometric equations were used to determine aboveground biomass based upon the DBH of hardwood trees and the height of palms. Forest inventory techniques were used to collect the appropriate field data following Pearson et al (2005).

Every tree tallied was marked with a metal identification tag and given a unique identification number for future monitoring. Raw data were entered into a spreadsheet for data analysis and carbon calculations. Detailed procedures for field measurements may be found in the Monitoring Plan Section 8.1.

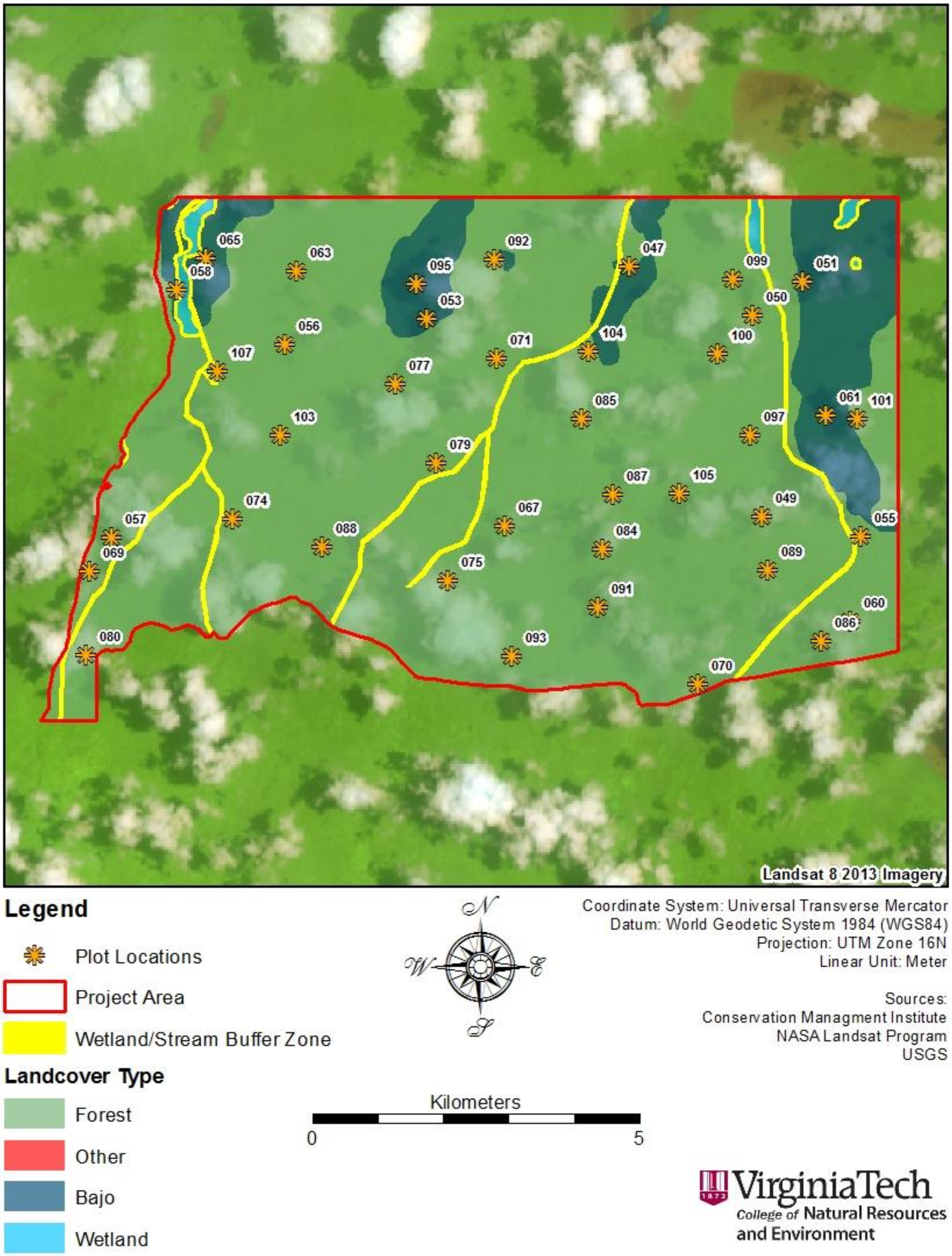

Figure 3: Project area plot locations.

Carbon Stock Calculations

The dry tropical (900-1500 mm rainfall) forest equation in Pearson et. al. (2005) was used to determine aboveground biomass for trees, and equations from Brown (2015) were used to determine aboveground biomass for three common species of palms. The equations were validated according to the methodology for testing allometric equations and found to be representative and unbiased.

For belowground tree biomass, the root-to-shoot ratios indicated in the methodology CP-AB was used which results in a ratio of .24 for plots indicating a mean aboveground biomass of 125 tons/ha or greater and a ratio of .2 for plots indicating a mean aboveground biomass of less than 125 tons/ha.

The average aboveground and belowground biomass was determined to be 353.02 tCO_2e/ha. Based on Cho (2007) and Meerman and Sabido (2001), two vegetation types were evaluated and mapped, high forest and bajo. Biomass data from inventory plots was collected from each type, and the difference in the means of the two types were found to be insignificantly different from the mean of all plots (-9.09% for bajo and +2.64% for high forest) therefore the two types were treated as one strata.

Table 2: Equations used for calculating biomass.

Classification	Equation: DBH = diameter breast height, D=wood density, H= height		Maximum DBH or height
Aboveground Tree Biomass: Pearson et. al. 2005 Tropical Dry (900-1500mm rainfall)	$AGB = 0.2035 * DBH^{2.3196}$		DBH <= 63 cm
Palm aboveground biomass (AGB): Brown 2015	Chrysophylla stauracantha	AGB = ((0.8966 * H) – 0.37988)	H 0.45-10.0 m
	Attalea cohune	AGB = (302.6 * ln(H)) + 276.93)	H 0.31-15.7 m
	Sabal mauritiiformis	AGB = ((14.596 * H) + 13.54)	H 0.3-14.53 m
Belowground Tree Biomass	If AGB is > 125 t/ha then BGB = AGB x .24 else BGB = AGB x .2		

Communities Located in the Project Zone

Due to the remote nature of the property, the only community in the project zone is the community of farm workers and managers that live on the farm at the center of the property, at Chan Chich Lodge and in Sylvester Village. The only employment in the community is through Gallon Jug Agroindustries. As a result of the project, The Forestland Group purchased a large portion of the property for low intensity selective harvesting. The mill at Yalbac to the south therefore became a part of the community since the millworkers now depend on timber from the newly acquired property.

Table 3: 2010 Census for Orange Walk District and Blue Creek[4].

Orange Walk Population by Gender, Number of Households and Average Household Size, 2010					
City, Town or Village	Total	Males	Females	No. of HH	Avg. HH Size
Total	45,946	23,214	22,732	10,452	4.4
Blue Creek	407	217	190	111	3.7

Table 4: 2010 Census for Belize by Age Group[5].

Age Group	Census 2010
Under 15	114,748
15 - 24	65,196
15 - 64	194,105
65 +	13,587
80 +	3,132

The community is a melting pot of people with different backgrounds, ethnicities, and histories much like the rest of Belize where mixing of ethnicities and origins (Maya, Hispanic from surrounding countries, Garifuna [African ancestry], British, American, and many others) have come together to form a unique culture much different than the rest of Latin America. Wages are controlled by the Belizean minimum wage law which in 2010 was $1.55/hour[5]. Supervisors are typically paid $3.75/hour. Housing is provided to workers at Gallon Jug at no cost. In 2010, the unemployment rate in the Orange Walk district ranged from 14% for older workers (35-39) to almost 40% for the youngest workers (14-19). Unemployment at Gallon Jug is essentially zero due to the Gallon Jug Agroindustries policy of only providing housing for workers (Jeal 2015).

Sylvester Village: This is a small village of approximately 40 houses for the workers at Gallon Jug Agroindustries (GJA). Supplies are brought in from Blue Creek, a very small town over an hour away by truck. A small store, two churches, and a community center are in Sylvester Village. Sylvester Village did not exist until Gallon Jug Agroindustries purchased the property and most of the buildings were built by GJA. Electricity and water are provided by GJA. The inhabitants are a mix of ethnic backgrounds from Belize and elsewhere in Central America. All of the inhabitants translocated to Sylvester Village as a result of a job offer from GJA as there are no other jobs available in the community. Since housing is provided by GJA, only families with jobs at GJA are permitted to stay in the village.

None of the community members at Sylvester Village depend upon the project area for material sustenance. The exception is that the Gallon Jug sawmill processes logs from the property. That mill will continue operating in the project scenario by processing logs for TFG. Residents at Sylvester Village are part of the community because of the project plan to support the Gallon Jug School scholarship program.

Chan Chich Lodge: There is a small group of homes (~16) at Chan Chich Lodge that house workers. These workers are drawn from the same pool of workers described for Sylvester Village. Women that work outside the home are typically working at the Lodge or in food processing on the farm. Electricity and water are provided by GJA. None of the community members at Chan Chich Lodge depend upon the project area for material sustenance. Residents

[4] Statistical Institute of Belize http://www.sib.org.bz/
[5] Beltraide: http://www.belizeinvest.org.bz/statistics-and-publications/labour-force/

at Chan Chich Lodge are part of the community, because of the project plan to support the Gallon Jug School scholarship program.

Gallon Jug School: Children from Sylvester Village and Chan Chich are transported to the school building on the farm each day that school is in session. This school serves approximately 75 children in grades K-8. After 8th grade, families that wish for their child to continue an education are required to send that child to high school in Orange Walk, a road trip of approximately 2 hours one way. High schools provide room and board and tuition is expected to be provided by the family. A scholarship fund has been established to defray the cost of high school attendance for children in the community.

Yalbac Mill: As a result of the purchase of a large portion of the property by The Forestland Group, the millworkers that TFG employs near Spanish Lookout are now considered a community by virtue of the timber provided by the property to feed the mill. No significant differences could be detected in ethnic background for this group. Since these workers actually live in villages scattered throughout the area, no significant impact could be discerned for any individual village.

Current Land Use and Land Tenure in the Project Zone

The Project does not encroach upon community property. The property is privately held and no additional approvals are required from the Government of Belize or the local communities to conduct the project. A license is required to sell timber and that license is premised on a forest management plan (Cho 2007) which has already been approved and the license granted. There are no ongoing indigenous peoples' property disputes with the Project property (Maya Atlas 1997). The forest management plan does not preclude clearing for agriculture. The current owners, TFG, are using the forest management plan as the basis for timber management.

Within the project zone, timber harvesting and milling are the primary activity at Yalbac Ranch. To the north and east, Rio Bravo Conservation and Management Area hosts visitors, students, and researchers at the La Milpa Field Station and the Hillbank Field Station serving as an educational, research, and ecotourism destination. Programme for Belize, the NGO that manages the Rio Bravo Conservation and Management Area, in collaboration with The Nature Conservancy, has recently validated a VCS forest carbon project[6]. The primary land use at Gallon Jug is agriculture, cattle and coffee. Prior to the sale of the majority of the property to The Forestland Group, selective harvesting of timber and on site milling was also a major source of revenue.

Copies of current land titles for the project area have been made available for review by the auditors of the project. Legal rights to land ownership in Belize encompass all potential development and use rights with the exception of mineral extraction. Project area rights were owned by Gallon Jug Agroindustries and are now owned by The Forestland Group. Rights to change land use, sell timber, or otherwise impact the carbon pools on the project area are owned fee simple by The Forestland Group.

[6] See http://www.vcsprojectdatabase.org/#/project_details/852

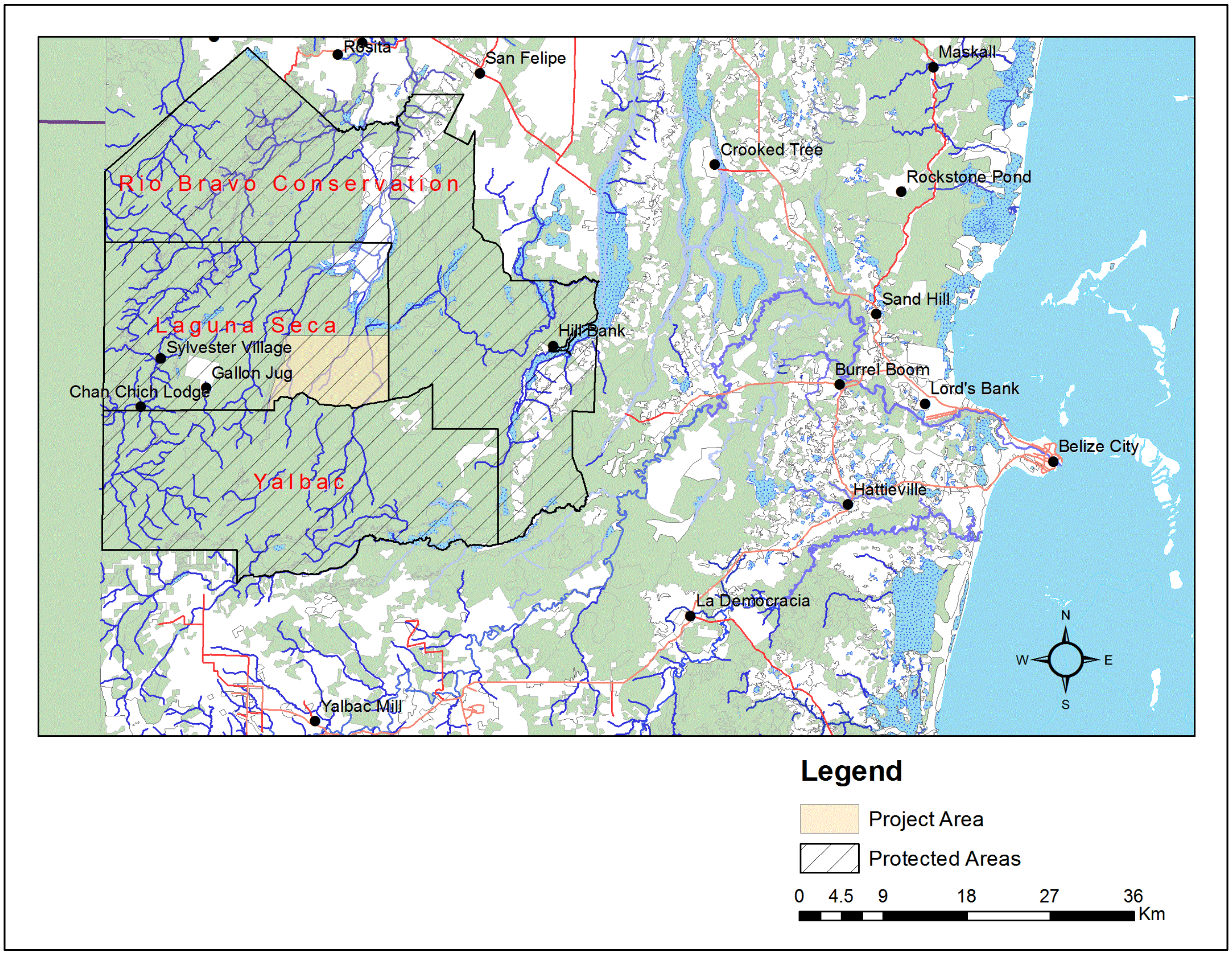

Figure 4: Project Zone.

Current Biodiversity within the Project Area

The GJA property has been the site of multiple biodiversity studies since the 1980's conducted by Bruce and Carolyn Miller formerly with the Wildlife Conservation Society and others (Miller and Miller 2011, Kricher 1997). The property provides habitat for large predators such as the jaguar, puma, and ocelot along with a diverse array of prey species (Miller and Miller 2011). The property also provides suitable habitat for the IUCN-EN Geoffroy's spider monkey, along with many more species of concern.

Figure 5: Geoffroy's spider monkey (*Ateles geoffroyi*) observed on site.

The current threats to the biodiversity in the Project area and Project zone in the "without-Project" scenario are:

- Lack of protection from illegal hunting.

Hunting associated with the illegal collection of xate (*Chamaedorea spp*.) particularly for large animals and collection of parrots has been identified as a conservation concern in Belize (Young 2008, Bridgewater 2011, and UNDP 2010). Due to the close proximity of the border with Guatemala, this threat is a concern although no evidence of illegal xate harvesting has been observed to date.

- Loss of broadleaf forest habitat.

The primary threat facing the biodiversity of the site in the baseline scenario would be the removal of habitat. The baseline scenario would convert the habitat from a primary forest to a sugarcane plantation. None of the at-risk species identified for the property can complete their life cycles in a sugarcane plantation due to a change in habitat and disturbance by the sugarcane workers (IUCN 2015).

Table 5 outlines the species of special concern in the Project zone documented by Miller and Miller (2011). All species listed on the Belize National List of Critical Species, and the IUCN Red List are included. IUCN species of Least Concern are included only if listed by the Belize National List of Critical Species. All species listed in Table 4 were documented by TFG, its associated researchers, staff and/or consultants onsite.

Table 5: IUCN red list species documented in the Project area (Miller and Miller 2011).

Common name	Scientific name	IUCN	BZE	With-Project	Without-Project	Observed on site
Amphibians and Reptiles						
Regulose rainfrog	*Craugastor sabrinus*	EN	DD	No change	Loss of habitat	Yes

Morelet's Crocodile	*Crocodylus moreletii*	CD	CD	No change	Loss of habitat	Yes
Central American River Turtle	*Dermatemys mawii*	CR	EN	No change	Loss of habitat	Yes
Three-keeled musk turtle	*Staurotypus triporcatus*	NT	NT	No change	Loss of habitat	Yes
Mud turtle	*Kinosternon acutum*	NT	NT	No change	Loss of habitat	Yes
Furrowed wood turtle	*Rhinoclemmys areolata*	NT	DD	No change	Loss of habitat	Yes
Common slider	*Trachemys scripta*	NT	DD	No change	Loss of habitat	Yes
Mammals						
nine-banded armadillo	*Dasypus novemcinctus*	DD	DD	No change	Loss of habitat	Yes
Thomas' bat	*Centronycteris centralis*	VU	VU	No change	Loss of habitat	Yes
Peter's ghost-faced bat	*Mormoops megalophyla*		VU	No change	Loss of habitat	Yes
Great false vampire bat	*Vampyrum spectrum*	NT	VU	No change	Loss of habitat	Yes
Van Gelder's bat	*Bauerus dubiaquercus*	NT	NT	No change	Loss of habitat	Yes
Mexican dog-faced bat	*Cynomops mexicanus*	VU	VU	No change	Loss of habitat	Yes
Yucatan Black Howler	*Alouatta pigra*	EN	VU	No change	Loss of habitat	Yes
Baird's tapir	*Tapirus bairdii*	EN	VU	No change.	Illegal hunting. Direct mortality from wildfires.	Yes
Geoffrey's spider monkey	*Ateles geoffroyi*	EN	VU	No change	Loss of habitat	Yes
Southern river otter	*Lutra longicaudis*	DD	VU	No change.	Habitat loss in riparian areas.	Yes
Jaguar	*Panthera onca*	NT	NT	No change.	Loss of prey species due to illegal hunting. Direct mortality from wildfires.	Yes
Margay	*Leopardus wiedii*	NT	VU	No change.	Loss of prey species due to illegal hunting. Loss of riparian habitat. Direct mortality from wildfires.	Yes
White-lipped peccary	*Tayassu pecari*	NT	VU	No change.	Habitat loss in riparian areas. Illegal hunting. Direct mortality from wildfires.	Yes
Ocelot	*Leopardus pardalis*	LC	VU	No change.	Loss of prey species due to	Yes

					illegal hunting. Loss of riparian habitat. Direct mortality from wildfires.	
Puma	*Puma concolor*	LC	NT	No change.	Loss of prey species due to illegal hunting. Direct mortality from wildfires.	Yes
Birds						
Great curassow	*Crax rubra*	VU	VU	No change.	Habitat loss.	Yes
Ocellated turkey	*Meleagris ocellata*	NT	VU	No change.	Habitat loss in riparian areas.	Yes
Crested guan	*Penelope purpurascens*	LC	VU	No change.	Habitat loss in riparian areas. Possible wildfire negative impacts on nesting birds.	Yes
Harpy Eagle	*Harpia harpyja*	NT	CR	No change	Habitat loss	Yes
Yellow-headed parrot	*Amazona oratrix*	EN	EN	No change	Habitat loss	Yes
Olive-sided flycatcher	*Contopus cooperi*	NT	DD	No change	Habitat loss	Yes
Black catbird	*Melanoptila glabrirostris*	NT	NT	No change	Habitat loss	Yes
Cerulean warbler	*Setophaga cerulea*	VU	VU	No change	Habitat loss	Yes
Golden-winged Warbler	*Vermivora chrysoptera*	NT		No change	Habitat loss	Yes

A system of key biodiversity areas (KBA) was identified in Meerman (2007). The project site is identified as part of the Selva Maya KBA. Ecosystems of the project site are best described in Meerman and Sabido (2001) as lowland broadleaf forest. Communities include *Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: central-western variant* and *Tropical evergreen seasonal broadleaf lowland swamp forest: high variant.*

High Conservation Values within the Project Zone

An assessment and evaluation of High Conservation Values with the Project zone and Project area is shown in Table 6.

Table 6: High Conservation Values within the Project area and Project zone.

High Conservation Values Community	Project Description
a. Areas that provide critical ecosystem services b. Areas that are fundamental for the livelihoods of Communities; and c. Areas that are critical for the traditional cultural identity of Communities.	No HCVs identified on the project area for the community.
High Conservation Values Biodiversity	**Project Description**
a. Globally, regionally or nationally significant concentrations of biodiversity values; i. Protected areas ii. Threatened species iii. Endemic species iv. Areas that support significant concentrations of a species during any time in their lifecycle b. Globally, regionally or nationally significant large landscape-level areas where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance; c. Threatened or rare ecosystems.	a (i): Protected areas in the Project Zone include Rio Bravo Conservation and Management Area. a (ii): IUCN listed species in Table 5 are documented to occur on the site. Each IUCN endangered species on the list is considered an HCV. b: Project site resides within the Mesoamerican Biological Corridor (Miller et. al. 2001). Project site within Conservation International Biodiversity Hotspot (Olivet and Asquith 2004). Project area included within Key Biodiversity Area (Meerman 2007). b: Large private property within the regional Selva Maya. The Selva Maya is the largest continuous expanse of tropical rainforest in the Americas after the Amazon (Olivet and Asquith 2004). Project area included within Key Biodiversity Area (Meerman 2007). b: Connects Maya Biosphere Reserve with Rio Bravo Conservation and Management Area.

This Project addresses multiple High Conservation Values in the form of threatened species, protected areas, and globally and regionally significant large landscape-level areas where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance. The threatened species are listed in Table 5.

The Project helps comprise the Mesoamerican Biological Corridor and is a part of a Conservation International Biodiversity Hotspot. The Mesoamerican Biological Corridor spans eight countries from southern Mexico to northern Panama.

Although no high value community/cultural sites are known to occur within the project site, ancient Mayan sites (plaza ruins, cenotes, causeways, etc…) are very common throughout the area, and an archaeological survey has not been done on the site. It is presumed that at least minimal Mayan archaeological sites occur on the site. Historically, looting of Mayan archaeological sites was common.

1.4 Project Proponent (G4)

Gallon Jug Agroindustry Ltd. Belize was the owner of the property at the time of project initiation. Gallon Jug Agroindustry Ltd. is a subsidiary of Bowen & Bowen Ltd. Belize. Gallon Jug Agroindustry Ltd. hired FCO to develop the strategy, implementation, and monitoring of the carbon credits generated by this project. Gallon Jug Agroindustry Ltd. sold the property and the carbon project to The Forestland Group LLC (TFG) in 2012, and TFG is now the project proponent.

FCO hired CMI Virginia Tech to collect initial data, develop the monitoring protocol and conduct the baseline study for the monitoring program. TFG later hired ERA/Offsetters to update the inventory (Offsetters 2014b) and collect more input from local communities (Offsetters 2014a). Decisions on implementation of the project activities are the responsibility of TFG.

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1.5 Other Entities Involved in the Project (G4)

ERA/Offsetters provided the most recent technical support for field data collection, remote sensing, GIS, and modelling. CMI provided initial support for mapping and inventory, and later updated the mapping component.

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Technical and Management Expertise

The key technical skills to implement the Project are:

Skill	Key Individual	Experience (Years)
The business skills required to successfully manage a large and complex operation	Kaarsten Turner Dalby	16
The managerial skills to manage the property effectively	Jeff Roberson	26
The diplomatic skills to successfully interact with the local communities	Jeff Roberson	26
The technical skills to conduct monitoring on a periodic basis	Jeff Waldon	30

The Forestland Group, LLC (TFG), formed in 1995, is an independent timberland investment management organization ("TIMO") which emphasizes naturally regenerating hardwood and some softwood forests. TFG currently manages approximately 3.4 million acres in 20 U.S. states as well as in Belize, Canada, and Costa Rica. The firm manages its investments through a series of limited partnerships and private real estate investment trusts with a mix of both institutional and high-net-worth investors encompassing some 130 different entities. Headquartered in Chapel Hill, North Carolina, TFG has a corporate office near Boston and an array of forest management offices near its land bases. TFG was a pioneering TIMO with respect to managing its portfolio as a Certified Resource Manager under the Forest Stewardship Council™ FSC® C018151 guidelines.

TFG's staff includes some of the nation's leaders in forestry, forest finance, and conservation. In addition, TFG and its affiliated entities contract with independent forestry, environmental, and natural resource consulting firms to more effectively manage its timber and non-timber assets. More information regarding TFG may be found at the company website. TFG is the largest private landowner in Belize.

Forest Carbon Offsets, LLC managerial experience is considerable with current biographies available at www.forestcarbonoffsets.net. FCO has experience with carbon offset projects in Belize having successfully registered the first Reduced Emissions from Deforestation and Degradation in Belize and in the western hemisphere.

Key Individuals:

Jeff Roberson: Mr. Roberson is the Belize country manager for The Forestland Group residing in Belize, and managing all land projects in Belize. Mr. Roberson has 26 years experience in forestry and forestry products in Belize. For the last four years his responsibilities included managing all aspects of the entire Belize TFG operation; bush and field work, subcontract logging, log yards, milling, local and international sales, security and administration. Mr. Roberson has been instrumental in obtaining and maintaining FSC Certification.

Kaarsten Turner Dalby, Vice President – Ecological Services: Management responsibilities include oversight of the FSC certification program, and TFG's efforts to generate increased revenues from a diversity of ecological services including sales of carbon credits and working-forest conservation easements, leasing of wind-energy rights and monetization of non-timber attributes associated with forestland ownership. In addition, Ms. Turner Dalby is involved in the development and implementation of forest management plans involving TFG's operational staff and non-affiliated forestry management consultants. In her previous position, Ms. Turner Dalby was Senior Director – Ecological Services. Prior to her current roles in ecological services, Ms. Turner Dalby served as Director of Forest Information Systems with management responsibility for the design and implementation of TFG's Forest Information System. Previously, Ms. Turner Dalby served as a Forest Information Analyst and started her employment with TFG as an intern in July of 1998. Prior to her employment with TFG in 1998, Ms. Turner Dalby consulted with a Boston-based TIMO where she identified and researched a diversity of parameters for agroforestry ventures with non-industrial private landowners in New Zealand. She has worked for a number of domestic and international conservation organizations on public and private land management issues. Ms. Turner Dalby has a B.A. from Smith College and an M.S. from the University of Montana School of Forestry, and an M.B.A. from the University of North Carolina's Kenan-Flagler School of Business. She has professional affiliations with the Society of American Foresters and the Forest Stewards Guild. Currently, Ms. Turner Dalby serves on the Board of Directors for the World Forestry Center.

Jeff Waldon, Chief Technical Officer, Forest Carbon Offsets LLC: Mr. Waldon is a Certified Wildlife Biologist with 30-years-experience in natural resources technology integration, habitat restoration, land management, and administration. Mr. Waldon has been working periodically in Belize since 1989, most recently serving as the primary developer of Belize REDD+ projects starting in 2009. In 2013, Mr. Waldon served as the carbon accounting specialist for the World Bank planning project entitled "Management and Protection of Key Biodiversity Areas in Belize".

1.6 Project Start Date (G3)

Project start date is based on the signed contract between the former landowners and FCO to begin the project dated September 9, 2010. A small delay after signing of the project occurred in getting patrols started resulting in a start date of January 1, 2011.

1.7 Project Crediting Period (G3)

Project crediting period start date is January 1, 2011. Project end date is December 31, 2040. Project length is 30 years.

Implementation Schedule:

Project Activity	2011-2014	2014-2016	2017	2021	2026	2031	2036	2040	2041
Avoid conversion to sugarcane									
Contributions to Scholarship Fund									
Patrols									
FSC Certification									
Selective Harvesting									
Monitoring									
Validation									

Verification									
Baseline reset									
Project Ends									

Establishing the project took from 2011 to 2016 including a change in ownership, data collection, validation, and verification auditing. FSC certification will occur in 2016 and selective harvesting is expected in 2017. Monitoring is required no less frequently than every 5 years and verification audits are expected at each monitoring event. Baseline reset is required no less frequently than every 10 years.

2 DESIGN

2.1 Sectoral Scope and Project Type

This project is certified as compliant with the Verified Carbon Standard Version 3.5 as an Agriculture, Forestry, or Land Use (AFOLU) Project using a strategy of Reduced Emissions from Deforestation and Degradation (REDD) and assuming a baseline of planned deforestation. This project is not a grouped project.

2.2 Description of the Project Activity (G3)

Using the "Theory of Change" model (Richards and Panfil 2011), the major project activities are:

Strategy	Activities	Outputs	Outcomes	Impacts
Avoid conversion of the project area to sugarcane.	Patrols. Monitoring	Multiple patrols per year to prevent illegal timber harvest. Monitoring data and analysis.	Natural forest cover maintained. Habitat maintained on site.	Significant avoided emissions of GHG. Biodiversity loss avoided.
Utilize the site in such a way as to maintain carbon stocks	Sustainable, low intensity, timber harvest.	High quality timber for the local and international market.	Livelihoods for local communities.	Increase in average income. Reduce risk of mill closures. Provide income for communities.
Support community goals	Contribute to high school scholarship fund. Monitoring.	Minimum BZ$10,000 average annual contributions to the scholarship fund.	Children of community residents have an opportunity to attend high school.	Increase in educational attainment. High school graduates have more opportunities to attend college or secure good paying jobs.

The project will use carbon financing to protect the forest and avoid conversion to sugarcane. Donations made to the Gallon Jug-Chan Chich High School Scholarship Fund will provide benefits to the community, making it possible for school children to attend high school. Scholarship amount determined in discussions with scholarship fund administrators, the Gallon Jug-Chan Chich High School Scholarship Fund[7]. Project activities are expected to be positive for communities and biodiversity as a result.

The primary technology employed to achieve the desired result is patrols of the property to prevent incursions and illegal logging plus monitoring of the results. The following activities will occur:

- rangers and patrols,
- monitoring
  - forest carbon data collection,
  - biodiversity data collection,
  - remote sensing
- accounting,
- personnel management, and
- road maintenance.

Monitoring will occur regularly with verification audits no less frequently than every 5 years. The lifetime of the project activities extends throughout the life of the project (through 2040).

To comply with the requirement to address protection of wetlands by eliminating negative impacts from project activities, the streamside and wetland buffer component of the project area is excluded from timber harvest plans.

2.3 Management of Risks to Project Benefits (G3)

The project proponent accepts that all projects have some risk, but the key to success is management of risks and adapting the project as challenges arise, and more information is known about those risks. The following risks are known regarding the project:

- Risks to the Project from instability in the Government or a change in leadership at TFG are considered minimal.

- No oil or mineral resources are known to occur on the Project site. Government sponsored extraction of petroleum is occurring in the area, and a firm in Belize has been granted the right by the Government of Belize to explore for oil on the project area and surrounding lands. If commercially viable oil or gas is discovered on the site, it may belong to the Government of Belize, and would be extracted by the contractor holding the lease for the area[8]. Similar sites in Belize where oil extraction is taking place have minimal aboveground disturbance. Section 26 paragraph 6 of the National Petroleum Act states:

  (6) Subject to this Act, where, in the course of conducting petroleum operations pursuant to a contract, the rights of the owner or lawful occupier

[7] See scholarship fund web page at: https://sites.google.com/site/gallonjugschool/gallonjug-chanchichscholarshipfund

[8] An access and exploration agreement was put in place between The Forestland Group and Maranco Energy Belize Ltd., an oil development firm based in Belize, in April of 2015.

of any land are disturbed or damage to any crops, trees, buildings, stock, works or other property thereon is caused, the contractor is liable to pay the owner or lawful occupier fair and reasonable compensation in respect of the disturbance or damage according to the respective rights or interests of the owner or lawful occupier concerned. The amount of compensation payable shall be determined by agreement between the parties or if the parties are unable to reach agreement or the agreed compensation is not paid, the matter may be treated in accordance with the Arbitration Act.

Based on this, the contractor for the Government extracting the oil may be responsible for compensating the owner of the credits for any damages suffered as a result of the oil extraction process.

- Risks from pests and disease to natural forests are considered minimal due to the high biodiversity and very long timeframes under which natural forests in Belize have been able to co-adapt with pests and diseases. There is an unknown risk of invasive pests introduced from other ecosystems.

- The project area exhibits low risk from hurricanes due to its distance from the coast, but occasional blow downs do occur (CCRIF 2013). Recovery rates from hurricanes can be quite rapid (Bridgewater 2011). A hurricane occurred in the area in 2010, and based on an evaluation by Dettman (2013), no discernible impact could be detected using remotely sensed data and little impact to permanent plots was detected.

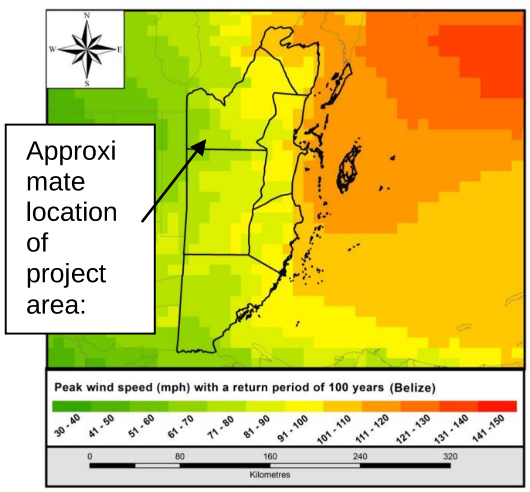

Figure 6: Peak wind speed with a return period of 100 years (CCRIF 2013).

Risks to biodiversity resulting from illegal hunting activities is considered minimal due to access constraints. Planned patrols should detect and curtail any illegal hunting activities that may occur.

The broadleaf forest slated for conversion is fire resistant (Meerman and Sabido 2001). The project proponents plan to train a fire crew and have equipment on hand to fight wildfires.

Risks from illegal timber harvest for fuel or lumber is considered extremely low due to limited access and the availability of low cost or free lumber and firewood from the local sawmill.

Based on an analysis and summation of risks following the VCS Risk Reporting Tool version 3.2, a cumulative risk level of 27% was found for the project.

Extending Project Benefits Beyond the Project Lifetime

This project is proposed on private property owned by a major international timber investment group. While there are no contractual obligations beyond the end date of the project, the success of this project will result in a new, economically viable option for land conservation in Belize. The key will be advertising that success. TFG intends for this Project to be a focal point for forest protection in the Selva Maya region (the large forested region that straddles southern Mexico, eastern Guatemala and much of Belize) and ecosystem demonstrating how carbon sequestration, biodiversity, and community benefits can be achieved concurrently. Because of the Project's profile within Belize it is expected that the Project will act as a catalyst for other projects regionally. Discussions with the Belize Association of Private Protected Areas (BAPPA) have already resulted in contacts regarding additional conservation projects throughout Belize.

Specifically,

1. the project proponents will make a presentation to BAPPA to explain the process so other projects can be catalysed;
2. success of the project will be advertised within the landowner community in Belize;
3. the stakeholders will become more educated about the benefits of the project; and
4. capacity built in human and physical capital will remain after the end of the project making the continuation of the project highly likely.

The project proponent will adapt the project as risks become better known or change over time. This will be accomplished by regular updates to the project plan triggered by monitoring events and audits.

2.4 Measures to Maintain High Conservation Values (G3)

The high conservation values on the site are all biodiversity components. Conserving and protecting the forest should maintain the HCVs. Patrols to prevent illegal hunting and maintaining existing high quality habitat should result in maintenance of HCVs.

2.5 Project Financing (G3 & G4)

The Forestland Group LLC is a United States registered private limited liability company and, as such, is governed by the corporation laws of the United Sates which ensure that, at all times, the company remain financially solvent and able to meet its liabilities. TFG is sufficiently capitalized to ensure completion of the Project.

Carbon financing received after contractual obligations will fund TFG to pay for the management and monitoring activities. TFG's management and financial plan were made available to the auditors during the site visit to the project performed by the audit team.

Primary expenses are to pay land taxes, for patrols, and pay for biodiversity, carbon sequestration, and community monitoring expenses and to pay for the educational initiatives. Some income is expected from timber harvesting. A complete financial plan was made available to the auditor during the validation audit.

2.6 Employment Opportunities and Worker Safety (G4)

All local, district, and national workplace standards will be met at the moment of hiring of each staff member. Local regulations and safety concerns will be discussed with each staff with an emphasis on guaranteeing workplace safety according to Belizean law. Safety information is available in Table 7.

Table 7: Staff safety

Hazard	Safety strategy and equipment
Snake bite	Staff emergency medical technician. Helicopter evacuation. First aid training. Adequate boots. Radios. Minimum two person crews.
Poachers	Radios. Minimum two person crews.
Fire	Staff emergency medical technician. First aid kit. Radios. Gloves. Eye protection.
Vehicle accidents	Staff emergency medical technician. Helicopter evacuation. First aid training. Radios.
Machete cuts	First aid training. First aid kit. Radios. Minimum two person crews. Eye protection. Adequate boots. Gloves.
Chainsaw cuts	Staff emergency medical technician. Helicopter evacuation. First aid training. First aid kit. Radios. Minimum two person crews. Eye and ear protection. Adequate boots. Chaps and gloves (optional).
Lightning strike	Develop procedures for avoiding lightning strikes. Radio.

TFG employs and trains local staff from northern Belize and elsewhere in Central America. Staff will be trained in the following roles:

- Rangers and patrols.
- Assisting forest carbon data and biodiversity data collection.
- Firefighting

Figure 7: Forest monitoring crew comprised of CMI and GJ staff (June 2011).

All staff are local and are representative of the general population in the area consisting of Belizeans of Mayan and Hispanic heritage plus immigrants from surrounding countries.

Staff retention has not been a problem in the past at TFG. Jobs at TFG are considered to be better than average and the managers are well-regarded in the community. Some staff turnover is inevitable over such a long time period however, and when there is staff turnover, measures will be taken not to lose local capacity and skills by providing orientation and training to new staff.

The Project employs individuals from the local communities patrolling and monitoring the Project area. Employment opportunities will be advertised at local shops in the Spanish Lookout area in the vicinity of the mill where all segments of society gather. Recruitment of new employees in the Gallon Jug area would likely be unsuccessful, since full employment already exists at Gallon Jug with positions at Gallon Jug Agroindustries.

Employment at TFG will follow Belize labor law and codes. Women and underrepresented minorities will be encouraged to apply for the positions. Staff will be chosen based on capacity to meet the needs of TFG so that TFG can perform its business mission. Culturally in Belize, women seldom seek employment in the forest, however with the advent of a new, invigorated program at the University of Belize that may change in the future.

2.7 Stakeholders (G3)

FCO and TFG have actively engaged local stakeholders in soliciting comments on the design of the CCB Project with various onsite consultations. Stakeholder and community outreach was undertaken by FCO utilizing the services of CMI in January of 2012 (Teets, Emrick, and Schneider 2012) and TFG utilizing the services of ERA/Offsetters in January of 2014 (Offsetters 2014a) . Stakeholders were identified using the procedural steps found in the “Community

Development Toolkit" methodology at http://www.icmm.com/community-development-toolkit. Those steps are:

1. Brainstorm existing stakeholders: Based on project proponent and contractor knowledge of the site, a preliminary list was established.
2. Network to expand the list: After meeting with the managers at Gallon Jug and Yalbac the list was expanded to include the workers at the Yalbac Mill.
3. Check that all possible stakeholders are included by asking the question ""Who will the project impact (positively or negatively) and whose support or lack of it might significantly influence the success of the project?". The list was expanded again to include the Forestry Department and the UNFCCC Belize Focal Point and Designated National Authority.

Based on this process stakeholder groups are:

- TFG owners and staff.
- Gallon Jug farm residents.
- Rio Bravo Conservation and Management Area.
- Belize Forestry Department Ministry of Natural Resources REDD Coordinator.
- UNFCCC Belize Focal Point and Designated National Authority.

The community members are all employed at, or a member of their family is employed at, the farm or the mills. Stakeholder meetings were announced by emailing stakeholders where possible, by posting a notice at the post office and community store, by farm/mill managers informing their staff, and by working with a community organizer with experience in Sylvester Village. Community meetings were held at Sylvester Village (at the community center), at the Gallon Jug Agroindustries Farm, at the TFG lumber camp and mill, and at Chan Chich Lodge which is owned and operated by Gallon Jug Agroindustries. An informational poster was developed and posted. Informational handouts were developed and distributed.

At each of the community meetings, climate change, REDD+, the auditing process, and the reason for the site visit was discussed. Input on the project was sought without leading the groups to particular benefit strategies. The results of the community benefits input is summarized in Section 6.1.

Local stakeholders are primarily Gallon Jug Agroindustries (and their families) and TFG staff and to a lesser extent staff at the Rio Bravo Conservation and Management Area, where a similar carbon project was recently approved, so the staff there are more informed and aware of climate change and forest conservation than would normally be expected in Belize.

TFG staff will be actively engaged in Project activities including permanent sample plot measurements, setting up remote camera traps, conducting forest patrols, and engaging in other knowledge transfer activities. Post CCB validation, TFG will provide an annual update in written form to all stakeholders describing Project status as a method to continue communication and consultation between stakeholders and Project managers. Furthermore, TFG will continue and improve upon its current enacted policy to proactively seek stakeholder consultation whenever possible through regular meetings and a survey of attitudes regarding the project.

Figure 8: Community meeting at the Gallon Jug coffee warehouse (January 17, 2012).

Figure 9: Community meeting at the Gallon Jug sawmill (January 19, 2012).

Figure 10: Community meeting, Sylvester Village community center (January 19, 2012).

An additional meeting was held with the auditors present in June of 2014 at the Sylvester Village Community Center.

Public Comment Period

Public comment was sought through the following avenues:

- Direct email and phone contact with Rio Bravo Conservation and Management Area, TFG staff, Belize Forestry Department Ministry of Natural Resources REDD Coordinator, Gallon Jug-Chan Chich High School Scholarship Fund and UNFCCC Belize Focal Point and Designated National Authority.
- The PDD was made available on the CCBA webpage and open to public comments (http://www.climate-standards.org/projects/index.html).
- Posters were placed at Gallon Jug Post Office and Sylvester Village Store. A copy of the PDD was placed at the Gallon Jug Post Office.

Public comment periods were held twice, May 30 - June 29, 2014 and June 5, 2015 to July 5, 2015.

Conflict Resolution Tools

The Belize Association of Private Protected Areas (BAPPA) has agreed to serve as an independent 3rd party in country to receive and document grievances related to the CCB Project. BAPPA will serve as a mediator keeping all parties informed of the status of grievances and their resolution. A record of grievances and their resolution will be a part of the monitoring process for future verifications. Stakeholder grievances related to employment will be handled according to Belizean law through the Belize Labor Department. Non-employee stakeholders need to be informed that they should contact BAPPA. BAPPA can be contacted at:

office@wildtracksbelize.org

BAPPA's office will do the following:

- A BAPPA representative meets with the landowner annually to review the project plan.
- A BAPPA representative attends an annual stakeholder meeting for the project.
- BAPPA is available by phone or email throughout the year to independently field complaints.
- BAPPA queries appropriate government offices once per year to get a report on any biodiversity or labor violations that might have occurred.
- BAPPA writes a report for the landowner annually on their findings. That report will go to the landowner and the project developer and become a part of the verification process for the project.
- If there is a dispute that requires more detailed involvement by BAPPA, the landowner will contract with BAPPA as needed/available for further help in resolving the dispute.

The BAPPA representative will resolve disputes by collecting and documenting the complaint and whatever information about the situation that can be independently determined. The BAPPA representative will determine if the complaint is reasonable and if so, determine a likely strategy for addressing the complaint. The complaint and the proposed strategy will be presented to TFG. TFG will address the complaint or propose a different strategy for addressing the complaint within 30 days.

2.8 Commercially Sensitive Information

Land titles, baseline and project business plan, audited financials, budget documentation, and economic analysis.

3 LEGAL STATUS

3.1 Compliance with Laws, Statutes, Property Rights and Other Regulatory Frameworks (G4 & G5)

TFG has a history of compliance with and currently complies with all applicable local, district, and national labour standards. The Project Proponent and any of the other entities involved in project design and implementation are not involved in or are not complicit in any form of corruption such as bribery, embezzlement, fraud, favoritism, cronyism, nepotism, extortion, and collusion. All employees must sign a contract that is witnessed by a Labour Officer. The contract informs them of their rights by referring to different labor laws. TFG will follow all applicable environmental laws including the Belize Environmental Protection Act Chapter 328, Revised Edition 2000. Belize has the following relevant labor laws:

Table 8: Belizean Laws Applicable to the Project.

Statute	Relevance
International Labour Organization Conventions	Belize is a signatory to many of the International Labour Organization's conventions[9]. Those conventions are addressed in Belize labour laws. The ILO Conventions Act commits Belize to following the ILO conventions.
Labour Act and Labour (Subsidiary Laws)	Addresses labour laws and regulations. Compliance with this law ensures that the project proponent and all other entities involved in project design and implementation are

[9] See ILO web site at http://www.ilo.org/dyn/normlex/en/f?p=1000:11200:0::NO:11200:P11200_COUNTRY_ID:103222

Protection Against Sexual Harassment Act and Protection Against Sexual Harassment Commencement Act Order	not involved in or complicit in any form of discrimination or sexual harassment with respect to the project.
Trade Unions Act, Trade Unions Regulations Trade Unions and Employers Organizations (Registration, Status and Recognition) Act, and Trade Unions and Employers Organizations (Registration, Status and Recognition) Act (Commencement) Order	Addresses the rights of workers to organize.
Belize Private Forests (Conservation) Act, Chapter 217, Revised Edition 2000	This is a revised edition of the law, prepared by the Law Revision Commissioner under the authority of the Law Revision Act, Chapter 3 of the Laws of Belize, Revised Edition 1980 - 1990. Requires permit on private land to fell mahogany or cedar.
Forests Act, Chapter 213, Revised Edition 2003 and Forests Act, Chapter 213S Forest Act - Subsidiary	Describes rights of the government to reserve/dereserve land, regulate forest harvest/operations, require royalties, prohibit import/export of wildlife/plants.
Forest Fire Protection Act, Chapter 212, Revised Edition 2000	Addresses national forest fire protection program.
Water and Sewage Act, Chapter 222	Defines riparian protection as "that the flow of the stream does not fall below the minimum quantity necessary to secure the interest of public health and the protection of the rights of riparian and other land-owners." (p. 46)
Timber Industry Act, Chapter 341	Regulates sawmills and wood products. Sets export levy.
Land Utilization Act, Chapter 188.	The Minister may, for the better utilization of land, make regulations- - to demarcate areas, water catchment areas or watersheds and prohibiting the clearing of any vegetation within those areas; - to provide for such other measures as may be required to prevent soil erosion; restricting the construction of buildings within stipulated distances from the middle line of any road or street; - to demarcate specific areas as special development areas and to stipulate the type of development that will be permitted within those areas; - for the clearing of any forest or the felling of any trees; and to provide for all such other things as may be necessary for the better carrying out of the provisions of this Part of the Act.
National Institute of Culture and History Act, Chapter 331, Revised Edition 2000	This act addresses ex post discovery of ancient artifacts or sites, and prohibits the possession or destruction of artifacts without a permit. Regulates the disposition and care of Mayan artifacts. Ex ante permits are not required

	to clear land, however if sites are found they must be protected until a permit can be obtained to modify or destroy the site.
Environmental Protection Act Chapter 328 and Environmental Impact Assessment (Amendment) Regulations 2007.	The Environmental Impact Act establishes the Department of the Environment, addresses prevention and control of pollution, establishes a prohibition against dumping, and institutes the environmental impact assessment requirement. Powers of officers and penalties are established. Nutrient releases, investigation powers, and various administrative requirements and functions are addressed. Specific to the baseline scenario, All lands cleared over 300 acres in Belize are subject to the environmental impact assessment requirement based on the amended regulations promulgated in 2007. There are no published reports[10] of environmental impact assessments (EIAs) being conducted for agricultural land clearing prior to clearing, and there are no published reports of projects terminated based on an EIA. The Government of Belize recognizes that situation exists and is working with the World Bank and others to close the loophole (FCPF 2015). This law has clearly not been a barrier to clearing land for other activities as evidenced by the extensive land clearing that has gone on in the country since 2001 (Cherrington et. al. 2010) when the law was first passed. Given the monumental effort Belize is undergoing to support agriculture[11] and the national policy supporting the expansion of agriculture[12] including technical, financial, and international development assistance, it is unlikely that any undo restriction would be placed on land clearing for agriculture if an EIA or study were required. If an EIA or environmental study were required it would be conducted and approved given that no EIAs have been publicly declined. From this analysis, it is clear that the tropical hardwood component of the TFG property could have easily been converted legally to an agricultural plantation after performing the necessary EIA in accordance to generally accepted practices in Belize. The only caveat is that there should be a one-chain riparian buffer on either side of permanent streams (personal communication with the Ministry of Natural Resources and Environment, Belize). There are no property disputes within the Project area.

[10] See Belize Department of the Environment at http://www.doe.gov.bz/index.php/eias
[11] See Belize National Food and Agriculture Policy (2002-2020) at http://www.agriculture.gov.bz/PDF/Policy_Document.pdf.
[12] See Embassy of Belize summary of national policy at http://www.embassyofbelize.org/belize-profile/economy-of-belize.html

Discrimination by gender, race, or ethnicity is both illegal in Belize and against the policy of TFG. TFG takes the following actions to eliminated the possibility of discrimination:

1. Hiring advertisements include an explicit statement regarding discrimination to let potential applicants know that they are welcome to apply regardless of gender, race, or ethnicity.
2. Managers are instructed in the importance of avoiding the act or the appearance of favouritism based on gender, race, or ethnicity.
3. Hiring and promotions are reviewed for potential discrimination by human resources specialists and upper management in the US to confirm fair treatment of potential hires and staff eligible for promotion.

3.2 Evidence of Right of Use (G5)

The property is owned in fee simple ownership under the laws of Belize. Titles have been produced and reviewed by the auditors. The project is authorized by virtue of approval for selective harvesting as indicated by a forest license and an approved sustainable harvest management plan.

3.3 Emissions Trading Programs and Other Binding Limits (CL1)

Credit sales will be tracked using the APX[13] registry. Emissions reductions or removals generated by the project will not be used for compliance with an emissions trading program or to meet binding limits on GHG emissions. Belize currently does not have a national, legally binding limit on greenhouse gas emissions, and there currently is no compliance emissions trading program which accepts REDD credits in Belize.

3.4 Participation under Other GHG Programs (CL1)

This is the first and only application for this project to a GHG program.

3.5 Other Forms of Environmental Credit (CL1)

No other environmental credit has been created by this project. The co-benefits of the project have been proposed for validation to the Climate, Community, and Biodiversity Alliance using the Climate, Community and Biodiversity Standard 3rd Edition. Gold level validation is proposed based on exceptional biodiversity benefits.

3.6 Projects Rejected by Other GHG Programs (CL1)

This is the first and only application for this project to a GHG program.

3.7 Respect for Rights and No Involuntary Relocation (G5)

Free, Prior, and Informed Consent

TFG owns the property fee simple. Fee simple ownership in Belize represents absolute ownership of real property. The Project does not encroach upon private property, community property, or government property. According to the Maya Atlas: The Struggle to Preserve Maya

[13] See https://vcsregistry2.apx.com/

Land in Southern Belize (Maya Atlas 1997), the property has not been associated with any Maya communal land claims. There are no current land disputes regarding the project area.

Involuntary Relocations

FCO has verified by direct observation that the Project area does not have human inhabitants. Moreover, FCO has observed that the Project does not involve the relocation or inward migration of any people. If immigration were to occur, the Project's monitoring teams will work with all stakeholders using appropriate tools to engage towards a resolution.

3.8 Illegal Activities and Project Benefits (G5)

Project will include regular patrols to address illegal hunting, timber poaching, or wood gathering. No evidence of these activities was detected during site visits.

4 APPLICATION OF METHODOLOGY

4.1 Title and Reference of Methodology

This project is designed for validation under the Verified Carbon Standard Version 3.5, AFOLU Requirements Version 3.4 and utilizing methodology VM0007 REDD Methodology Modules (http://www.v-c-s.org/methodologies/redd-methodology-framework-redd-mf-v15) for planned deforestation. In particular the following methodology modules were used for this project:

Title	Version
VCS Methodology VM0007: REDD Methodology Modules (REDD-MF)	1.5
Methods for Monitoring of GHG Emissions and Removals (M-MON)	2.1
Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry, and Other Land Use (AFOLU) Project Activities (T-ADD)	3.0
Estimation of Uncertainty for REDD Project Activities (X-UNC)	2.1
Methods for Stratification of the Project Area (X-STR)	1.1
Estimation of Baseline Carbon Stock Changes and Greenhouse Gas Emissions From Planned Deforestation and Planned Degradation (BL-PL)	1.2
Estimation of Emissions From Activity Shifting for Avoided Planned Deforestation and Planned Degradation (LK-ASP)	1.2
Estimation of emissions from market-effects (LK-ME)	1.1
Estimation of Carbon Stocks in the Above- and Belowground Biomass in Live Tree and Nontree Pools (CP-AB)	1.1
Estimation of Carbon Stocks in the Long-Term Wood Products Pool (CP-W)	1.1
Tool for testing significance of GHG emissions in A/R CDM project activities (T-SIG): This module is used to determine if sources or activities are de minimis based on the contribution of that source or activity to the overall project.	01
Estimation of greenhouse gas emissions from biomass and peat burning (E-BPB)	1.1

AFOLU Non-Permanence Risk Tool	3.2

4.2 Applicability of Methodology

Based on the methodology and the reference for the methodology, VCS Methodology VM0007: REDD Methodology Modules (REDD-MF), this project qualifies because of a reduction in emissions of carbon dioxide from planned deforestation in the baseline scenario. This methodology is applicable because:

- land in the project area qualified as forest at least 10 years before the project start date based on definition of forest land in FAO Forest Resource Assessment of 2000[14] (FAO 2010) and remote sensing analysis;
- no peat soils are known to be present on the project site (if peat soils occur, they are most likely to be near streams or in wetlands and a stream/wetland buffer is excluded from consideration);
- project proponents can show ownership of the project site and ownership of the carbon rights for the project area;
- baseline deforestation in the project area falls within the category of avoided planned deforestation (VCS category APD);
- baselines shall be renewed every 10 years after the start of the project;
- no areas registered under the CDM or any other carbon trading scheme are included within the project site; validation under the Climate, Community, and Biodiversity Alliance for co-benefits has been disclosed;
- the baseline condition is conversion of the property to a permanent deforested state of sugarcane agriculture;
- no reforestation is proposed for the project; and
- leakage avoidance activities do not include either agriculture lands flooded to increase production, or intensifying livestock production.

The project is considered under the category "Avoided Planned Deforestation". This project qualifies because:

- Conversion of forest lands to a deforested condition is legally permitted,
- Documentation is available to clearly demonstrate with credible evidence that the land would have been converted to non-forest use if not for the REDD project, and
- Post deforestation land use does not include reforestation.

[14] Forest is defined by FAO (2010) as "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use."

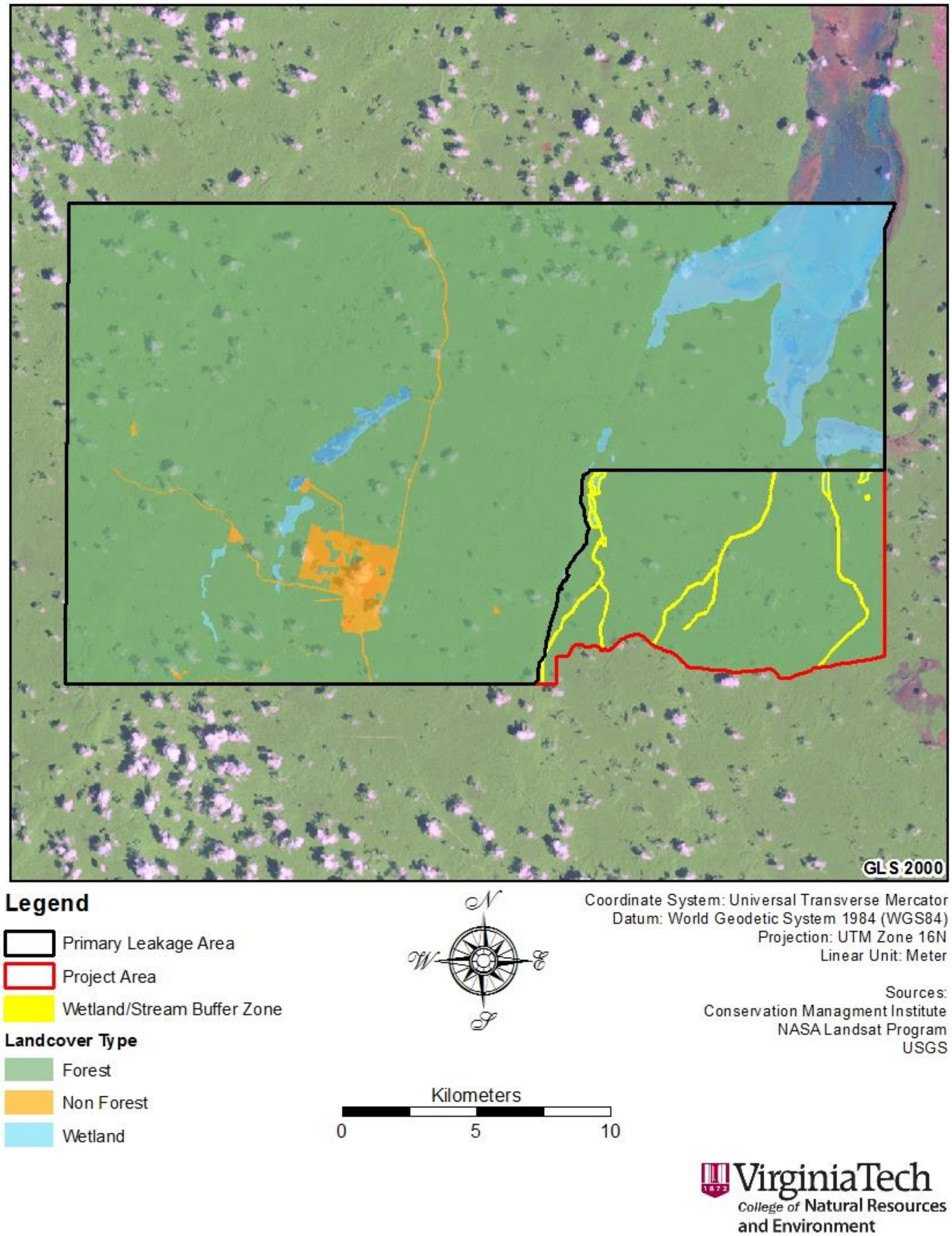

Figure 11: Map showing project area was completely forested 10 years prior to project start date.

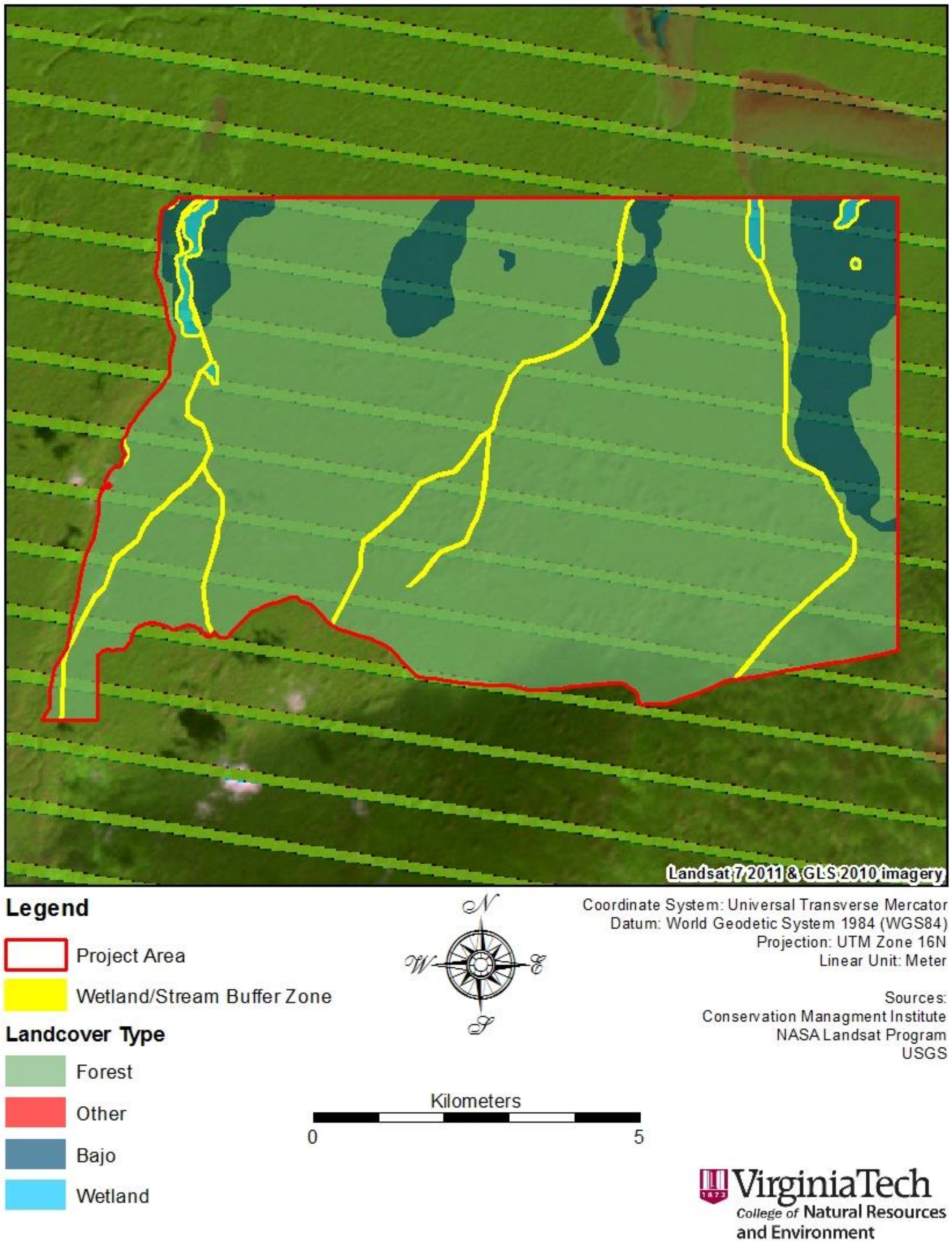

Figure 12: Project Forest Cover Benchmark Map showing project area was completely forested in 2011. Bajo and Forest types treated as one strata.

4.3 Methodology Deviations

Calculation of Ex Post Emissions from Fuelwood Collection

Based on the very low number of people in the community that have access to the project area, the large area of forest available to the community, and the availability of free firewood from the local sawmill, a PRA was not conducted but rather an indisputably conservative assumption regarding the number of fuelwood users and the amount of fuelwood used (described in Section 5.4.1). The total emissions predicted using this approach was found to be de minimis and removed from further consideration. The following parameters are affected:

Parameter	Description	Value
$\Delta C_{P,DegW,i,t}$	Net carbon stock changes as a result of degradation in stratum i in the project area at time t; tCO_2e	2,275
$A_{DegW,i}$	Area potentially impacted by degradation processes in stratum i; ha	8,240
$C_{DegW,i,t}$	Biomass carbon of trees cut and removed through degradation process from plots measured in stratum i at time t; tCO_2e	0.27607
A_{Pi}	Total area of degradation sample plots in stratum i; ha	0
i	1, 2, 3 …M strata	1
t	1, 2, 3, … t* years elapsed since the start of the REDD project activity	10

An indisputably conservative assumption was made to arrive at $A_{degW,i}$. It was assumed that 150 people use fuelwood from the project area, and that each uses .55 m^3/person-year FAO (2008) for 30 years. Each m^3 of wood weighs a conservative 1600 kg/m^3. A fraction of carbon of .47 (IPCC 2006) is used to convert greenwood to dry wood. A ratio of 44/12 is used to convert carbon to CO_2. Calculate for the baseline period of 10 years. Multiplying these numbers (.55 * 1600/1000 * 150 * 10 * .47 * 44/12) arrives at a total of 2,275 tCO_2e emissions as a result of fuelwood collection or 0.276 tCO_2e/ha.

This methodology deviation applies to the first monitoring period only.

Calculation of Ex Post Emissions from Sustainable Timber Harvest

Based on the very low merchantable volume available on the project area and in the leakage area, rather than measuring and calculating project emissions from selective harvest of timber, an indisputably conservative assumption was made that impacts from timber harvesting could be as much as 3x the emissions found on a nearby property harvesting similar species in a similar manner (Whitman et.al. 1997). Based on that assumption, emissions were calculated (see Section 5.4.1) and found to be de minimis.

The following parameters are affected:

Parameter	Description	Value
$\Delta C_{P,SelLog,i,t}$	Net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas in the project area in the project case in stratum i at time t; t CO_2-e	30,262
$C_{LG,i,t}$	Actual (projected) net project emissions arising in the logging gap in stratum i at time t; t CO_2-e	

$C_{LR,i,t}$	Actual (projected) net project emissions arising from logging infrastructure in stratum i at time t; t CO_2-e	
$C_{LG,i,t} + C_{LR,i,t}$		96,884
	Total damage estimate from Whitman et. al. (1997) of 4.8% x 3 to result in indisputably conservative assumption.	14.40%
$C_{tree,i,t}$	Total AGBtree in tco2e	2,354,810
$C_{WP\ i,t}$	Carbon stock in wood products pool from stratum i, at time t; t CO_2-e	66,621
t	1, 2, 3 … t years elapsed since the start of the project activity. Only two years are planned for harvest during the baseline period.	4

Values for the parameters were available at validation. Monitoring of timber sales records will be used to monitor timber harvest and determine de minimis status. Note also that the Whitman et.al. (1997) reference lumped parameters $C_{LG,i,t}$ and $C_{LR,i,t}$ and these are combined in the de minimis analysis.

Palm Allometric Equations

Palm biomass is significant in these systems and palm equations for the three most common palms, cohune (*Attalea cohune*), give-and-take (*Chrysophylla stauracantha*), and botan (*Sabal mauritiiformis*) are included based on equations developed at a neighbouring property in 2000 (Brown 2015). This report indicates that data for 15 of each species were collected and measured to develop site specific equations for these three species. The methodology calls for a minimum of 30 individuals to qualify. Based on the close proximity and the exact species match, these equations are considered more appropriate than family level equations from elsewhere despite the low sample size. The data from the study was evaluated and qualifies as representative following the instructions in CP-AB. The equations were available at project validation. Palm biomass is treated as a component of tree biomass using parameter $C_{AB\_tree,i}$.

Calculation vs. Measurement of Tree Heights

To validate the conservative application of the allometric equations used to predict aboveground tree biomass, tree height to a 10 cm diameter top or to the first branch must be measured. Field observations were attempted using these instructions, but the difficulty in determining first branch or seeing accurately the point of the bole where the diameter was 10 cm made the process unacceptably qualitative. An alternative method was employed by measuring the total height of each tree using a clinometer, and the DBH of each tree with a tape measure then using this information to calculate the height to a 10 cm top using a simple linear taper equation. Smalian's formula was used for calculating volume of logs and then multiplied times the wood density for comparison to the predicted biomass from the allometric equation. Since tree bole forms are generally parabaloid rather than neiloid, a simple linear taper equation will underestimate the height of the tree at a 10 cm diameter (Cruz de León and Uranga-Valencia 2013). This provides a conservative estimate of height.

Tree heights were available at project validation. The parameter impacted is $Ht_{,tree,i,}$. Since the testing of the allometric equations is only conducted at project validation, no further monitoring of tree heights is planned although tree height data will continue to be collected for use in the future when better allometric equations may become available.

4.4 Project Boundary (G1)

Source		Gas	Included?	Justification/Explanation
Baseline	Aboveground tree biomass	CO_2	Yes	Required pool. Three species of palms included.
		CH_4	No	
		N_2O	No	
		Other	No	
	Belowground tree biomass	CO_2	Yes	Significant pool calculated based on aboveground biomass pool.
		CH_4	No	
		N_2O	No	
		Other	No	
	Aboveground nontree biomass	CO_2	Yes	This pool is included and estimated using an indisputably conservative assumption based on Dewalt and Chave (2004).
		CH_4	No	
		N_2O	No	
		Other	No	
	Belowground nontree biomass	CO_2	Yes	Significant pool calculated based on aboveground biomass pool using root-to-shoot ratio.
		CH_4	No	
		N_2O	No	
		Other	No	
	Soil Carbon	CO_2	No	This pool is conservatively excluded.
		CH_4	No	
		N_2O	No	
		Other	No	
	Dead Wood	CO_2	No	This pool is conservatively excluded.
		CH_4	No	
		N_2O	No	
		Other	No	
	Harvested Wood Products	CO_2	Yes	The standard practice in Belize for conversion of forest to agricultural lands is to remove valuable timber species and then bulldoze and burn the remaining trees.
		CH_4	No	
		N_2O	No	
		Other	No	
	Litter	CO_2	No	This pool is conservatively excluded.
		CH_4	No	
		N_2O	No	
		Other	No	
	Biomass Burning	CO_2	No	CO_2 emissions are accounted for by biomass changes in the aboveground and belowground biomass pools.
		CH_4	Yes	CH_4 and N_2O emissions from land clearing and burning are included in the emissions change model for the baseline. No biomass burning is proposed as a project activity.
		N_2O	Yes	
		Other	No	
	Combustion of Fossil Fuels	CO_2	No	Conservatively omitted from both the baseline and project scenarios.
		CH_4	No	
		N_2O	No	
		Other	No	
	Use of Fertilizers	CO_2	No	Conservatively omitted from both the baseline and project scenarios.
		CH_4	No	

Source		Gas	Included?	Justification/Explanation
		N_2O	No	
		Other	No	
Project	Aboveground tree biomass	CO_2	Yes	Required pool. Three species of palms included.
		CH_4	No	
		N_2O	No	
		Other	No	
	Belowground tree biomass	CO_2	Yes	Significant pool calculated based on aboveground biomass pool.
		CH_4	No	
		N_2O	No	
		Other	No	
	Aboveground nontree biomass	CO_2	Yes	This pool is included based on the project plan of the agent of deforestation..
		CH_4	No	
		N_2O	No	
		Other	No	
	Biomass Burning	CO_2	No	CO_2 emissions are accounted for by biomass changes in the aboveground and belowground biomass pools.
		CH_4	Yes	CH_4 and N_2O emissions from land clearing and burning are included in the emissions change model for the baseline. No biomass burning is proposed as a project activity.
		N_2O	Yes	
		Other	No	
	Belowground nontree biomass	CO_2	Yes	This pool is included based on aboveground nontree biomass and a root-to-shoot ratio.
		CH_4	No	
		N_2O	No	
		Other	No	
	Harvested Wood Products	CO_2	No	Based on the project plan and very low harvest damage rates in Belize, timber harvest is considered de minimis based on the M-MON and T-SIG analysis ex ante but must be evaluated during monitoring at each verification using the M-MON module.
		CH_4	No	
		N_2O	No	
		Other	No	

4.5 Baseline Scenario (G2)

In order to estimate potential carbon stock changes over the life of the project, a detailed description of a plausible and realistic baseline scenario is required. Based upon analysis of alternative land use scenarios, the conversion to agriculture is the most likely land use in the baseline scenario. Of the various agricultural conversion options common in the area, sugarcane conversion is the most likely based on the history and plans of the former property owner. The methodology provides a systematic procedure for determining the most likely baseline in module BL-PL. Where a known agent of deforestation can be identified, if a "valid and verifiable" plan for deforestation is presented, that plan becomes the most likely baseline scenario. The baseline agent of deforestation was determined to be Gallon Jug Agroindustries, the former owner of the property, and the plan developed by Gallon Jug Agroindustries (2010) is considered valid and verifiable.

4.5.1 Impacts to Climate from the Baseline Scenario

The baseline scenario would result in deforestation of the project area. The climate impacts, in terms of CO_2 emissions, are described in detail in section 5.3 of this document.

4.5.2 Impacts to the Community from the Baseline Scenario

The communities are defined in the Climate, Community, and Biodiversity Alliance Standard December 2013 as follows:

> *"Communities – Are all groups of people—including Indigenous Peoples, mobile peoples and other local communities—who derive income, livelihood or cultural values and other contributions to wellbeing from the Project Area* ***at the start of the project and/or under the with-project scenario****."*

The communities that derived "income, livelihood, or cultural values and other contributions to wellbeing" at the start of the project are very limited. The forest on the project area had not provided this sort of support since the last time it was selectively harvested. No hunting is allowed on the property. Fuel wood collection doesn't occur because of the remote nature of that part of the property and the availability of much higher quality, free wood at the local mill. None of the people currently at the site were at the site at the time of the last timber harvest, so arguably there are no communities by this definition at the start of the project based on the without-project scenario.

The with-project scenario calls for support of the local scholarship fund for high school attendance. That plan encompasses the communities that use the school and would potentially be beneficiaries of the scholarship fund. The with-project plan also calls for low level selective harvest of the forest to help support a small mill at Gallon Jug and a larger mill at Spanish Lookout/Yalbac. That part of the plan expands the community to the workers at those mills.

The economic impact of the baseline scenario to the community potentially benefitting from the high school scholarship fund would be negligible. There is full employment at Gallon Jug by definition since only Gallon Jug Agroindustries workers are allowed to live in the village. New jobs associated with the baseline scenario would necessarily require recruiting people outside the community. The baseline scenario for the mill workers at Gallon Jug is unchanged by the project scenario. The project area will be harvested and logs processed at Gallon Jug. A reduction of log processing at Gallon Jug will be replaced with an increase in log processing at the Yalbac mill resulting in no net change in jobs.

4.5.3 Impacts to Archaeological Sites from the Baseline Scenario

There is a requirement to inform the Ministry if an archaeological find is made. If a find is made the Ministry may provide a permit to demolish the find for agriculture. If the Ministry does not award a permit, the landowner must work around the site. There is no requirement for an archaeology destruction permit for agricultural clearing ex ante. Possession or destruction of archaeological artifacts is prohibited without a permit.

4.5.4 Impacts to Biodiversity from the Baseline Scenario

Since the baseline scenario presumes that the project area would be cleared, and the biodiversity of the site depends entirely upon the forest, the presumption is that all the impacts to existing biodiversity would be devastatingly negative.

4.5.5 Risk of Abandonment

To comply with the BL-PL Ver. 1.2 module, a risk of abandonment analysis was performed using five qualifying proxy areas. Proxy Areas were identified to determine the "risk of abandonment" per methodology BL-PL 1.2 Section 1.5 and none of the proxy areas have been abandoned to regrowth. The following criteria were used to select proxy areas.

1. Land conversion practices shall be the same as those used by the baseline agent or class of agent.	Each proxy area was converted to sugarcane by deforesting a property.
2. The post-deforestation land use shall be the same in the proxy areas as expected in the project area under business as usual.	Each proxy area is now a sugarcane field.
3. The proxy areas shall have the same management and land use rights type as the proposed project area under business as usual.	Each proxy area is on private land.
4. If suitable sites exist they shall be in the immediate area of the project; if an insufficient number of sites exists in the immediate area of the project.	Each proxy area is within the immediate area of the project between Blue Creek and Tower Hill in the Orange Walk District of Belize.
5. Agents of deforestation in proxy areas must have deforested their land under the same criteria that the project lands must follow.	Conversion to sugar cane was legally permissible at the time each site was converted since the regulation that required an EIA wasn't passed until 2007. Each site is a documented sugarcane site, therefore each site must also be suitable for sugarcane.
6. Deforestation in the proxy area shall have occurred at least 10 years prior to the baseline period.	Each proxy area was converted more than 10 years prior to 2011.
7. The three following conditions shall be met: a. The forest types surrounding the proxy area or in the proxy area prior to deforestation shall be in the same proportion as in the project area (±20%). b. Soil types that are suitable for the land-use practice used by the agent of deforestation in the project area must be present in the proxy area in the same proportion as the project area (±20%). The ratio of slope classes "gentle" (slope <15%) to "steep" (slope ≥15%) in the proxy	a. The forest areas in the Orange Walk District are essentially the same. Very little distinction can be made. A review of forest types in the area based on the map published by Meerman and Sabido (2001) indicates that the forest types around the proxy areas are essentially the same as the project area. b. Proxy areas are sugarcane so they are suitable for sugarcane. The soil types around the sugarcane proxy areas indicate that they too are suitable for sugarcane since many are planted to sugarcane. Sugarcane is a soil generalist and can be grown on many types of soils[15]. The project area is essentially flat

[15] See http://www.sugarcanecrops.com/soil_requirement/ for a discussion of soil requirements for sugarcane.

areas shall be (±20%) the same of the ratio in the project area. c. Elevation classes (500m classes) in the proxy area shall be in the same proportion as in the project area (±20%).	and all the proxy areas are also essentially flat[16]. c. Elevation of proxy areas is within 500 meters of elevation of project area. Project area is at 10-20 m, and the proxy areas are at or below this level[17].

Five proxy areas were chosen in the Orange Walk District that met the criteria. All five are sugarcane fields. Ground level photos with GPS locations were recorded and the fields evaluated using imagery from 1999-2000 to confirm that each was in sugarcane at least 10 years prior to project start. None of the proxy areas have been abandoned to forest regrowth as of the date of the ground verification pictures displayed below from June 2014. The locations are indicated below:

Proxy Area Number	Latitude/Longitude	Picture	Filename	Approximate Area (ha)
1	N18-04.409' W88-38.878'		DSC00017	22.3
2	N18-03.717 W88-38.660		DSC0018	13.0
3	N18-03.527 W88-38.200		DSC000019	20.0
4	N18-03.289 W88-37.465		DSC000020	12.6
5	N18-03.020 W88-36.037		DSC00021	118.0

[16] See http://biological-diversity.info/topography.htm for a discussion of topography in Belize.
[17] See http://biological-diversity.info/topography.htm for maps and discussion of topography in Belize.

Each area was examined using the Landsat Archive provided by the US Geological Survey at http://landsatlook.usgs.gov/viewer.html. This tool merges cloud free imagery over specified dates. Visual inspection of imagery from November 29, 1999 indicates that all five proxy areas were in sugarcane at least 10 years prior to project start.

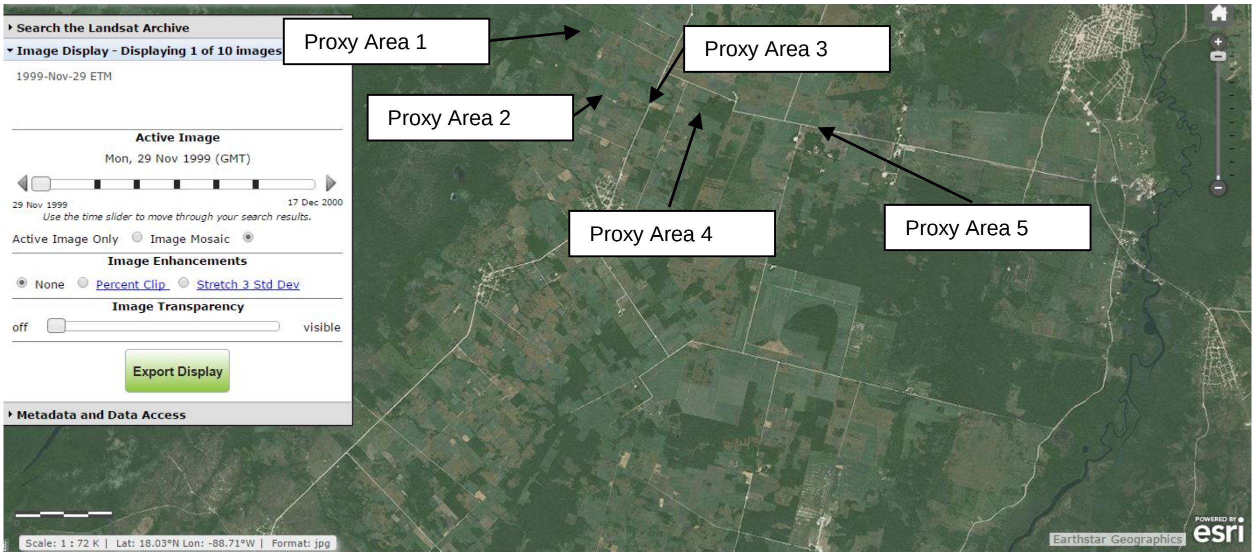

Figure 13: Proxy areas analyzed for risk of abandonment.

4.6 Additionality (G2)

The former property owner had a conversion plan that has been evaluated and a pilot project conducted to convert land to sugarcane. The equipment and manpower required was on site. Conversion of the forest includes harvesting merchantable trees, bulldozing, piling, and burning the remaining vegetation, and planting the site to sugarcane.

Additionality Analysis

Per instructions from the methodology, the following analysis is conducted to determine alternative baseline scenarios according to the procedure presented in “VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities”

This tool is applicable because a) the proposed project activities will not violate any Belizean law, and b) the use of this tool results in identification of the most plausible baseline scenario of the several possible baseline scenarios identified below.

Step 1: Identification of alternative land use scenarios to the AFOLU project activity.

Some of the alternative land uses are more likely and pose a much larger deforestation threat than others. The following is a "ranking" of the most likely alternative land uses. Each alternative is considered legal in Belize.

Sub-step 1a. Identify credible alternative land use scenarios to the proposed VCS AFOLU project activity.

1. Conversion to Agriculture

The most likely alternative land use scenario is the conversion to agriculture, and it is the most pervasive driver for deforestation and land use change in the region. The conversion of forestland in Belize to agriculture is both a national and regional trend. The FAO (2010) estimated that by 1997 about 385 thousand hectares, or about 16.9%, of the national land area had been converted from forest to agricultural land. By 2004, an additional 56 thousand ha had been converted (FAO 2010). Conversion of forest land for agriculture is occurring in Belize near the project area and forest cover declined 21% (6,123 acres/year) from 1980 to 2010 in the Orange Walk District (Cherrington et.al. 2010) almost exclusively from agricultural development.

Suitability of soils for conversion to agriculture, particularly sugarcane, was evaluated on a nearby site by planting and harvesting sugarcane over many years in small (estimated 50-100 ha) plots. Based upon published soils maps of Belize[18] and overlaying known sugarcane sites would indicate that the two soil types, Gleysoles (primarily) and Leptosols are commonly used for sugarcane. Wright (1959) included extensive notes about soils and potential agricultural uses including a description of the Yaxa suite west of the Hillbank lagoon (encompassing the project area) as suitable for sugarcane. An agricultural potential map published by the Belize Department of Agriculture[19] at indicates that the project area is in the "high potential" category for agriculture. Finally, given what is known about sugarcane agronomy in that it is a generalist growing on multiple soils[20] there would be no reason to believe that the sugarcane trials conducted at Gallon Jug would necessarily be invalid because they weren't conducted on the nearby project area.

This is a planned deforestation project and the valid and verified plan of the baseline agent of deforestation calls for sugarcane conversion. Conversion of land for agriculture is considered legal. Analysis of the financial plan for the project and the baseline indicates that a sugarcane project would generate net positive financial flows far in excess of the project.

A land clearing permit is required for clearings of over 300 acres. An environmental impact analysis (EIA) is required. Based on analysis of the EIA database for Belize, the EIA process is not a barrier for the project[21]. Confirmation of the legality of conversion can be obtained by communicating with the Belize National REDD coordinator at the Belize Forest Department. A similar project in size and scope was begun in 2012[22] without a formal environmental impact statement, and only after the company was apprehended building a major canal through a wildlife

[18] See DataBasin at http://databasin.org/maps/new#datasets=21a4f58393904edcbdb1ae031a4c6b68 to view a soils map of Belize.
[19] See http://www.pnuma.org/deat1/pdf/GEOBelize_Final_June2010.docx.pdf for extensive information regarding the agricultural potential of Belize.
[20] See http://www.sugarcanecrops.com/soil_requirement/ for a general discussion of sugarcane soils requirements.
[21] See Belize Department of the Environment web site http://www.doe.gov.bz/index.php/eias .
[22] See http://www.iuf.org/sugarworkers/belize-green-tropics-building-second-sugar-factory-country/ for a report about the Santander GreenTropic sugarcane project in Belize.

sanctuary, and the ensuing outcry from the conservation community, was an EIA commissioned and the project approved in the fall of 2013 (Meerman, Usher, and Boomsma 2013).

Sugarcane production in Belize is very well established and based on the common practice of converting forest to sugarcane in nearby areas of Belize, and the pilot project data collected at the property where the project is located, conversion is considered both feasible and likely. Access to markets is considered good to excellent. The proposed sugar project would produce sugar, molasses, and electricity. All three products were in demand and the price outlook was strong during the planning phase of the baseline sugar project (BEL 2011, McConnell et. al. 2010, Baron 2012). Timber from the project area would be harvested and sold up to the limits of the timber license for the property. Trees not sold would be burned on site.

A financial pro forma for a sugarcane production project that included generating revenue from the production of sugar, molasses, and electricity using bagasse as a feedstock was conducted. This option also included revenue from selling timber during the land clearing phase and the net revenue from that aspect of the sugarcane project is equivalent to the timber net revenue that is expected from the project This option was found to have the highest net present value (NPV discount rate 9.2% based on Asonuma et. al. 2014) of all the potential options for the property since it includes both the profitability of sugarcane production and the value of the timber. Options 4 and 5 only include the timber net revenue.

2. Purchase of the Land to Operate an Ecotourism Lodge

One alternative land use would be the conversion of the property for ecotourism. The agent of deforestation is already engaged in this strategy on another part of the property. This strategy is employed by several lodges in Belize. This strategy is considered unlikely for the obvious reason that one lodge is already located on the property. Since the maximum capacity of the existing lodge has not been reached, it is unlikely that a second lodge would be successful in the same area. A different sort of lodge, not ecotourism, is an option, but given the remoteness of the area, and the great cost involved, this option is considered unlikely to succeed.

A financial pro forma for an additional ecotourism operation was developed to compare with other options. Even with very optimistic projections for average daily rate and occupancy, the NPV (discount rate 9.2% based on Asonuma et. al. 2014) of this option was much lower than Option 1 Agricultural Conversion.

3. Management of the Land as a Conservation Area

There are privately owned protected areas in the district and throughout Belize. Most landowners that own these properties are members of the Belize Association of Private Protected Areas (BAPPA). Landowners purchase properties for conservation for a variety of reasons. Some establish nonprofit companies to hold the property and some simply hold onto the property out of a desire to protect the biodiversity or other values of the site. There is no inherent financial income stream from owning a private protected area while there are several required expenses. The initial purchase price, annual taxes, maintenance, and protection from trespass are all expenses that can run into the millions of dollars. Landowners that pursue this strategy are required to be relatively wealthy or have outside sponsors or pursue a strategy of income generation that is consistent with conservation such as ecotourism. Purchasing land for conservation purposes is legal. The NPV for this option is considered negative due to the lack of a confirmed income stream. While it is hypothetically possible that a grant or donor could be identified to support the property, this analysis is based on profitability, and a donation or grant to a for-profit entity for conserving the property is so far-fetched as to not be a serious consideration. A grant or donor would not allow a profit to be made from the donation.

4. Continuation of the preproject land use, timber management.

The project area has been in forest as far as the historical record goes back. The preproject land use consisted of holding the property for selective harvesting of timber. While no income had been derived from the project area by the agent of deforestation (GJA) since taking possession of the property, presumably the project area would be harvested selectively at some point in the future. That option was evaluated using current prices for logs and the sustainable forest management plan already prepared for the entire Gallon Jug property (130,000 acres). The NPV (discount rate 9.2% based on Asonuma et. al. 2014) for this option is less than the projected NPV for agricultural conversion.

5. Project activity on the land within the project boundary performed without being registered as the VCS AFOLU project

This alternative land use is essentially continuation of the preproject land use with the added expenses of patrols and monitoring. Income from the project area is just that associated with selective timber harvest, while expenses for this scenario include property taxes, patrols, and monitoring. Therefore conducting the project without registration as a VCS AFOLU project also produces a much lower NPV than the agricultural conversion option.

6. Comparison of the potential Scenarios:

Ranked by order of profitability as determined by NPV:

Chosen Scenario	Relative Rank	Comparison to most profitable
1. Conversion to Agriculture (uses average of high and low assumptions for timber revenue).	1	0.0%
4. Continuation of the preproject land use, timber management. Using average of high and low assumptions.	2	-50.0%
5. Project activity on the land within the project boundary performed without being registered as the VCS AFOLU project. The same as 4.	2	-50.0%
2. Purchase of the Land to Operate an Ecotourism Lodge	4	-96.6%
3. Management of the Land as a Conservation Area	5	-100.0%

Based on this comparison, conversion to agriculture is the most profitable potential land use.

Sub-step 1b. Consistency of credible land use scenarios with enforced mandatory laws and regulations.

All the alternatives presented are legal and permissible under Belizean law. Clearing of land over 300 acres is legal and permissible but requires an environmental impact statement and a permit. This requirement is not considered a barrier as evidenced by other large projects[23] in the immediate vicinity.

[23] See Green Tropic LLC http://www.reporter.bz/front-page/green-tropics-ltd-to-build-new-sugar-factory-in-cayo/

Step 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

The project will generate some financial benefit other than VCS related income from timber harvesting. Therefore investment comparison analysis or benchmark analysis is required.

Sub-step 2b. Option 2. Apply investment comparison analysis.

NPV for the baseline scenario, sugarcane development, is significantly more than the NPV of the project scenario excluding carbon finance. Since the NPV of the baseline scenario is significantly higher than the NPV of the project scenario, the project is financially additional. Financial plans of the project proponent are confidential and have been disclosed to the auditors. Financial pro forma for all scenarios were completed and reviewed by the auditors.

Step 4. Common Practice Analysis

Activities similar to the proposed project activities have been common practice within the last 10 years on lands adjoining the project area.

Option 1: Agricultural conversion of forest occurs in Belize regularly and as of the date of this document, Belize still requires that grantees of government land “improve” the land to maintain rights to the grant. That improvement typically includes clearing. More relevant to this analysis, a major sugarcane project (Green Tropic) was implemented just to the south of the project area in the Cayo District in 2012 (Meerman et. al. 2013). That project began initially with over 7,000 acres of land that was cleared in the first few years of the project and now is clearly visible on remotely sensed images. Cherrington et. al. (2010) found that from 1980 to 2010 an average of 24,835 acres/year were deforested in Belize (6,123 acres/year in Orange Walk District) primarily for agricultural uses. The Government of Belize in collaboration with the World Bank Forest Carbon Partnership Facility recently concluded in a report addressing deforestation in Belize *“Another policy-based intervention is required to address the loophole in the law* [ed.] *that allows a private forest owner to log a forest and then convert it to agriculture or sell it after it has been logged or degraded by natural disasters”* (FCPF 2015). The FCPF proposes funding for strengthening the EIA process to gain control over deforestation drivers of all sorts including agricultural conversion.

Option 2: Ecotourism lodges are well known in Belize and in fact one of the finest in the country is in the immediate vicinity of the project area, Chan Chich Lodge.

Option 3: Multiple private properties are listed as private protected areas in Belize through the Belize Association of Private Protected Areas. The essential distinction between the project and other lands managed as private protected areas is that the other lands are able, at least in some cases, to support the annual costs of management through outside means e.g. ecotourism, private funds, or outside donors/nongovernmental organizations. Those sources of income are not available to this landowner as a for-profit entity, and therefore the project activity is additional. An example is the establishment of the Balam Na area by Wildtracks in 2000[24].

Option 4 and 5: Timber management is common practice on private lands throughout Belize including all the lands surrounding the project area. All lands surrounding the project area are

[24] Tropical Rainforest Coalition: http://rainforest.org/balam-na-belize/

owned by either The Forestland Group or the Rio Bravo Conservation and Management area both of which practice selective harvesting of timber.

5 QUANTIFICATON OF GHG EMISSION REDUCTIONS AND REMOVALS (CLIMATE)

5.1 Project Scale and Estimated GHG Emission Reductions or Removals

Project	X
Large project	

Years	Estimated GHG emission reductions or removals (tCO_2e): (Adjusted-$C_{REDD,i,t}$)
2011	229,011
2012	234,994
2013	240,977
2014	246,960
2015	252,943
2016	258,926
2017	264,909
2018	270,892
2019	276,875
2020	282,858
Total estimated ERs	2,559,345
Total number of crediting years	10
Average annual ERs	255,935

The entire project area was forested at project start (Figure 14), and 10 years prior to Project Start (Figure 11). Based on head's up digitizing of cloud-free remote sensing imagery, LANDSAT 7 GLS 2000[25].

[25] 30 meter imagery was downloaded from the United States Geographic Survey's Global Visualization Viewer (GloVis -- http://glovis.usgs.gov).

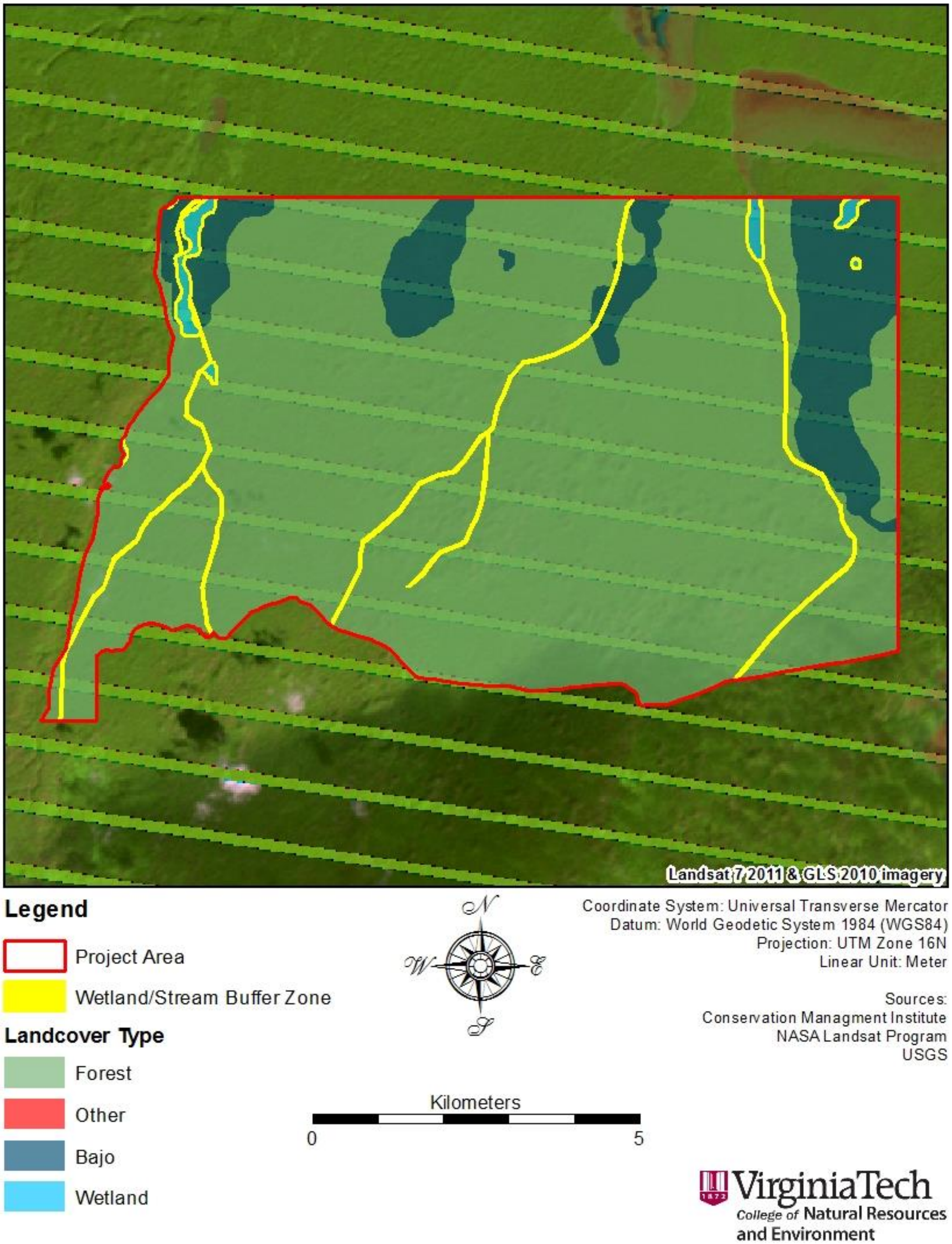

Figure 14: Forest Cover at Project Start.

A complete discussion of remote sensing data, preprocessing, post processing and analysis is contained in Appendix A.

5.2 Leakage Management (CL2)

Leakage was determined using module “Estimation of emissions from activity shifting for avoided planned deforestation (LK-ASP)” and module “Estimation of emissions from market-effects (LK-ME)”. Monitoring of the agent of deforestation’s property will occur as indicated in LK-ASP and M-MON, and if any deforestation for sugarcane agriculture is detected, leakage deductions will be taken using the equations in Section 5.5.

The project proponent, a timber investment company, now owns and controls almost 75% of the land owned by Gallon Jug Agroindustries at the project start, and will protect the property with patrols and monitoring to protect the investment. The remainder of the property still owned by Gallon Jug Agroindustries will be monitored by remote sensing for any deforestation activities related to sugarcane agriculture.

5.3 Baseline Emissions (G2)

This project claims avoided emissions compared to a baseline scenario of planned deforestation to support a sugarcane business. The methodology requires that a “valid and verifiable” plan (Gallon Jug Agroindustries 2010) is in place to both prove the intent to deforest and to evaluate the likely emissions reductions compared to the project scenario. The sugarcane plan was under development well prior to project initiation as evidenced by consultant studies (Kwok 2010) and sugarcane pilot projects. The pilot projects were recorded with hand written notes of field shape and size, fertilizer, planting rates, cane varieties, etc. A business pro forma was developed and a narrative produced based on these and other inputs. The variables required to drive a model of emissions are derived from this plan.

In order to estimate GHG loss und the baseline scenario the following pools and sources of emissions are analysed:

5.3.1 Area of Forest available for Conversion and Rate of Conversion

Of the total area of the property, 8,432 ha are slated for conversion to sugarcane. In the baseline, 8240 ha are converted to sugarcane ($A_{planned,I}$ = 8240). A 1-chain buffer around perennial streams and wetlands is excluded to comply with directives from the Belize Forest Department accounting for 118.3 ha.

5.3.2 Biomass Baseline Carbon Stocks

Prestratification was not conducted. However, ancillary data in the form of maps published by Cho (2007) indicated that more than one strata may exist. After extensive analysis of plot data and high resolution imagery, two potential strata were identified, a “bajo” type similar to the strata suggested by Cho (2007) but of much greater extent based on remote sensing analysis (see Appendix A for complete discussion of mapping techniques and accuracy assessment) and a broadleaf type (“high forest”). A small part of the forest, 1.1 ha was classified as “other”. Stream and wetland buffers were mapped as well to conservatively remove the buffers from calculations. To determine whether the potential strata were significantly different, the module X-STR was used to analyse the difference in means for total biomass/ha and found to be insufficiently different (means varied by only +2.64% for high forest and -9.09% for bajo) therefore the potential strata were pooled and treated as one strata for subsequent analysis. Additional analysis of potential strata resulting from hurricane damage was analyzed specifically and found to not warrant a separate strata as well (Dettman 2013).

Total Project Area (ha)			**Buffer (ha)**		**Net (ha)**
Bajo	1049.21		11.7		1037.46
Forest	7308.06		106.6		7201.48
Other	1.10				1.10
Totals	8358.36		118.32		8240.04

Baseline biomass carbon stocks consisted of aboveground biomass and belowground biomass of the tree and nontree pools in the sugarcane conversion area. The mean carbon pool in 2013 was based on field measurements conducted in 2013 and independently verified. The dry tropical (900-1500mm rainfall) forest allometric equation for biomass prediction published in Pearson et. al. (2005) was used to predict aboveground biomass Table 9. A factor of 47% was used to convert biomass to carbon. A pantropic equation utilizing DBH was chosen because higher priority equations were unavailable or unsuitable for the forest on the project area. Accuracy of the equation was validated using the procedure described in module CP-AB "Estimation of carbon stocks in the above- and belowground biomass in live tree and nontree pools" by selecting the largest tree from each plot <= 63 cm in DBH and testing the value derived against a general volumetric model (Smalian's volume formula to a 10 cm top * wood density). The Pearson et. al. (2005) dry tropical forest equation (900-1500mm rainfall) predicted 67.5% of the test trees at greater than the test value and 32.5% of the test trees below the test value therefore complying with the methodology for conservativeness.

Table 9: Equations used for calculating biomass.

Classification	Equation: DBH = diameter breast height, D=wood density, H= height		Maximum DBH or height
Aboveground Tree Biomass: Pearson et. al. 2005 Tropical Dry (900-1500mm rainfall)	$AGB = 0.2035 * DBH^{2.3196}$		DBH <= 63 cm
Palm aboveground biomass (AGB): Brown 2015	*Chrysophylla stauracantha*	$AGB = ((0.8966 * H) – 0.37988)$	H 0.45-10.0 m
	Attalea cohune	$AGB = (302.6 * \ln(H)) + 276.93)$	H 0.31-15.7 m
	Sabal mauritiiformis	$AGB = ((14.596 * H) + 13.54)$	H 0.15-14.53 m
Belowground Biomass	If AGB is > 125 t/ha then BGB = AGB x .24 else BGB = AGB x .2		DBH <= 63.4

The procedure for performing this estimate involved randomly allocating permanent plots in the forest, establishing and marking those plots, and measuring the trees and palms on those plots according to the methodology described in the monitoring plan. The number of plots was determined to capture the likely variability of the forest vegetation with adequate statistical power.

The DBH and total height of trees and the height of palms were recorded in the field and transcribed to spreadsheets for calculation of biomass, carbon, and metric tons of CO_2 equivalent. Plots were mathematically averaged to produce a mean by plot. Plot means were averaged to produce a mean for the project. An error rate was produced based on the standard deviation of the plot means. The error rate was used to produce an uncertainty estimate for the inventory for each pool (aboveground biomass and belowground biomass). The combined uncertainty rate for all pools and sources of emissions was found to be 8.51%.

Belowground biomass was estimated based on aboveground biomass using the root-to-shoot ratios indicated in the CP-AB methodology. Belowground biomass, per methodology module BL-PL, is treated as if emissions occur steadily over a 10-year period. In the baseline scenario, since 10% of the deforestation is occurring each year and only 10% of the belowground biomass is emitted each year, the emissions model accounts for each annual deforestation event separately and applies 10% of that event per year for 10 years.

Aboveground biomass attributed to palm biomass was included for three common species of palms and calculated AGB based on equations developed on a nearby study site were used to predict biomass (Brown 2015). The allometric equation used was evaluated per the methodology by reviewing the source data from which the equation was derived and confirming that the source data is representative of the species and conditions in the project and covers the range of potential sizes. The R^2 of each model is within the limit set by the methodology (R^2>.8). The range of heights is compared below:

Table 10: Palm equation range and R^2.

Species	R^2	Height range of the model	Height range of the inventory	Palms out of Range
cohune (*Attalea cohune*)	0.84	H 0.31-15.7 m	0.4-26.5 meters	2
give-and-take (*Chrysophylla staurucantha)*	0.94	H 0.45-10.0 m	1.0-8.8 meters	0
botan a.k.a sabal (*Sabal mauritiiformis*)	0.81	H 0.15-14.53 m	1.7-21.9 meters	4

To account for the four palms out of range for the botan model and the two palms out of range for the cohune model, the heights were arbitrarily, and conservatively capped at 15.7 meters for the cohune, and 14.5 meters for sabal thereby excluding those out of range palms from the calculation.

The tree biomass pool in 2013 is calculated as 285.78 tCO_2e/ha for aboveground tree biomass and 67.24 tCO_2e/ha for belowground tree biomass. Sum of the pools equals 353.02 tCO_2e/ha.

5.3.3 Rate of Deforestation and Agricultural Conversion

The likelihood of conversion to sugarcane is considered 100% based on the expected profitability of the project and the lack of barriers.

The annual rate of deforestation is derived using the following equation:

$$AA_{planned,i,t} = (A_{planned,i} * D\%_{planned,i,t}) * L\text{-}D_i$$

Where:

Parameter	Description	Value
$AA_{planned,i,t}$	Annual area of baseline planned deforestation for stratum *i* at time *t*; ha	824 ha/year for 10 years
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum i during year t. If actual annual proportion is known and documented (e.g. 25% per year for 4 years), set to proportion; %	10%/year for 10 years
$A_{planned,i}$	Total area of planned deforestation over the baseline period for stratum i; ha	8240 ha
$L\text{-}D_i$	Likelihood of deforestation for stratum i; %	100%

According to methodology module BL-PL "Where a valid verifiable plan exists for rate at which deforestation is projected to occur, this rate shall be used." Therefore a rate of 10%/year is used for 10 years. This rate was determined to be feasible and in line with common practice.

5.3.4 Carbon stocks in agro-ecosystems and the nontree biomass pool

To account for the nontree biomass pool both pre-deforestation and post-deforestation, the following assumptions were made based on the literature. Equations and parameters may be found in Section 5.3.6. Nontree biomass is defined as living plants that don't qualify as trees i.e. non-woody or too small to qualify for the tree inventory (DBH < 5 cm). Sugarcane is defined for this purpose as nontree biomass, however since it is harvested annually, the average long term carbon content value is used.

The above ground nontree biomass pre-deforestation ($C_{ABnon\text{-}treebsl,i}$) is determined through the literature citing Dewalt and Chave (2004) who reported liana biomass in four neotropical forests and found that the average AGB for lianas is 13 t C (dry matter x 44/12 converts to 47.67 tCO_2e). Of the four sites reported, the sites most similar to the project site, La Selva in Costa Rica and Barro Colorado in Panama, reported 17.2 t C/ha and 8.0 t C/ha respectively. An average of the two is 12.6 t C/ha or 46.2 t CO_2e/ha for $C_{ABnon\text{-}tree,bsl,i}$. This is considered an indisputably conservative estimate for $C_{ABnon\text{-}treebsl,i}$ since it does not include trees/palms smaller than 5 cm dbh or plants other than lianas that would be allowably included in the non-tree biomass pool.

The above ground nontree biomass post-deforestation ($C_{ABnon\text{-}treepost,i}$) is calculated as the annual average AGB of sugarcane. Since it is a cyclical system, an annual average (which is defined as half the harvested aboveground wet biomass based on an expected 4 crops in every 5 years) converted to dry matter using a conversion ratio found in Bakker (2004) and confirmed in FAO (1994). Bakker (2004) recommends monitoring sugarcane until it reaches 70% moisture content as an indicator of when harvest is ready. Therefore a carbon fraction of .3 is used conservatively assuming that all remaining matter after drying is carbon.

The sugarcane plan presumes a harvest rate of 25 short tons/acre of green sugarcane. Converting that to metric tons (25 * .907185) results in 22.7 metric tons. Converting that to hectares (22.7 * 0.404686) results in 56.04 mt green biomass/ha. Converting that to dry matter (56.04 * .3) results in a harvest rate of 16.81 t C/ha. To convert t C to t CO_2e multiply 16.81 x 44/12 = 61.65 t CO_2e/ha. The annual average is used for a cyclical biomass like sugarcane based on a conservative assumption that only four crops can be produced every five years because of weather or other operational constraints so 61.65 t C is multiplied by 5/4 resulting in 38.53 t CO_2e/ha for variable $C_{ABnon\text{-}tree,post,i}$.

Below ground biomass for both the pre-deforestation and post-deforestation pools is calculated using a root-to-shoot ratio of .24 (IPCC 2006). That results in $C_{BBnon\text{-}treebsl,i}$ = 11.1 tCO_2e/ha and $C_{BBnon\text{-}treepost,I}$ = 9.2 tCO_2e/ha.

5.3.5 Fate of Forest Resources Lost to Agricultural Conversion (Long-lived Wood Products)

The standard practice in Belize for conversion of forest to agricultural lands is to remove valuable timber species (commercially valuable and greater than or equal to 25 cm DBH based on Cho 2007) and then bulldoze and burn the remaining trees for agriculture (FCPF 2015). The aboveground and belowground tree biomass in the project area is presumed to be removed in the baseline scenario. Using module CP-W (Option 2), the long-lived wood product pool was calculated as follows:

Step 1: Calculate the biomass carbon of the volume extracted by wood product type from the project using the following equation.

$$C_{XB,i} = C_{AB\_tree,i} * \frac{1}{BCEF} * Pcom_i$$

Parameter	Description	Value
$C_{XB,i}$	Mean stock of extracted biomass carbon by class of wood product ty from stratum i; tCO_2e ha-1	10.64
$C_{AB\_tree,i}$	Mean aboveground biomass carbon stock in stratum *i*; tCO_2e ha-1	285.8
BCEF	Biomass conversion and expansion factor (BCEF) for conversion of merchantable volume to total aboveground tree biomass; dimensionless. Selection of value based on Table 4.52 in IPCC (2006). Estimated total biomass 23.48 m^3/ha based on inventory.	2.8
$Pcom_i$	Commercial volume as a percent of total aboveground volume in stratum *i*; dimensionless	10.42%
i	1, 2, 3, … *M* strata	One strata

Step 2: Identify wood product classes. In Belize, sawnwood is the only viable product based on the lack of processing capacity for other products such as plywood, paper, or chip board. Based on common practice, the only feasible outlet for logs is to the two sawmills (one at Gallon Jug and one at Yalbac) that are only able to saw logs into boards or flitches based on direct observation of the equipment and mill records.

Step 3: Calculate the biomass carbon that enters the wood products pool at the time of deforestation utilizing the following equation:

$$C_{WP,i} = \sum_{ty=s,w,oir,p,o} C_{XB,ty,i} * (1 - WW_{ty})$$

Parameter	Description	Value
$C_{WP,i}$	Carbon stock entering the wood products pool from stratum *i*; tCO_2e ha^{-1}	8.09
$C_{XB,ty,i}$	Mean stock of extracted biomass carbon by class of wood product *ty* from stratum *i*; tCO_2e ha^{-1}	10.64
WW_{ty}	Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product ty; dimensionless	0.24
ty	Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)	sawnwood
i	*1, 2, 3, … M* strata	One strata

Step 4: Calculate the amount of wood products entering the pool at the time of deforestation ($C_{WP,i}$, calculated in C-WP) that is expected to be emitted over a 100-year timeframe.

$$C_{WP100,i} = C_{WP,i} - C_{WP,i} * (1 - SLFp) * (1 - Ofp)$$

Parameter	Description	Value
$C_{WP100,i}$	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum i; $tCO_2e\ ha^{-1}$	7.05
$C_{WP,i}$	Carbon stock entering wood products pool at time of deforestation from stratum i; $tCO_2e\ ha^{-1}$	8.09
SLF_{ty}	Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product *ty*; dimensionless	0.2
OF_{ty}	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product *ty*; dimensionless	0.84
ty	Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)	Sawnwood
i	*1, 2, 3, … M* strata	One strata

5.3.6 Baseline Emissions Calculations by Pool

Stock changes in each pool are calculated by subtracting post-deforestation carbon stocks from forest carbon stocks.

$$\Delta C_{AB_{tree},i} = C_{AB_{tree_{bsl}},i} - C_{AB_{tree_{post}},i}$$

$$\Delta C_{BB\_tree,i} = C_{BB_{tree_{bsl}},i} - C_{BB_{tree_{post}},i}$$

$$\Delta C_{AB_{non-tree},i} = C_{AB_{non-tree_{bsl}},i} - C_{AB_{non-tree_{post}},i}$$

$$\Delta C_{BB_{non-tree},i} = C_{BB_{non}-tree,bsl,i} - C_{BB_{non}-tree,post,i}$$

Where:

Parameter	Description	Value
$\Delta C_{AB\_tree,i}$	Baseline carbon stock change in aboveground tree biomass in stratum *i*; $tCO_2e\ ha^{-1}$	285.8
$C_{AB\_tree,bsl,i}$	Forest carbon stock in aboveground tree biomass in stratum *i*; $tCO_2e\ ha^{-1}$	285.8
$C_{AB\_tree,post,i}$	Post-deforestation carbon stock in aboveground tree biomass in stratum *i*; $tCO_2e\ ha^{-1}$	0

$\Delta C_{BB\_tree,i}$	Baseline carbon stock change in belowground tree biomass in stratum *i*; $tCO_2e\ ha^{-1}$	67.2
$C_{BB\_tree,bsl,i}$	Forest carbon stock in belowground tree biomass in stratum *i*; $tCO_2e\ ha^{-1}$	67.2
$C_{BB\_tree,post,i}$	Post-deforestation carbon stock in belowground tree biomass in stratum *i*; $tCO_2e\ ha^{-1}$	0
$\Delta C_{AB\_non\text{-}tree,i}$	$\Delta C_{AB\_non\text{-}tree,i}$ Baseline carbon stock change in aboveground nontree biomass in stratum i; t CO_2-e ha-1	7.7
$C_{AB\_non\text{-}tree,bsl,i}$	$C_{AB\_non\text{-}tree,bsl,i}$ Forest carbon stock in aboveground nontree biomass in stratum i; t CO_2-e ha-1	46.2
$C_{AB\_non\text{-}tree,post,i}$	$C_{AB\_non\text{-}tree,post,i}$ Post-deforestation carbon stock in aboveground nontree biomass in stratum i; t CO_2-e ha-1	38.5
$\Delta C_{BB\_non\text{-}tree,i}$	$\Delta C_{BB\_non\text{-}tree,i}$ Baseline carbon stock change in belowground nontree biomass in stratum i; t CO_2-e ha-1	1.8
$C_{BB\_non\text{-}tree,bsl,i}$	$C_{BB\_non\text{-}tree,bsl,i}$ Forest carbon stock in belowground nontree biomass in stratum i; t CO_2-e ha-1	11.1
$C_{BB\_non\text{-}tree,post,i}$	$C_{BB\_non\text{-}tree,post,i}$ Post-deforestation carbon stock in belowground nontree biomass in stratum i; t CO_2-e ha-1	9.2
i	1, 2, 3, … *M strata*	One strata

$$\Delta C_{BSL,i,t} = AA_{planned,i,t} * \left(\Delta C_{ABtree,i} + \Delta C_{ABnon-tree,i} + \Delta C_{LI,i}\right)$$
$$+ \sum_{t-10}^{t}\left(AA_{planned,i,t} * \left(\Delta C_{BBtree,i} + \Delta C_{BBnon-tree,i} + \Delta C_{DW,i}\right) * \frac{1}{10}\right)$$
$$+ \sum_{t-20}^{t}\left(AA_{planned,i,t} * \left(C_{WP100,i} + \Delta C_{SOC,i}\right) * \frac{1}{20}\right)$$

Parameter	Description	Value
$\Delta C_{BSL,i,t}$	Sum of the baseline carbon stock change in all pools in stratum *i* at time *t,* tCO_2e	2,747,078
$AA_{planned,i,t}$	Annual area of baseline planned deforestation for stratum *i* at time *t*; ha	824 ha per year for 10 years
$C_{WP100,i}$	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum *i*; $tCO_2e\ ha^{-1}$; a complete explanation of the calculations for this parameter may be found in Section 5.3.5.	7.05
$\Delta C_{AB\_tree,i}$	Baseline carbon stock change in aboveground tree biomass in stratum *i*; $tCO_2e\ ha^{-1}$	285.8
$\Delta C_{BB\_tree,i}$	Baseline carbon stock change in belowground tree biomass in stratum *i*; $tCO_2e\ ha^{-1}$	67.2
$\Delta C_{AB\_non\text{-}tree,i}$	$\Delta C_{AB\_non\text{-}tree,i}$ Baseline carbon stock change in aboveground nontree biomass in stratum i; t CO_2-e ha-1	7.7
$\Delta C_{BB\_non\text{-}tree,i}$	$\Delta C_{BB\_non\text{-}tree,i}$ Baseline carbon stock change in belowground nontree biomass in stratum i; t CO_2-e ha-1	1.8

i	1, 2, 3, … *M strata*	One strata
t	1, 2, 3, … *t* years elapsed since the projected start of the REDD project activity	10

Note that soil carbon, dead wood, litter, and soil organic carbon are all conservatively excluded from the analysis.

5.3.7 Greenhouse Gas Emissions Other than Biomass Pool Change

GHG emissions are calculated based on the following equations and parameters.

$$GHG_{BSL,E,i,t} = E_{FC,i,t} + E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t}$$

Where:

Parameter	Description	Value
$GHG_{BSL\text{-}E}$	Greenhouse gas emissions as a result deforestation activities within the project boundary in the stratum i in year t; tCO_2e	139,992
$E_{biomassburn,i,t}$	Non-CO_2 emissions due to biomass burning that results in deforestation in stratum *i* in year *t* (t CO_2e)	139,992
$N_2O_{direct\text{-}N,i,t}$	Direct N2O emission as a result of nitrogen application on the alternative land use in stratum i in year t (t CO_2e). Conservatively excluded pool.	0
i	1, 2, 3, … *M* strata (unitless)	one strata
t	*1, 2, 3 … t** time elapsed since the start of the project activity (years)	10

5.3.7.1 Avoided emissions from biomass burning

In the baseline scenario, land clearing would include piling and burning of biomass on the site. An analysis of emissions from biomass burning was conducted to determine CH_4 and N_2O using module "Estimation of greenhouse gas emissions from biomass burning (E-BPB)". Avoided emissions from CO_2 release are omitted because they are accounted for by biomass changes in the aboveground and belowground biomass pools. Avoided emissions attributable to CH_4 and N_2O, tCO_2e, are included based on the following equation:

$$E_{biomassburn,i,t} = \sum_{g=1}^{G} \left(\left(\left(A_{burn,i,t} \times B_{i,t} \times COMF_i \times G_{g,i} \right) \times 10^{-3} \right) \times GWP_g \right)$$

Parameter	Description	Value
$E_{biomassburn,i,t}$	Greenhouse gas emissions due to biomass burning as part of deforestation activities in stratum *i* in year *t* of each GHG (CH_4, N_2O) (t CO_2e)	139,992
$A_{burn,i,t}$	Area burnt for stratum *i* in year *t* (ha)	824 ha/year for 10 years
$B_{i,t}$	Average aboveground biomass stock before burning stratum *i*, year (t d.m. ha^{-1})	165.8
$COMF_i$	Combustion factor for stratum *i* (unitless)	0.5
$G_{g,i}$	Emission factor for stratum *i* for gas g (kg t^{-1} d.m. burnt)	6.8 for CH_4 and 0.2 for N_2O
GWP_g	Global warming potential for gas g (t CO_2/t gas g)	21 for CH_4 and 310 for N_2O
g	1, 2, 3 ... G greenhouse gases including carbon dioxide[1], methane and nitrous oxide (unitless)	CH_4 and N_2O
i	1, 2, 3 …M strata (unitless)	1
t	1, 2, 3, … *t** time elapsed since the start of the project activity (years)	10

5.3.7.2 Avoided emissions from fertilizer application

Emissions related to nitrogen fertilizer application is a conservatively excluded pool in both the baseline and project scenarios.

5.3.7.3 Avoided emissions from transportation fuel use

Emissions from transportation fuel use are conservatively omitted in both the baseline and project scenarios.

5.3.8 Baseline Emissions Summed

The baseline net GHG emissions are determined as:

$$\Delta C_{BSL,planned} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(\Delta C_{BSL,i,t} + GHG_{BSL-E,i,t} \right)$$

Parameter	Description	Value
$\Delta C_{BSL,planned}$	Net greenhouse gas emissions in the baseline from planned deforestation; t CO_2-e	2,887,000
$\Delta C_{BSL,i,t}$	Net carbon stock changes in all pools in the baseline stratum *i* at time *t*; t CO_2-e	2,747,078

$GHG_{BSL\text{-}E,i,t}$	Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline stratum *i* during project year *t*; t CO_2-e $year^{-1}$ Note: value provided is total for all years.	139,992
i	1, 2, 3, … *M* strata (unitless)	one strata
t	*1, 2, 3 … t** time elapsed since the start of the project activity (years)	10 years

Results by year are reported in Table 11.

Table 11a: Results of calculations for Baseline Emissions.

Year	Biomass Change AGB ($\Delta C_{AB\_tree,i,t}$)	Biomass Change BGB ($\Delta C_{BB\_tree,i,t}$)	Biomass Change AGB ($\Delta C_{AB\_non\text{-}tree,i,t}$)	Biomass Change BGB ($\Delta C_{BB\_non\text{-}tree,i,t}$)	Long Term Wood Products Pool ($C_{wp100,i,t}$)	Biomass Change ($\Delta C_{BSL,i,t}$)
2011	235,481	5,541	6,321	152	290	247,785
2012	235,481	11,081	6,321	303	581	253,768
2013	235,481	16,622	6,321	455	871	259,750
2014	235,481	22,163	6,321	607	1,162	265,733
2015	235,481	27,704	6,321	758	1,452	271,716
2016	235,481	33,244	6,321	910	1,743	277,699
2017	235,481	38,785	6,321	1,062	2,033	283,682
2018	235,481	44,326	6,321	1,214	2,324	289,665
2019	235,481	49,867	6,321	1,365	2,614	295,648
2020	235,481	55,407	6,321	1,517	2,905	301,631

Table 11b: Results of calculations for Baseline Emissions.

Year	Biomass Change ($\Delta C_{BSL,i,t}$)	Non-CO_2 Biomass Burning ($E_{biomassburn,i,t}$)	Total Baseline Emissions ($GHG_{BSL,E,i,t}$)	Total Baseline Emissions and Reductions ($\Delta C_{BSL,\ planned,I,t}$)	Total Baseline Emissions and Reductions ($\Delta C_{BSL,I,t}$)
2011	247,785	13,992	13,992	261,777	261,777
2012	253,768	13,992	13,992	267,760	267,760
2013	259,750	13,992	13,992	273,743	273,743
2014	265,733	13,992	13,992	279,726	279,726
2015	271,716	13,992	13,992	285,709	285,709
2016	277,699	13,992	13,992	291,691	291,691
2017	283,682	13,992	13,992	297,674	297,674
2018	289,665	13,992	13,992	303,657	303,657
2019	295,648	13,992	13,992	309,640	309,640
2020	301,631	13,992	13,992	315,623	315,623

5.4 Project Emissions (CL1)

GHG emissions and/or removals for the project are described for the same pools and variables as the baseline scenario. Project emissions are estimated by applying module M-MON (VMD0015, Version 2.1) of VM0007.

Possible sources of emissions are explained below.

5.4.1 Degradation from timber harvest and potential fuelwood collection

Two very small potential sources of emissions include planned sustainable timber harvest under a Forest Sustainability Council certificate (FSC), and the potential for emissions from fuelwood collection by the local community. Both sources of emissions are calculated using the following equations and parameters:

$$\Delta C_{P,Deg,i,t} = \Delta C_{P,DegW,i,t} + \Delta C_{P,SelLog,i,t}$$

Parameter	Description	Value
$\Delta C_{P,Deg,i,t}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum i at time t; tCO_2e	32,537
$\Delta C_{P,DegW,i,t}$	Net carbon stock change as a result of degradation through extraction of trees for illegal timber or fuelwood and charcoal in the project area in the project case in stratum i at time t; tCO_2e. This pool was analyzed for significance and found to be de minimis. Value set to 0.	2,275
$\Delta C_{P,SelLog,i,t}$	Net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas in the project area in the project case in stratum i at time t; tCO_2e. This pool was analyzed for significance and found to be de minimis. Value set to 0.	30,262
i	1, 2, 3 …M strata	1
t	1, 2, 3, … t* years elapsed since the start of the REDD project activity	10

Timber Harvest:

The emissions from wood harvest were calculated based on Whitman et. al. (1997) from their study of this topic on property immediately adjacent to the project area near Hillbank, Belize. This study indicated damage to the forest trees of 4.8%. Conservatively assuming that the impact is 3X this estimate, all trees suffer mortality, and conservatively assuming that no regrowth occurs, then a simple calculation of 14.4% of the biomass on site at project start would result in a conservative estimate of emissions related to commercial wood harvest. The project plan calls for four years of harvest during the baseline (2017-2020).

The VCS standard (AFOLU Requirements version 3) indicates a requirement to follow the guidelines for Wetlands Restoration and Conservation (WRC) where timber harvest is envisioned on forested wetlands unless the soil organic carbon pool can be conservatively excluded from the project. The bajo component of the forest is, by VCS definition, a forested wetland, however the soil organic carbon pools in both the baseline and project scenarios have been conservatively excluded therefore the WRC guidelines don't apply. The timber license for the project excludes a large portion of the bajo from consideration from timber harvest.

Based on the equation and parameters in M-MON, the amount of potential emissions resulting from selective harvesting during the project lifetime is estimated as follows:

$$\Delta C_{P,SelLog,i,t} = \sum_{t=1}^{t} \left(C_{LG,i,t} + C_{LR,i,t} - C_{WP,i,t} \right)$$

Where:

Parameter	Description	Value
$\Delta C_{P,SelLog,i,t}$	Net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas in the project area in the project case in stratum i at time t; tCO_2e	30,262
$C_{LG,i,t}$	Actual (projected) net project emissions arising in the logging gap in stratum i at time t; tCO_2e	
$C_{LR,i,t}$	Actual (projected) net project emissions arising from logging infrastructure in stratum i at time t; tCO_2e	
$C_{LG,i,t} + C_{LR,i,t}$	The difference between $C_{LG,i,t}$ and $C_{LR,i,t}$ is not easily defined in Whitman et. al. (1997) but the combination of the two can be determined.	96,884
	Total damage estimate from Whitman et. al. (1997) of 4.8% x 3 to result in indisputably conservative assumption.	14.4%
$C_{tree,i,t}$	Total AGBtree in tCO_2e	2,354,810
$C_{WP\ i,t}$	Carbon stock in wood products pool from stratum i, at time t; tCO_2e	66,621
t	1, 2, 3 … t years elapsed since the start of the project activity	4

Based on these calculations the total contribution to emissions from this source was determined to be de minimis using module T-SIG.

<u>Fuelwood Collection:</u>

Fuelwood collection is a minor activity on the project based on the small size of the community and the large size of forest available to the community. A methodology deviation was employed to address this potential source of emissions (see section 4.3) to utilize the equations and parameters that follow:

$$\Delta C_{P,DegW,i,t} = A_{DegW,i} * \frac{C_{DegW,i,t}}{AP_i}$$

Where:

Parameter	Description	Value
$\Delta C_{P,DegW,i,t}$	Net carbon stock changes as a result of degradation in stratum i in the project area at time t; tCO_2e	2,275
$A_{DegW,i}$	Area potentially impacted by degradation processes in stratum i; ha	8,240
$C_{DegW,i,t}$	Biomass carbon of trees cut and removed through degradation process from plots measured in stratum i at time t; tCO_2e	0.27607
A_{Pi}	Total area of degradation sample plots in stratum i; ha	0
i	1, 2, 3 …M strata	1
t	1, 2, 3, … t* years elapsed since the start of the REDD project activity	10

An indisputably conservative assumption was made to arrive at $A_{degW,i}$. It was assumed that 150 people use fuelwood from the project area, and that each uses .55 m^3/person-year FAO (2008) for 10 years. Each m^3 of wood weighs a conservative 1600 kg/m^3. A fraction of carbon of .47 (IPCC 2006) is used to convert greenwood to dry wood. A ratio of 44/12 is used to convert carbon to CO_2. Multiplying these numbers (.55 * 1600/1000 * 150 * 30 * .47 * 44/12) arrives at a total of 2,275 tCO_2e emissions as a result of fuelwood collection or 0.276 tCO_2e/ha.

Based on this very low potential rate of use for fuelwood and emissions from sustainable harvest of timber, the combined pool ($\Delta C_{P,Deg,i,t}$) was analyzed with module T-SIG and found to be de minimis.

5.4.2 Avoided emissions from fertilizer or chemical use

No fertilization or chemical use is anticipated as a project activity. GHG emissions from fertilizer and chemical use are a conservatively excluded pool in both the project and baseline.

5.4.3 Avoided emissions from biomass burning

In the event of ex-post wildfires occurring that result in deforestation, the REDD Methodological Module: Estimation of greenhouse gas emissions from biomass burning (E-BPB) Sectoral Scope 14 will be applied.

5.4.4 Avoided emissions from transportation fuel use

Emissions from transportation fuel use are conservatively omitted in both the baseline and project

5.5 Leakage (CL2)

Leakage will be determined using module “Estimation of emissions from activity shifting for avoided planned deforestation (LK-ASP)” and module “Estimation of emissions from market-effects (LK-ME)”.

Activity Shifting Leakage

The deforestation agent was determined to be the former landowner, Gallon Jug Agroindustries. At project start Gallon Jug Agroindustries owned 37,535 ha of forest. That forest will constitute the leakage belt for monitoring. Belize does not maintain records of planned deforestation so there is no way to determine a priori intent to deforest. Large-scale forest clearing requires an environmental assessment which is posted at the web site of the Belize Department of the Environment. No such EIA has been posted, although the EIA requirement isn't a barrier to deforestation (see discussion in Section 4.6). A query was submitted to Gallon Jug Agroindustries regarding intent to deforest lands for sugarcane, and the response was that no plans exist for such activities.

$$\Delta C_{LK-AS,planned} = \sum_{t=1}^{t^*}\sum_{i=1}^{M}\left(\left(LKA_{planned,i,t} * \Delta C_{BSL,i}\right) + GHG_{LK,E,i,t} + LK_{peat}\right)$$

Where:

Parameter	Description	Value
$\Delta C_{LK-AS,planned}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation; tCO_2e	0
$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum i at time t; ha	0
$\Delta C_{BSL,i}$	Net carbon stock changes in all pools in baseline stratum i; tCO_2e ha-1	362.5
$GHG_{LK,E,i,t}$	Greenhouse gas emissions as a result of leakage of avoided deforestation activities in stratum i in year t; tCO_2e	0
$LK_{peat,t}$	Net greenhouse gas emissions due to leakage to peatlands as a result of implementation of a planned deforestation project at time t; tCO_2e	N/A no peat present
i	1, 2, 3, … *M* strata	one strata
t	1, 2, 3, … *t** years elapsed since the projected start of the REDD project activity	10

Step 1 Option 1.2 (option 1.1 is infeasible since no deforestation has been detected in the previous 5 years): Determine the baseline rate of forest clearance for the deforestation agent: Total area deforested by the deforestation agent over the previous 5 years is zero. Since there is no history of deforestation and no verifiable plans for controlled lands and future-controlled lands then WoPR must be set to planned baseline rate for the project ($D\%_{planned} * A_{planned}$) from the planned deforestation baseline module or 8240 ha.

Official records of deforestation were not required for areas under 300 acres. Areas above 300 acres technically required an environmental impact assessment, but common practice was to ignore this requirement for agricultural clearing. See section 4.6 Step 4 for additional discussion. Remote sensing analysis was conducted over the entire Gallon Jug Agroindustries property to determine deforestation rate in previous 5 years.

$$WoPR_{i,t} = \sum_{ag=1}^{ag} \frac{HistHa_{i,ag}}{5}$$

Parameter	Description	Value
$WoPR_{i,t}$	Deforestation by the baseline agent of the planned deforestation in stratum *i* in year *t* in the absence of the project; ha: Where there is no history of deforestation	8240

	and no verifiable plans for controlled lands and future-controlled lands then WoPR must be set to planned baseline rate for the project ($D\%_{planned}$ * $A_{planned}$ from the planned deforestation baseline module).	
$HistHa_{i,ag}$	The number of hectares of forest cleared by the baseline agent of the planned deforestation in the five years prior to project implementation in stratum i by agent ag within the country; ha	0
i	1, 2, 3, … *M* strata	One strata
ag	1, 2, 3, … *ag* agents of deforestation	One agent of deforestation
t	1, 2, 3, … *t** years elapsed since the projected start of the REDD project activity	10 years

Step 2: Estimate new projection of forest clearance by the baseline agent of deforestation with project implementation if no leakage occurring: NewR is equal to zero because planned deforestation in the project case is zero. In step 1, WoPR is equal to 8240 ha. In step 2 NewR is set to WoPR – ($D\%_{planned}$ * $A_{planned,i}$) = 0 where $D\%_{planned,i,t}$ = 100%, and $A_{planned}$ = 8240 which is equivalent to 8240-(1*8240) = 0 ha.

$$NewR_{i,t} = WoPR_{i,t} - \left(D\%_{planned,i,t} * A_{planned,i}\right)$$

Where:

Parameter	Description	Value
$NewR_{i,t}$	New calculated forest clearance in stratum *i* at time *t* by the baseline agent of the planned deforestation where no leakage is occurring; ha	0
$WoPR_{i,t}$	Deforestation by the baseline agent of the planned deforestation in stratum *i* in year *t* in the absence of the project; ha	824 ha/year for 10 years
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum *i* at year *t;* %	10% for 10 years or 100%
$A_{planned,i}$	Total area of planned deforestation over the baseline period for stratum *i*; ha	8240
i	1, 2, 3, … *M* strata	one strata
t	1, 2, 3, … *t** years elapsed since the projected start of the REDD project activity	10 years

Step 3: Monitor all areas deforested by baseline agent of deforestation through the year in which planned deforestation was forecast to occur: All areas owned or controlled by the baseline agent of deforestation in Belize will be monitored for deforestation through 2020. Since $NewR_{it}$ = 0 ha and $A_{defLK,i,t}$ was measured using remote sensing at 0 ha then $LKA_{planned,i,t}$ is 0. Result is presumed to be zero hectares in the baseline.

$$LKA_{planned,i,t} = A_{defLK,i,t} - NewR_{i,t}$$

Parameter	Description	Value
$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum i at time t; ha	0

$NewR_{i,t}$	New calculated forest clearance in stratum *i* at time *t* by the baseline agent of the planned deforestation where no leakage is occurring; ha	0
$A_{defLK,i,t}$	The total area of deforestation by the baseline agent of the planned deforestation in stratum i at time, t; ha	0
i	1, 2, 3, … *M* strata	one strata
t	1, 2, 3, … *t** years elapsed since the projected start of the REDD project activity	10 years

Step 4: Monitor greenhouse gas emissions outside the project boundary by baseline agent of deforestation: Biomass burning that results from intentional deforestation will be monitored on all lands owned by the baseline agent of deforestation in Belize at project start. Biomass burning, in this context meaning intentional burning by the agent of deforestation related to deforestation for sugarcane agriculture, is not planned by Gallon Jug Agroindustries, so biomass burning is also considered 0 ex ante.

$$GHG_{LK,E,i,t} = E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t}$$

Where:

Parameter	Description	Value
$GHG_{LK,E,i,t}$	Greenhouse gas emissions as a result of leakage of avoiding deforestation activities in stratum *i* in year *t* (t CO_2e)	0
$E_{biomassburn,i,t}$	Non-CO_2 emissions due to biomass burning in stratum *i* in year *t* (t CO_2e)	0
$N_2O_{direct-N,i,t}$	Direct N2O emission as a result of nitrogen application on the alternative land use in stratum i in year t (t CO_2e). Conservatively excluded pool.	0
i	1, 2, 3, … *M* strata (unitless)	one strata
t	*1, 2, 3 … t** time elapsed since the start of the project activity (years)	10 years

Market Effects Leakage

Market effects leakage captures possible emissions from timber harvest that could be generated when the project is removed from the available land base and additional pressure is put on surrounding landowners to provide timber to the market. Market effects leakage is calculated as follows:

$$\Delta C_{LK-ME} = LK_{MarketEffects,timber} + LK_{MarketEffects,FW/C}$$

Where:

Parameter	Description	Value
$\Delta C_{LK\text{-}ME}$	Net greenhouse gas emissions due to market-effects leakage (t CO_2e).	327,655
$LK_{MarketEffects,timber}$	Total GHG emissions due to market-effects leakage through decreased timber harvest (t CO_2e)	327,655
$LK_{MarketEffects,FW/C}$	Total GHG emissions due to market-effects leakage through decreased harvest of fuelwood and charcoal sold into regional and/or national markets (t CO_2e); no commercial harvest of charcoal or fuelwood exists in the community.	0
$LK_{MarketEffects,Peat}$	Total GHG emissions due to market-effects leakage through decreased timber, fuelwood and charcoal harvest resulting in increased peatland drainage (t CO_2-e)	0

$$LK_{MarketEffects,timber} = \sum_{i=1}^{M}\left(LF_{ME} \times LK_{MAF} \times AL_{T,i}\right)$$

Where:

Parameter	Description	Value
$LK_{MarketEffects,timber}$	Total GHG emissions due to market-effects leakage through decreased timber harvest (t CO_2e)	327,655
LF_{ME}	Leakage factor for market-effects calculations (dimensionless)	0.4
LK_{MAF}	Leakage management adjustment factor (dimensionless): LKMAF is conservatively set to 1 meaning no reduction in leakage is presumed from leakage management areas for the baseline period.	1
$AL_{T,i}$	Summed emissions from timber harvest in stratum *i* in the baseline case potentially displaced through implementation of the project (t CO_2e)	819,138
i	1,2,3,…M strata (dimensionless)	1

$$LK_{MAF} = 1 - (PRODMB_{LMA,t} / PRODMB_{BL,t})$$

Where:

Parameter	Description	Value
LK_{MAF}	Leakage management adjustment factor (dimensionless): LKMAF is conservatively set to 1 meaning no reduction in leakage is presumed from leakage management areas for the baseline period.	1
$PRODMB_{LMA,t}$	Production biomass in commercial species that is merchantable in year t in leakage management areas (t per year). Since no leakage management areas have been established this is set to 0.	0
$PRODMB_{BL,t}$	Production of biomass in commercial species that is merchantable in year t in the baseline case (t per year)	740,759

t	t* time elapsed since the start of the project activity (years)	10

$$AL_{T,i} = \sum_{t=1}^{t}\left(C_{BSL,XBT,i,t}\right)$$

Parameter	Description	Value
$AL_{T,i}$	Summed emissions from timber harvest in stratum *i* in the baseline case laced through implementation of carbon project (t CO_2e)	819,138
$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum *i* in year *t* (t CO_2e)	819,138
i	1, 2, 3, … *M* strata (unitless)	1
t	*1, 2, 3 … t** time elapsed since the start of the project activity (years)	10 years

$$C_{BSL,XBT,i,t} = \left(\left[V_{BSL,XE,i,t} * D_{mn} * CF\right] + \left[V_{BSL,XE,i,t} * LDF\right] + \left[V_{BSL,XE,i,t} * LIF\right]\right) * \frac{44}{12}$$

Where:

Parameter	Description	Value
$C_{BSL,XBT,i,t}$	Carbon emission due to timber harvests in the baseline scenario in stratum *i* in year *t* (t CO_2e)	819,138
$V_{BSL,EX,i,t}$	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum *i* in year *t* (m^3)	193,481
D_{mn}	Mean wood density of commercially harvested species (t d.m.m^{-3})	0.712
CF	Carbon fraction of biomass for commercially harvested species *j* (t C t d.m.$^{-1}$)	0.47
LDF	Logging damage factor (t C m^{-3})	0.53
LIF	Logging infrastructure factor (t C m^{-3})	0.29
i	1, 2, 3, … *M* strata (unitless)	1
t	*1, 2, 3 … t** time elapsed since the start of the project activity (years)	10 years

Table 12: Results of Market Leakage Calculations

Year	$V_{BSL,EX,i,t}$	$C_{BSL,XBT,i,t}$	$A_{LT,i}$	$PRODMB_{LMA,t}$	$PRODMB_{BL,t}$	LK_{MAF}	$LK_{MarketEffects,timber}$	ΔC_{LK-ME}
2011	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2012	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2013	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2014	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2015	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2016	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2017	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2018	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2019	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766
2020	19,348	81,914	81,914	0.0	74,076	1.0	32,766	32,766

Total leakage effects are calculated as follows:

$$\Delta C_{LK} = \Delta C_{LK-AS,planned} + \Delta C_{LK-AS,unplanned} + \Delta C_{LK-AS,degrad-FW/C} + \Delta C_{LK-ME}$$

Where:

Parameter	Description	Value
ΔC_{LK}	Net greenhouse gas emissions due to leakage; tCO_2e; note annual reporting of parameter in Table 13.	327,655
$\Delta C_{LK-AS,planned}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation; tCO_2e (from LK-ASP)	0
$\Delta C_{LK-AS,unplanned}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing unplanned deforestation; tCO_2e (from LK-ASU): note this is a avoided planned deforestation and this parameter is n/a.	N/A
ΔC_{LK-ME}	Net greenhouse gas emissions due to market-effects leakage; tCO_2e (from LK-ME).	327,655
$\Delta C_{LK-AS,degrad-FW/C}$	Net greenhouse gas emissions due to activity shifting leakage for degradation caused by extraction of wood for fuel; tCO_2e (from LK-DFW).	N/A

Table 13: Sum of Leakage Sources

Year	$\Delta C_{LK-AS,planned}$	ΔC_{LK-ME}	ΔC_{LK}
2011	0	32,766	32,766
2012	0	32,766	32,766
2013	0	32,766	32,766
2014	0	32,766	32,766
2015	0	32,766	32,766
2016	0	32,766	32,766
2017	0	32,766	32,766
2018	0	32,766	32,766
2019	0	32,766	32,766
2020	0	32,766	32,766

5.6 Summary of GHG Emission Reductions and Removals (CL1 & CL2)

The procedures for calculating the summary of emissions reductions and removals follows the equation:

$$C_{REDD,t} = \Delta C_{BSL} - \Delta C_P - \Delta C_{LK}$$

Where:

Parameter	Description	Value
$C_{REDD,t}$	Total net greenhouse emission reductions at time *t*; tCO_2e; Results by year reported in Table 12.	2,559,345
ΔC_{BSL}	Net greenhouse gas emissions under the baseline scenario; tCO_2e	2,887,000
ΔC_P	Net greenhouse gas emissions within the project area under the project scenario; tCO_2e (from M-MON)	0
ΔC_{LK}	Net greenhouse gas emissions due to leakage; tCO_2e	327,655

$$\Delta C_{BSL} = \Delta C_{BSL,planned} + \Delta C_{BSL,unplanned} + \Delta C_{BSL,degrad-FW/C}$$

Where:

Parameter	Description	Value
ΔC_{BSL}	Net greenhouse gas emissions under the baseline scenario; tCO_2e; Results by year reported in Table 12.	2,887,000
$\Delta C_{BSL,planned}$	Net greenhouse gas emissions in the baseline from planned deforestation; tCO_2e (from BL-PL)	2,887,000
$\Delta C_{BSL,unplanned}$	Net greenhouse gas emissions in the baseline from unplanned deforestation; tCO_2e (from BL-UP): note this is an avoided planned deforestation and this parameter is n/a.	N/A
$\Delta C_{BSL,degrad-FW/C}$	Net greenhouse gas emissions in the baseline from degradation caused by fuelwood collection and	0

	charcoal making; tCO_2e (from BL-DFW): note that extraction of wood for fuel is considered sustainable and de minimis.	

$$\Delta C_P = \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(\Delta C_{P,DefPA,i,t} + \Delta C_{P,Deg,i,t} + \Delta C_{P,DistPA,i,t} + GHG_{P-E,i,t} - \Delta C_{P,Enh,i,t} \right)$$

Where:

Parameter	Description	Ex Ante Value Applied
ΔC_P	Net greenhouse gas emissions within the project area under the project scenario; tCO_2e; Results by year reported in Table 15.	0
$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* at time *t*; tCO_2e	0
$\Delta C_{P,Deg,i,t}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum *i* at time *t*; tCO_2e: This source of emissions was found to be de minimis and will not be monitored.	0
$\Delta C_{P,DistPA,i,t}$	Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum *i* at time *t*; tCO_2e	0
$GHG_{P-E,i,t}$	Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum *i* in year *t*; tCO_2e	0
$\Delta C_{P,Enh,i,t}$	Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline[2] in stratum *i* at time *t*; tCO_2e	0
i	1, 2, 3 …*M* strata	One strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity	10 years

$$\Delta C_{P,DefPA,i,t} = \sum_{u=1}^{U} \left(A_{DefPA,u,i,t} * \Delta C_{pools,P,Def,u,i,t} \right)$$

$$\Delta C_{P,DefLB,i,t} = \sum_{u=1}^{U} \left(A_{DefLB,u,i,t} * \Delta C_{pools,P,Def,u,i,t} \right)$$

Where:

Parameter	Description	Ex Ante Value Applied
$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* at time *t*; tCO_2e	0
$\Delta C_{P,DefLB,i,t}$	Net carbon stock change as a result of deforestation in the project case in the leakage belt in stratum i at time t; $t\ CO_2\text{-}e$	0
$A_{DefPA,u,i,t}$	Area of recorded deforestation in the project area stratum i converted to land use u at time t; ha	0

$A_{DefLB,u,i,t}$	Area of recorded deforestation in the leakage belt stratum i converted to land use u at time t; ha	0
$\Delta C_{pools,Def,u,i,t}$	Net carbon stock changes in all pools in the project case in land use u in stratum i at time t; t CO_2-e ha-1	Varies by year, see table below.
u	1,2,3,…U post-deforestation land uses	1
i	1, 2, 3 …*M* strata	One strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity	10 years

$$\Delta C_{pools,Def,i,t} = C_{BSL,i} - C_{P,post,i} - C_{WP,i}$$

Where:

Parameter	Description
$\Delta C_{pools,Def,u,i,t}$	Net carbon stock changes in all pools in the project case in land use u in stratum i at time t; t CO_2-e ha-1
$C_{BSL,i}$	Carbon stock in all pools in the baseline case in stratum i; t CO_2-e ha-1
$C_{P,post,u,i}$	Carbon stock in all pools in post-deforestation land use u in stratum i; t CO_2-e ha-1
$C_{WP,i}$	Carbon stock sequestered in wood products from harvests in stratum i; t CO_2-e ha-1. Conservatively presumed to 0 for the purpose of calculating $\Delta C_{pools,Def,u,i,t.}$
u	1,2,3,…U post-deforestation land uses
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

$C_{WP,i,t}$ is conservatively presumed to be 0. Because of the requirement to apply emissions related to belowground biomass over a 10 year period after deforestation, $\Delta C_{pools,Def,u,i,t}$ varies by year as follows:

Table 14: Annual Reporting for $C_{WP,i,t}$, $C_{P,post,u,i,t}$, $C_{BSL,i}$, and $\Delta C_{pools,Def,u,i,t}$

Year	$C_{WP,i,t}$	$C_{P,post,u,i,t}$	$C_{BSL,i,}$	$\Delta C_{pools,Def,u,i,t}$
2011	0.00	49.62	362.53	312.91
2012	0.00	49.62	362.53	312.91
2013	0.00	49.62	362.53	312.91
2014	1.41	49.62	362.53	311.50
2015	1.76	49.62	362.53	311.15
2016	2.12	49.62	362.53	310.80
2017	2.47	49.62	362.53	310.45
2018	2.82	49.62	362.53	310.09
2019	3.17	49.62	362.53	309.74
2020	3.53	49.62	362.53	309.39

$$C_{post,u,i} = C_{AB\_tree,i} + C_{BB\_tree,i} + C_{AB\_non-tree,i} + C_{BB\_non-tree,i} + C_{DW,i} + C_{LI,i} + C_{SOC,PD-BSL,i}$$

Where:

Parameter	Description	Ex Ante Value Applied
$C_{P,post,u,i}$	Carbon stock in all pools in post-deforestation land use u in stratum i; t CO_2-e ha-1	49.6
$C_{AB\_tree,i}$	Carbon stock in aboveground tree biomass in stratum *i*; t CO_2-e ha-1	0
$C_{BB\_tree,i}$	Carbon stock in belowground tree biomass in stratum *i*; t CO_2-e ha-1	0
$C_{AB\_non-tree,i}$	Carbon stock in aboveground nontree vegetation in stratum *i*; t CO_2-e ha-1	38.5
$C_{BB\_non-tree,i}$	Carbon stock in belowground nontree vegetation in stratum *i*; t CO_2-e ha-1	11.1
$C_{DW,i}$	Carbon stock in dead wood in stratum *i*; t CO_2-e ha-1	N/A
$C_{LI,i}$	Carbon stock in litter in stratum *i*; t CO_2-e ha-1	N/A
$C_{SOC,PD-BSL,i}$	Mean post-deforestation stock in soil organic carbon in the post deforestation stratum *i*; t CO_2-e ha-1	N/A
u	1,2,3,…U post-deforestation land uses	1
i	1, 2, 3 …*M* strata	One strata

$$\Delta C_{LK} = \Delta C_{LK-AS,planned} + \Delta C_{LK-AS,unplanned} + \Delta C_{LK-AS,degrad-FW/C} + \Delta C_{LK-ME}$$

Where:

Parameter	Description	Value
ΔC_{LK}	Net greenhouse gas emissions due to leakage; tCO_2e	327,655
$\Delta C_{LK-AS,planned}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation; tCO_2e (from LK-ASP)	0
$\Delta C_{LK-AS,unplanned}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing unplanned deforestation; tCO_2e (from LK-ASU): note this is a avoided planned deforestation and this parameter is n/a.	0
ΔC_{LK-ME}	Net greenhouse gas emissions due to market-effects leakage; tCO_2e (from LK-ME). Analyzed using T-SIG and found to be de minimis.	327,655
$\Delta C_{LK-AS,degrad-FW/C}$	Net greenhouse gas emissions due to activity shifting leakage for degradation caused by extraction of wood for fuel; tCO_2e (from LK-DFW): note that extraction of wood for fuel is considered sustainable and de minimis.	N/A

Based on the use of these formulas and parameters the following summary table is provided:

Table 15: Summary of Baseline, Project, Leakage, and Total Emissions by Year

Years (t)	Estimated baseline emissions or removals (tCO_2e): $\Delta C_{BSL,i,t}$	Estimated project emissions or removals (tCO_2e): $\Delta C_{P,i,t}$	Estimated leakage emissions (tCO_2e): $\Delta C_{LK,i,t}$	Estimated net GHG emission reductions or removals (tCO_2e): $C_{REDD,t}$
2011	261,777	0	32,766	229,011
2012	267,760	0	32,766	234,994
2013	273,743	0	32,766	240,977
2014	279,726	0	32,766	246,960
2015	285,709	0	32,766	252,943
2016	291,691	0	32,766	258,926
2017	297,674	0	32,766	264,909
2018	303,657	0	32,766	270,892
2019	309,640	0	32,766	276,875
2020	315,623	0	32,766	282,858

5.6.1 Uncertainty

A cumulative uncertainty level of 8.51% (total combined uncertainty: C_{REDD_ERROR,t^*}) was calculated using module “Estimation of uncertainty for REDD project activities (X-UNC)”. Uncertainty stems from the variability of the data that is used to estimate means of biomass pools and emission sources (Tree biomass, sequestration in long term wood products, and emissions from biomass burning). A small amount of uncertainty in biological data sets is normal. Uncertainty is expressed as the 95% confidence interval as a percentage of the mean combined across strata, across carbon pools, and emission sources and cumulatively between the baseline and project scenarios. Since data to evaluate at project validation does not include monitoring data, uncertainty regarding the project is considered 0 ex ante. Per the methodology, uncertainty above 15% requires a reduction in the estimate of avoided emissions, therefore 0% of each year of the estimated avoided emissions related to biomass is removed to account for uncertainty.

The uncertainty level is based on methodology X-UNC version 2.1 and uses the following equations and parameters to determine uncertainty in the rate of deforestation, the estimation of stocks in carbon pools and changes in carbon stocks, and uncertainty in estimation of project emissions.

Values for nontree pools are based on indisputably conservative estimates from the literature. X-UNC guidance indicates that “Alternatively, (indisputably) conservative estimates can also be used instead of uncertainties, provided that they are based on verifiable literature sources or expert judgment. In this case the uncertainty is assumed to be zero.” Therefore zero is used as the uncertainty for these pools. Uncertainty related to the baseline rate of deforestation is considered zero because it is based on the project plan.

Uncertainty related to the baseline carbon pools (aboveground tree biomass, belowground tree biomass, GHG emissions from burning, and long term wood products) is based on the following equation and parameters:

$$Uncertainty_{BSL,SS,i} = \frac{\sqrt{\sum_1^n (U_{BSL,SS,i,pool\#} * E_{BSL,SS,i,pool\#})^2}}{\sum_1^n E_{BSL,SS,i,pool\#}}$$

Where:

Parameter	Description	Value
$Uncertainty_{BSL,SS,i}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in the baseline case in stratum i; %	8.51%
$U_{BSL,SS,i,pool\#}$	Percentage uncertainty (expressed as 95% confidence interval as a percentage of the mean where appropriate) for carbon stocks and greenhouse gas sources in the baseline case in stratum i (1,2…n represent different carbon pools and/or GHG sources); %	C_{ABtree} = 10.84%; C_{BBtree} = 11.97% C_{WP} = 16.14% $E_{biomassburn}$ = 10.84% Based on the inventory.
$E_{BSL,SS,i,pool\#}$	Carbon stock or GHG sources (e.g. trees, down dead wood, soil organic carbon, emission from fertilizer addition, emission from biomass burning etc.) in stratum i (1,2…n represent different carbon pools and/or GHG sources) in the baseline case; tCO_2e	C_{ABtree} = 2,354,810 C_{BBtree} = 554,074 C_{WP} = 58,094 $E_{biomassburn}$ = 139,922 Based on the inventory.
i	1, 2, 3 …M strata	One strata

$$C_{REDD\_ERROR,t*} = Uncertainty_{BSL,t*}$$

Parameter	Description	Value
$C_{REDD\_ERROR,t*}$	Cumulative uncertainty for REDD project activity through time t; %	8.51%
$Uncertainty_{BSL,SS,i}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in the baseline case in stratum i; %	8.51%
t	1, 2, 3, …t* years elapsed since the start of the REDD VCS project activity	10 years

Years (t)	Total net GHG emissions ($C_{REDD,t}$)	Uncertainty Deduction ($C_{REDD\_ERROR,t}$*): *above 15%*	Total Avoided Emissions minus Uncertainty (Adjusted-$C_{REDD,i,t}$)
2011	229,011	0	229,011
2012	234,994	0	234,994
2013	240,977	0	240,977
2014	246,960	0	246,960
2015	252,943	0	252,943
2016	258,926	0	258,926

2017	264,909	0	264,909
2018	270,892	0	270,892
2019	276,875	0	276,875
2020	282,858	0	282,858

5.6.2 Insignificant Pools

To determine if any pools of GHG emissions are too small to justify inclusion in the analysis, the T-SIG tool was used to analyse contributions to the total emissions during the baseline period using the following steps:

1. Estimate the project GHG emissions by sources (per each source) and possible decreases in carbon pools and activities following the approved methodology(s).

2. Estimate leakage emissions per activity by sources (per each source) and possible decreases in carbon pools and activities following the approved methodology.

3. If the IPCC default emission factors are used then the same default value shall be used for the ex ante and the ex post estimates as appropriate.

4. Recalculate all GHG emissions into CO_2 equivalents using the GWP impact factors as decided by COP31 or as amended later.

5. Calculate the relative contributions of the project GHG emissions by sources and possible decreases in carbon pools and emissions by leakage activities according to the following equation:

$$RC_{E_i} = \frac{E_i}{\sum_{i=1}^{I} E_i}$$

Where:

RC_{Ei}	Relative contribution of each source i to the sum of project and leakage GHG emissions;
E_i	GHG emissions by sources of project and possible decreases in carbon pools and leakage emissions i as estimated under steps 1 and 2;
i	Index for individual sources of project and leakage GHG emissions (I = total number of sources considered under step 1 and 2).

6. Rank the project and the leakage emissions in descending order of their relative contributions and order them according to their ranks (i.e. the lowest emission shall get the highest rank and shall occupy the last position in the ordered sequence of emissions).

Start calculating the cumulative sum of the relative contributions (ordered according to the step 6) beginning with the lowest rank. Mark each individual source of project and leakage emissions as it is included in the summation. Cease the summation when the cumulative sum reaches the lowest value not less than the threshold of 0.95.

Baseline Source/Activity	**Description**	**Total GHG emissions baseline**	**Contribution relative total decreases in carbon pools and increases in emissions**	**Contribution relative to net anthropogenic removals by sinks**
Without Project Change in Carbon Pools ($\Delta C_{BSL,I,t}$)	Biomass change from planned deforestation	2,747,078	84.60%	107.34%
$E_{biomassburn,i,t}$	Non-CO_2 Biomass Burning	139,922	4.31%	5.47%
$\Delta C_{LK\text{-}ME}$	Net greenhouse gas emissions due to market-effects leakage; t CO_2-e	327,655	10.09%	12.80%
Project Area Degradation ($\Delta C_{P,SelLog,i,t}$)	Degradation from timber harvest	30,262	0.93%	1.18%
Project Area Degradation ($\Delta C_{P,DegW,i,t}$)	Degradation from timber fuelwood collection	2,275	0.07%	0.09%
Total		3,247,192	100.00%	126.88%

Emission pools are compared against total decreases in carbon pools and increases in emissions indicated as Total GHG Emissions in the chart (3,247,192 t CO_2e). Emission pools are also compared against anthropogenic removals by sinks which is defined for the purpose of this analysis as the total emissions benefits claimed by the project for the baseline period, C_{REDD} = 2,559,345 t CO_2e.

The project biomass change due to sustainable harvesting ($\Delta C_{P,SelLog,i,t}$), and potential fuel wood collection by the community ($\Delta C_{P,Deg,i,t}$) are considered de minimis for the baseline period.

5.7 Climate Change Adaptation Benefits (GL1)

Support of high school education for community members will make it more likely that the upcoming generation will fully understand the implications of climate change and their role in adapting and mitigating the predicted effects.

Climate change impacts to biodiversity (hurricanes, fire and drought) are expected to be limited in scope and dealt with most effectively by reducing fragmentation and maintaining large habitat blocks allowing animals to migrate around temporarily damaged areas while recovery is underway. This project addresses this strategy by limiting fragmentation and eliminating anthropogenic fire sources from agriculture (Meerman and Sabido 2001). The limitations on hunting also eliminate direct biodiversity impacts that may occur in an agricultural setting.

6 COMMUNITY

6.1 Net Positive Community Impacts (CM1)

No communities exist within the project area, but two communities exist with the project zone, the Sylvester Village/Gallon Jug community and the Yalbac Mill community. The second community is added as a result of the TFG purchase of the project and the intended use of the mill to process logs.

Community meetings were held January 16-20, 2012 at Gallon Jug and Sylvester Village by members of the Conservation Management Institute team from Virginia Tech (Teets et. al. 2012). Additional meetings were held in January of 2014 by the ERA Offsetters team at the Yalbac Mill (Offsetters. 2014a).

These communities are not reliant on the project area for their livelihoods as no resource extraction has been conducted in the area during the time since this community was formed. The project area is a potential resource in the future for the mill, and that potential benefit has been maintained in the project scenario by maintaining use of the mill by the new owners of the property.

The following analysis follows the Social Impact and Opportunities Assessment procedure found at http://www.icmm.com/community-development-toolkit and developed by the International Council of Mining and Metals.

Step 1: Review social baseline study and determine areas of concern to the communities, potential impacts, as well as areas where the project might present opportunities.

After interviewing stakeholders, a list of community opportunities for the project scenario and list of concerns for the baseline scenario were developed.

Step 2: Assess potential impacts and opportunities and identify areas needing impact management programs.

No negative impacts were suggested by the stakeholders for the project scenario.

Step 3: Propose measures to manage and if necessary mitigate the identified impacts and enhance opportunities.

No negative impacts of the project were suggested.

Step 4: Reassess the impacts and opportunities, taking proposed management measures into account.

Opportunities suggested by the stakeholders are reflected in the project plan.

Step 5: Work with community and other partners on participatory development plans that address community priority programs (enhancing opportunities) as well as required mitigation programs (mitigating impacts).

The community suggested the project plan components:

Short term	Long term
Continued employment opportunities	Health clinic on property
Increased employment opportunities	Start high school
Provide transportation to town	
Scheduled preventative health care	
Easier way to cash paychecks	
Housing improvements/maintenance	
Increased pay	
Fund school scholarship program	

No high school currently exists for the community and the only current option is to attend boarding school in other nearby towns that could be more than 2 hours away. Plans are in place by the project proponents to include assisting community with tuition for high school students by means of contributions to the Gallon Jug-Chan Chich High School Scholarship Fund for the purpose of providing tuition assistance to high school students to travel to nearby towns and attend boarding school.

Step 6: Review management measures and programs

Table 16: Project Scenario Impacts to Existing Community and Stakeholders.

Impact Area	Positive or Negative Impact	Significance
Livelihoods - Predicted impacts - Predicted impacts after mitigation measures	Neutral N/A	Neutral N/A
Community Relations - Predicted impacts - Predicted impacts after mitigation measures	Positive N/A	High N/A
Education - Predicted impacts - Predicted impacts after mitigation measures	Positive N/A	High N/A
Health - Predicted impacts - Predicted impacts after mitigation measures	N/A N/A	N/A N/A
Infrastructure - Predicted impacts - Predicted impacts after mitigation measures	N/A N/A	N/A N/A

Community Development - Predicted impacts - Predicted impacts after mitigation measures	 N/A N/A	 N/A N/A

Table 17: Baseline Scenario Impacts to Existing Community and Stakeholders.

Impact Area	Positive or Negative Impact	Significance
Livelihoods - Predicted impacts - Predicted impacts after mitigation measures	 N/A N/A	 N/A N/A
Community Relations - Predicted impacts - Predicted impacts after mitigation measures	 Neutral Neutral	 Low Low
Education - Predicted impacts - Predicted impacts after mitigation measures	 Neutral Neutral	 Low Low
Health - Predicted impacts - Predicted impacts after mitigation measures	 No impact No impact	 Low Low
Infrastructure - Predicted impacts - Predicted impacts after mitigation measures	 Neutral Neutral	 Low Low
Community Development - Predicted impacts - Predicted impacts after mitigation measures	 Neutral Neutral	 Low Low

A comparison of the project vs. baseline scenarios indicates significant net positive benefits for the existing community. Community benefits will accrue primarily in two ways, livelihoods supported directly by the project and additional educational opportunities made available to the community.

Livelihoods

The current plan calls for support of 4.3 full time equivalents additional to existing staff. These positions may be recruited from existing communities, but since full employment already exists in these communities, outside recruiting will be required either to backfill existing positions or add these new positions.

Education

The project plan calls for making funding available to provide scholarships for attending high school for all qualifying children in the community. The project plan commits to a minimum $5000/year in support to the Gallon Jug-Chan Chich High School Scholarship Fund[26]. Prior to the initiation of the project, contributions to the Fund have come from outside parties including tourists staying at Chan Chich Lodge.

Gender and Cultural Sensitivity

Based on the attendance by women at the meetings, (see Figure 10 as an example), gender discrimination did not occur at the planning stages. New jobs will be created mostly in patrols and monitoring. Culturally in Belize forest jobs are done by men, so it would be unlikely that women would apply. If any do, they will be treated equally, trained, equipped, and supervised like their male counterparts. No gender discrimination would be allowed in the scholarship program, however, the scholarship program is dependent on family decisions. Gender balance in Belize high schools is typically good, 48.2% male and 51.8% female in 2012/2013 (based on data from the Statistical Institute of Belize), and gender discrimination is illegal in Belize.

[26] https://sites.google.com/site/gallonjugschool/gallonjug-chanchichscholarshipfund

Figure 15: Gallon Jug Community School.

6.2 Negative Offsite Stakeholder impacts (CM2)

The Project is not expected to have any negative offsite impacts.

6.3 Exceptional Community Benefits (GL2)

N/A

7 BIODIVERSITY

7.1 Net Positive Biodiversity Impacts (B1)

The biodiversity objective for the Project is to maintain existing biodiversity and HCVs to the extent possible barring setbacks from natural processes.

Table 18: Comparison of Baseline and Project Biodiversity based on IUCN Redlist (2012) for selected species found at Laguna Seca.

Common name	Scientific name	Habitat (extracted from IUCN Redlist Database)	With-Project	Without-Project
Baird's tapir	*Tapirus bairdii*	"wet tropical rainforest, riparian woodland, monsoon deciduous forest, dry deciduous forest, montane cloud forest and paramo"	Habitat exists. Population exists.	Habitat lost. Population lost.

Southern river otter	*Lutra longicaudis*	"Rest and den sites are found in areas with dense vegetation"…" associated with dense mature forest with thick undergrowth extending close to shore. Both the aboveground root systems of mature or fallen trees and the dense vegetation cover are important components of L. provocax habitat; absence of these key features may result in absence of otters, even if abundance of prey is not limiting"	Habitat exists. Population exists.	Habitat lost. Population lost.
Margay	*Leopardus wiedii*	"The margay is strongly associated with forest habitat/tree cover, both evergreen and deciduous, although it has been occasionally reported outside forested areas"	Habitat exists. Population exists.	Habitat lost. Population lost.
Geoffrey's Spider Monkey	*Ateles geoffroyi*	"Spider monkeys travel and forage in the upper levels of the forest. They spend much time in the canopy and also use the middle and lower strata but are rarely seen in the understory. In accordance with their use of the highest levels of the forest, they are highly suspensory."	Habitat exists. Population exists.	Habitat lost. Population lost.
Yucatan Black Howler Monkey	*Alouatta pigra*	"This species occurs in primary terra firma rain forest, riparian forest, seasonally flooded riparian areas, and swamps."	Habitat exists. Population exists.	Habitat lost. Population lost.
Great curassow	*Crax rubra*	"It is restricted to undisturbed humid evergreen forest (also seasonally dry forest in some areas) and mangroves. It is primarily a lowland species but has been recorded at altitudes of up to 1,900 m in Panama."	Habitat exists. Population exists.	Habitat lost. Population lost.
Ocellated turkey	*Meleagris ocellata*	It occupies non-flooded mature forest, but associates with seasonally flooded habitat and open areas when breeding	Habitat exists. Population exists.	Habitat lost. Population lost.

The biodiversity objective for the Project is to maintain existing biodiversity and HCVs to the extent possible barring setbacks from natural processes. A complete synthesis of information about the biodiversity of the site and a proposal for a biodiversity monitoring program is contained in Miller and Miller (2011). There is almost no overlap between the species list of animals associated with mature forest habitats and sugarcane. Nearly 100% loss of biodiversity is expected in the without project scenario.

<u>Project Scenario</u>

The Project scenario presumes that with proper protection of the site, the exceptional existing biodiversity of the site will be maintained. Monitoring surveys of large/medium mammals and bats will provide valuable information on several IUCN species. Patrols to eliminate potential hunting and illegal removal of tree cover will ensure existing populations and habitat will remain on the site. Any potential impacts to populations or habitat will be from natural causes only. The following surveys will be conducted:

- Large-medium mammals will be surveyed using remotely-triggered camera traps.
- Anecdotal observations of other species will be noted with particular emphasis on species of High Conservation value (those listed on the IUCN Red List and the Belize National List of Critical Species (Table 5).

No replanting of the project area is planned. No invasive or outside species will be used.

<u>Baseline Scenario</u>

The baseline scenario presumes that the property will receive less protection for HCVs and that significant habitat loss will occur. Removal of the tropical forest will eliminate habitat for many species (IUCN 2015) and severely degrade the value of riparian corridors within the property. Travel corridors across the property will be eliminated reducing genetic interchange between surrounding protected areas.

<u>No GMO Pledge; fertilizer, chemical pesticides, biological agents, waste products</u>

No genetically modified organisms will be used on the project. No fertilizer, chemical pesticides, or biological agents are planned for use on the project. Possible adverse effects from these substances is considered zero. One possible exception could be the use of herbicides to control invasive species. If a decision is made to use herbicides, balancing potential risks vs. benefits, then an herbicide will be selected to minimize adverse effects, and all labelling and guidelines for application will be followed.

No waste products will be produced by the project and none will be left on site.

<u>Invasive Species</u>

No intentional planting is planned in the project area therefore no intentional introduction of invasive species will take place. Unintentional introduction of invasive species is theoretically possible, however since the area has been selectively logged for hundreds of years without invasive species taking hold in the area, the likelihood of this is extremely low.

7.2 Negative Offsite Biodiversity Impacts (B2)

The Project does not anticipate any offsite negative biodiversity impacts. Offsite impacts will be positive since larger habitat and forest areas will improve the long-term viability of populations off-site through connectivity of off-site habitats on surrounding conservation lands.

If any negative impact is identified, the TFG team and the stakeholder representative will address such problems with fast and effective solutions. The issue will be discussed and mitigation actions will be designed. Unanticipated negative impacts are by definition impossible to describe ex ante.

7.3 Exceptional Biodiversity Benefits (GL3)

The project area is identified as a portion of a Key Biodiversity Area in Belize (Meerman 2007) based on populations of multiple trigger species (IUCN Endangered) considered HCVs. The Project scenario will maintain existing HCVs by means of regular patrols and protection of habitat. This Project addresses multiple High Conservation Values. Climate, Community, and Biodiversity Standard Gold Level is achieved by virtue of the significant biodiversity resources conserved on the property including habitat for multiple IUCN listed species and most notably IUCN-Endangered Baird's tapir (*Tapirus bairdii*), Yucatan black howler monkey (*Alouatta pigra*) and Geoffroy's spider monkey (*Ateles geoffroyi*).

Population trends are unknown for the project area, however, populations of these species have occurred at the site for many years (Miller and Miller 2011). The habitat for these species has been stable for decades and presumably population trends have also been stable. Based on habitat requirements of these species, a complete loss of these populations is expected in the baseline scenario.

The causal model for actions to maintain these populations is the same as the causal model for the project as a whole.

Strategy	Activities	Outputs	Outcomes	Impacts
Avoid conversion of the project area to sugarcane.	Patrols. Monitoring	Multiple patrols per year to prevent illegal timber harvest. Monitoring data and analysis.	Natural forest cover maintained. Habitat maintained on site.	Significant avoided emissions of GHG. Biodiversity loss avoided.
Utilize the site in such a way as to maintain carbon stocks	Sustainable, low intensity, timber harvest.	High quality timber for the local and international market.	Livelihoods for local communities.	Increase in average income. Reduce risk of mill closures. Provide income for communities.
Support community goals	Contribute to high school scholarship fund. Monitoring.	Minimum BZ$10,000 average annual contributions to the scholarship fund.	Children of community residents have an opportunity to attend high school.	Increase in educational attainment. High school graduates have more opportunities to attend college or secure good paying jobs.

Indicators of population trends for each HCV are considered a combination of habitat availability and presence as indicated by detections during monitoring. Maintenance of these species is considered achieved when the habitat is protected and the species is still detected using the site.

8 MONITORING

8.1 Description of the Monitoring Plan (CL3, CM3 & B3)

The overall objective of the monitoring plan is to detect any changes in project emissions or carbon stock enhancement. In addition, carbon stock changes must be monitored prior to baseline revision. Potential sources of leakage and other GHG emissions will also be monitored. Community and biodiversity benefits will be monitored no less frequently than every 5 years, however the intent is to monitor these benefits at each verification. The purpose of monitoring is to insure that the benefits of the project are produced as expected.

8.1.1 Monitoring of actual carbon stock changes and greenhouse gas emissions

a) Technical description of the monitoring task.

Monitoring of the project, all variables, will occur no less often than every 5 years. At each monitoring event M-MON and supporting methodologies will be used to determine the emissions and carbon sequestration that have occurred during the monitoring period.

At each verification, forest cover will be monitored. Monitoring is intended to detect natural and anthropomorphic impacts that would materially and significantly impact the climate benefits of the project. Above- and belowground biomass stock estimates are valid in the baseline (i.e. treated as constant) for 10 years, after which they must be re-estimated from new field measurements. For each stratum, where the re-measured estimate is within the 90% confidence interval of the t=0 estimate, the t=0 stock estimate takes precedence and is re-employed, and where the re-measured estimate is outside (i.e. greater than or less than) the 90% confidence interval of the t=0 estimate, the new stock estimate takes precedence and is used for the subsequent period.

To accomplish these objectives, a system of permanent plots has been established and remote sensing will be used to produce a forest/nonforest map. The plot data will be used as ground reference for the mapping work. Plots will be remeasured as required to support baseline revision.

Degradation related to timber harvest and fuelwood collection is expected to be de minimis during the baseline period and subsequent periods. A PRA in the community will be conducted at each monitoring interval to confirm this assumption in regards to fuelwood collection. Sales records will be retained and reviewed to confirm that timber harvest is also de minimis during the monitoring period. If these sources of emissions are determined to exceed the de minimis threshold, then the M-MON module will be employed to further document and monitor the sources.

b) Data to be collected.

The net carbon stock change as a result of deforestation is equal to the area deforested multiplied by the emission per unit area. The following equations and parameters will be used to determine changes in carbon stocks during a monitoring period:

$$\Delta C_P = \sum_{t=1}^{t^*} \sum_{i=1}^{M} \left(\Delta C_{P,DefPA,i,t} + \Delta C_{P,Deg,i,t} + \Delta C_{P,DistPA,i,t} + GHG_{P-E,i,t} - \Delta C_{P,Enh,i,t} \right)$$

Where:

Parameter	Description
ΔC_P	Net greenhouse gas emissions within the project area under the project scenario; tCO_2e
$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* at time *t*; tCO_2e
$\Delta C_{P,Deg,i,t}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum *i* at time *t*; tCO_2e: This source of emissions was found to be de minimis and will not be monitored.
$\Delta C_{P,DistPA,i,t}$	Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum *i* at time *t*; tCO_2e

$GHG_{P\text{-}E,i,t}$	Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum *i* in year *t*; tCO_2e
$\Delta C_{P,Enh,i,t}$	Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline in stratum *i* at time *t*; tCO_2e
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

For the leakage belt the net greenhouse gas emissions in the project case will be equal to the sum of stock changes due to deforestation in the leakage belt. The leakage belt consists of 40,177.7 ha of forest owned by the agent of deforestation, Gallon Jug Agroindustries, at project start in 2011.

$$\Delta C_{P,LB} = \sum_{t=1}^{t} \sum_{i=1}^{M} \Delta C_{P,DefLB,i,t}$$

Parameter	Description
$\Delta C_{P,LB}$	Net greenhouse gas emissions in the leakage belt in the project case; t CO_2-e
$\Delta C_{P,DefLB,i,t}$	Net carbon stock change as a result of deforestation in the leakage belt the project case in stratum *i* at time *t*; t CO_2-e
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

The net carbon stock change as a result of deforestation will be equal to the area deforested multiplied by the emission per unit area.

$$\Delta C_{P,DefPA,i,t} = \sum_{u=1}^{U} \left(A_{DefPA,u,i,t} * \Delta C_{pools,P,Def,u,i,t} \right)$$

$$\Delta C_{P,DefLB,i,t} = \sum_{u=1}^{U} \left(A_{DefLB,u,i,t} * \Delta C_{pools,P,Def,u,i,t} \right)$$

Where:

Parameter	Description
$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* at time *t*; tCO_2e
$\Delta C_{P,DefLB,i,t}$	Net carbon stock change as a result of deforestation in the project case in the leakage belt in stratum *i* at time *t*; t CO_2-e
$A_{DefPA,u,i,t}$	Area of recorded deforestation in the project area stratum *i* converted to land use *u* at time *t*; ha
$A_{DefLB,u,i,t}$	Area of recorded deforestation in the leakage belt stratum *i* converted to land use *u* at time *t*; ha: note this parameter is equivalent in this case to

	$LKA_{planned,i,t}$ and therefore activity shifting leakage will be handled using module LK-ASP and the derived value $\Delta C_{LK\text{-}AS,planned}$.
$\Delta C_{pools,Def,u,i,t}$	Net carbon stock changes in all pools in the project case in land use *u* in stratum *i* at time *t*; t CO_2-e ha-1
u	*1,2,3,…U* post-deforestation land uses; in this case, only one post-deforestation land use, sugar cane agriculture.
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

The emission per unit area will be equal to the difference between the stocks before and after deforestation minus any wood products created from timber extraction in the process of deforestation:

$$\Delta C_{pools,Def,i,t} = C_{BSL,i} - C_{P,post,i} - C_{WP,i}$$

Parameter	Description
$\Delta C_{pools,Def,u,i,t}$	Net carbon stock changes in all pools in the project case in land use *u* in stratum *i* at time *t*; t CO_2-e ha-1
$C_{BSL,i}$	Carbon stock in all pools in the baseline case in stratum *i*; t CO_2-e ha-1
$C_{P,post,u,i}$	Carbon stock in all pools in post-deforestation land use *u* in stratum *i*; t CO_2-e ha-1
$C_{WP,i}$	Carbon stock sequestered in wood products from harvests in stratum *i*; t CO_2-e ha-1
u	*1,2,3,…U* post-deforestation land uses; in this case, only one post-deforestation land use, sugar cane agriculture.
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

For each post-deforestation land use (u), the long-term carbon stock will be estimated. Carbon stocks in the selected pools (must be the same as those used in the baseline modules) must be measured and estimated using the methods given in modules CP-AB, CP-D, CP-L, and/or CP-S.

$$C_{P,post,i} = C_{AB\_tree,i} + C_{BB\_tree,i} + C_{AB\_non-tree,i} + C_{BB\_non-tree,i} + C_{DW,i} + C_{LI,i} + C_{SOC,PD-BSL,i}$$

Parameter	Description
$C_{P,post,u,i}$	Carbon stock in all pools in post-deforestation land use *u* in stratum *i*; t CO_2-e ha-1
$C_{AB\_tree,i}$	Carbon stock in all pools in the baseline case in stratum *i*; t CO_2-e ha-1
$C_{BB\_tree,i}$	Carbon stock in belowground tree biomass in stratum *i*; t CO_2-e ha-1
$C_{AB\_non\text{-}tree,i,i}$	Carbon stock in aboveground nontree vegetation in stratum *i*; t CO_2-e ha-1; excluded from project and accounted as 0.
$C_{BB\_non\text{-}tree,i}$	Carbon stock in belowground nontree vegetation in stratum *i*; t CO_2-e ha-1; excluded from project and accounted as 0.
$C_{DW,i}$	Carbon stock in dead wood in stratum *i*; t CO_2-e ha-1; excluded from project and accounted as 0.
$C_{LI,i}$	Carbon stock in litter in stratum *i*; t CO_2-e ha-1; excluded from project and accounted as 0.

$C_{SOC,PD-BSL,i}$	Mean post-deforestation stock in soil organic carbon in the post deforestation stratum *i*; t CO_2-e ha-1; excluded from project and accounted as 0.
u	*1,2,3,…U* post-deforestation land uses; in this case, only one post-deforestation land use, sugar cane agriculture.
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

If carbon stock enhancement is observed based on monitoring data the following equation and parameters will be used:

$$\Delta C_{P,Enh,i,t} = \sum_{t=1}^{t}\sum_{i=1}^{M}\left(\left(C_{P,i,t} - C_{BSL,i}\right) * A_{Enh,PL,i,t}\right)$$

Where:

Parameter	Description
$\Delta C_{P,Enh,i,t}$	Net carbon stock changes as a result of forest carbon stock enhancement in stratum *i* in the project area at time *t*; t CO_2-e
$C_{P,i,t}$	Carbon stock in all pools in the project case in stratum *i* at time *t*; t CO_2-e
$C_{BSL,i}$	Carbon stock in all pools in the baseline in stratum *i*; t CO_2-e ha-1
$A_{Enh,PL,i,t}$	Project area in stratum *i* in which carbon stocks are accumulating but that would have undergone planned deforestation in the baseline scenario at time *t*; ha
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

and where:

$$A_{Enh,PL,i,t} = D\%_{planned,i,t} * A_{planned,i,t}$$

Parameter	Description
$A_{Enh,PL,i,t}$	Project area in stratum *i* in which carbon stocks are accumulating but that would have undergone planned deforestation in the baseline scenario at time *t*; ha
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum *i* at time *t*; %
$A_{planned,i,}$	Total area of planned deforestation over the entire project lifetime for stratum *i*; ha
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

and where:

$$C_{P,i,t} = C_{AB\_tree,i} + C_{BB\_tree,i} + C_{AB\_non-tree,i} + C_{BB\_non-tree,i} + C_{DW,i} + C_{LI,i} + C_{SOC,i}$$

Parameter	Description
$C_{P,i,t}$	Carbon stock in all pools in the project case in stratum *i* at time *t*; t CO_2-e
$C_{AB\_tree,i}$	Carbon stock in aboveground tree biomass in the project case in stratum *i*; t CO_2-e ha^{-1}
$C_{BB\_tree,i}$	Carbon stock in belowground tree biomass in the project case in stratum *i*; t CO_2-e ha^{-1}
$C_{AB\_non\text{-}tree,i}$	Carbon stock in aboveground nontree vegetation in stratum *i*; t CO_2-e ha^{-1}
$C_{BB\_non\text{-}tree,i}$	Carbon stock in belowground nontree vegetation in stratum *i*; t CO_2-e ha^{-1}
$C_{DW,i}$	Carbon stock in dead wood in the project case in stratum *i*; t CO_2-e ha^{-1}
$C_{LI,i}$	Carbon stock in litter in the project case in stratum *i*; t CO_2-e ha^{-1}
$C_{SOC,i}$	Carbon stock in soil organic carbon in the project case in stratum *i*; t CO_2-e ha^{-1}
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

Carbon pools excluded from the project, $C_{DW,I}$, $C_{LI,I}$, and $C_{SOC,I}$, will be accounted as zero.

c) Overview of data collection procedures.

Monitoring frequency is indicated by variable in section 8.3. In general, data on forest cover changes and data on carbon pools will be collected at verification audit events.

Updating of Strata

The ex-post stratification shall be updated if the following conditions occur:

- unexpected disturbances occurring during the crediting period (e.g. due to fire, pests, storms, or disease outbreaks), affecting differently various parts of an originally homogeneous stratum; and
- unplanned forest management activities that affect the existing stratification.

Established strata may be merged if reason for their establishing said strata have disappeared. If a change is detected that requires a strata update, additional data on carbon pools for the new strata will be collected.

Field Plot Methods

To ensure that the full range of variability was captured, a total of 40 forest inventory plots were established. Plots were randomly allocated within the ‘Forest Land’ land-use and land cover (LULC) class using geographic information systems (GIS) and identified by specific XY coordinates, WGS 84 projection (Table19). These same plots will be used for monitoring.

Table 19: Locations of forestry plots used to determine aboveground biomass.

Plot ID	Plot X Coordinates	Plot Y Coordinates
1	298139	1947137
2	300164	1943314
3	300035	1946389
4	300787	1946903

5	295045	1946339
6	301676	1943013
7	292876	1945946
8	290218	1942990
9	291218	1946789
10	301524	1941719
11	301149	1944865
12	293053	1947061
13	291670	1947269
14	296245	1943174
15	289894	1942475
16	299197	1940753
17	296123	1945732
18	292084	1943271
19	295366	1942326
20	294572	1945342
21	295191	1944133
22	289843	1941189
23	297741	1942805
24	297413	1944802
25	301078	1941413
26	297901	1943645
27	293439	1942855
28	300261	1942487
29	297660	1941917
30	296073	1947246
31	296353	1941182
32	294894	1946867
33	299991	1944566
34	299723	1946948
35	299489	1945806
36	301637	1944798
37	292805	1944551
38	297513	1945842
39	298915	1943669
40	291845	1945535

Field Plot Measurements

The methods for measuring the carbon pools at Laguna Seca are based on the Sourcebook for Land Use, Land-Use Change and Forestry Projects (Pearson et al 2005). Because destructive sampling is not practical to measure aboveground carbon stocks, published allometric equations will be used to determine aboveground biomass based upon the DBH of hardwood trees and the height of palms. Allometric equations and other parameters are included in Section 8.2.

The following forest inventory techniques will be used to collect the appropriate data (Pearson et al 2005). All of the plots have been monumented in the field, and trees within each plot tagged and numbered. Data collection is based on a nested circular plot design described in Pearson et al (2005).

Tree species, DBH and tree height will be recorded for every tree found to occur in the plot. Notes on aberrations will be included for every tree where standard measurements may be impacted. Every tree tallied will be tagged and given a unique ID number for future monitoring. If a tree is found on the plot without a tag, an effort will be made to determine if the tree lost its tag and can be identified or if it was missed in previous measurement events and should receive a new tag. Regardless, every tree will be tagged at every monitoring event and discrepancies noted in the database. Raw data will be entered in a spreadsheet for data summaries and carbon calculations.

The following equipment list is recommended for re-measurement of established forest monitoring points:

GPS (using WGS 84 Datum)
30 Meter Fiberglass Measuring Tape
Compass
Tree diameter at breast height (DBH) tape
Clinometer (percent scale)
Data Notebook
Writing Utensils
Machete for clearing
1.3m pole or stick (x2)
Fluorescent Orange or Pink Flagging

The following are the basic steps necessary to consistently measure aboveground biomass in forest monitoring plots.

Step 1: Navigate to plot center using Global Positioning System (GPS), XY coordinates and appropriate datum (Table 19). The plot center should be conspicuously marked with brightly-colored flagging, and a PVC or rebar center marker. Mark additional trees and plot center with brightly-colored flagging (orange or pink) to augment the remaining markings. Replace PVC as necessary.

Step 2: Fill out a data sheet by recording field crew members, date, plot number, slope, azimuth, and any additional notes on plot characteristics or vegetation.

Step 3: Starting from a due north position, begin measuring living trees within 4m of the plot center, measured to the face of the tree. Trees which are ≥ 5.0 cm and within 4m of the plot center will be recorded. Continue measuring and recording all trees within 4.0m of plot center in a clockwise direction around the center.

Step 4: Once all of the trees within the 4.0 m class have been measured, all trees ≥ 20.0 cm will be measured and recorded within 14.0 m of the plot center, starting due north and moving in a clockwise direction.

Step 5: Once all of the 20.0cm trees have been measured within 14.0m of the plot center, any trees within 20.0 m of the plot center ≥ 50.0cm will be measured starting due north, and working in a clockwise direction. Figure 16 illustrates the plot design.

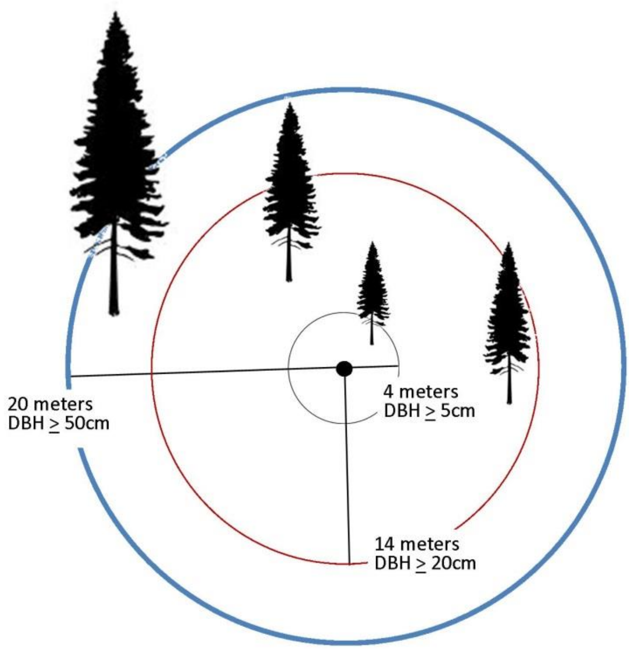

Figure 16: Nested forestry plot design. 4m radius for trees measuring ≥ 5 cm, 14m radius for trees ≥ 20cm, and 20m radius for trees ≥ 50cm dbh.

<u>Plot Measurement Best Practices</u>

Careful and consistent measurements make it possible for others to replicate identical measurements.

Measurement of DBH

When measuring DBH, set a pole/stick cut to exactly 1.3m on the ground adjacent to the tree and measure the DBH at the top of the measuring stick. When using a DBH tape insure that the tape is wrapped around the tree without any folding or kinks. Measure trees with their natural angle, if a tree is leaning wrap the tape around at the same angle. If a tree is growing straight the tape must be parallel to the ground. If a tree splits into separate branches below breast height it is treated as multiple trees, and if the branch is the appropriate size it is tagged and recorded. If a tree is on a slope, DBH will be measured from the uphill side of the slope. If the tree is growing irregularly, or fallen down, the tree will be measured where it reaches breast height. If the side branches of a fallen tree are large enough to be measured, their DBH will be measured from the ground, not 1.3m from the top of the downed tree.

In all cases the DBH tape should be directly against the bark around the entire circumference of the tree being measured. Vines growing up a tree should be pulled away from the bark, and the DBH measured underneath. If the vine cannot be manually pulled away it can be cut, or the tree diameter estimated using the reverse side of the DBH tape. It is important to leave the majority of vines intact to allow the plots to maintain similar growing conditions to surrounding stands. When applicable, measure above other natural growths at breast height, including irregular tree growths, termite nests, fungal growths, etc. If the natural growths extend out of reach measure just below growth. If the tree has buttresses which would affect the diameter at breast height, measure above the buttresses. If the buttresses extend out of reach, measure as high as possible while remaining accurate. Make a note of the buttresses which can be corrected in later calculations.

Check the plot measurement data from the previous inventory to spot potential measurement errors or missed tagged trees.

Measuring Distance from Plot Center

If a tree lies partially within the plot circle diameter, the distance to the face of the tree is collected at breast height. This information will be used in conjunction with the radius of the tree to determine whether it is "in", based on calculated distance to the tree center.

Previously Tagged Trees

Trees large enough to be recorded in each class will be inspected for previous tags. Trees which have been previously tagged will be recorded with the identification number, adjusted DBH, species (if known), and height (if applicable to the allometric equation). If the tree has not been tagged, it should be tagged with an aluminum uniquely numbered tag and aluminum nail. In this case the new identification number, DBH, species (if known), and height (if applicable to the allometric equation) are also recorded. If the tree species is unknown, attempt to identify the tree using any available resources. If the tree cannot be correctly identified, the tree type will be recorded (e.g. hardwood, pine, palm, tree fern, etc.).

Palms

At Laguna Seca the most common palms are the cohune, give-and-take, and sabal. Cohune palms in the early years of growth have no true trunk, just a series of palm fronds which slough off as it grows. Thus it is impossible to tag young palms for the purposes of monitoring. If the palm is considered in, the height is measured. If the height is within range for the selected allometric equations, AGB for that palm is calculated and included in the plot total.

Tree Height Measurements

All height measurements are taken either using a clinometer (percent scale) for standing trees (whether leaning or straight), or direct measurement with metric tapes for trees that are short enough to reach and measure directly or down on the ground and able to be measured by extending the tape measure along the bole. To measure the height of a tree either use a distance range finder and follow the manufacturer's instructions, or use a clinometer. A clinometer can be used more accurately when standing further away from an object. For this reason, it is recommended that the observer stand at least 15 m from the tree being measured. From a vantage point with a clear line of sight, measure and record angle to the top of the trunk (not the leaves) and the base of the tree with a clinometer. Using a fiberglass measuring tape, measure distance from tree to the observer using the 1.3 m poles for consistent measurements. The height can be calculated using simple trigonometry, the two angles, and the distance to the tree (See Figure 17).

Once all of the trees have been measured and tagged, review data sheet to ensure no data points have been forgotten (slope, azimuth, tree measurements, etc.) and recheck plot for any trees missed. If everything is checked, and the team agrees everything has been completed, all gear is collected and the team continues to the next plot.

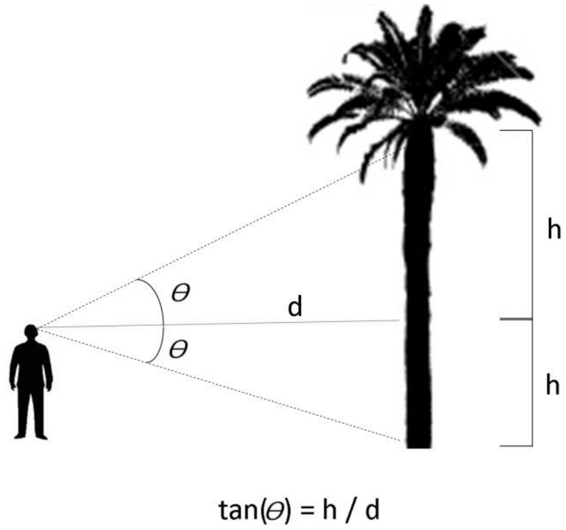

Figure 17: Measuring palm heights in the field with a clinometer.

At the end of each plot measurement, and the end of each day a designated team member will check that there are completely filled out data sheets for each plot inventoried. Completed data sheets will be stored in a portfolio case that is not taken into the field.

Mapping Methods

Remote sensing methods will follow GOFC-GOLD Sourcebook (2014) using Landsat TM or higher resolution imagery. Head's up digitizing utilizing trained analysts will be employed to produce a forest/nonforest map of the project area and the leakage area. A classification accuracy of 90% or better will be achieved. The minimum requirements for image interpretation are: 'Geo-location accuracy < 1 pixel. Minimum mapping unit is 1 ha. A consistency assessment should be carried out' (GOFC-GOLD 2014). Detected deforested areas burned, damaged by wind, or illegally cleared will be mapped using a combination of these methods plus ground surveys with a GPS.

STEP 1. Selection and analyses of sources of land-use and land-cover (LU/LC) change data

Medium resolution remotely sensed spatial data shall be used (30m x 30m resolution or less) such as Landsat, Resourcesat-1 or Spot sensor data. In general, the same source of remotely sensed data and data analysis techniques must be used within the period for which the baseline is fixed. If remotely sensed data have become available from new and higher resolution sources (e.g. from a different sensor system) during this period then it is possible to change the source of the remotely sensed data. Equally if the same source is no longer available (e.g. due to satellites or sensors going out of service) an alternate source may be used. A change in source data may only occur if the images based on interpretation of the new data overlap the images based on interpretation of the old data by at least 1 year and they cross calibrate to acceptable levels based on commonly used methods in the remote sensing community.

The data collected and analyzed must cover the entire project area plus the potential leakage area (forest land owned by Gallon Jug Agroindustries), and data shall be available for the year in which monitoring and verification is occurring.

Preprocessing LU/LC Change Data: The remotely sensed data collected must be prepared for analysis. Minimum pre-processing involves geometric correction, georeferencing, and cloud and shadow detection and removal. Guidance for interpretation of remote sensing imagery is given in the GOFC-GOLD 2008 Sourcebook for REDD and shall be followed as appropriate.

Post-processing assessment: Post-processing is required to:

1. Map area of change detected in the imagery.
2. Calculate the area of each category of change within the project area. For periodical revisiting of the baseline, do this also for the reference region.

   For the calculation of each category of change, at the end of each monitoring period:

   a. Calculate the area of each category within the project area.
   b. Update the Forest Cover Maps for the project area and any forest lands owned by Gallon Jug Agroindustries.

Estimating land-use and land-cover (LU/LC) change data in cloud-obscured areas: Multi-date images must be used to reduce cloud cover to no more than 10% of any image. If the areas with 10% cloud cover in either date in question do not overlap exactly, then the rate must come from areas that were cloud free in both dates in question. This must be estimated in % per year. Then, a maximum possible forest cover map must be made for the most recent time period. The historical rate in % must be multiplied by the maximum forest cover area at the start of the period for estimating the total area of deforestation during the period. The overall classification accuracy of the outcome of the previous steps must be 90% or more.

Image classification consists of seven categories: Forest, Bajo, Cropland, Grassland, Settlements, Wetland, and Other based GOFC-GOLD (2014) with a minimum mapping unit (mmu) of 1 hectare. Because the project area is relatively small, and mapping is accomplished through visual interpretation, a wall-to-wall mapping strategy will be employed as it is practical and the most suitable method for the project (GOFC-GOLD 2014).

STEP 2. Interpretation and analyses

A full visual delineation of the project area using Landsat imagery will be conducted. All digitization will be performed at an approximate scale of 1:15,000 by an experienced photo-interpreter (PI) familiar with satellite imagery applications, photo-interpretation and possessing a priori knowledge of land use/land cover in the area. The band combination of 5,4,2 (short-wave infrared, near infrared, green) will be employed.

STEP 3. Documentation

A consistent time-series of data on land use-change, and emissions and removals of CO_2 must emerge from periodic monitoring. This is only possible if a consistent methodology is applied over time. The methodological procedures used in steps 1-2 above must be documented. In particular, the following information must be provided when remotely sensed data are used:

a. Data sources and pre-processing: Type, resolution, source and acquisition date of the remotely sensed data (and other data) used; geometric, radiometric and other corrections performed, if any; spectral bands and indexes used (such as NDVI); projection and parameters used to geo-reference the images; error estimate of the geometric correction; software and software version used to perform tasks; etc.

b. Data classification: Definition of the classes and categories; classification approach and classification algorithms; coordinates and description of the ground-reference data collected for training purposes; ancillary data used in the classification, if any; software and software version used to perform the classification; additional spatial data and analysis used for post-classification analysis, including class subdivisions using non-spectral criteria, if any; etc.

c. Changes in Data sources and pre-processing / Data classification: If in subsequent periods changes will be made to the original data or use of data:
    i. Each change and its justification must be explained and recorded; and
    ii. When data from new satellites are used documentation must follow a) to c) above

Extracted Biomass and the Long Term Wood Products Pool

Although biomass change due to sustainable timber harvest is expected to be a de minimis contribution to the project, monitoring of the extracted wood products from the project will take place in the normal course of business to comply with the timber license for the project area. That data will be compiled annually and reviewed at verification and baseline reset to confirm that the impact from timber harvest continues to be a de minimis contribution to the project.

Degradation as a result of Sustainable Harvest of Fuelwood

Given the location of the project area, the small size of the community, and the availability of fuelwood from other sources, fuelwood collection at the project area is considered de minimis based on an indisputably conservative estimate of the potential impact of fuelwood collection (see Section 4.3 for methodology deviation). Add to that the expected elimination of any fuelwood collection resulting from patrols of the area, and the likelihood of any detectable fuelwood collection is remote.

The M-MON methodology module explicitly indicates that *"If this assessment finds no potential pressure for these activities then degradation ($\Delta C_{P,DegW,i,t}$) can be assumed to be zero and no monitoring is needed."* Since, the result of the analysis indicates that there is no potential impact from fuelwood collection i.e. the impacts are unlikely and conservatively they are de minimis if there are impacts, then no monitoring is required for degradation from fuelwood collection. However, a new PRA should be conducted every two years to determine if the potential for degradation by the community has changed. If two years has passed since the last monitoring event, then a PRA is required.

d) Quality control and quality assurance procedure.

Inventory: Once all of the trees have been measured and tagged, each data sheet is reviewed to ensure no data points have been forgotten (slope, azimuth, tree measurements, etc.) and recheck plot for any trees missed. At the end of each plot measurement, and the end of each day a designated team member will check that there are completely filled out data sheets for each plot inventoried. As a part of the verification process when a new inventory is required, a subset of plots will be reviewed by an independent third-party auditor, remeasured and compared to determine accuracy.

Calibration of Equipment: Monitoring equipment required, GPS, diameter tape, and measurement tape require little in the way of calibration. GPS is used to find existing permanent plots. If the plot is found the GPS is calibrated adequately.

Mapping: An accuracy assessment on all project area land cover and leakage area land cover following industry standards and applicable practices as described in Congalton (1991) and GFOI (2013) will be performed. Using the specific land cover layer, random points will be created for each cover class. Points should be created using the Create Random Points tool in ArcGIS 10.1 (or a similar tool) with the following parameters: 75 points for the forest class and 50 points each for other classes with a point separation of 250 meters. Points within 15 meters of a boundary may be removed to eliminate confusion during the accuracy assessment. For classes covering a very small percentage of the total area, 50 points may not be reached and what points that can be generated will be used for accuracy assessment. A subject matter expert (based on education, experience, and on-the-ground familiarity with the project area) will classify all points using Rapid Eye[27] high resolution imagery (or similar product) from the respective mapping year, after which the points are intersected with the land cover layer to calculate accuracy.

e) Data archiving.

Data archiving will be accomplished by saving data to permanent media (such as DVD) and stored in Belize at the offices of The Forestland Group in Belize. Copies will also be maintained in the United States.

Data collection, analysis and archiving is an important aspect of the monitoring process and keeping good records for the life of the project is a key component of providing benefits over time. In general all raw and processed data will be kept for the life of the project. Paper records will be scanned and archived digitally, and the paper records will be kept as well. All records will be kept at the TFG offices in Belize, and an electronic backup archive will be kept either in the US or using cloud-based storage to prevent loss from theft or fire. All data collected as part of monitoring will be archived electronically on DVD (or similar media) in Excel compatible spreadsheets or Arc/View compatible (.shp) files and kept at least for two years after the end of the project.

Field Records

Field records can take the form of observation sheets or hand-held recorder database records. Either are acceptable, but as soon as practical a copy should be made and archived. Original records should never be taken back out into the field. Field data should be transcribed from hard copy sheets as soon as possible into spreadsheets for analysis. Entries on field sheets should be done in English and as clearly and legibly as possible avoiding the use of abbreviations or codes unless those codes are clearly delineated on the field sheet. GPS locations, pictures, observer information, date and time, and field conditions should all be recorded and archived as a component of the field records.

Remote Sensing

During verification events, and baseline reset, when remote sensing data is required to analyze the forest cover of the project and potential leakage area, the original scenes and any analytical transformations or derivative products should be saved and archived. Analysis of error rates, control points, or other ancillary data used for classification should also be

[27] Rapid Eye Imagery: http://www.satimagingcorp.com/satellite-sensors/other-satellite-sensors/rapideye/

archived with the images.

f) Organisation and responsibilities of the parties involved in all the above.

TFG is responsible for all monitoring tasks. TFG may hire qualified subcontractors to perform the work as needed.

8.1.2 Monitoring of leakage

a) Technical description of the monitoring task.

Monitoring of activity shifting leakage (deforestation for the purpose of sugarcane agricultural production) will take place through year 2020 since that is the period in the baseline when planned deforestation was to occur. The leakage for this project will be determined using module LK-ASP and is presumed to be zero ex ante. That presumes that the original baseline deforestation agent, Gallon Jug Agroindustries, does not deforest additional acres in Belize under its control for sugarcane production. Monitoring of those forest lands under control of Gallon Jug Agroindustries will occur using the remote sensing techniques used for monitoring the project but without the use of permanent plots on Gallon Jug Agroindustries land.

Oil and gas exploration was ongoing preproject on Gallon Jug Agroindustries land and is expected to continue. Deforestation from this activity will not be monitored as leakage.

Monitoring of non-CO_2 emissions that result from burning biomass connected with deforestation in the leakage area will be monitored based on the biomass change from the deforestation activities using module E-BPB.

b) Data to be collected.

Data elements are described in section 8.3. Changes due to leakage will be calculated using the following equation and parameters.

$$\Delta C_{LK} = \Delta C_{LK-AS,planned} + \Delta C_{LK-AS,unplanned} + \Delta C_{LK-AS,degrad-FW/C} + \Delta C_{LK-ME}$$

Where:

Parameter	Description
ΔC_{LK}	Net greenhouse gas emissions due to leakage; tCO_2e
$\Delta C_{LK-AS,planned}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation; tCO_2e (from LK-ASP)
$\Delta C_{LK-AS,unplanned}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing unplanned deforestation; tCO_2e (from LK-ASU): note this is a avoided planned deforestation and this parameter is n/a.
ΔC_{LK-ME}	Net greenhouse gas emissions due to market-effects leakage; tCO_2e (from LK-ME).
$\Delta C_{LK-AS,degrad-FW/C}$	Net greenhouse gas emissions due to activity shifting leakage for degradation caused by extraction of wood for fuel; tCO_2e (from LK-DFW). N/A in this project.

GHG emissions in the leakage area will also be monitored using the following equation and parameters:

$$GHG_{P,E,i,t} = E_{FC,i,t} + E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t}$$

Where:

Parameter	Description
$GHG_{P,E,i,t}$	Greenhouse gas emissions as a result of deforestation activities within the project area in the project case in stratum *i* in year *t*; tCO_2e
$E_{FC,i,t}$	Emission from fossil fuel combustion in stratum *i* within the project area in year *t*; tCO_2e. Note this is conservatively excluded from both the project and baseline scenarios, and not monitored.
$E_{biomassburn,i,t}$	Non-CO_2 emissions due to biomass burning that results in deforestation in stratum *i* in year *t* (t CO_2e)
$N_2O_{direct-N,i,t}$	Direct N2O emission as a result of nitrogen application on the alternative land use in stratum i in year t (t CO_2e). Note this is conservatively excluded from both the project and baseline scenarios, and not monitored.
i	1, 2, 3, … *M* strata (unitless)
t	*1, 2, 3 … t** time elapsed since the start of the project activity (years)

c) Overview of data collection procedures.

Data collection methods are the same as those described for the project area changes in carbon stocks in Section 8.1.1 with the exception that biomass inventory data will not be collected in the leakage area. Biomass levels will be extrapolated from the inventory data from the project area. The leakage area is displayed in Figure 11.

d) Quality control and quality assurance procedure.

Data collection methods are the same as those described for the project area changes in carbon stocks in Section 8.1.1.

e) Data archiving.

Data archiving methods are the same as those described for the project area changes in carbon stocks in Section 8.1.1.

f) Organisation and responsibilities of the parties involved in all the above.

TFG is responsible for all monitoring tasks. TFG may hire qualified subcontractors to perform the work as needed.

8.1.3 Estimation of ex-post net greenhouse gas emissions.

a) Technical description of the monitoring task.

If a natural disaster is detected it would most likely be a catastrophic event like a hurricane and possibly a follow-on fire. A sugarcane agricultural conversion and biomass burning (a reversal) could be a source of GHG emissions and is hypothetically possible. In the case of biomass burning from either deforestation event, an estimate of the emissions will be made from the changes in biomass pools following module E-BPB for NO_2 and CH_4. Monitoring will occur by remote sensing and follow up ground surveys if a fire is detected on the project area that results in deforestation. CO_2 emissions will be accounted through any biomass change detected. Emissions resulting from natural disturbances, such as lightning caused fire, may be omitted if they are deemed de minimis through the use of the module T-SIG.

Fossil fuel combustion and nitrogen fertilizer use is conservatively omitted in both the project and baseline scenarios and not monitored.

Monitoring of leakage for CH_4 and N_2O from deforestation related biomass burning will take place through year 2020 since that is the period in the baseline when planned deforestation was to occur.

b) Data to be collected.

Parameters and equation are described Section 5.3.7.2 for biomass burning. Emissions are estimated using the following equation and parameters. Parameters are described in detail in Section 8.3. Calculation of $GHG_{P,E,i,t}$ can be found in Section 8.1.2b.

c) Overview of data collection procedures.

Monitoring of biomass burning emissions is based on biomass changes detected as a part of the deforestation monitoring effort. Procedures for monitoring biomass change are described in Section 8.1.1.

d) Quality control and quality assurance procedure.

Data collection methods are the same as those described for the project area changes in carbon stocks in Section 8.1.1.

e) Data archiving.

Data archiving methods are the same as those described for the project area changes in carbon stocks in Section 8.1.1.

f) Organisation and responsibilities of the parties involved in all the above.

TFG is responsible for all monitoring tasks. TFG may hire qualified subcontractors to perform the work as needed.

8.1.4 Revision of the baseline

a) Technical description of the monitoring task.

Baselines shall be revised every 10 years. The methodological procedure used to update the baseline shall be the same as used in the first estimation. In this project that means module BL-PL will be reapplied to develop a revised baseline. Since the deforestation process is planned deforestation, and the agent of deforestation is known, changes in the baseline using BL-PL are unlikely unless revisions are made to the methodology (or methodologies that BL-PL relies upon like CP-W for wood products) and updates are required. Baseline reset includes analysis of reference areas.

At baseline revision, forest cover must be monitored. Monitoring is intended to detect natural and anthropomorphic impacts that would materially and significantly impact the climate benefits of the project. Above- and belowground biomass stock estimates are valid in the baseline (i.e. treated as constant) for 10 years, after which they must be re-estimated from new field measurements. For each stratum, where the re-measured estimate is within the 90% confidence interval of the t=0 estimate, the t=0 stock estimate takes precedence and is re-employed, and where the re-measured estimate is outside (i.e. greater than or less than) the 90% confidence interval of the t=0 estimate, the new stock estimate takes precedence and is used for the subsequent period.

b) Data to be collected.

Data elements are described in section 8.2 and 8.3.

c) Overview of data collection procedures.

Data related to biomass on the project area will be collected by a combination of remote sensing and permanent plots as described in the monitoring plan.

d) Quality control and quality assurance procedure.

Quality control and quality assurance procedures are the same as those described elsewhere in the monitoring plan.

e) Data archiving.

Data archiving will be accomplished by saving data to permanent media (such as DVD) and stored in Belize at the offices of The Forestland Group in Orange Walk, Belize. Copies will also be maintained in the United States.

f) Organisation and responsibilities of the parties involved in all the above.

TFG is responsible for all monitoring tasks. TFG may hire qualified subcontractors to perform the work as needed.

8.1.5 Community Benefits

a) Technical description of the monitoring task.

The objective of the community benefits monitoring program is to determine that the claimed community benefits, contributions to the Gallon Jug-Chan Chich High School Scholarship Fund[28], are produced. This task is intended to gather information about these benefits and gather input from the community regarding these benefits.

[28] https://sites.google.com/site/gallonjugschool/gallonjug-chanchichscholarshipfund

b) Data to be collected.

Community data will be collected in the form of records of funds transfers, and records of expenditures for high school scholarships utilized by the community. Community meetings will be held to receive input regarding the success or problems with the program.

c) Overview of data collection procedures.

Community benefits will be monitored through community meetings and records of funds transfers to the Gallon Jug-Chan Chich High School Scholarship Fund at each verification event. Meetings will be held at each monitoring event. Funds transfer records will be archived as the funds transfers happen. Records of the spending and results from spending on high school scholarships will be recorded and included in the monitoring report. There are no known community HCVs in the project area so monitoring for community HCVs will not occur. Results of monitoring data will be made available publicly through the Climate, Community, and Biodiversity Alliance web site. Monitoring data results will also be made available to participants at community meetings at verification events.

d) Quality control and quality assurance procedure.

Data received from the Gallon Jug-Chan Chich High School Scholarship Fund will be considered accurate. Data will be discussed at the community meetings to confirm that the data is accurate.

e) Data archiving.

Data archiving will be accomplished by saving data to permanent media (such as DVD) and stored in Belize at the offices of The Forestland Group in Orange Walk, Belize. Copies will also be maintained in the United States.

f) Organisation and responsibilities of the parties involved in all the above.

TFG is responsible for all monitoring tasks. TFG may hire qualified subcontractors to perform the work as needed.

8.1.6 Biodiversity Benefits

a) Technical description of the monitoring task.

The objective of the biodiversity monitoring program is to prove that biodiversity on the site, as indicated by key trigger species, still inhabit the project area.

Biodiversity will be monitored using a combination of techniques including camera traps, and anecdotal observations of high priority species. Anecdotal observations of monkeys, highly visible and IUCN Endangered, will be recorded and archived. Results of monitoring data will be made available publicly through the Climate, Community, and Biodiversity Alliance web site. Monitoring data results will also be made available to participants at community meetings at verification events.

Harmsen et. al. (2010) determined that jaguars (*Panthera onca*) and pumas (*Puma concolor*) and typical common mammalian prey could be detected using camera traps in Belize. Davis, Kelly, and Stauffer (2010) included trap success data in their work in the Mountain Pine

Ridge of Belize and most of the species listed in Table 5 are above zero. Similarly Di Bitetti et. al. (2010) found positive detection rates for felids. A detailed discussion of camera trapping and detection probabilities can be found in O'Brien (2010) and Waldon, Miller, and Miller (2011).

The forest monitoring plan is also a biodiversity monitoring plan since the forest is a key overriding habitat feature for the biodiversity of forest including the HCVs. The primary biodiversity variable used will be vertebrate species richness as indicated by the list of detected species on the project area during a monitoring period. The area to be monitored will be the accessible portions of the project area, primarily roads and permanent plots. Biodiversity monitoring will take place at verification monitoring events, no less frequently than every five years.

b) Data to be collected.

Data for biodiversity monitoring will consist of observations, either through camera traps or anecdotally, of species on the project area. Anecdotal observations can take the form of tracks, scat, calls, or sightings.

c) Overview of data collection procedures.

Biodiversity will be monitored using two methods, camera traps and anecdotal observations of IUCN endangered mammals particularly monkeys. Current biodiversity was established over many years using camera traps on, and near the project area by Miller and Miller (2011). Six stations, infrared digital cameras, will be installed on roads and run 24 hours per day for three weeks resulting in 126 potential trap nights. Presuming equipment failure or other problems with the data that should result in a minimum of 100 trap nights. Pictures from the cameras will be reviewed, catalogued, and archived by date and GPS location. Cameras should be checked weekly during the study to change batteries and confirm operational status. A species list will be developed from the data and archived with the pictures.

Anecdotal observations of IUCN Endangered mammals on the project site will be recorded by date, and location in a log book at the Yalbac mill. All observations of Baird's tapir (*Tapirus bairdii*), Yucatan black howler monkey (*Alouatta pigra*), and Geoffroy's spider monkey (*Ateles geoffroyi*) will be recorded. These observations will be archived digitally (scanned and kept with the project records). Pictures and location of tapir tracks will be recorded if found.

The three trigger species, all HCV species as well, are considered highly detectable by tracks/scat, calls, or visibility in the forest. The project will be considered effective if populations of these animals continue to be detected by monitoring. The monkey species are indicators of mature forest habitat. The Tapir is an indicator of illegal hunting.
Wildlife observations can take the form of pictures from a hand-held camera or camera trap or data recorded by a qualified observer. In every case, a GPS location, date and time, and type of observation (call, sign, animal observed) should be recorded for the observation. Observations of wildlife should be treated like other field records in transcribing and archiving.

d) Quality control and quality assurance procedure.

Wildlife observations from camera traps sometimes require interpretation when the animal is only partially captured or otherwise obscured. A qualified analyst with experience interpreting pictures should be utilized to analyse the camera trap data. Local guides and workers have extensive experience with observing animals on the project area, and their observations will be considered accurate for highly visible species like tapir, jaguar, or monkeys. Observations of more cryptic animals should be accompanied by either documentary evidence (e.g. picture of a track or scat), or a confirmation from a qualified observer with extensive experience in identifying animals in the neotropics.

e) Data archiving.

Data archiving will be accomplished by saving data to permanent media (such as DVD) and stored in Belize at the offices of The Forestland Group in Orange Walk, Belize. Copies will also be maintained in the United States.

f) Organisation and responsibilities of the parties involved in all the above.

TFG is responsible for all monitoring tasks. TFG may hire qualified subcontractors to perform the work as needed.

8.1.7 Data Management

Data collection, analysis and archiving is an important aspect of the monitoring process and keeping good records for the life of the project is a key component of providing benefits over time. In general all raw and processed data will be kept for the life of the project. Paper records will be scanned and archived digitally, and the paper records will be kept as well. All records will be kept at the TFG offices in Belize, and an electronic backup archive will be kept either in the US or using cloud-based storage to prevent loss from theft or fire. All data collected as part of monitoring will be archived electronically on DVD (or similar media) in Excel compatible spreadsheets or Arc/View compatible (.shp) files and kept at least for two years after the end of the project.

Monitoring data will be collected periodically, except in cases where some plots are inaccessible due to high water or other factor making access unsafe, and summarized for periodic 3rd party independent audits. Audits will occur no less frequently than every 10 years. It is the responsibility of the landowner to conduct monitoring either utilizing contractors or in-house staff.

<u>Field Records</u>

Field records can take the form of observation sheets or hand-held recorder database records. Either are acceptable, but as soon as practical a copy should be made and archived. Original records should never be taken back out into the field. Field data should be transcribed from hard copy sheets as soon as possible into spreadsheets for analysis. Entries on field sheets should be done in English and as clearly and legibly as possible avoiding the use of abbreviations or codes unless those codes are clearly delineated on the field sheet. GPS locations, pictures, observer information, date and time, and field conditions should all be recorded and archived as a component of the field records.

<u>Wildlife Observations</u>

Wildlife observations can take the form of pictures from a hand-held camera or camera trap or data recorded by a qualified observer. In every case, a GPS location, date and time, and type of observation (call, sign, animal observed) should be recorded for the observation. Observations of wildlife should be treated like other field records in transcribing and archiving.

<u>Remote Sensing</u>

During verification events, and baseline reset, when remote sensing data is required to analyze the forest cover of the project and potential leakage area, the original scenes and any analytical transformations or derivative products should be saved and archived. Analysis of error rates, control points, or other ancillary data used for classification should also be archived with the images.

8.2 Data and Parameters Available at Validation (CL3)

Data Unit / Parameter:	*Project Forest Cover Benchmark Map*
Data unit:	Ha, minimum mapping unit 1 ha.
Description:	Map showing the location of forest land within the reference region at the beginning of the project crediting period
Source of data:	Remote sensing in combination with GPS data collected during ground-reference.
Value applied:	See map graphic in Section 5.1.
Justification of choice of data or description of measurement methods and procedures applied:	Map accuracy tested and found to be 95.1%. Accuracy by class included in Appendix A. Methods described in Appendix A.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*u*
Data unit:	List of post deforestation land uses.
Description:	The intended use of land deforested either in the project area or leakage area.
Source of data:	Based on the deforestation plan for the baseline.
Value applied:	1 use: sugar cane
Justification of choice of data or description of measurement methods and procedures applied:	According to the methodology the approved baseline deforestation plan defines the post deforestation land use. That land use is the land use monitored in the leakage belt.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*i*
Data unit:	List of strata
Description:	Forest vegetation strata based on statistical analysis described in X-STR.
Source of data:	Remote sensing and inventory data.
Value applied:	1
Justification of choice of data or description of measurement	Based on comparison of inventory data permanent plots. Two possible strata (bajo and high forest) were identified and compared, and the statistical difference was too minor to justify separate strata.

methods and procedures applied:	
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*t*
Data unit:	Years
Description:	Number of years in the project.
Source of data:	Minimum number of years required to pass risk assessment is 30 years.
Value applied:	30
Justification of choice of data or description of measurement methods and procedures applied:	Based on methodology and standard and preference of Project Proponent.
Purpose of Data:	Calculation of baseline emissions.
Comment:	Calculations for validation are based on the first baseline period of 10 years so *t* is set to 10 for the purposes of this document.

Data Unit / Parameter:	$A_{planned,i}$
Data unit:	Ha
Description:	Total area of planned deforestation over the baseline period for stratum i
Source of data:	Validated deforestation plan.
Value applied:	8240 ha
Justification of choice of data or description of measurement methods and procedures applied:	Based on validated deforestation plan.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$AA_{planned,i,t}$
Data unit:	Ha
Description:	Area of planned deforestation in the project area for stratum *i* at time *t*
Source of data:	Validated deforestation plan.
Value applied:	824 ha/year for 10 years.
Justification of choice of data or description of measurement methods and procedures applied:	Based on validated deforestation plan.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$A_{Enh,PL,i,t}$

Data unit:	Ha
Description:	Project area in stratum *i* in which carbon stocks are accumulating but that would have undergone planned deforestation in the baseline scenario at time *t*; ha
Source of data:	Validated deforestation plan.
Value applied:	824 ha/year for 10 years.
Justification of choice of data or description of measurement methods and procedures applied:	Based on validated deforestation plan.
Purpose of Data:	Calculation of project emissions.
Comment:	

Data Unit / Parameter:	$D\%_{planned,i,t}$
Data unit:	% year
Description:	Projected annual proportion of land that will be deforested in stratum *i* during year *t*
Source of data:	Validated deforestation plan.
Value applied:	10%/year
Justification of choice of data or description of measurement methods and procedures applied:	Based on validated deforestation plan.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{BSL,planned}$
Data unit:	tCO_2e
Description:	Net greenhouse gas emissions in the baseline from planned deforestation.
Source of data:	Calculated based on equations in Section 5.6.
Value applied:	2,887,000
Justification of choice of data or description of measurement methods and procedures applied:	Per methodology for planned deforestation
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{BSL,i,t}$
Data unit:	tCO_2e ha-1
Description:	Carbon stock in all pools in the baseline in stratum *I* at time *t*
Source of data:	Calculated based on equations in Section 5.6.
Value applied:	Annual values provided in Table 15.

Justification of choice of data or description of measurement methods and procedures applied:	Per methodology for planned deforestation
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$GHG_{BSL-E,I,t}$
Data unit:	tCO_2e ha-1
Description:	GHG emissions other than from carbon stock change in the baseline in stratum *i* at time *t*
Source of data:	Calculated based on equations in Section 5.6.
Value applied:	Annual values provided in Table 11.
Justification of choice of data or description of measurement methods and procedures applied:	Per methodology for planned deforestation.
Purpose of Data:	Calculation of baseline emissions.
Comment:	Nitrogen fertilizer use and fossil fuel use are conservatively excluded pools in the baseline and project. This parameter only includes biomass burning.

Data Unit / Parameter:	$L\text{-}D_i$
Data unit:	%
Description:	Likelihood of deforestation in strata *i*
Source of data:	Validated deforestation plan.
Value applied:	100%
Justification of choice of data or description of measurement methods and procedures applied:	Based on validated sugarcane plan (Gallon Jug Agroindustries 2010), common practice review, financial additionality comparison with other feasible land use practices, and documentary evidence of planning.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$E_{BiomassBurn,i,t}$
Data unit:	tCO_2e
Description:	Non-CO_2 emissions due to biomass burning that results in deforestation in stratum *i* in year *t* (t CO_2e)
Source of data:	Calculated based on equations in Section 5.6.
Value applied:	Annual values provided in Table 11.
Justification of choice of data or description of measurement methods and procedures applied:	Methods are described in "Estimation of greenhouse gas emissions from biomass burning (E-BPB)".

Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$B_{i,t}$
Data unit:	mt d.m./ha
Description:	Average aboveground biomass stock before burning stratum *i*, year (t d.m. ha^{-1})
Source of data:	Field inventory
Value applied:	165.8
Justification of choice of data or description of measurement methods and procedures applied:	Inventory described fully elsewhere. Field methods and calculations follow CP-AB and BL-PL following techniques described in Pearson et.al. (2005).
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	GWP_g
Data unit:	tCO_2e
Description:	Global warming potential for gas *g* (t CO_2/t gas g)
Source of data:	IPCC https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html
Value applied:	310 for nitrous oxide and 21 for methane
Justification of choice of data or description of measurement methods and procedures applied:	Methodology instructions.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$COMF_i$
Data unit:	unitless
Description:	Combustion factor for stratum i (unitless)
Source of data:	Default values in Table 2.6 of IPCC, 2006 (Appendix 2)
Value applied:	0.5
Justification of choice of data or description of measurement methods and procedures applied:	The combustion factor is a measure of the proportion of the fuel that is actually combusted, which varies as a function of the size and architecture of the fuel load (ie, a smaller proportion of large, coarse fuel such as tree stems will be burnt compared to fine fuels, such as grass leaves), the moisture content of the fuel and the type of fire (ie, intensity and rate of spread). Default values must be updated whenever new guidelines are produced by the IPCC.
Purpose of Data:	Calculation of baseline emissions.

Comment:	

Data Unit / Parameter:	$G_{g,i}$
Data unit:	kg t^{-1} d.m. burnt
Description:	Emission factor for stratum i for gas g (kg t^{-1} d.m. burnt)
Source of data:	Defaults can be found in Volume 4, Chapter 2, of the IPCC 2006 Inventory Guidelines in table 2.5 (see Appendix 2: emission factors for various types of burning for CH4 and N2O)
Value applied:	6.8 for CH_4 and 0.2 for N_2O
Justification of choice of data or description of measurement methods and procedures applied:	Defaults can be found in Volume 4, Chapter 2, of the IPCC 2006 Inventory Guidelines in table 2.5 (see Appendix 2: emission factors for various types of burning for CH4 and N2O). Default values must be updated whenever new guidelines are produced by the IPCC.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*g*
Data unit:	unitless
Description:	List of greenhouse gases included in analysis
Source of data:	Methodology
Value applied:	CH_4 and N_2O
Justification of choice of data or description of measurement methods and procedures applied:	As indicated in methodology. CO_2 emissions from biomass burning excluded in this analysis, but included in analysis of biomass change as a result of burning.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{AB\_tree,i}$,
Data unit:	tCO_2e ha-1
Description:	Carbon stock in aboveground biomass in trees in the baseline case in stratum *i.*
Source of data:	Field measurements applied with allometric equation published in Pearson et. al. (2005)
Value applied:	Annual values presented in Table 11.
Justification of choice of data or description of measurement methods and procedures applied:	Computer and spreadsheet software. Additional equipment required for field data collection.
Purpose of Data:	Calculation of baseline emissions.
Comment:	Key variable used to calculate with project carbon stocks

Data Unit / Parameter:	$C_{BB,tree,i}$,
Data unit:	tCO_2e ha-1
Description:	Carbon stock in belowground biomass in trees in the baseline case in stratum *i.*
Source of data:	Field measurements applied at plot level with root to shoot equation
Value applied:	Annual values presented in Table 11.
Justification of choice of data or description of measurement methods and procedures applied:	Not measured. Calculated based on root to shoot ratio. For belowground biomass, the root-to-shoot ratios indicated in the methodology CP-AB was used which results in a ratio of .24 for plots with a mean aboveground biomass of 125 tons/ha or greater and a ratio of .2 for plots indicating a mean aboveground biomass of less than 125 tons/ha.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{AB\_non\text{-}tree,i}$,
Data unit:	tCO_2e ha-1
Description:	Carbon stock in aboveground biomass in nontrees in the baseline case in stratum *i.*
Source of data:	Dewalt and Chave (2004)
Value applied:	Annual values presented in Table 11.
Justification of choice of data or description of measurement methods and procedures applied:	Methodology permits use of peer-reviewed literature that is appropriate to the species in the project area or to the geographic region, elevation and precipitation regime in the project area. Data from study areas in Costa Rica and Panama averaged.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{BB,non\text{-}tree,i}$,
Data unit:	tCO_2e ha-1
Description:	Carbon stock in belowground biomass in nontrees in the baseline case in stratum *i.*
Source of data:	Dewalt and Chave (2004)
Value applied:	Annual values presented in Table 11.
Justification of choice of data or description of measurement methods and procedures applied:	Not measured. Calculated based on root to shoot ratio. For belowground biomass, the root-to-shoot ratios indicated in the methodology CP-AB was used which results in a ratio of .24 for plots with a mean aboveground biomass of 125 tons/ha or greater and a ratio of .2 for plots indicating a mean aboveground biomass of less than 125 tons/ha.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*fj(X,Y)*
Data unit:	Functions return AGB $tree^{-1}$
Description:	Allometric equation for aboveground and belowground biomass. Dry matter estimate is calculated for each tree at each plot within each strata and carried over time. Sum of dry matter estimates generate sum for plot. Mean of plots result in dry matter estimate for project.
Source of data:	Pearson et. al. (2005) and Brown (2015)
Value applied:	The equations used are: Aboveground Tree Biomass: $AGB = 0.2035 * DBH^{2.3196}$ Palm aboveground biomass (AGB) from Brown 2015: Chrysophylla stauracantha : AGB = ((0.8966 * H) – 0.37988) Attalea cohune: AGB = (302.6 * ln(H)) + 276.93) Sabal mauritiiformis: AGB = (302.6 * ln(H)) + 276.93) Belowground Biomass: If AGB is > 125 t/ha then BGB = AGB x .24 else BGB = AGB x .2
Justification of choice of data or description of measurement methods and procedures applied:	Pearson equation was an acceptable fit based on independent test as prescribed in methodology. Allometric validation conducted on equation comparing largest tree at each plot against hypothetical biomass (volume * D) and found to predict 67.5% higher than test and 32.5% lower than hypothetical biomass. Brown (2015) equations developed at contiguous site on the three species in inventory.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*R*
Data unit:	t root d.m. t -1 shoot d.m.
Description:	Root to shoot ratio appropriate to species or forest type / biome.
Source of data:	IPCC GL AFOLU per methodology
Value applied:	.24 when 125 tons/ha AGB or greater is indicated and .2 when less than 125 tons/ha.
Justification of choice of data or description of measurement methods and procedures applied:	Required by methodology.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$D_{,tree}$
Data unit:	g/cm^3
Description:	Density of dry wood for each species
Source of data:	Published source; Zanne et. al. 2009.
Value applied:	See database of tree measurements.
Justification of choice of data or description of measurement methods and procedures applied:	Required by methodology to test allometric equations. Must be reviewed at baseline reset.
Purpose of Data:	Calculation of baseline emissions.
Comment:	D was applied using the reference in all but 22 trees in the initial inventory. If the species was listed from Mexico or Central America (CA) that value was used. If there were multiple values, they were averaged. If values weren't available from Mexico/CA then the South America values were used, again averaging if necessary. If the species wasn't available, the Genus was averaged. If the Genus wasn't available, the Family was averaged. The decision criteria in order of precedence: 1. Species-M,CA 2. Species-SA 3. Genus-M,CA 4. Genus-SA 5. Family-M,CA 6. Family-SA Trees where D could not be determined were assigned a value of .651 based on the lower 95% confidence limit of the mean of the remaining trees that could be identified, weighted by frequency. Weighting by frequency is employed to take into account the patchy nature of tree distribution that is evident in the inventory data, and the presumption that unidentified trees are most likely to be species already identified elsewhere in the inventory.

Data Unit / Parameter:	D_{mn}
Data unit:	g/cm^3
Description:	Mean wood density of commercially harvested species.
Source of data:	Published source; Zanne et. al. (2009). Used mean of D for commercial species listed in sustainable forest management plan (Cho 2007) and found in inventory.
Value applied:	0.712
Justification of choice of data or description of measurement methods and procedures applied:	Required by methodology. See parameter $D_{,tree}$ for explanation of data priorities.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*CF*
Data unit:	t C t-1 d.m.
Description:	Carbon fraction of dry matter
Source of data:	
Value applied:	.47
Justification of choice of data or description of measurement methods and procedures applied:	Based on published value (IPCC 2006).
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$Ht,_{tree,i,}$
Data unit:	meters
Description:	Height of the tree from the ground based on measurements with a clinometer or other device. See monitoring plan for field methods.
Source of data:	Field measurements
Value applied:	See database of tree measurements.
Justification of choice of data or description of measurement methods and procedures applied:	See field methods section of monitoring plan. Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Purpose of Data:	Calculation of baseline emissions.
Comment:	This variable is collected, but not necessary for allometric equation used. This variable is used to validate the allometric equation.

Data Unit / Parameter:	$DBH,_{tree,i,}$
Data unit:	Cm
Description:	Diameter at 1.3 meters above the ground of each tree on each plot.
Source of data:	Field measurements. See procedures for measurement in the monitoring plan.
Value applied:	See database of tree measurements.
Justification of choice of data or description of measurement methods and procedures applied:	Required by methodology. See field methods section of monitoring plan. Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$SLFt_y$
Data unit:	Fraction of wood products that will be emitted to the atmosphere within 5 years of production by class of wood product.
Description:	Winjum et. al. (1998) give the following proportions for wood products with short-term (<5 yr) uses after which they are retired and oxidized (applicable internationally). In Belize there are no markets for products other than Sawnwood therefore SLF = 0.2 as indicated.
Source of data:	CP-W 1.1 and Winjum et. al. (1998).
Value applied:	0.2
Justification of choice of data or description of measurement methods and procedures applied:	Per methodology.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	OF_{ty}
Data unit:	dimensionless
Description:	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product ty; dimensionless
Source of data:	CP-W 1.0 methodology
Value applied:	0.84
Justification of choice of data or description of measurement methods and procedures applied:	Winjum et al. (1998) gives annual oxidation fractions for each class of wood products split by forest region (boreal, temperate and tropical). This methodology projects these fractions over 95 years to give the additional proportion (OF value) that is oxidized between the 5th and 100th years after initial harvest. Based on sawnwood and tropical regions, the value provided is .84.
Purpose of Data:	Calculation of baseline emissions.
Comment:	Note that this parameter was inadvertently omitted in CP-W 1.1 and the value from CPW 1.0 is used.

Data Unit / Parameter:	*WWty*
Data unit:	WW = Fraction of extracted biomass effectively emitted to the atmosphere during production by class of wood product ty
Description:	Winjum et al. (1998) indicate that the proportion of extracted biomass that is oxidized (burning or decaying) from the production of commodities to be equal to 19% for developed countries, 24% for developing countries. WW is therefore equal to 0.24 for Belize.
Source of data:	CP-W 1.1 and Winjum et. al. (1998).
Value applied:	.24
Justification of choice of data or description of measurement	Per methodology.

methods and procedures applied:	
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*ty*
Data unit:	Class of wood product
Description:	Per CP-W methodology classes are defined as sawnwood, wood-based panels, other industrial roundwood, paper and paper board, and other.
Source of data:	CP-W 1.1
Value applied:	sawnwood
Justification of choice of data or description of measurement methods and procedures applied:	Based on inspection of the mill and sales records only one product class can be produced.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	G_{gi}
Data unit:	g kg^{-1} dry matter burnt
Description:	Emission factor for stratum *i* for gas *g*,
Source of data:	Defaults can be found in Volume 4, Chapter 2, of the IPCC 2006 Inventory Guidelines in table 2.5 (see Annex 2: emission factors for various types of burning for CH_4 and N_2O).
Value applied:	6.8 for CH_4 and .2 for N_2O
Justification of choice of data or description of measurement methods and procedures applied:	Methodology requirement.
Purpose of Data:	Calculation of baseline emissions.
Comment:	Default values shall be updated whenever new guidelines are produced by the IPCC

Data Unit / Parameter:	$C_{XB,i}$
Data unit:	tCO_2e ha-1
Description:	Mean stock of extracted biomass carbon by class of wood product ty from stratum i; tCO_2e ha-1
Source of data:	Calculated in CP-W based on merchantable volume estimated on project area from inventory.
Value applied:	10.64
Justification of choice of data or description of measurement	Best available data is recent inventory. Merchantability standards and species based on sustainable forest management plan that is the basis for license to sell timber from property. BCEF based on

methods and procedures applied:	methodology default. Pcom$_i$ based on commercial volume percentage of total volume.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{XB,ty,i}$
Data unit:	tCO_2e ha^{-1}
Description:	Mean stock of extracted biomass carbon by class of wood product *ty* from stratum i; tCO_2e ha^{-1}
Source of data:	Methodology default
Value applied:	10.64
Justification of choice of data or description of measurement methods and procedures applied:	Stock of extracted biomass based on inventory data, and merchantability standards in sustainable forest management plan. Presumes only one product, sawnwood, based on mill capabilities and sales records.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{WP,i}$
Data unit:	$tCO_2e\ ha^{-1}$
Description:	Carbon stock entering the wood products pool from stratum i; $tCO_2e\ ha^{-1}$
Source of data:	Calculated in CP-W based on merchantable volume estimated on project area from inventory.
Value applied:	See Table 14.
Justification of choice of data or description of measurement methods and procedures applied:	Best available data is recent inventory. Merchantability standards and species based on sustainable forest management plan that is the basis for license to sell timber from property. WWty based on methodology default.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{WP,i,t}$
Data unit:	$tCO_2e\ ha^{-1}$
Description:	Carbon stock entering the wood products pool from stratum i; $tCO_2e\ ha^{-1}$ in year t
Source of data:	Calculated in CP-W based on merchantable volume estimated on project area from inventory. Values by year in Table 14.
Value applied:	Varies by year based on requirement to apply 1/20 each year for 20 years. Table by year in Section 5.6.
Justification of choice of data or description of measurement methods and procedures applied:	Best available data is recent inventory. Merchantability standards and species based on sustainable forest management plan that is the basis for license to sell timber from property. WWty based on methodology default.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$C_{WP100,i}$
Data unit:	$tCO_2e\ ha^{-1}$
Description:	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum i; $tCO_2e\ ha^{-1}$
Source of data:	Calculated in CP-W based on merchantable volume estimated on project area from inventory.
Value applied:	7.05
Justification of choice of data or description of measurement methods and procedures applied:	Best available data is recent inventory. Merchantability standards and species based on sustainable forest management plan that is the basis for license to sell timber from property. SLF_{ty} and OF_{ty} based on methodology defaults.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	*BCEF*
Data unit:	unitless
Description:	Biomass conversion and expansion factor (BCEF) for conversion of merchantable volume to total aboveground tree biomass; dimensionless
Source of data:	Methodology default
Value applied:	2.8
Justification of choice of data or description of measurement methods and procedures applied:	BCEF from IPCC 2006 is 4 (humid tropical forests with commercial volumes from 11-20 based on inventory data: 11.09 m3/ha).
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$Pcom_i$
Data unit:	dimensionless
Description:	Commercial volume as a percent of total aboveground volume in stratum i; dimensionless
Source of data:	Methodology default
Value applied:	10.42%
Justification of choice of data or description of measurement methods and procedures applied:	$Pcom_i$ is based on the ratio of total commercial volume to aboveground tree volume based on inventory data.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$\Delta C_{BSL,i,t}$
Data unit:	tCO_2e ha-1
Description:	Net greenhouse gas emissions in the baseline from planned deforestation in stratum *i* in year *t* (t CO_2e)
Source of data:	Calculated based on inventory data and project plan using multiple methodologies.
Value applied:	Annual values presented in Table 15.
Justification of choice of data or description of measurement methods and procedures applied:	Per methodology for planned deforestation
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$\Delta C_{pools,Def,u,i,t}$
Data unit:	tCO_2e ha-1

Description:	Net carbon stock changes in all pools in the project case in land use *u* in stratum *i* at time *t*; t CO_2-e ha-1
Source of data:	Remote sensing and inventory data.
Value applied:	Ex ante estimation is provided in table form in Section 5.6.
Justification of choice of data or description of measurement methods and procedures applied:	Formula and parameters provided in section 5.6.
Purpose of Data:	Calculation of project emissions
Comment:	

Data Unit / Parameter:	$C_{P,post,u,i}$
Data unit:	tCO_2e ha-1
Description:	Carbon stock in all pools in post-deforestation land use *u* in stratum *i*; t CO_2-e ha-1
Source of data:	Literature
Value applied:	Annual ex ante estimation is provided in table form in Section 5.6. Value set to zero.
Justification of choice of data or description of measurement methods and procedures applied:	Formula and parameters provided in section 5.6.
Purpose of Data:	Calculation of baseline emissions.
Comment:	

Data Unit / Parameter:	$\Delta C_{P,Deg,i,t}$
Data unit:	tCO_2e ha-1
Description:	Net carbon stock change as a result of degradation in the project area in the project case in stratum i at time t; tCO_2e
Source of data:	Calculated based on indisputably conservative assumptions.
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied:	Based on indisputably conservative assumptions, these pools are de minimis.
Purpose of Data:	Calculation of project emissions
Comment:	

Data Unit / Parameter:	$\Delta C_{P,DegW,i,t}$
Data unit:	tCO_2e ha-1
Description:	Net carbon stock change as a result of degradation through extraction of trees for illegal timber or fuelwood and charcoal in the project area in the project case in stratum i at time t; tCO_2e
Source of data:	Calculated based on indisputably conservative assumptions.
Value applied:	0 tCO_2e/ha

Justification of choice of data or description of measurement methods and procedures applied:	Based on indisputably conservative assumptions, this pool is de minimis.
Purpose of Data:	Calculation of project emissions
Comment:	

Data Unit / Parameter:	$A_{DegW,i}$
Data unit:	ha
Description:	Area potentially impacted by degradation processes in stratum i; ha
Source of data:	Conservative assumption that entire project area is available for fuelwood collection.
Value applied:	8240 ha
Justification of choice of data or description of measurement methods and procedures applied:	Indisputably conservative assumption. In fact the community has little to no access to the project area.
Purpose of Data:	Calculation of project emissions
Comment:	

Data Unit / Parameter:	$C_{DegW,i,t}$
Data unit:	tCO_2e ha-1
Description:	Biomass carbon of trees cut and removed through degradation process from plots measured in stratum i at time t; tCO_2e
Source of data:	Based on indisputably conservative assumption detailed in section 5.4.5
Value applied:	.276 tCO_2e/ha
Justification of choice of data or description of measurement methods and procedures applied:	Indisputably conservative assumption.
Purpose of Data:	Calculation of project emissions
Comment:	

Data Unit / Parameter:	A_{Pi}
Data unit:	ha
Description:	Total area of degradation sample plots in stratum i; ha.
Source of data:	This part of the analysis is based on assumptions from the literature rather than measurement.
Value applied:	0 ha
Justification of choice of data or description of measurement methods and procedures applied:	Indisputably conservative assumption.
Purpose of Data:	Calculation of project emissions

Comment:	

Data Unit / Parameter:	$\Delta C_{P,SelLog,i,t}$
Data unit:	tCO_2e
Description:	Net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas in the project area in the project case in stratum i at time t; tCO_2e
Source of data:	Calculated based on indisputably conservative assumptions.
Value applied:	30,262
Justification of choice of data or description of measurement methods and procedures applied:	Based on indisputably conservative assumptions, this pool is de minimis.
Purpose of Data:	Calculation of project emissions
Comment:	

Data Unit / Parameter:	$C_{LG,i,t} + C_{LR,i,t}$
Data unit:	tCO_2e
Description:	Actual (projected) net project emissions arising in the logging gap in stratum i at time t; tCO_2e plus actual (projected) net project emissions arising from logging infrastructure in stratum i at time t; tCO_2e. The difference between $C_{LG,i,t}$ and $C_{LR,i,t}$ is not easily defined in Whitman et. al. (1997) but the combination of the two can be extrapolated.
Source of data:	Total damage estimate from Whitman et. al. (1997) of 4.8% x 3 to result in indisputably conservative assumption.
Value applied:	96,884 tCO_2e
Justification of choice of data or description of measurement methods and procedures applied:	Based on indisputably conservative assumptions, this pool is de minimis.
Purpose of Data:	Calculation of project emissions
Comment:	

Data Unit / Parameter:	$C_{tree,I,t}$
Data unit:	tCO_2e ha-1
Description:	Total AGBtree in tCO_2e
Source of data:	Total damage estimate from Whitman et. al. (1997) of 4.8% x 3 to result in indisputably conservative assumption.
Value applied:	2,354,810 tCO_2e
Justification of choice of data or description of measurement methods and procedures applied:	This is a derivative value based on other parameters.
Purpose of Data:	Calculation of project emissions
Comment:	

Data Unit / Parameter:	*ag*
Data unit:	unitless
Description:	Number of agents of deforestation
Source of data:	Deforestation plan (Gallon Jug Agroindustries 2010)
Value applied:	1: Gallon Jug Agroindustries
Justification of choice of data or description of measurement methods and procedures applied:	Per methodology, based on deforestation plan.
Purpose of Data:	Calculation of leakage emissions.
Comment:	

Data Unit / Parameter:	$HistHa_{i,ag}$
Data unit:	ha
Description:	Number of hectares of forest cleared by the baseline agent of the planned deforestation in the five years prior to project implementation in stratum i by agent ag within the country.
Source of data:	Remote sensing
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied:	Based on deforestation analysis performed using remote sensing analysis described in Appendix A.
Purpose of Data:	Calculation of leakage emissions.
Comment:	

Data Unit / Parameter:	*LDF*
Data unit:	t C m^{-3}
Description:	Factor for calculating the biomass of dead wood created during logging operations per cubic meter extracted
Source of data:	Default value provided
Value applied:	Default value for broadleaf and mixed forests of 0.53 t C m^{-3}
Justification of choice of data or description of measurement methods and procedures applied:	Default value for broadleaf and mixed forests of 0.53 t C m^{-3} from 774 logging gaps measured by Winrock International in Bolivia, Belize, the Republic of Congo, Brazil and Indonesia.
Purpose of Data:	Calculation of leakage emissions.
Comment:	

Data Unit / Parameter:	*LIF*
Data unit:	$t\ C\ m^{-3}$
Description:	Factor for calculating the emissions arising from the creation of logging infrastructure (roads, skid trails and decks) during logging operations per cubic meter extracted
Source of data:	Default value provided
Value applied:	Conservative default value of 0.29 $t\ CO_2e\ m^{-3}$
Justification of choice of data or description of measurement methods and procedures applied:	Conservative default value of 0.29 $t\ CO_2e\ m^{-3}$ calculated from 1,839 hectares of logging concessions analysed by Winrock International in the Republic of Congo and Brazil.
Purpose of Data:	Calculation of leakage emissions.
Comment:	

Data Unit / Parameter:	LF_{ME}
Data unit:	dimensionless
Description:	Leakage factor for market effects calculations.
Source of data:	Default value based on the proportion of total biomass in commercial species that is merchantable (PML_{FT}) compared to mean proportion of total biomass that is merchantable in each forest type (PMP).
Value applied:	.4
Justification of choice of data or description of measurement methods and procedures applied:	LF_{ME} is .4 when PMLFT is equal to +/- 15% compared to PMP. In this case there is just one merchantable forest type since of the two forest types on the project area, the bajo type is excluded from the forest license. Therefore the comparison yields a 0% difference between PM_{LFT} and PMP.
Purpose of Data:	Calculation of leakage emissions.
Comment:	

Data Unit / Parameter:	PML_{ft}
Data unit:	dimensionless
Description:	The mean proportion of total biomass that is merchantable for each forest type.
Source of data:	Default value based on the proportion of total biomass in commercial species that is merchantable (PML_{FT}) compared to mean proportion of total biomass that is merchantable in each forest type (PMP).
Value applied:	.4
Justification of choice of data or description of measurement methods and procedures applied:	LF_{ME} is .4 when PMLFT is equal to +/- 15% compared to PMP. In this case there is just one merchantable forest type since of the two forest types on the project area, the bajo type is excluded from the forest license. Therefore the comparison yields a 0% difference between PM_{LFT} and PMPi.
Purpose of Data:	Calculation of leakage emissions.

Comment:	

Data Unit / Parameter:	LK_{MAF}
Data unit:	Leakage management adjustment factor
Description:	If the leakage management areas produce an amount equal or higher than the expected baseline production of biomass in commercial species that is merchantable, leakage shall be assumed to be zero. In order to apply this factor, project proponents need to demonstrate the production of the volume biomass in commercial species that is merchantable used to estimate this deduction, as well as evidence that such biomass has reached the relevant regional/national markets. Any increase in GHG emissions associated with the leakage management activities shall be accounted for, unless deemed de minimis or conservatively excluded.
Source of data:	No leakage management areas have been established.
Value applied:	1
Justification of choice of data or description of measurement methods and procedures applied:	Conservative default applied.
Purpose of Data:	Calculation of leakage emissions.
Comment:	

Data Unit / Parameter:	$PRODMB_{BL,t}$
Data unit:	tons per year
Description:	Production of biomass in commercial species that is merchantable in year *t* in the baseline case (t per year)
Source of data:	Based on inventory data
Value applied:	740,759
Justification of choice of data or description of measurement methods and procedures applied:	Best available data from inventory and commercial criteria from Cho (2007) cutting diameter and commercial species list.
Purpose of Data:	Calculation of leakage emissions.
Comment:	

Data Unit / Parameter:	$PRODMB_{LMA,t}$
Data unit:	tons per year
Description:	Production biomass in commercial species that is merchantable in year t in leakage management areas (t per year).
Source of data:	Project proponent.

Value applied:	Since no leakage management areas have been established this is set to 0.
Justification of choice of data or description of measurement methods and procedures applied:	Conservative default applied.
Purpose of Data:	Calculation of leakage emissions.
Comment:	

Data Unit / Parameter:	$V_{BSL,EX,i,t}$
Data unit:	m^3
Description:	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum *i* in year *t*
Source of data:	Based on inventory data.
Value applied:	193,481
Justification of choice of data or description of measurement methods and procedures applied:	Estimates from inventory are highest priority data source if timber harvest records are unavailable.
Purpose of Data:	Calculation of leakage emissions.
Comment:	Gross AGB used.

Data Unit / Parameter:	*Species List*
Data unit:	Species
Description:	List of detected species known to occur on the site.
Source of data:	Pictures, acoustic recordings, tracks, observations by trained observers.
Value applied:	Presence/Absence
Justification of choice of data or description of measurement methods and procedures applied:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Purpose of Data:	Used to determine biodiversity impacts.
Comment:	Species list developed by Miller and Miller (2011)

8.3 Data and Parameters Monitored (CL3, CM3 & B3)

Data Unit / Parameter:	*Project Forest Cover Monitoring Map*
Data unit:	Ha: minimum mapping unit 1 ha.

Description:	Map showing the location of forest land within the project area at the beginning of each monitoring period. If within the Project Area some forest land is cleared, the benchmark map must show the deforested areas at each monitoring event
Source of data:	Remote sensing in combination with GPS data collected during ground reference.
Description of measurement methods and procedures to be applied:	The minimum map accuracy should be 90% for the classification of forest/non-forest in the remote sensing imagery. If the classification accuracy is less than 90% then the map is not acceptable for further analysis. More remote sensing data and ground reference data will be needed to produce a product that reaches the 90% minimum mapping accuracy.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied:	Map produced at each monitoring event showing forest cover presumed ex ante at 100%.
Monitoring equipment:	Computer and appropriate analytical software.
QA/QC procedures to be applied:	Based on plot remeasurements, and high resolution imagery verification.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Head's up delineation using GIS and landsat imagery (or higher resolution) using multiple images to get a cloud free image.
Comment:	If stratification is required in the future, then new strata will be identified using module X-STR.

Data Unit / Parameter:	$A_{DefPA,i,t}$
Data unit:	Ha
Description:	Area of recorded deforestation in the project area at time *t (if any occurs)*
Source of data:	Remote sensing imagery
Description of measurement methods and procedures to be applied:	Head's up delineation using GIS and landsat imagery (or higher resolution) using multiple images to get a cloud free image.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied:	0
Monitoring equipment:	Computer and appropriate analytical software.
QA/QC procedures to be applied:	Remeasurement of permanent plots.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Head's up delineation using GIS and landsat imagery (or higher resolution) using multiple images to get a cloud free image.
Comment:	This is presumed to be zero ex ante.

Data Unit / Parameter:	$A_{DefLK,i,t}$

Data unit:	Ha
Description:	Area of recorded deforestation by the baseline agent of deforestation in Belize at time *t (if any occurs)*
Source of data:	Remote sensing imagery
Description of measurement methods and procedures to be applied:	Head's up delineation using GIS and landsat imagery (30 meter or higher resolution) using multiple images to get a cloud free image.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied:	0
Monitoring equipment:	Computer and appropriate analytical software.
QA/QC procedures to be applied:	Field observations where possible. Spot check with higher resolution imagery if available.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Head's up delineation using GIS and landsat imagery (30 meter or higher resolution) using multiple images to get a cloud free image.
Comment:	This is presumed to be zero ex ante.

Data Unit / Parameter:	$A_{burn,i,t}$
Data unit:	Ha
Description:	Area burnt at time *t (if any occurs)*
Source of data:	Remote sensing imagery
Description of measurement methods and procedures to be applied:	Head's up delineation using GIS and landsat imagery (or higher resolution) using multiple images to get a cloud free image.
Frequency of monitoring/recording:	Areas burnt shall be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied:	0 ex ante
Monitoring equipment:	Computer and appropriate analytical software.
QA/QC procedures to be applied:	Remeasurement of permanent plots.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Head's up delineation using GIS and landsat imagery (or higher resolution) using multiple images to get a cloud free image.
Comment:	This is presumed to be zero ex ante.

Data Unit / Parameter:	$E_{BiomassBurn,i,t}$
Data unit:	tCO_2e
Description:	Non-CO_2 emissions due to biomass burning that results in deforestation in stratum *i* in year *t* (t CO_2e)
Source of data:	Calculated based on module EBPB

Description of measurement methods and procedures to be applied:	Remote sensing. Methods described in monitoring plan. Calculations based on module "Estimation of greenhouse gas emissions from biomass burning (E-BPB)".
Frequency of monitoring/recording:	Areas burnt shall be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied:	0 ex ante
Monitoring equipment:	Computer and appropriate analytical software.
QA/QC procedures to be applied:	Remeasurement of permanent plots.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Calculated parameter.
Comment:	

Data Unit / Parameter:	$B_{i,t}$
Data unit:	tCO_2e/ha
Description:	Average aboveground biomass stock before burning stratum i, year (t d.m. ha-1)
Source of data:	Field inventory and remote sensing.
Description of measurement methods and procedures to be applied:	Field measurements applied with allometric equation published in Pearson et. al. (2005). Remote sensing procedures described in monitoring plan.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	165.8
Monitoring equipment:	Computer and appropriate analytical software.
QA/QC procedures to be applied:	AGB is a calculated parameter. Input variables (DBH and HT) are checked by independent audit at verification events.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Inventory described fully elsewhere. Field methods and calculations follow CP-AB and BL-PL following techniques described in Pearson et.al. (2005).
Comment:	

Data Unit / Parameter:	ΔC_P
Data unit:	tCO_2e
Description:	Net greenhouse gas emissions within the project area under the project scenario; tCO_2e
Source of data:	Calculated parameter at verification described in Section 8.1.1
Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1.1

Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of project emissions.
Calculation method:	Based on equation in Section 8.1.1
Comment:	

Data Unit / Parameter:	$\Delta C_{pools,Def,u,i,t}$
Data unit:	tCO_2e ha-1
Description:	Net carbon stock changes in all pools in the project case in land use *u* in stratum *i* at time *t*; t CO_2-e ha-1
Source of data:	Remote sensing and inventory data.
Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1.1
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	Ex ante estimation is provided in table form in Section 5.6.
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of project emissions.
Calculation method:	Formula and parameters provided in section 5.6.
Comment:	

Data Unit / Parameter:	$\Delta C_{P,DefPA,i,t}$
Data unit:	tCO_2e
Description:	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* at time *t*; tCO_2e
Source of data:	Remote Sensing
Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1.1
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated

Purpose of Data:	Calculation of project emissions.
Calculation method:	Based on equation in Section 8.1.1
Comment:	

Data Unit / Parameter:	$\Delta C_{P,DefLB,i,t}$
Data unit:	tCO_2e
Description:	Net carbon stock change as a result of deforestation in the project case in the leakage belt in stratum i at time t; t CO_2-e
Source of data:	Remote Sensing and inventory plots.
Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1.1
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of project emissions.
Calculation method:	Based on equation in Section 8.1.1
Comment:	

Data Unit / Parameter:	$A_{DefPA,u,i,t}$
Data unit:	ha
Description:	Area of recorded deforestation in the project area stratum *i* converted to land use *u* at time *t*; ha
Source of data:	Remote Sensing
Description of measurement methods and procedures to be applied:	See remote sensing methods in Monitoring Plan Section 8.1.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of project emissions.
Calculation method:	Based on equation in Section 8.1.1
Comment:	

Data Unit / Parameter:	$A_{DefLB,u,i,t}$
Data unit:	ha
Description:	Area of recorded deforestation in the leakage belt stratum *i* converted to land use *u* at time *t*; ha.
Source of data:	Remote Sensing
Description of measurement methods and procedures to be applied:	See remote sensing methods in Monitoring Plan Section 8.1.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of leakage emissions.
Calculation method:	Based on equation in Section 8.1.1
Comment:	

Data Unit / Parameter:	$\Delta C_{P,DistPA,i,t}$
Data unit:	tCO_2e
Description:	Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum *i* at time *t*; tCO_2e
Source of data:	Remote Sensing
Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of project emissions.
Calculation method:	Based on equation in Section 8.1.1
Comment:	

Data Unit / Parameter:	$GHG_{P-E,i,t}$
Data unit:	tCO_2e
Description:	Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum *i* in year *t*; tCO_2e
Source of data:	Remote Sensing

Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of project emissions.
Calculation method:	Based on equation in Section 8.1.1
Comment:	

Data Unit / Parameter:	$\Delta C_{P,Enh,i,t}$
Data unit:	tCO_2e
Description:	Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline in stratum *i* at time *t*; tCO_2e
Source of data:	Remote sensing and inventory data.
Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of project emissions.
Calculation method:	Based on difference between biomass since baseline reset or previous monitoring period.
Comment:	$\Delta C_{P,Enh,i,t}$ will capture growth in biomass if evident from inventory remeasurement in future monitoring events.

Data Unit / Parameter:	$C_{P,i,t}$
Data unit:	tCO_2e
Description:	Carbon stock in all pools in the project case in stratum *i* at time *t*; t CO_2-e
Source of data:	Remote sensing and inventory data.
Description of measurement methods and	Calculated parameter. See equations in Section 8.1

procedures to be applied:	
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Calculated
QA/QC procedures to be applied:	Calculated
Purpose of Data:	Calculation of project emissions.
Calculation method:	Equation and parameters described in Section 8.1.
Comment:	

Data Unit / Parameter:	$A_{distPA,q,I,t}$
Data unit:	Ha
Description:	Area impacted by natural disturbance in the project stratum i converted to natural disturbance stratum q at time t; ha *(if any occurs)*
Source of data:	Remote Sensing imagery combined with ground verification or GPS coordinates. Minimum monitoring unit shall be equal to a minimum of 11 Landsat pixels or one hectare.
Description of measurement methods and procedures to be applied:	Head's up delineation using GIS and landsat imagery (or higher resolution) using multiple images to get a cloud free image.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied:	0
Monitoring equipment:	Computer and appropriate analytical software. Field equipment for plot measurements and GPS for ground level confirmation.
QA/QC procedures to be applied:	Remeasurement of permanent plots.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Head's up delineation using GIS and landsat imagery (or higher resolution) using multiple images to get a cloud free image.
Comment:	

Data Unit / Parameter:	$C_{AB\_tree,i}$
Data unit:	tCO_2e ha-1
Description:	Carbon stock in aboveground biomass in trees in the project case in stratum *i.*
Source of data:	Field measurements applied with allometric equation published in Pearson et. al. (2005)
Description of measurement methods and procedures to be applied:	See field methods section.

Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	See Table 11 for baseline values.
Monitoring equipment:	Computer and spreadsheet software. Additional equipment required for field data collection.
QA/QC procedures to be applied:	Independent 3rd party audit of field measurements utilizing remeasurement of a sample of plots.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Calculation method follows Pearson et. al. 2005.
Comment:	Key variable used to calculate with project carbon stocks

Data Unit / Parameter:	$C_{BB\_tree,i,}$
Data unit:	tCO_2e ha-1
Description:	Carbon stock in belowground biomass in trees in the project case in stratum *i.*
Source of data:	Field measurements applied with root to shoot equation
Description of measurement methods and procedures to be applied:	See field methods section.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	See Table 11 for baseline values.
Monitoring equipment:	Computer and spreadsheet software. Additional equipment required for field data collection.
QA/QC procedures to be applied:	Independent 3rd party audit of field measurements utilizing remeasurement of a sample of plots.
Purpose of Data:	Calculation of project emissions.
Calculation method:	For belowground biomass, the root-to-shoot ratios indicated in the methodology CP-AB was used which results in a ratio of .24 for plots indicating a mean aboveground biomass of 125 tons/ha or greater and a ratio of .2 for plots indicating a mean aboveground biomass of less than 125 tons/ha.
Comment:	Key variable used to calculate with project carbon stocks

Data Unit / Parameter:	A_{sp}
Data unit:	ha
Description:	Area of sample plots in ha
Source of data:	Recording and archiving of number and size of sample plots
Description of measurement methods and procedures to be applied:	Per field technique (Pearson et. al. 2005). Plot areas (diameter) are measured at each plot at each inventory. Inventory remeasurement is required at baseline renewal.
Frequency of monitoring/recording:	Verification plan calls for reinventory no less frequently than every five years. QA/QC is addressed by periodic third party verification audits.

Value applied:	40 nested plots. Each plot consists of three fixed radius plots 4 m, 14 m, and 20 m. Subplot area based on ($\pi * r^2$) is .005024 ha for the 4m plot, .061544 ha for the 14m plot, and .1256 ha for the 20 m plot.
Monitoring equipment:	Tape measure or similar device
QA/QC procedures to be applied:	Plot diameters are independently confirmed at verification audits.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Direct measurement of plot radius. Area = pi * $radius^2$
Comment:	

Data Unit / Parameter:	*N*
Data unit:	unitless
Description:	Number of sample points
Source of data:	Recording and archiving of number and size of sample plots
Description of measurement methods and procedures to be applied:	Direct count.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	40
Monitoring equipment:	None required
QA/QC procedures to be applied:	QA/QC is addressed by periodic third party verification audits. Based on the field inventory variability, the number of plots is considered adequate using module X-UNC.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Based on power analysis conducted on data from Cho (2007) by Teets et. al. (2012).
Comment:	The number and location of plots may change in the future if a plot location becomes unreachable or hazardous to field crews. Justification for any changes must be documented and explained.

Data Unit / Parameter:	$Ht_{,tree,i,}$
Data unit:	Meters
Description:	Height of the tree from the ground
Source of data:	Field measurements
Description of measurement methods and procedures to be applied:	See procedures for measurement in the monitoring plan (Section 8.1).
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	See database of tree measurements.
Monitoring equipment:	Clinometer, tape, or equivalent

QA/QC procedures to be applied:	A subset of heights are remeasured at verification audits.
Purpose of Data:	Calculation of project emissions.
Calculation method:	See field methods section of monitoring plan. Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Comment:	This variable is collected, but not necessary for allometric equation used. This variable is used to validate the allometric equation.

Data Unit / Parameter:	$DBH_{,tree,i,}$
Data unit:	Cm
Description:	Diameter at 1.3 meters above the ground of each tree on each plot.
Source of data:	Field measurements
Description of measurement methods and procedures to be applied:	See procedures for measurement in the monitoring plan (Section 8.1).
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	See database of baseline tree measurements.
Monitoring equipment:	Diameter tape incremented in centimeters. Measuring tape to determine inclusion of trees on plots. GPS to navigate to permanent plots.
QA/QC procedures to be applied:	Independent 3rd party audit of field measurements utilizing remeasurement of a sample of plots. Field observation sheets will include DBH of each tagged tree for evaluation of reasonableness of measurement based on feasible growth rate.
Purpose of Data:	Calculation of project emissions.
Calculation method:	Direct observation.
Comment:	Key variable used to calculate with project carbon stocks

Data Unit / Parameter:	$\Delta C_{LK\text{-}AS,planned,E,i,t}$
Data unit:	tCO_2e
Description:	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation; tCO_2e
Source of data:	Calculated from $LKA_{planned,i,t}$, $\Delta C_{BSL,I,}$ and $GHG_{LK,E,i,t}$ per formula in LK-ASP
Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Remote sensing

QA/QC procedures to be applied:	Confirmation by interpretation of high resolution image such as Rapid Eye.
Purpose of Data:	Calculation of leakage emissions.
Calculation method:	Method for preprocessing, and analysis described in monitoring plan.
Comment:	

Data Unit / Parameter:	$LKA_{planned,i,t}$
Data unit:	ha
Description:	The area of activity shifting leakage in stratum i at time t; ha
Source of data:	Remote sensing.
Description of measurement methods and procedures to be applied:	Head’s up delineation using GIS and landsat imagery (or higher resolution) using multiple images to get a cloud free image.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Remote sensing
QA/QC procedures to be applied:	Confirmation by interpretation of high resolution image such as Rapid Eye.
Purpose of Data:	Calculation of leakage emissions.
Calculation method:	Method for preprocessing, and analysis described in monitoring plan.
Comment:	

Data Unit / Parameter:	$GHG_{LK,E,i,t}$
Data unit:	tCO_2e
Description:	Greenhouse gas emissions as a result of leakage of avoiding deforestation activities in stratum i in year t (tCO_2e)
Source of data:	Summation of emissions from biomass burning. Area data for biomass burning derived from remote sensing.
Description of measurement methods and procedures to be applied:	Calculated parameter. See equations in Section 8.1
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	0
Monitoring equipment:	Remote sensing
QA/QC procedures to be applied:	Based on area and biomass estimates developed in other parameters.
Purpose of Data:	Calculation of leakage emissions.
Calculation method:	As indicated in methodology module LK-ASP.
Comment:	

Data Unit / Parameter:	*Species List*
Data unit:	Species
Description:	List of detected species known to occur on the site.
Source of data:	Pictures, acoustic recordings, tracks, observations by trained observers.
Description of measurement methods and procedures to be applied:	Observations made at CCB verification audit events using remote cameras, acoustic recordings, and transects. Anecdotal observations recorded during normal operations of project.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	Presence/Absence
Monitoring equipment:	Remotely triggered cameras, binoculars, camera.
QA/QC procedures to be applied:	None required.
Purpose of Data:	Monitoring biodiversity on project area.
Calculation method:	No calculation required.
Comment:	

Data Unit / Parameter:	*Contributions to Gallon Jug-Chan Chich High School Scholarship Fund*
Data unit:	BZ dollars
Description:	Documentation of donations.
Source of data:	Written receipts.
Description of measurement methods and procedures to be applied:	Recording the receipts will indicate compliance with the CCB community benefits plan.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	ex ante BZ$10,000/year
Monitoring equipment:	None required.
QA/QC procedures to be applied:	None required.
Purpose of Data:	Monitor community benefits plan.
Calculation method:	Simple sum of contributions.
Comment:	

Data Unit / Parameter:	*Observations of biodiversity species s at time t and location l*
Data unit:	observation
Description:	Observations of biodiversity

Source of data:	Based on camera traps or anecdotal observations (visual, auditory, or tracks) by field crews.
Description of measurement methods and procedures to be applied:	Observations made at CCB verification audit events using remote cameras, acoustic recordings, and transects. Anecdotal observations recorded during normal operations of project.
Frequency of monitoring/recording:	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied:	Presumption is that current list of animal species will continue to occur at the project ex ante throughout the life of the project.
Monitoring equipment:	Remotely triggered cameras, binoculars, camera.
QA/QC procedures to be applied:	Observations without documentary evidence should only be recorded if observer is qualified and experienced.
Purpose of Data:	To provide updates to Species List.
Calculation method:	None required.
Comment:	

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APPENDIX A: LAND COVER MAPPING

Develop and Update Geospatial Data to Support the Laguna Seca Forest Carbon Offset Project

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1.0 Background

As part of an ongoing effort, The Conservation Management Institute at Virginia Tech (CMIVT) was tasked with developing geospatial data and map products to support Laguna Seca forest carbon offset project in Belize. The project is being certified under Verified Carbon Standard (VCS) methodology VM0007. Geospatial analysis and map product creation followed guidelines and recommendations contained in the GOFC-GOLD Sourcebook (2014) unless otherwise noted. The following detailed information outlines the materials, methods, and parameters used to complete the mapping.

2.0 Image Acquisition and Processing

2.1 Imagery Selection

Landsat sensors were used in geospatial analysis and to create landcover maps for the project. The medium resolution imagery provided by landsat sensors is commonly used to map deforestation and estimate area change and widely recognized as a cost effective and accurate image source for mid-resolution data analysis. The primary Landsat images used were: LANDSAT 8 2013 Julian Day 219, LANDSAT 7 2013 Julian Day 83, LANDSAT 7 2011 Julian Day 14, and LANDSAT 7 GLS 2010. Ancillary Landsat images included: LANDSAT 8 2014 Julian Day 350 and LANDSAT 7 GLS 2000. All Landsat 7 ETM+, 30 meter and Landsat 8 OLI, 30 meter imagery were downloaded from the United States Geologic Survey's Global Visualization Viewer (GloVis) (http://glovis.usgs.gov).

Rapideye imagery was used to assess the accuracy of the landcover maps and is considered an appropriate tool for '"ground-truthing" the interpretation of satellite imagery and for assessing the accuracy. The two Rapideye images (March 30, 2011 and March 22, 2013), both 5-band images with five meter resolution, were used to assess accuracy. Both images were obtained directly from the vendor.

2.2 Image Preprocessing

Preprocessing should include the following three steps: geometric corrections, cloud removal, and radiometric corrections. Since we employed a visual interpretation method (see below), we determined radiometric corrections would provide little additional benefit and given that '*For simple scene by scene analysis (e.g. visual interpretation), the radiometric effects of topography and atmosphere should be considered in the interpretation process but do not need to be digitally normalized' (Sourcebook 2014)*.

Thus we determined that foregoing this step would have no impact on the map products or resulting geospatial analysis. Employing visual interpretation techniques also allowed for cloud coverage to be effectively handled as part of the interpretation process. Sections 3.1 and 3.2 provide further discussion of visual interpretation methods as well as techniques used to mitigate cloud coverage.

We performed geometric corrections on all Landsat images and referenced to the Landsat GLS 2010 as a baseline. CMIVT analysts completed the georectification in ArcGIS 10.1 with the 'Georeferencing' toolbar using the '*Adjust*' transformation to resample using cubic convolution. Rectification followed all relevant industry standards described in the GEO GOFI Guidance (2014). RMSE was calculated for each image and were well within the recommended Sourcebook (2014) error of less than 1 pixel (30 meters in this case). RMSE (in meters) for each image:

Mapping Imagery:

- LANDSAT 8 2013 Julian Day 219 – RMS Forward: 4.50439
- LANDSAT 7 2013 Julian Day 83 – RMS Forward: 1.91068
- LANDSAT 7 2011 Julian Day 14 – RMS Forward: 1.91511

Historic and Ancillary Imagery:

- LANDSAT 7 GLS 2000 – RMS Forward: 2.2772
- LANDSAT 8 2014 Julian Day 350 – RMS Forward: 8.28421

Georectification Reference Image:

- LANDSAT 7 GLS 2010 (also used to map 2011 landcover)

2.3 Landcover Classification

Image classification consisted of seven categories: Forest, Bajo (i.e. wet forest), Cropland, Grassland, Settlements, Wetland, and Other based off the Sourcebook (2014), Table 1.2.1 with a MMU of 1 hectare. Because the project area was relatively small, and mapping was accomplished through visual interpretation, a wall-to-wall mapping strategy was employed as it was practical and the most suitable method for the project.

3.0 Analysis and Methods

The minimum requirements for image interpretation as described in the Sourcebook (2014) are: '*Geo-location accuracy < 1 pixel, i.e. < 30m, Minimum mapping unit should be between 1 and 6 ha, A consistency assessment should be carried out'.*

3.1 Image Interpretation

CMIVT performed a full visual delineation of the project area using Landsat. All digitization was performed at an approximate scale of 1:15,000 by an experienced photo-interpreter (PI) familiar with satellite imagery applications, photo-interpretation and possessing *a priori* knowledge of land use/land cover in the area. We used the band combination of 5,4,2 (short-wave infrared, near infrared, green). Subject Matter Experts possessing significant field experience on the Gallon Jug property also provided input and assistance during the mapping process. Upon completion of the initial map, final review and quality control was performed by senior staff per CMIVT organizational standard operating procedures before the validation and accuracy assessment step.

3.2 Approach

Because the Landsat 8 image from 2014 was the most cloud free, we used it to create an initial landcover map using photo-interpretive digitization of multi-date imagery, on-screen, using ArcGIS 10.1 software. We subsequently referenced the Landsat 7, 2011 (cloud-free, with striping due to SLC off) as well as the GLS 2010 (stripe free, to fill in Landsat 7 gaps) to create the 2011 landcover map and a record of change between 2011 and 2014.

As none of the available 2013 Landsat images were cloud free, a multi-date approach was used to identify specifically when these landcover changes occurred. By referencing each 2013 image in turn, analysts identified cloud free areas for all targeted changes in 2013 and could determine if changes were pre or post monitoring period (i.e., between 2011 and 2013 or later). In doing so, a change detection map for the project and subsequently a full 2013 landcover map were created. Thus, the 2014 land cover was ultimately no longer referenced or relevant and was eliminated from further analysis. The above approach was also applied to create the historic Forest/Non-Forest layer displayed in the Historic map with GLS 2000 imagery.

3.3 Forest Change

For this project, detection of forest change was incorporated into the original mapping process (see section 3.2). Following the Sourcebook (2014), a direct visual interpretation of images was employed as opposed to a post-hoc analysis of landcover maps

3.4 Accuracy Assessment

We conducted an accuracy assessment on all project area land cover and leakage area land cover maps following industry standards and applicable practices as described in Congalton (1991) and GFOI (2013). Using the specific land cover layer, random points were created for each cover class. Points were created and allocated using the Create Random Points tool in ArcGIS 10.1 with the following parameters: 75 points for forest class and 50 points each for other classes with a point separation of 250 meters. Points within 15 meters of a boundary were removed to eliminate confusion during the accuracy assessment. For those classes covering a very small percentage of the total area, 50 points often could not be allocated. In these case the maximum number of points were allocated according to the parameters above.

A subject matter expert (based on education, experience, and on-the-ground familiarity with the project area) classified all points using Rapid Eye high resolution imagery from the respective mapping year, after which the points were intersected with the land cover layer to calculate accuracy.

Table A1: Project Area 2011 Accuracy Assessment

	Bajo	Forest	Other	Wetland	**Total**	*User Accuracy*
Bajo	28	3			31	90.3%
Forest		68			68	100.0%
Other			1		1	100.0%
Wetland	2			1	3	33.3%
Total	30	71	1	1	103	
Producer's Accuracy	93.3%	95.8%	100.0%	100.0%		95.1%

Table A2: Leakage Area 2011 Accuracy Assessment

Land Use	Bajo	Crop land	Forest	Grass -land	Other	Settle-ments	Wetland	**Total**	*User Accuracy*
Bajo	45							45	100.0%
Cropland		2		6				8	25.0%
Forest	2		73					75	97.3%
Grassland				12		1		13	92.3%
Other					1			1	100.0%
Settle-ments			1			7		8	87.5%
Wetland							50	50	100.0%
Total	47	2	74	18	1	8	50	200	
Producer's Accuracy	95.7%	100.0%	98.6%	66.7%	100.0%	87.5%	100.0%		95.0%

Table A3: Project Area 2013 Accuracy Assessment

Landcover Class	Bajo	Forest	Other	Wetland	Grand Total	User Accuracy
Bajo	18	4		1	23	78.3%
Forest	4	71			75	94.7%
Other			1		1	100.0%
Wetland				1	1	100.0%
Grand Total	22	75	1	2	100	
Producer Accuracy	81.8%	94.7%	100.0%	50.0%		
						Total Accuracy: 91.0%

Table A4: Leakage Area 2013 2013 Accuracy Assessment

Land Use	Bajo	Crop land	Forest	Grass-land	Other	Settle-ments	Wetland	**Total**	*User Accuracy*
Bajo	38		1					39	97.4%
Cropland		1		3				4	25.0%
Forest	9		73	1				83	88.0%
Grassland		1		10				11	90.9%
Other					1			1	100.0%
Settlements						5		5	100.0%
Wetland							49	49	100.0%
Grand Total	47	2	74	14	1	5	49	192	
Producer Accuracy	80.9%	50.0%	98.7%	71.44%	100.0%	100.0%	100.0%		
									Total Accuracy : 92.2%

4.0 Deliverables

The deliverables for this project include tables, geospatial data, and maps.

4.1 Tables

Land cover area for both the project area and leakage area and their associated accuracy assessments are provided in the XL workbook “*Laguna _Seca_data_Tables_20150520 version 1* “ in individual worksheets.

4.2 Maps

The following maps are provided as JPEG attachments to support the Laguna Seca Forest Carbon Project (Table A5).

Table A5: Map products developed in support of the Laguna Seca Forest Carbon project.

Maps	**Descriptions**	**Validation or Verification or Both**
General Boundaries	General map displaying the Project Area, know as the Lower Wamil, and the Leakage Area within the historic Gallon Jug Property.	Both
Lower Wamil Landcover 2011	Land cover of the Project Area as of 2011 (benchmark period).	Both
Lower Wamil Landcover 2013	Land cover of the Project Area as of 2013 (monitoring period).	Verification
Leakage Area Landcover 2011	Land cover of the Leakage Area as of 2011, separated by the specified cover classes.	Both
Leakage Area Landcover 2013	Land cover of the Leakage Area as of 2013, separated by the specified cover classes.	Verification
Landcover Change	Displaying the Project Area land covers from 2011 and 2013 and that the area had remained unchanged.	Verification
Historic Landcover	Displays the Forest/Non Forest cover of the entire Historic Gallon Jug Property 10 years prior to start of the project.	Validation
Regional	Location of the Historic Gallon Jug Property in relation to the country of Belize and in Central America.	Both
Plot Points	Forest plot locations and in which land cover class they reside in the Project Area.	Both

4.3 Geospatial Data

The following geospatial data were created as to support the Laguna Seca Forest Carbon Project (Table A4).

Table A6: Map products developed in support of the Laguna Seca Forest Carbon project.

Spatial	**Description**	**Validation or Verification or Both**
Accuracy Assessment Project Area 2011	Random points created based on the 2011 Land cover layer to perform the Accuracy Assessment.	Both
Accuracy Assessment Project Area 2013	Random points created based on the 2013 Land cover layer to perform the Accuracy Assessment.	Verification
Lower Wamil Landcover 2011	Polygon layers distinguishing land cover of the Project Area in 2011 according to the specified cover classes.	Both
Lower Wamil Landcover 2013	Polygon layers distinguishing land cover of the Project Area in 2013 according to the specified cover classes.	Verification
Leakage Area Landcover 2011	Polygon layers distinguishing land cover of the Leakage Area in 2011 according to the specified cover classes.	Both
Leakage Area Landcover 2013	Polygon layers distinguishing land cover of the Leakage Area in 2013 according to the specified cover classes.	Verification
Historic Property Area	Polygon layer classifying the Forest and Non Forest areas in the Historic Gallon Jug Property a decade before the start of the project.	Both
Wetland Buffers	A single chain (66 feet) buffer surrounding all wetlands.	Both
Lower Wamil Project Area	Boundary of the Lower Wamil, henceforth known as the Project Area.	Both

Leakage Area	Part of the Historic Gallon Jug Property that is not within the Lower Wamil, and known henceforth as the Leakage Area.	Both
Plot Points	Forest plot locations where measurements were conducted within the Project Area (the Lower Wamil).	Both

Citations

Congalton, R.G. 1991. A review of assessing the accuracy of classifications of remotely sensed data. Remote Sensing of Environment. 37:35-46.

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